Intro to CXR for Non-Radiologists

Introduction to CXRs — For Non-Radiologists

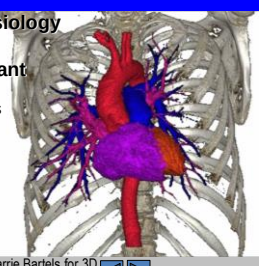
Objectives

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Review anatomy & physiology of the heart & lungs.

Understand the significant differences between:
- Upright PA and lateral views
- Portable supine AP view

Recognize common abnormalities:
- Pneumothorax
- Pleural Effusion
- Pneumonia
- Pulmonary Edema



Thanks to Carrie Bartels for 3D processing and segmentation!

Introduction to CXRs — For Non-Radiologists

Disclaimer

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Pul.Edema
WOW

I am *not* Chest Radiologist
- This is my first CXR lecture

I *do* read CXRs daily
- Mostly from the ER

Reading CXR is something all radiologists should be able to do

Looking at CXR something ALL health care providers should be willing to do

Introduction to CXRs — For Non-Radiologists

Terminology: "Chest" X-Ray (CXR)

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X-Rays pass thru entire chest
- Superficial tissues
  - ✓Skin, breasts, sub-q fat
- Muscles
  - ✓Intercostals
- Bones
  - ✓Ribs, sternum, spine
- Heart & Mediastinum
  - ✓Trachea, Vessels, …
- Lungs
  - ✓*mostly air*

Introduction to CXRs — For Non-Radiologists

Terminology: Chest "X-Ray" (CXR)

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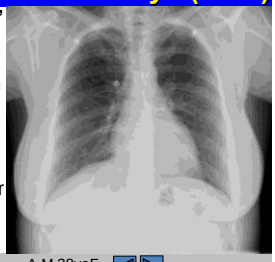
This is a "Radiograph"

Recall, "X-Rays" are:
- EM Spectrum energy
  - ✓Very short wavelength
    - ❖About size of an atom
  - ✓Man-made
- Emitted by a tube…
- …pass thru patient…
- …into a x-ray detector
  - ✓Film (old school)
  - ✓CR plate
  - ✓DR unit



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Introduction to CXRs — For Non-Radiologists

Radiographs Only Detect 4 Densities

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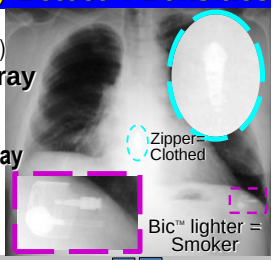
Air = Black
- Lungs (Air-filled alveoli)

Soft Tissues = Gray
- Superficial tissues
- Heart, Mediastinum

Bones = Lighter Gray
- Ribs, Spine

Metal = White
- Outside/Inside patient



Convention: We look at CXR like we look at Pt… Face-to-Face

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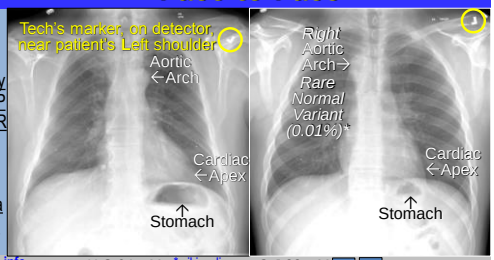

H,C 64yoM *wikipedia.org Q,J 23yoM

Intro to CXR for Non-Radiologists

Introduction to CXRs — For Non-Radiologists

PowerPoint Model: Lungs

- Physiology
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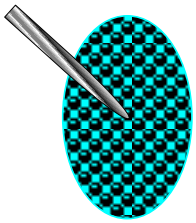
Bag of air
- Inhale: Fills
- Exhale: Empties (not completely)

Pipes
- Bronchus
  - ✓Gr: *"windpipe"*



Introduction to CXRs — For Non-Radiologists

PowerPoint Model: Lungs

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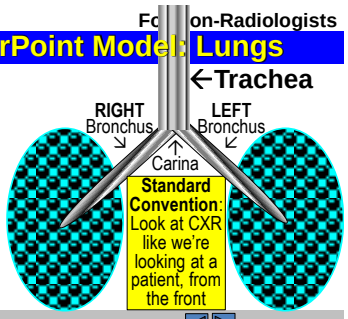
2 Lungs

3 Pipes
- **2 Bronchi**
  - "Main Stem Bronchi" Stem off Main Pipe:
- **1 Trachea**
- Meet at **Carina**

←Trachea



Introduction to CXRs — For Non-Radiologists

How Do The Lungs Work?

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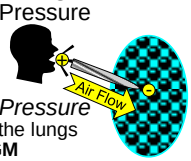
The lungs don't "work" (just bags of air)

Lungs inflate *passively* in response to pressure gradients
- Carina Pressure > Lung Pressure
  - ✓Rescue Breathing
  - ✓On a ventilator Tracheal Tube
- *Lung Pressure < Carina Pressure*
  - ✓Negative pressure outside the lungs
  - ✓Created by the **DIAPHRAGM**



Introduction to CXRs — For Non-Radiologists

Thought Experiment

- Physiology
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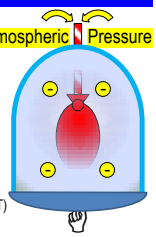
Balloon tied to a Straw Sealed inside glass jar
- Only way air gets into balloon is via end of straw outside jar
- Jar has sealed rubber bottom

Pulling down on bottom…
- Increases size of sealed jar
- Decreases pressure in jar (PV=nrT)
  - ✓Jar Pressure < Atmospheric
  - ✓Balloon Inflates!



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Lungs Work The Same

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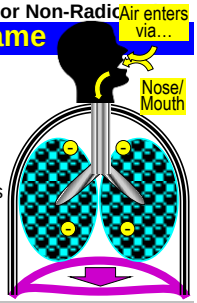
2 Lungs (bags of air)
Tracheobronchial tree
Sealed within Thorax
- Chest Wall (layers)
  - ✓Skin/Sub-Q
  - ✓Ribs, Intercostal A/N/Muscles
  - ✓Inner Pleural Lining
- Diaphragm – Domed
  - ✓When it contracts it flattens
    - ❖Increases intra-thoracic volume
    - ❖Decreases intra-pleural pressure



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Lungs Fill Pleural Space

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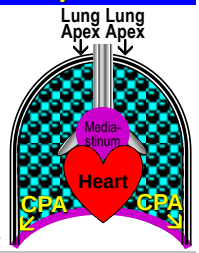
Not much in Thorax
- Lungs: Fill the Thorax
  - ✓From Apices
  - ✓Costo-Phrenic Angle (CPA)
    - ❖"Costo": Ribs
    - ❖"Phrenic": Diaphragm
- Tracheobronchial Tree
  - ✓Bronchioles branch off
- Heart
- Vessels (Mediastinum)
  - ✓Connect lungs to heart
  - ✓Connect heart to whole body



Intro to CXR for Non-Radiologists

Introduction to CXRs — For Non-Radiologists

Gas Exchange

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All human cells require O_2, emit CO_2

Red Blood Cells (RBC) transport gas

- Hemoglobin molecule (Hgb)

Occurs at capillaries

- Diameter = 1 RBC (5µm)
- Walls: Very thin, semipermeable membranes
- Permits Diffusion of gasses

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Introduction to CXRs — For Non-Radiologists

Diffusion

- Physiology
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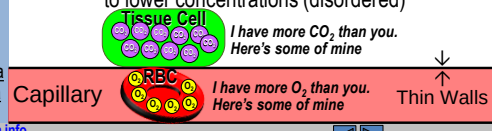
Way of moving things for free (No energy expense)

Related to a Fundamental Force: Entropy

- Things become disorderly
  - ✓It takes a lot less energy to knock down Jenga tower…

Diffusion: Things move from high concentration (ordered) to lower concentrations (disordered)



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Introduction to CXRs — For Non-Radiologists

Gas Exchange: Alveoli

- Physiology
- Anatomy
- ↑PA&Lat.
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***alveolus* [L]:**

- "little cavity"

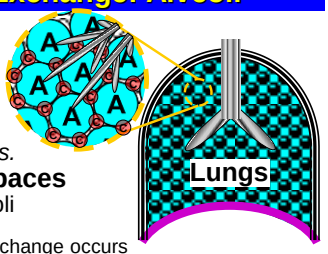
Air sacs

Bronchioles

Looks like bunch of grapes.

Interstitial spaces

- Outside alveoli
  - ✓Capillaries
  - ✓Where gas exchange occurs



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Introduction to CXRs — For Non-Radiologists

Gas Exchange: Alveoli

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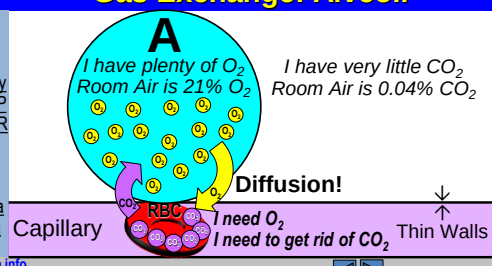

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Introduction to CXRs — For Non-Radiologists

Circulatory System

- Physiology
- Anatomy
- ↑PA&Lat.
- DualEnergy
- ↗PortableAP
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- Normal
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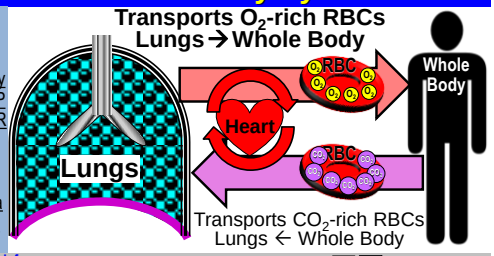
- Pul.Edema
- WOW

Transports O_2-rich RBCs
Lungs → Whole Body



Transports CO_2-rich RBCs
Lungs ← Whole Body

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Introduction to CXRs — For Non-Radiologists

The Heart: 4 Chambers

- Physiology
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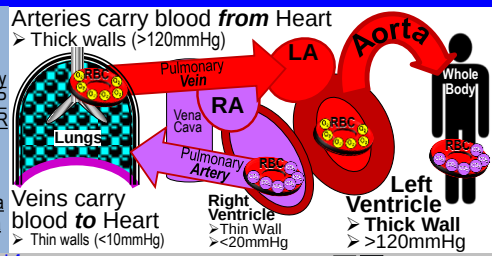
- WOW

Arteries carry blood ***from*** Heart

- Thick walls (>120mmHg)



Veins carry blood ***to*** Heart

- Thin walls (<10mmHg)

Right Ventricle
- Thin Wall
- <20mmHg

Left Ventricle
- **Thick Wall**
- >120mmHg

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Intro to CXR for Non-Radiologists

Introduction to CXRs — For Non-Radiologists

Cardio-Pulmonary System

Physiology
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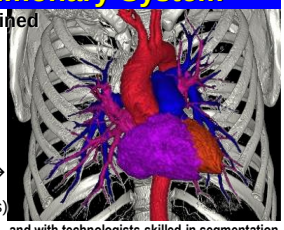
WOW

Heart & Lungs intertwined
- also vessels, bronchi

Anatomy of blood filled structures can be well demonstrated with CT-Angiography
- CT obtained immediately after IV contrast bolus →
- Basic 3D processing… →
- All blood/contrast filled structures (heart, vessels) have same density…
- Similar to bone density



and with technologists skilled in segmentation processing we can add artificial colors!

Introduction to CXRs — For Non-Radiologists

Left Ventricle (LV)

Physiology
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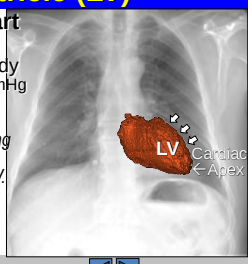
WOW

Workhorse of the heart
- Thick muscular wall
- Pump blood → entire body
  - ✓Generate pressure >120mmHg
  - ✓5½ FEET of H_2O!
- *It doesn't look like much here because this is a CTA, showing only the contrast in the blood INSIDE the chamber of the LV.*

Radiograph – LV:
- left cardiac border
- cardiac apex



Introduction to CXRs — For Non-Radiologists

Red Blood: LV → Aorta → Body

Physiology
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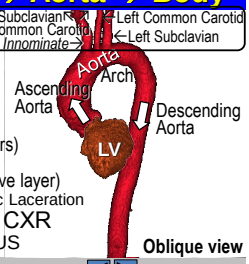
WOW

Great Vessels: Right Subclavian, Right Common Carotid, *Innominate*, Left Common Carotid, Left Subclavian

Aorta
- Thick wall, 3 layers
  - ✓*Intima* (inner layer)
    - ❖Tear → Dissection
  - ✓*Media* (muscle, elastic fibers)
    - ❖Tear → Aneurysm
  - ✓*Adventitia* (outer, supportive layer)
    - ❖Tear ALL THREE → Aortic Laceration
- Can't see of this with CXR
  - ✓Need to use: CT, MR, US



Oblique view

Introduction to CXRs — For Non-Radiologists

Blue Blood: Body → RA → RV → PulArt

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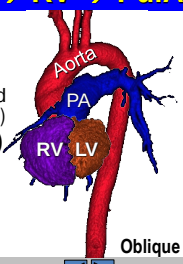
Right Ventricle (RV)
- Wraps around LV
- Thin muscular wall
  - ✓Only needs to pump blood to adjacent lungs (20mmHg)

Pulmonary Artery (PA)
- Carries blood from RV to both lungs
- Only artery to carry deoxygenated blood



Oblique view

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Blue Blood: Body → RA → RV → PulArt

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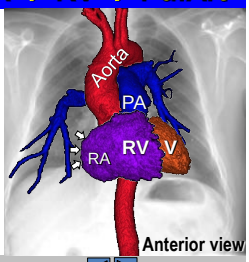
Right Atrium (RA)
- Forms right heart border on CXR

Right Ventricle (RV)
- Wraps around LV
- Does not contribute to heart shadow on frontal radiograph



Anterior view

Introduction to CXRs — For Non-Radiologists

Cardio-Pulmonary System

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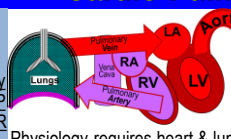


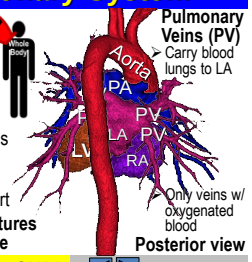
Physiology requires heart & lungs work together

Anatomy places heart & lungs adjacent so PA & PV can be short

A lot of air & blood filled structures in the tight intra-thoracic space

There's a lot to look at on CXR!

Pulmonary Veins (PV)
- Carry blood lungs to LA



Only veins w/ oxygenated blood

Posterior view

Intro to CXR for Non-Radiologists

Introduction to CXRs — For Non-Radiologists

Upright PA Chest Radiograph

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WOW

Standing Upright
- ➢*This is a big deal*
- ➢Permits full lung inflation
  - ✓Can't fully inflate laying/sitting
- ➢Makes use of gravity
  - ✓More blood flows ↘ bases
  - ✓Pleural effusions ↘ CP angles
  - ✓Pneumothoraces ↗ apices
- ➢Pulls scapulae away
  - ✓Patient hugs detector

Marty age 13

Introduction to CXRs — For Non-Radiologists

Upright *PA* Chest Radiograph

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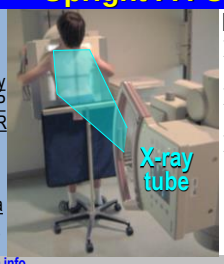

PA is Standard
- ➢X-rays enter *Posteriorly,* X-rays exit *Anteriorly*
- ➢Hence X-rays travel Posterior→Anterior,"PA"
- ➢**Detector is Anterior**
  - ✓Allows patient to abduct scapulae away from chest
  - ✓***Minimizes heart magnification***

Introduction to CXRs — For Non-Radiologists

Shadow-graphic Magnification

Physiology
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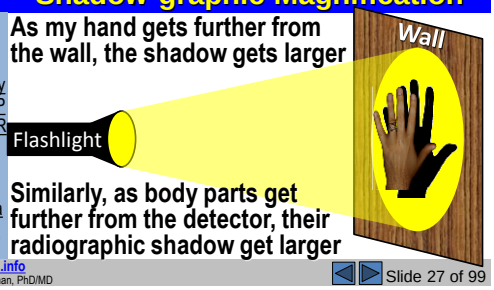
WOW



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Radiographic Magnification

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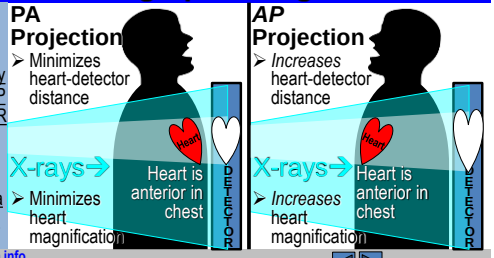
WOW



Introduction to CXRs — For Non-Radiologists

PA CXR is Backward

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Anatomy
↑PA&Lat.
DualEnergy
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Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

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Introduction to CXRs — For Non-Radiologists

Importance of Scapular Abduction

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
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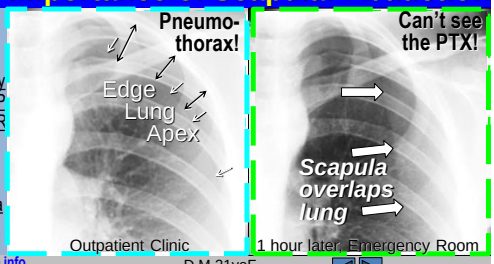
Pneumonia
Pul.Edema
WOW



D,M 21yoF

Intro to CXR for Non-Radiologists

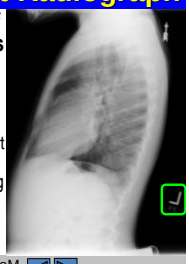
Introduction to CXRs — For Non-Radiologists

Upright Lateral Chest Radiograph

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Importance of multiple views

- Pt standing
  - ✓Lungs inflated
- Left side next to the detector
  - ✓Minimize heart magnification
- Tradition: Hung backwards
- **Arms Elevated!**



S,M 8yoM

Introduction to CXRs — For Non-Radiologists

Importance of Arm Elevation

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Initial Lateral View

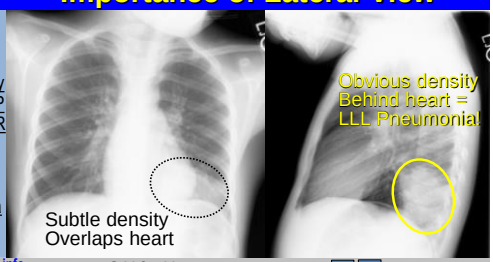
Repeat Lateral View

D,R 37yoM

Introduction to CXRs — For Non-Radiologists

Importance of Lateral View

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



S,M 8yoM

Introduction to CXRs — For Non-Radiologists

CXR is *NOT* a Simple Exam

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Requires patient able to:

- Stand upright
  - ✗Sitting in a chair is not the same
  - ✗Propped up on a cart, not the same
- Elevate their arms, abduct scapulae
- Take in a big breath, hold it 1 second

Requires technologist to:

- Make sure patient is optimally positioned
- Look at images to access optimal quality
  - ✓Repeat images as needed

Introduction to CXRs — For Non-Radiologists

Dual Energy CXR: Separate Lungs/Bones

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

The lungs are hard to see on CXR as they are nearly radiolucent, compared to the overlying bones which are relatively radiopaque. Wouldn't it be nice if we could remove calcified ribs on a CXR… generating a 2nd CXR of the lungs without the overlying ribs… and even generate a 3rd CXR showing just calcified structures!

At UW, our standard PA CXR is Dual Energy
Requires investment in dedicated DR unit

S,J 58yoM

Introduction to CXRs — For Non-Radiologists

Digital Radiography

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

CR (Computed Radiography)

- Similar to old-fashioned film radiography
  - ✓Technologist places a cassette under the patent
    - ❖Contains photostimulable phosphor plate, rather than film
  - ✓Runs cassette through IIP (Image Information Processor)
    - ❖Laser scanner, rather than darkroom chemical developer
- Used for bones, abdomen, portables

DR (Direct Radiography)

- Similar to modern digital camera
  - ✓Captures directly to image detector, no cassette
  - ✓Can take 2 images, rapidly, at 2 energies (DE)

Intro to CXR for Non-Radiologists

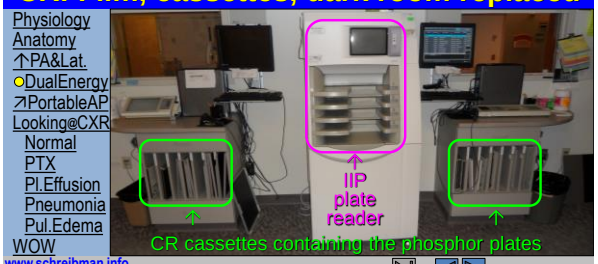
Introduction to CXRs — For Non-Radiologists

CR: Can use old film equipment

Slide 37 of 99

Introduction to CXRs — For Non-Radiologists

CR: Film, cassettes, dark room replaced



Slide 38 of 99

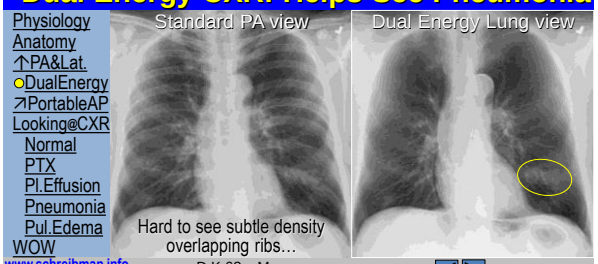
Introduction to CXRs — For Non-Radiologists

DR: Requires all new equipment

Slide 39 of 99

Introduction to CXRs — For Non-Radiologists

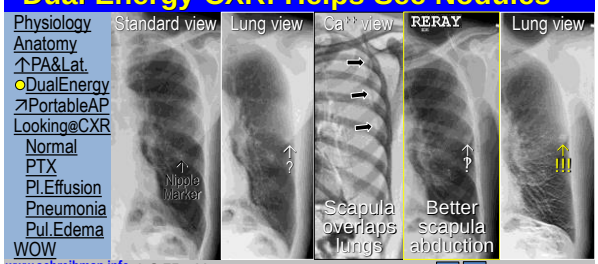
Dual Energy CXR: Helps See Pneumonia



Slide 40 of 99

Introduction to CXRs — For Non-Radiologists

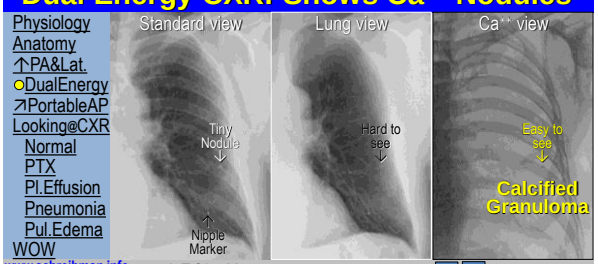
Dual Energy CXR: Helps See Nodules



Slide 41 of 99

Introduction to CXRs — For Non-Radiologists

Dual Energy CXR: Shows Ca++ Nodules



Slide 42 of 99

Intro to CXR for Non-Radiologists

Introduction to CXRs — For Non-Radiologists

Portable Supine AP CXR

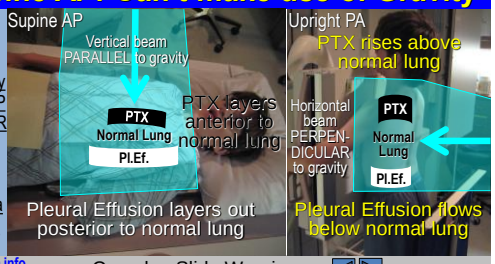
Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Used in cases when patient cannot stand for upright PA & Lateral views

Introduction to CXRs — For Non-Radiologists

Supine AP: Can't make use of Gravity

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



Complex Slide Warning

Introduction to CXRs — For Non-Radiologists

Problems with Supine AP vs PA

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

X-ray beam not perpendicular to gravity
- Hard to see PTX air rising anteriorly
- Hard to see pleural effusions layering out posteriorly
- Hard to assess increased blood flow to upper lobes

Lungs never well inflated

No lateral view

No dual energy

Hard to abduct scapulae

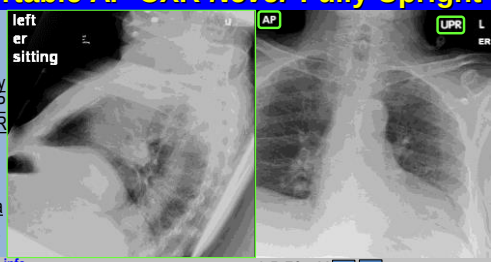
Heart is magnified
- Harder to assess heart size (cardiomegaly)

Second only text slide

Introduction to CXRs — For Non-Radiologists

Portable AP CXR *Never* Fully Upright

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

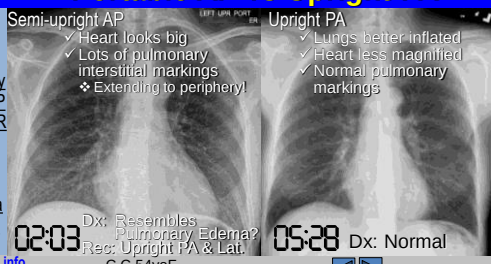


A,R 76yoM

Introduction to CXRs — For Non-Radiologists

Portable AP vs Upright PA

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

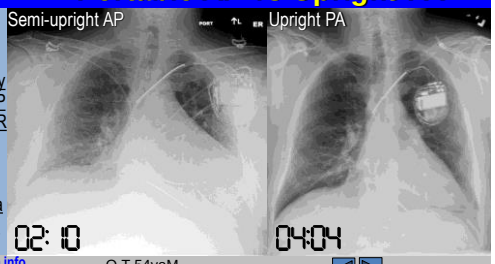


C,C 54yoF

Introduction to CXRs — For Non-Radiologists

Portable AP vs Upright PA

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



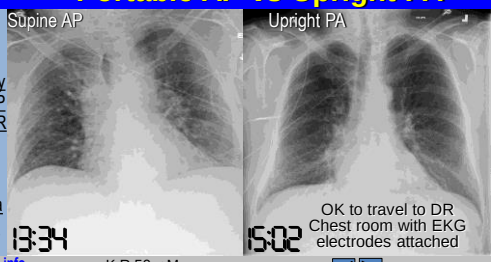
O,T 54yoM

Intro to CXR for Non-Radiologists

Introduction to CXRs — For Non-Radiologists

Portable AP vs Upright PA

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



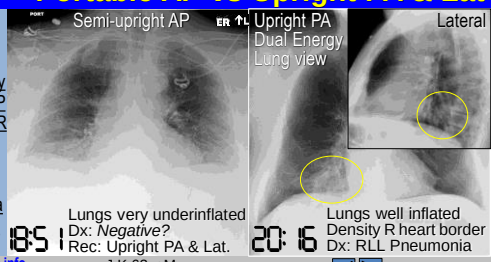
www.schreibman.info

K,R 50yoM
Slide 49 of 99

Introduction to CXRs — For Non-Radiologists

Portable AP vs Upright PA & Lat

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



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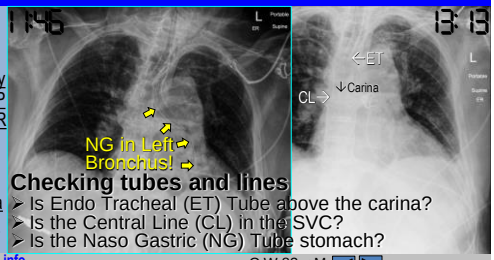
J,K 63yoM
Slide 50 of 99

Introduction to CXRs — For Non-Radiologists

What is the Portable AP CXR Good For?

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



Checking tubes and lines
- Is Endo Tracheal (ET) Tube above the carina?
- Is the Central Line (CL) in the SVC?
- Is the Naso Gastric (NG) Tube stomach?

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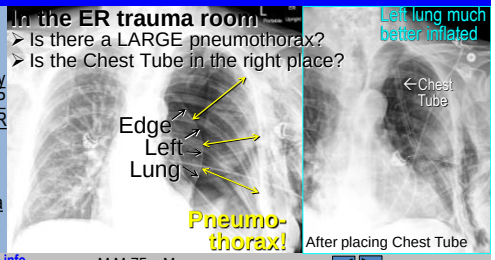
C,W 83yoM
Slide 51 of 99

Introduction to CXRs — For Non-Radiologists

What is the Portable AP CXR Good For?

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

In the ER trauma room
- Is there a LARGE pneumothorax?
- Is the Chest Tube in the right place?



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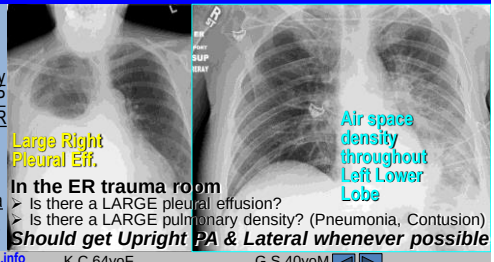
M,M 75yoM
Slide 52 of 99

Introduction to CXRs — For Non-Radiologists

What is the Portable AP CXR Good For?

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



In the ER trauma room
- Is there a LARGE pleural effusion?
- Is there a LARGE pulmonary density? (Pneumonia, Contusion)

Should get Upright PA & Lateral whenever possible

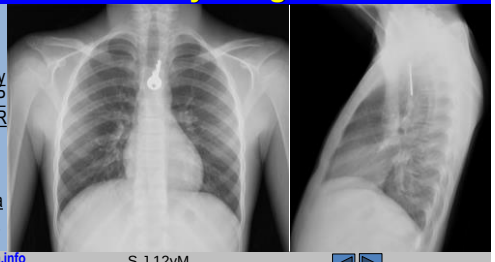
www.schreibman.info

K,C 64yoF
G,S 40yoM
Slide 53 of 99

Introduction to CXRs — For Non-Radiologists

Break… then Key things to look for…

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



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S,J 12yM
Slide 54 of 99

Intro to CXR for Non-Radiologists

Introduction to CXRs — For Non-Radiologists

Schreibman's Says…

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

1st Rule of Radiology:
Know what you're looking at!

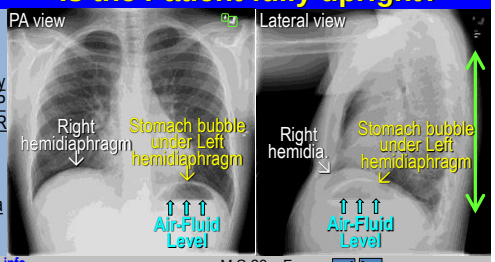
Is this the correct study? (YOU check every time)
- ✓Correct Patient
- ✓Correct Date/Time
- ✓Correct Study (CXR ≠ CT ≠ MR ≠ US)
- ✓Correct Body part

Is this a good study? (This takes experience)
- ✓Is it upright PA & lateral, or portable supine AP?
- ✓Is this a good quality study?
  - ❖Patient well positioned? Lungs well inflated?

Introduction to CXRs — For Non-Radiologists

Is the Patient fully upright?

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



Introduction to CXRs — For Non-Radiologists

Air Below Diaphragm

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Common below LEFT
- ➢Stomach
- ➢Colon (Splenic flexure)

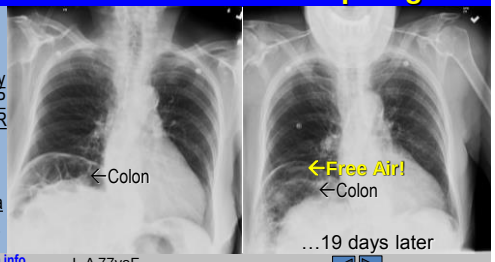
Uncommon below RIGHT
- ➢That's where the liver lives
- ➢Rarely (0.1%) loop of colon (hepatic flexure)
  - ✓Chilaiditi's ("Ky-La-Ditty")

Free air below diaphragm is Abnormal
- ➢Recent (past week) surgery, laparoscopy
- ➢**Bowel Perforation!** (Pneumoperitoneum)

Introduction to CXRs — For Non-Radiologists

Air Below RIGHT Diaphragm

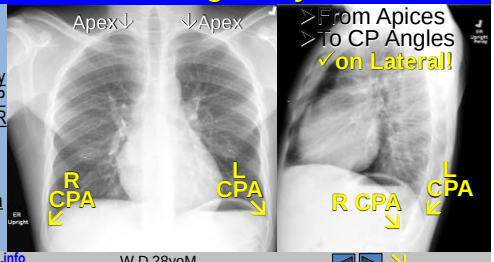
Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



Introduction to CXRs — For Non-Radiologists

Are the Lungs fully included?

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



Introduction to CXRs — For Non-Radiologists

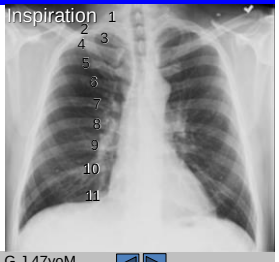
Are Lungs Well Inflated?

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Patient is instructed:
- ➢*"Breathe in… hold it…"*
  - ✓Tech shoots picture
- ➢*"… and breathe…"*

We want lungs maximally inflated

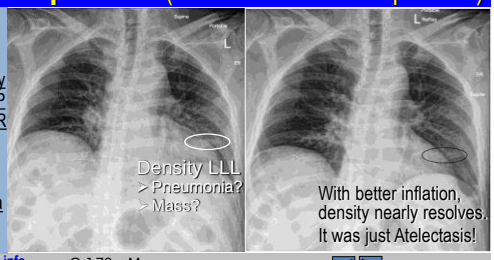
Old Radiology Lore:
- ➢The lungs are well inflated if you can see 10 ribs.
  (I can't find a reference)



Introduction to CXRs — For Non-Radiologists

Good Inspiration (even on Portable Supine AP)

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
○Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



C,J 70yoM

Introduction to CXRs — For Non-Radiologists

"Atelectasis"

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
○Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

[Gr] ἀτελής: *"incomplete"* + ἔκτασις: *"extension"*

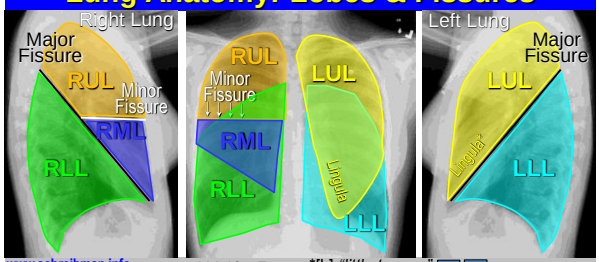
Incomplete expansion
- Sub-segmental
- Entire segment/lobe
- Entire lung

Can be caused by:
- Under inflation
- Airway obstruction (pneumonia)
- Pneumothorax
  - ✓Atelectasis ≠ Pneumothorax

wikipedia.org
G,M 62yoF

Introduction to CXRs — For Non-Radiologists

Lung Anatomy: Lobes & Fissures

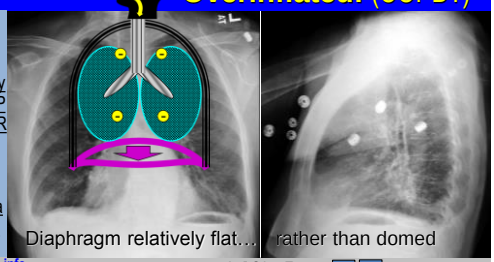


V,A 19yoF
*[L] *"little tongue"*

Introduction to CXRs — For Non-Radiologists

Overinflated! (COPD?)

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
○Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



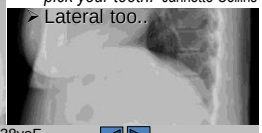
L,J 81yoF

Introduction to CXRs — For Non-Radiologists

Look for sharp margins

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
○Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

- ✓**Heart borders**
- ✓**Diaphragm**
- ✓**CPAs**
  - ➢ *"Should be sharp enough to pick your teeth!"* Jannette Collins

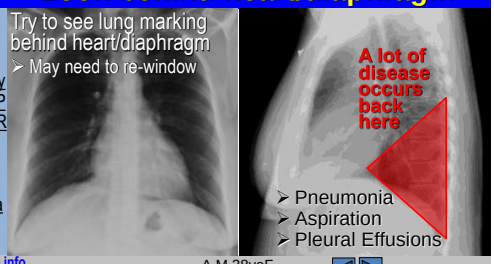


A,M 38yoF

Introduction to CXRs — For Non-Radiologists

Look behind heart/diaphragm

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
○Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



A,M 38yoF

Intro to CXR for Non-Radiologists

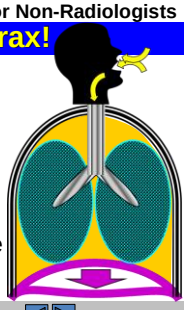
Introduction to CXRs — For Non-Radiologists

Pneumothorax!

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
○PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Air in the thorax… outside the lung
- Air in the pleural space
  - ✓(Here illustrated in orange)

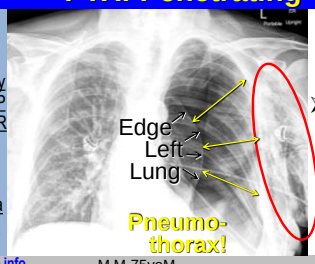
There should be *NOTHING* pleural space
- Literally a vacuum
- The more the pleural space fills with air *outside* lungs there's less air *inside* lungs



Introduction to CXRs — For Non-Radiologists

PTX: Penetrating Trauma

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



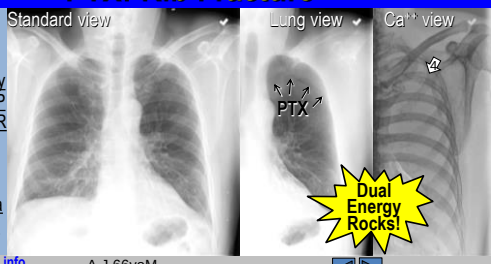
Air = Black
- Subcutaneous Air (Emphysema)

M,M 75yoM

Introduction to CXRs — For Non-Radiologists

PTX: Rib Fracture

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
○PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



A,J 66yoM

Introduction to CXRs — For Non-Radiologists

PTX: Spontaneous

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
○PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

S,M 18yoM

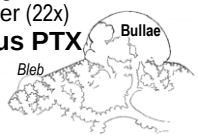
Introduction to CXRs — For Non-Radiologists

Spontaneous Pneumothorax

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
○PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Primary Spontaneous PTX
- Absence of underlying lung disease
- Tall (76"), male (3-6x), smoker (22x)

Secondary Spontaneous PTX
- Underlying lung disease
  - ✓Chronic Obstructive Pulmonary Disease (COPD): **70%**
    - ❖Bullae rupture

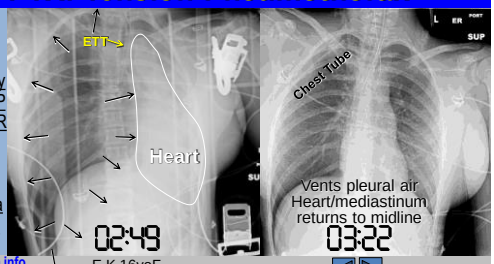


Death from PTX is uncommon (1:10^6)… ***except in TENSION PNEUMOTHORAX!***

Introduction to CXRs — For Non-Radiologists

PTX: Tension Pneumothorax

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
○PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW



E,K 16yoF

Introduction to CXRs — For Non-Radiologists

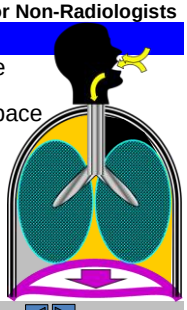
Pleural Effusion

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
○Pl.Effusion
Pneumonia
Pul.Edema
WOW

Just as PTX is air in pl. space
- Rises to apex on upright

Pleural Effusion: fluid in pl. space
- Flows to bases/CPA on upright

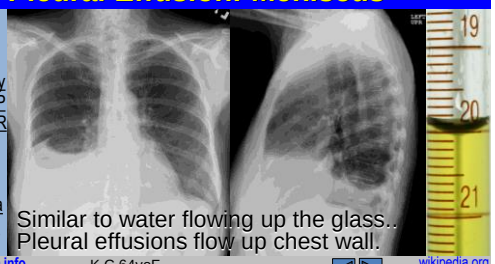
Can be due to:
- Lung disease
  - ✓Infection, PE, Malignancy
- Heart disease
  - ✓Congestive Heart Failure (CHF)
- Abdominal disease
  - ✓Hepatic cirrhosis, Nephrotic syndrome
- …



Introduction to CXRs — For Non-Radiologists

Pleural Effusion: Meniscus

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
○Pl.Effusion
Pneumonia
Pul.Edema
WOW



Similar to water flowing up the glass..
Pleural effusions flow up chest wall.

K,C 64yoF
wikipedia.org

Introduction to CXRs — For Non-Radiologists

Pleural Effusion: Silhouette Sign

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
○Pl.Effusion
Pneumonia
Pul.Edema
WOW

Basic Radiology Concept:
We see edges when adjacent structures are different density
- *We can see left heart border*
  Heart (tissue density) / Lung (air density)
- *We can see left hemidiaphragm*
  Diaphr. (tissue density) / Lung (air density)
- *We can't see* RIGHT *heart border*
  Heart / Pleural Effusion (both tissue den.)

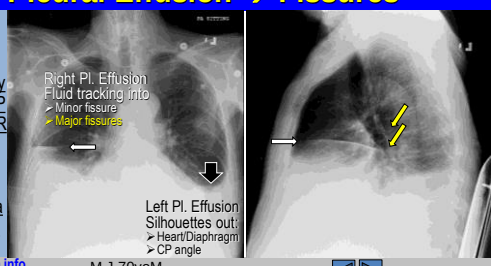
"The pleural effusion is silhouetting out the right heart border and hemidiaphragm"

K,C 64yoF

Introduction to CXRs — For Non-Radiologists

Pleural Effusion → Fissures

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
○Pl.Effusion
Pneumonia
Pul.Edema
WOW



M,J 70yoM

Introduction to CXRs — For Non-Radiologists

Pleural Effusion: Free Flowing

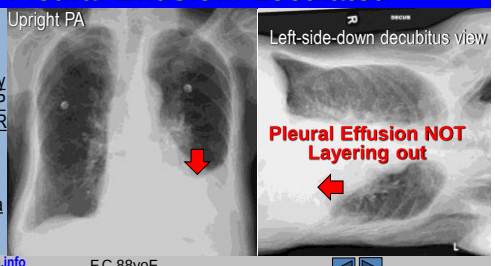
Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
○Pl.Effusion
Pneumonia
Pul.Edema
WOW

H,R 44yoM

Introduction to CXRs — For Non-Radiologists

Pleural Effusion: Loculated

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
○Pl.Effusion
Pneumonia
Pul.Edema
WOW



F,C 88yoF

Intro to CXR for Non-Radiologists

Introduction to CXRs — For Non-Radiologists

Pneumonia

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
○Pneumonia
Pul.Edema
WOW

Pleural Effusion: Fluid outside lung
- CXR: Tissue density (Silhouettes heart/diaphragm)
- Dependent on upright & decubitus views
- Sharp meniscus border

Pneumonia: Fluid inside lung (Alveoli)
- "Air Space Disease"
- CXR: Tissue density (Silhouettes heart/diaphragm)
- Lobar (segmental) distribution
- Fuzzy border

Fourth only text slide
Slide 79 of 99

Introduction to CXRs — For Non-Radiologists

Air Space Disease: Right Lower Lobe

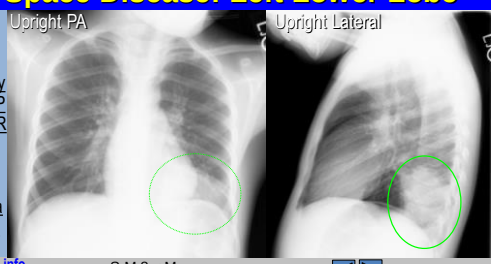
Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
○Pneumonia
Pul.Edema
WOW

T,A 39yoF
Slide 80 of 99

Introduction to CXRs — For Non-Radiologists

Air Space Disease: Left Lower Lobe

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
○Pneumonia
Pul.Edema
WOW

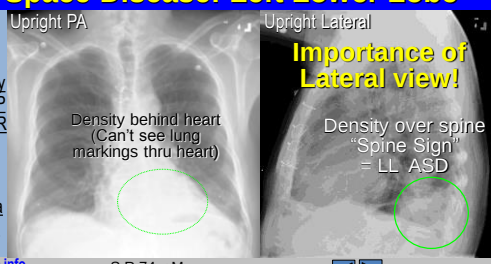


S,M 8yoM
Slide 81 of 99

Introduction to CXRs — For Non-Radiologists

Air Space Disease: Left Lower Lobe

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
○Pneumonia
Pul.Edema
WOW

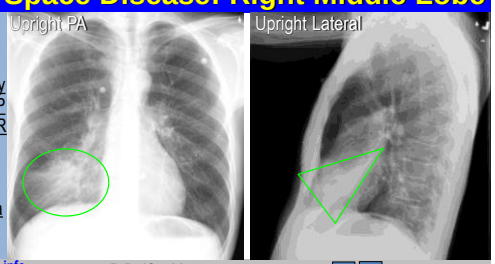


S,R 74yoM
Slide 82 of 99

Introduction to CXRs — For Non-Radiologists

Air Space Disease: Right Middle Lobe

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
○Pneumonia
Pul.Edema
WOW

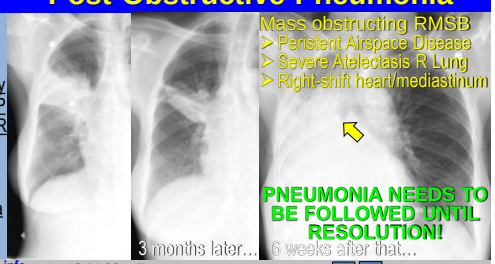


B,D 49yoM
Slide 83 of 99

Introduction to CXRs — For Non-Radiologists

Post-Obstructive Pneumonia

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
○Pneumonia
Pul.Edema
WOW



G,M 62yoF
Slide 84 of 99

Intro to CXR for Non-Radiologists

Introduction to CXRs — For Non-Radiologists

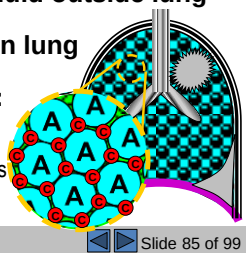
Pulmonary Edema: Spaces

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
○Pul.Edema
WOW

Pleural Effusion: Fluid outside lung
- *Pleural* Space

Pneumonia: Fluid in lung
- *Air* Space (*Alveoli*)

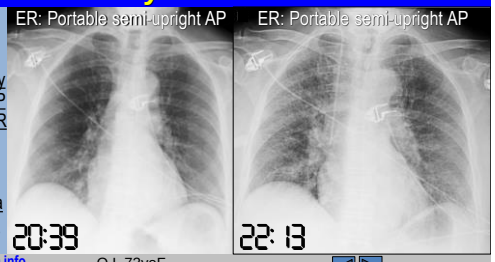
Pulmonary Edema: Fluid in lung
- *Interstitial* Space
- Fluid leaks from capillaries → Interstitial Space → Alveoli → Pleural Space



Introduction to CXRs — For Non-Radiologists

Pulmonary Edema: Fluid Overload

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
○Pul.Edema
WOW

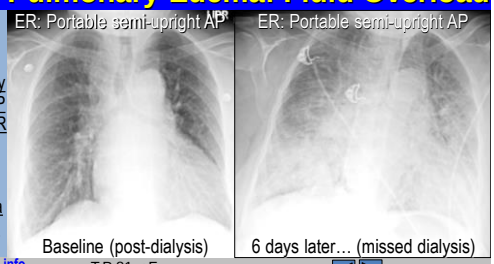


O,L 73yoF

Introduction to CXRs — For Non-Radiologists

Pulmonary Edema: Fluid Overload

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
○Pul.Edema
WOW



Baseline (post-dialysis) — 6 days later… (missed dialysis)

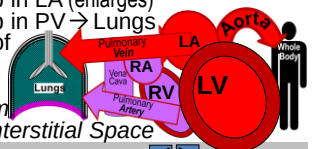
T,P 81yoF

Introduction to CXRs — For Non-Radiologists

Pulmonary Edema: Cardiogenic

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
○Pul.Edema
WOW

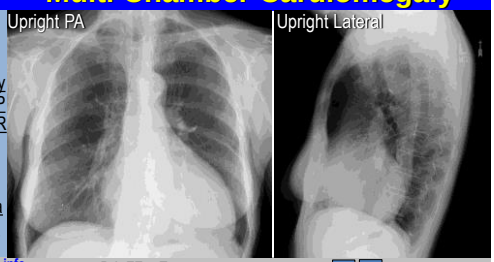
With Congestive Heart Failure (CHF)
- LV doesn't pump well (doesn't empty well)
- Blood gets backed up in LV
  - ✓LV dilates (chamber enlarges, wall thins)
- Blood backs up in LA (enlarges)
- Blood backs up in PV → Lungs
- Engorgement of pul. vessels
  - ✓Upper lobes
- *Fluid leaks from capillaries → Interstitial Space*



Introduction to CXRs — For Non-Radiologists

Multi Chamber Cardiomegaly

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
○Pul.Edema
WOW

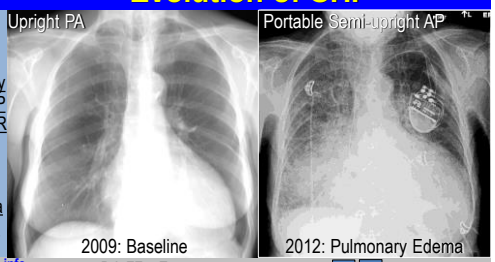


B,L 77yoF

Introduction to CXRs — For Non-Radiologists

Evolution of CHF

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
○Pul.Edema
WOW



2009: Baseline — 2012: Pulmonary Edema

B,L 77yoF

Intro to CXR for Non-Radiologists

Introduction to CXRs — For Non-Radiologists

What to Order When (WOW)

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Chest: PA & Lateral Upright views

- ➢This is the standard exam for the lungs
  - ✓Lungs maximally inflated
  - ✓Heart magnification minimized
  - ✓Importance of multiple views
- ➢Useful to see:
  - ✓Pneumonia (air space disease)
  - ✓Pneumothorax (+/- "tension")
  - ✓Congestive Heart Failure (CHF)
    - ❖Pleural Effusion
    - ❖Cardiomegaly
    - ❖Increased interstitial markings

Introduction to CXRs — For Non-Radiologists

What to Order When (WOW)

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Chest: Portable Supine AP view

- ➢NOT equivalent to PA & Lateral
- ➢Much harder to see
  - ✓Pneumothorax
  - ✓Pleural Effusions
  - ✓Cardiomegaly
- ➢Used ONLY when patient can't be upright
- ➢Used in ER/ICU
  - ✓To evaluate tube positions (ET, NG, central lines)
- ➢**Any findings on Portable CXR should be further imaged with another study**

Introduction to CXRs — For Non-Radiologists

CXR: Charges

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

UWHC 2013 Charges

- ➢PA & Lateral views: $227
- ➢Dual Energy PA & Lat: $227
- ➢Portable AP view: $203

Introduction to CXRs — For Non-Radiologists

What to Order When (WOW)

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Chest CT (Computed Tomography)

- ➢Best way to see inside lungs
  - ✓Following up suspicious things seen on CXR
  - ✓Working up pulmonary nodules, tumors
- ➢Can see tiny PTX, Effusions missed on CXR
  - ✓*But are these tiny things really a problem???*
- ➢Workup chronic interstitial lung disease
  - ✓Ordered by Pulmonologist
- ➢Chest CT = 3 years background radiation
  - ✓*Don't want to order too many serial Chest CTs too close together*

Introduction to CXRs — For Non-Radiologists

Pulmonary Emboli

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Life Threatening Condition

- ➢Blood clots in legs veins are common
  - ✓Deep Venous Thrombosis (DVT)
- ➢If a clot breaks loose, it travels up the veins, entering larger veins (won't get stuck), entering the vena cava → right heart, travels through main pulmonary artery, finally getting trapped in smaller arteriole.
- ➢No gas exchange occurs off that arteriole
- ➢If embolus is large enough, it will prevent gas exchange in a large percentage of the lung.

Introduction to CXRs — For Non-Radiologists

Pulmonary Emboli: WOW

Physiology
Anatomy
↑PA&Lat.
DualEnergy
↗PortableAP
Looking@CXR
Normal
PTX
Pl.Effusion
Pneumonia
Pul.Edema
WOW

Can't Diagnosis with CXR!

- ➢CXR may show non-specific findings
- ➢CXR may be normal!

Nuclear Medicine (VQ Scan)

Angiograms (Aorta, Pul.Art.)

- ➢We don't do these anymore
- ➢Been replaced by CT-A (MR-A)

Intro to CXR for Non-Radiologists

What to Order When (WOW)

Chest: CT-A (CT-Angiography)

- Rapid IV contrast bolus to see blood vessels
- Increasingly frequently being ordered in ER to rule out life threatening conditions:
  - ✓Pulmonary Embolism
  - ✓Traumatic Aortic Laceration
  - ✓Aortic Dissection
- Also gives very nice look a lungs
  - ✓*Don't need to order a Chest CT if you are already getting a Chest CT-A*
- 3 years radiation + large IV contrast bolus

What to Order When (WOW)

Chest MRI / MR-A

- Ordered much less frequently than CT
  - ✓More issues with MR, longer scan time
- At progressive imaging centers, like UW, very good at seeing inside blood vessels
- Can be used to see Pulmonary Emboli!
  - ✓**Without Radiation!**
    - ❖Used in young women to avoid rad. to developing breasts (Birth Control Pills are a risk for forming Pulmonary Emboli)
  - ✓**Without Iodine-Based Contrast!**
    - ❖Used in patients with allergies or renal issues

Any Questions?