
Basics of Chest X-ray Interpretation:

A Programmed Study – Barbara Ritter Ed.D, FNP

Acknowledgment is given to Leslie Muma, RN, MSN, NP for assistance in preparation of this learning module.

Description — The course is designed as an elective to give the advanced practice nurse, involved in the care of patients with cardiopulmonary problems, a basic introduction to the principles of chest x-ray interpretation. The course is in a self-programmed format whereby the student reviews chest films with accompanying case histories and answers. The chest films selected represent commonly occurring cardiopulmonary problems in the primary care setting and provide additional means by which nurses can correlate their knowledge of pathophysiology and cardiopulmonary physical assessment (theory and skills) with findings demonstrable on a chest x-ray.

Objectives:

- Identify cardiothoracic anatomical structures demonstrable on a chest film.
- Recognize a normal chest radiograph.
- Recognize and name the radiographic signs of atelectasis, consolidation, pneumothorax, pleural and pericardial effusions, and hyperinflation frequently seen in patients with cardiopulmonary disease.
- Correlate physical signs and symptoms of cardiopulmonary disease with chest radiographic findings.

Prerequisites:

- Graduate standing.
- Consent of instructor/department chair.

Course Requirements:

- Pre-test and Post-test of radiograph interpretation (instructor-administered).

Grading — Choice of letter grade or satisfactory/unsatisfactory. A satisfactory grade is obtained by achieving 80% or greater on the post-test. The post-test may be retaken as many times as necessary in order to achieve a passing grade.

Required Text:

Felson, B., Weinstein, A., & Spitz, H. (1965) Principles of Chest Roentgenology: A Programmed Text. Philadelphia: Saunders.

Novelline, R.A. (1997) Squires's Fundamentals of Radiology. Cambridge: Harvard University Press.

Required Articles:

Zelfsky, M.N. (1977) A simplified approach to reading x-rays of the heart. Modern Medicine, October 30, 33-36.

Schapiro, R.I., & Musallam, J.J. (1977) A radiologic approach to disorders involving the interstitium of the lung. Heart & Lung, 6, 635-643.

Required Web Sites:

Basics of Chest X-ray Interpretation: A Programmed Study

<http://nps.freeservers.com>

Recommended Articles:

See list at end of syllabus (Appendix B).

Recommended Texts:

Elliott, J.A. (1987) Exercises in Chest X-ray Diagnosis, Oxford, England: Butterworth Heinemann.

Recommended Web Sites:

Chest X-ray

<http://edcenter.med.cornell.edu>

<http://www.medexpert.net>

<http://www.vh.org>

Teaching Files on the Radiology Links Page

<http://www.med.stanford.edu>

Recommended Schedule for Chest X-ray Practicum:

This schedule is given to be used as a guideline to the practicum. The order of the films has been selected to build and reinforce prior learning. The material to be read may not follow exactly, but may be utilized as a reference. Although Novelline is lengthy at times, it has the best examples of films throughout the text. Felson and Basics of Chest X-ray Interpretation: A Programmed Study (**BCI**) are self-learning modules which you may use at your own pace.

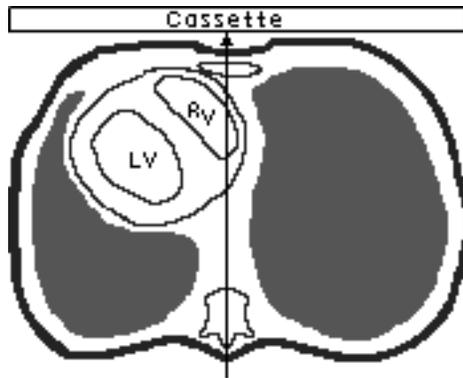
Films	Novelline	Articles	Felson	BCI
1. Radiographic Anatomy	Chapters 1, 2, 3, 4 & 5	Zelfsky	Chapters 1, 4, 5	Sections 1, 2, & 3
2. Interstitial		Schapiro & Musallam		Sections 1 & 4
3. Airway	Chapter 5 & 6		Chapters 2 & 3	Section 1
4. Pulmonary Edema	Chapters 7, 8, & 9			Sections 2 & 4
5. Pleura/Mediastinum	Chapters 7, 8, & 9		Chapters 7 & 8	Sections 2, 3, & 4
6. Cardiac	Chapter 10 and 17			Sections 2 & 3
7. Infection	Chapter 5 & 6			Section 4

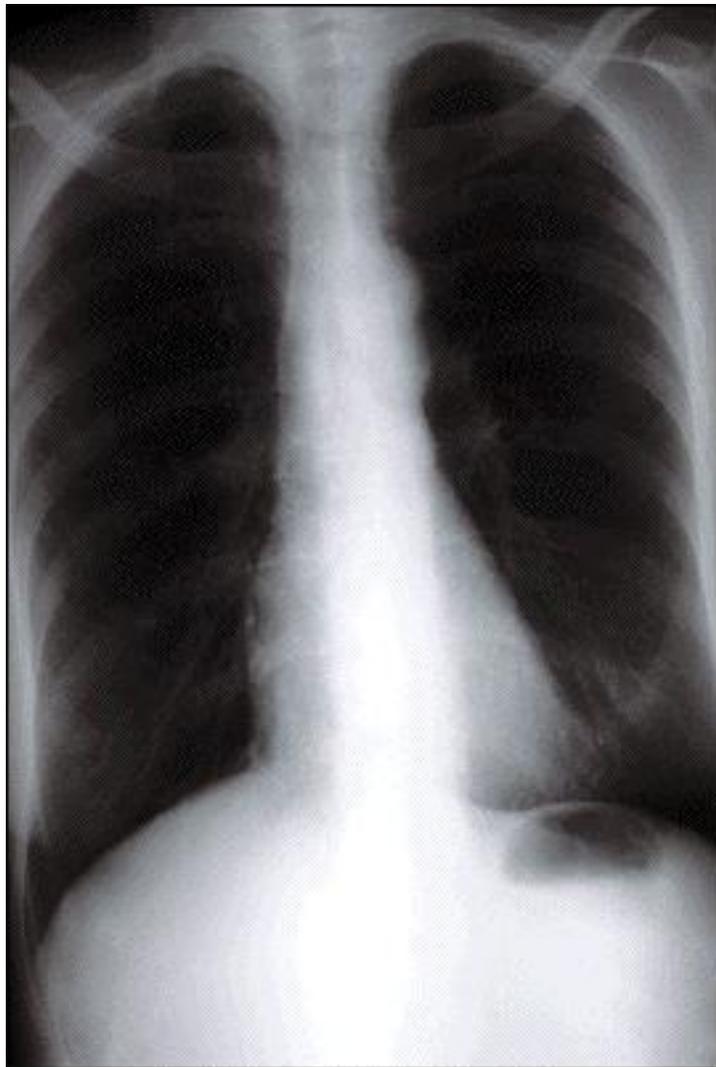
See Appendix A for Glossary of Terms.

See Appendix C for Chest X-ray Workbook.

STANDARD FRONTAL CHEST RADIOGRAPH (Roentgenogram) — upright; PA or posterior *Æ* anterior (film in *front* of patient, beam behind at a distance of six feet; patient usually upright; distance of beam determines magnification and clarity or sharpness

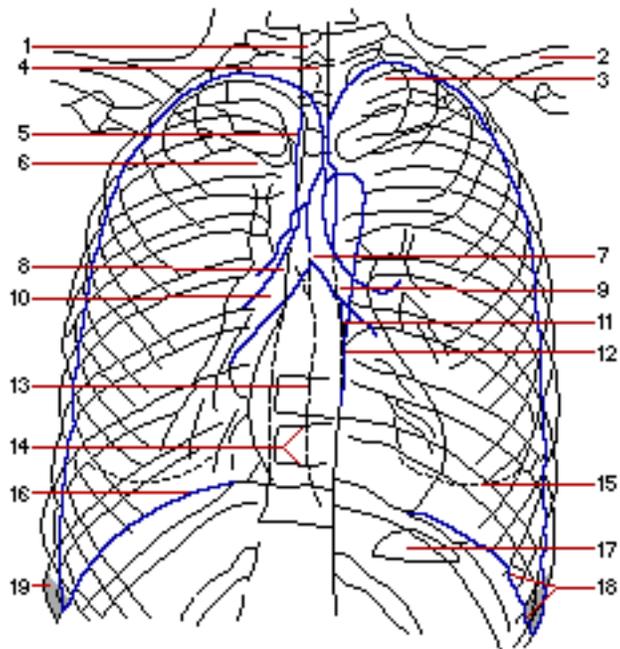
- Place the films on the view box as though you were facing the patient with his left on your right side.
- An AP film, taken from the same distance (6') enlarges the shadow of the heart which is far anterior in the chest and makes the posterior ribs appear more horizontal.
- In a supine film, the diaphragm will be higher and the lung volumes less than in a standing patient.





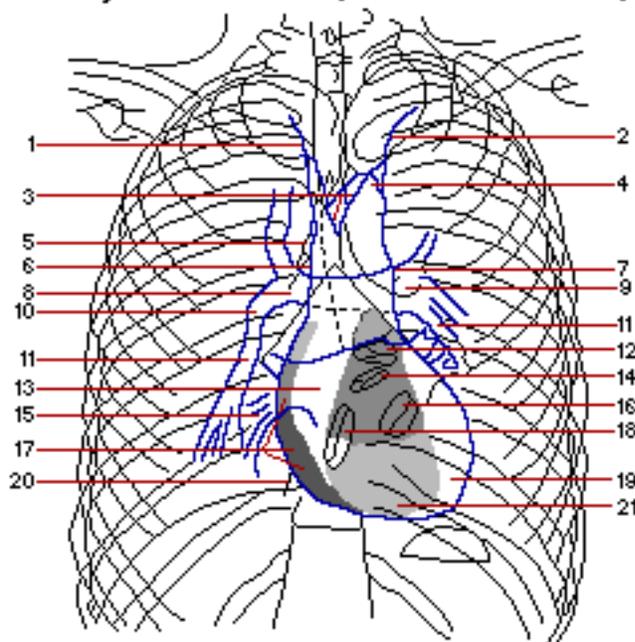
Chest X-ray , A-P View (Normal)
A normal adult chest X-ray.

Chest, Frontal View



- | | |
|---|----------------------------------|
| 1 Trachea | 11 Preaortic stripe |
| 2 Clavicle | 12 Descending aorta |
| 3 Lung apex | 13 Azgoesophageal stripe |
| 4, 5 Posterior superior junction-
line complex | 14 Paraspinal stripe |
| 6 Right paratracheal stripe | 15 Breast contour |
| 7 Tracheal carina | 16 Dome of the diaphragm |
| 8 Right main stem bronchus | 17 Stomach bubble |
| 9 Left main stem bronchus | 18 Diaphragmatic muscle
slips |
| 10 Bronchus intermedius | 19 Costophrenic sulcus |

Chest, Frontal View (Heart and Vessels)



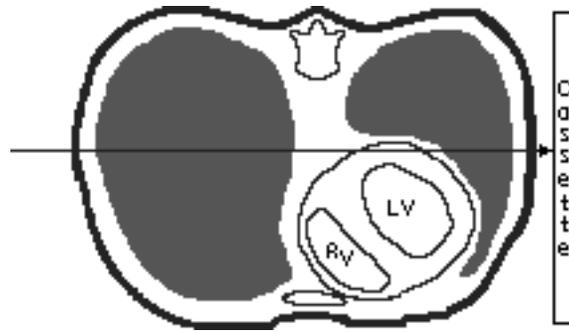
- | | |
|---|--------------------------------------|
| 1 Contour of the right brachiocephalic vein | 11 Right lower lobe pulmonary artery |
| 2 Contour of the subclavian artery | 12 Pulmonic valve |
| 3 Anterior junction line | 13 Left atrium |
| 4 Aortic arch | 14 Aortic valve |
| 5 Azygos vein | 15 Confluence of pulmonary veins |
| 6 Superior vena cava | 16 Mitral valve |
| 7 Main pulmonary artery segment | 17 Right atrium |
| 8 Right pulmonary artery | 18 Tricuspid valve |
| 9 Left pulmonary artery | 19 Left ventricle |
| 10 Interlobar pulmonary artery | 20 Inferior vena cava |
| | 21 Right ventricle |

STANDARD LATERAL CHEST RADIOGRAPH — *left* side of the chest against filmholder (cassette); beam from right at a distance of six feet; lesion located behind the left side of the heart or in the base of the lung are often invisible on the PA view because the heart or diaphragm shadow hides it; the left lateral will generally show such lesions; the left lateral is thus the customary lateral view as it is the *best view to visualize lesions in the left thorax*. Also, the heart is less magnified when it is closer to the film.

- Good for viewing area behind heart (retrosternal airspace — between the heart and sternum).
- Marked with a "R" or "L" according to whether the right or the left side of the patient was against the film — left lateral or right lateral.

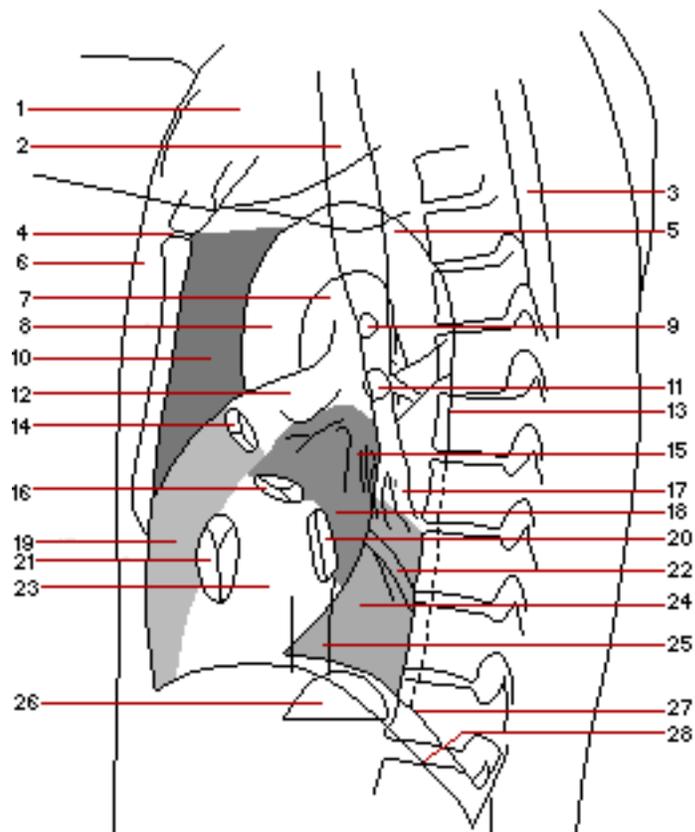
To visualize a lesion in the left thorax, it is better to get a left lateral view.

To visualize a lesion in the right thorax, it is better to get a right lateral view.



A fundamental rule of roentgenography — *Try to get the lesion as close to the film as possible.*

Left Lateral View



- | | |
|-------------------------------------|------------------------------------|
| 1 Shoulder soft tissues | 16 Aortic valve |
| 2 Trachea | 17 Lower lobe bronchus |
| 3 Scapula | 18 Left atrium |
| 4 Angle of Louis | 19 Right ventricle |
| 5 Aortic arch | 20 Mitral valve |
| 6 Sternal body | 21 Tricuspid valve |
| 7 Aortopulmonary window | 22 Left lower lobe pulmonary veins |
| 8 Ascending aorta | 23 Left ventricle |
| 9 Right upper lobe bronchus | 24 Retrocardiac space |
| 10 Retrosternal space | 25 Inferior vena cava |
| 11 Left upper lobe bronchus | 26 Stomach bubble |
| 12 Main pulmonary artery segment | 27 Left hemidiaphragm |
| 13 Descending aorta | 28 Right hemidiaphragm |
| 14 Pulmonic valve | |
| 15 Right lower lobe pulmonary veins | |

PORTABLE CHEST X-RAYS — are AP views (anterior \AA posterior); preferably upright but may be supine, depending on patient's condition; taken with beam at distance of 36 inches \AA blurring and magnification

OTHER VIEWS:

Posteroanterior Oblique Views — patient at 45° angle to cassette and beam.

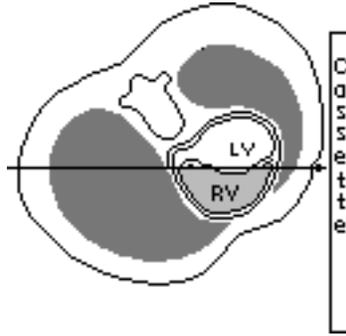
The tracheal bifurcation is best seen in an oblique view.

In bilateral involvement of the lungs (as by lymphoma involvement of the lower lungs), an oblique view avoids the superimposition of a lateral view.

Sometimes used in studying the heart or hila of the lungs; also in detailed study of the ribs.

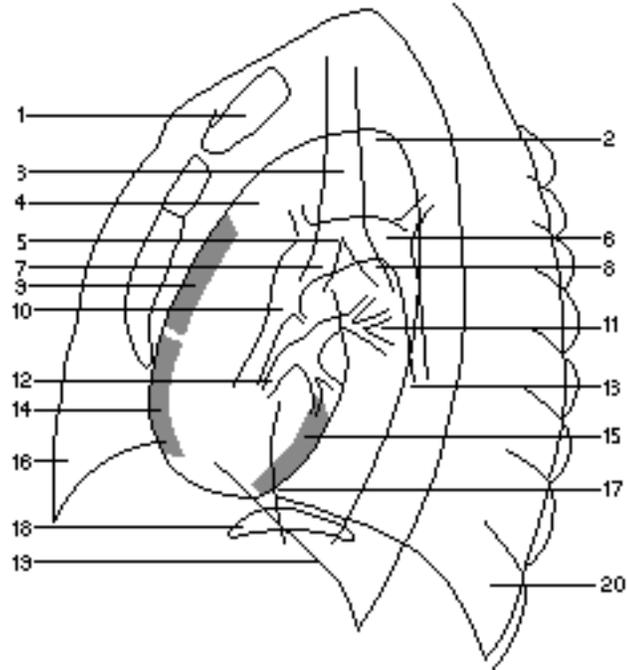
The optimum degree of obliquity depends on the site of the lesion being studied and the information desired — it may have to be determined by fluoroscopy.

When we're too tired to think of whether we need a right or a left oblique we just take both obliques.

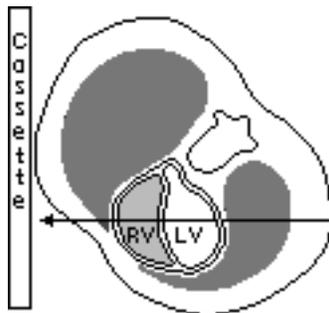


Left Anterior Oblique — Left Anterolateral Chest Next to Cassette

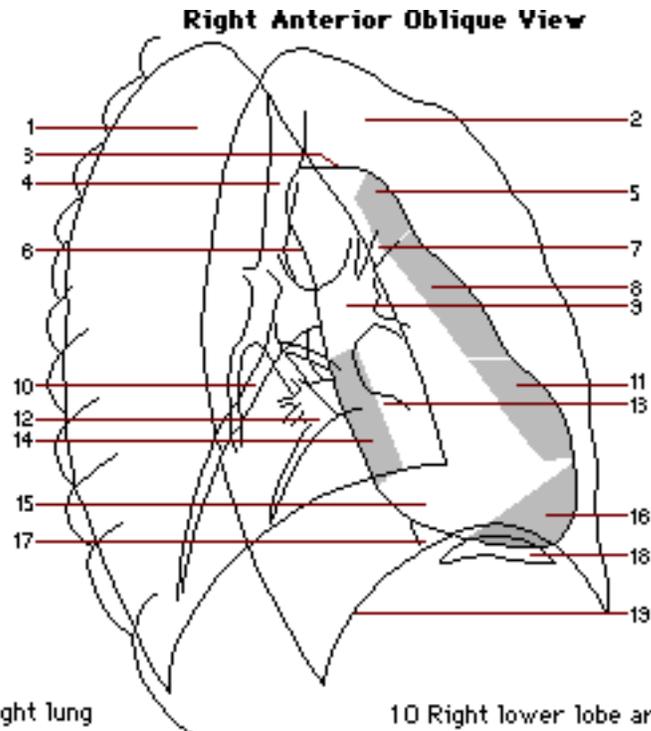
Left Anterior Oblique View



- | | |
|----------------------------|--|
| 1 Sternum | 11 Left pulmonary vein |
| 2 Aortic arch | 12 Right pulmonary vein |
| 3 Trachea | 13 Descending aorta |
| 4 Ascending aorta | 14 Right ventricle |
| 5 Carina | 15 Left ventricle |
| 6 Left pulmonary artery | 16 Right lung |
| 7 Right main stem bronchus | 17 Inferior vena cava |
| 8 Left main stem bronchus | 18 Stomach bubble (left hemidiaphragm) |
| 9 Right atrium | 19 Right hemidiaphragm |
| 10 Right pulmonary artery | 20 Left lung |



Right Anterior Oblique — Right Anterolateral Chest Next to Cassette



- | | |
|--|---|
| 1 Right lung | 10 Right lower lobe artery |
| 2 Left lung | 11 Infundibulum (pulmonary outflow tract) |
| 3 Aortic arch | 12 Inferior right pulmonary vein |
| 4 Trachea | 13 Inferior left pulmonary vein |
| 5 Ascending aorta | 14 Left atrium |
| 6 Descending aorta | 15 Right atrium |
| 7 Left upper lobe pulmonary vein, artery, and bronchus | 16 Left ventricle |
| 8 Main pulmonary artery segment | 17 Inferior vena cava |
| 9 Left pulmonary artery | 18 Diaphragm |

Decubitus Views — "decubitus" actually means "lying down;" made with the *patient lying on his side* and the x-ray beam horizontal (parallel) to the floor. Especially good to confirm air-fluid levels in the lung.

Cross-Table Lateral (Horizontal) Views — made with patient prone or supine and the beam horizontal to the floor.

Lordotic Views — formerly made in the upright AP position with the patient leaning backward at an angle of $\sim 30^\circ$ from the vertical which was very awkward; now made with the patient facing the film as for an upright PA view but the tube is elevated and angled downward 45° .

Projects the lung apices of the lungs below the clavicles and causes the ribs to project more horizontally.

Especially good for viewing the apices of the lungs, lesions that are partially obscured by ribs, or the right middle lobe or lingula of the left lung.

Expiratory Views — on expiration the lungs "cloud up" and the heart appears larger.

If the air on one side cannot be readily expelled, the lung on the obstructed side remains expanded and radiolucent on expiration.

Useful in detecting unilateral obstructive emphysema (as from a unilateral obstruction of a bronchus).

A pneumothorax always appears larger on expiration than on inspiration.

Since the thorax is smaller on expiration, the unchanged volume of pleural air spreads out in the smaller thoracic space.

Occasionally a small pneumothorax is only visible on expiration.

Bucky Films — made with a moving grid between the patient and the film which absorbs excess, scattered radiation.

Scattered radiation produces a hazy, unsharp image, or fog, and detracts from film clarity.

Used to delineate a thick pulmonary or pleural lesion, bony structures, or to more clearly see structures in an obese patient.

Bucky technique also used whenever the abdomen, spine, mediastinum, pelvis, or heavy long bones are studied.

Tomography (Laminagraphy)

An apparatus moves the tube and film synchronously in opposite directions; the adjustable fulcrum is set to the plane of the lesion to be studied; blurs structures in the planes above and below the level being studied.

Especially helpful in evaluating pulmonary nodules, demonstrating cavities, and depicting bronchial obstruction.

If you can't think of the exact name for a view, be descriptive or draw a picture (i.e., "Get me a cross-table view with the patient lying on his right side facing the tube.") or consult with the radiologist.

There are all sorts of ingenious projections and fascinating special procedures in the armamentarium of the radiologist.

DENSITIES Air < fat < liver < blood < muscle < bone < barium < lead.

- **Air** — least dense; most transparent or radiolucent; unobstructed beam or air-filled densities appear black

Lungs, gastric bubble, trachea, ? bifurcation of bronchi

- **Fat** — breasts

- **Fluid** — most of what you see; vessels, heart, diaphragm, soft tissues, mediastinal structures

- **Mineral** — most dense (or radiopaque) of body structures; mostly Ca^{++} ; bones (marrow is aerated), aortic calcifications such as the aortic knob, ? calcification of the coronary arteries, old granulomas; bullets, safety pins, etc.

- Structures which are perpendicular to the plane of the film appear as they were much more dense as the shadows represent the *sum* of the densities interposed between the beam source and the film. Learn to think in terms of those parts that are *relatively parallel to the film* and those that are *roughly perpendicular to it*. Think about it *three-dimensionally*.

- *Thickness* as well as *composition* determine radiodensity. The shadow cast by a thick mass of soft tissues will approach that of bone.

Section Two

PROCEDURE FOR INTERPRETATION OF CHEST FILMS

Develop a systematic approach and use it consistently.

(Usually external \emptyset internal.)

I. **LABEL** — Read the label on every film to verify the patient's name, age, and sex.

II. **ORIENTATION** — Identify the patient's right side, his position, and determine if he is rotated.

Symmetrical spacing of the clavicles and other structures on either side of the sternum; clavicles esp. will show whether or not patient is straight or rotated. Symmetry of the clavicles and ribs gives you assurance that no rotation is present. Even slight rotation is undesirable in a chest film as the heart and mediastinum are then radiography obliquely and their shadows appear enlarged and distorted.

III. **QUALITY** — In a film of good technical quality in a patient without gross cardiomegaly, you should be able to see the outlines of the vertebral bodies within the heart shadow; notice linearity of spine — is it straight?

IV. **INTERPRETATION:** the following should be identified:

A. **Skeletal Structures** — what you see of the bones is incidental as the technique used for chest films

has been designed for study of the lungs. Always compare for symmetry.

1. **Scapulae** — PA and lateral; are there two of each?

With hands on hips, palms out, and elbows forward the scapulae are rotated to the sides to prevent their superimposition upon the upper lung fields. Therefore only their medial margins are seen.

2. **Humeri and Shoulder Joints** — PA and lateral.

Little of the shoulder girdle and humerus will be seen in films of broad-chested individuals.

Coracoid is seen through the spine of the scapula because they superimpose.

Head of humerus and the acromium are also seen additively.

Are fractures or abnormal calcifications (dense white shadows) seen?

3. **Clavicles** — PA; symmetrical spacing on either side of sternum only if there is no rotation of the chest. Turned even a few degrees, the clavicles will exhibit a remarkable degree of asymmetry.

4. **Ribs** — count *on every film* to level of diaphragm.

Identify the first rib carefully by finding its anterior junction with the manubrium and following this rib *backward* to the spine. Then count down the posterior ribs.

Begin at the origin of the first rib at its junction with the first thoracic vertebra and trace each rib as far anteriorly as you can to the beginning of the radiolucent (and hence invisible) costal cartilage.

Interspaces are useful in identifying the location of a precise shadow and are named for the *posterior* rib above the interspace unless the anterior rib is specified as the marker.

of ribs helps you determine how much lungs are inflated.

9 or more ribs = good inflation.

Transverse cardiac shadow smallest — used for measurement.

Lungs better filled with air; therefore relatively minor disease is seen better.

10 or more ribs = hyperinflated

Expiratory film — see < 9 ribs.

Diaphragm higher; lung bases less well seen; transverse diameter of heart is larger.

Minimal pneumothorax can be seen better. Also, obstructive emphysema.

Compare both sides for symmetry,

Note width of the intercostal spaces. Are they equal?

Are they continuous or is there a fracture?

Beam only "sees" what is parallel to it; anterior ribs are more perpendicular and thus not seen very well.

5. **Spine** — notice linearity — is it straight?

Spine and sternum are superimposed upon each other and upon the dense shadows of the mediastinal structures in the PA view.

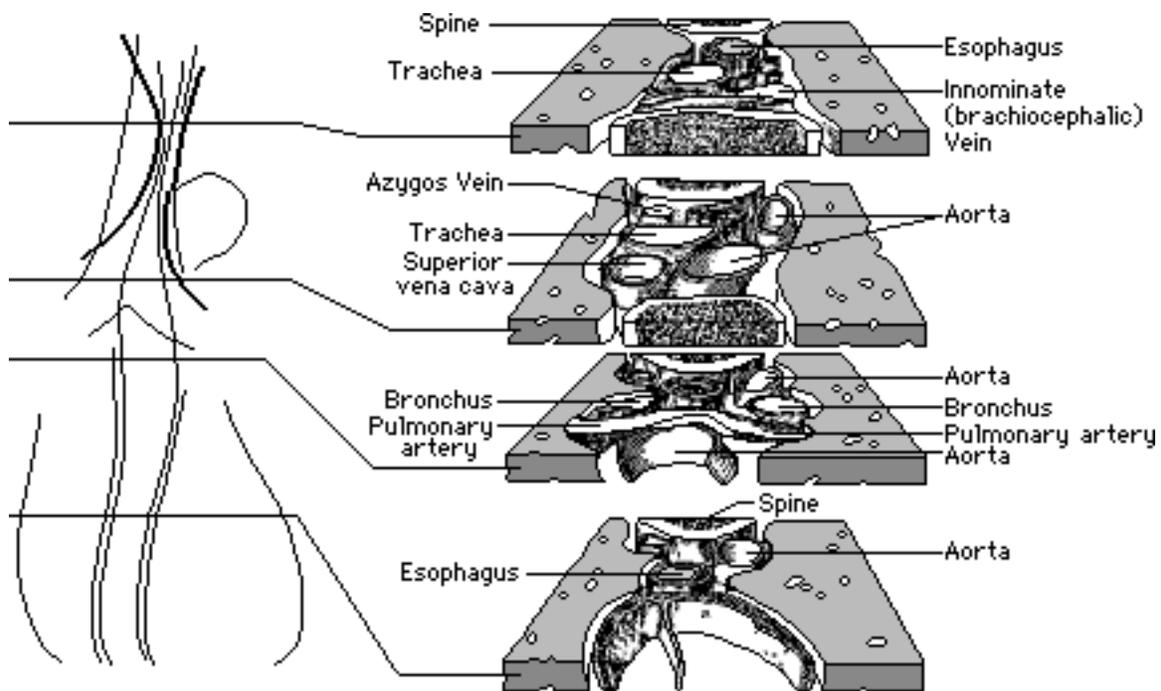
Scoliosis may mask margin of RA; don't mistake for RA with mediastinal shift.

B. **Soft Tissues** — Symmetry of Density.

1. Chest wall (outside of lung fields).

2. Neck.

3. Mediastinum.



MEDIASTINAL STRUCTURES

Identify trachea — is it midline, not shifted?

Identify bifurcation and position.

Should not be able to follow airways any further out as they are very thin walled; if visible (air bronchogram sign) - pulmonary edema.

4. **Breasts** — symmetrical in size, shape, position; nipples may possibly be visible.

Be sure to check whether there are two breasts.

The lung field under a missing breast will appear a little darker than the other lung field.

C. Diaphragm

1. Difference in the Level of the Hemidiaphragms

Right hemidiaphragm is normally a bit higher.

Impaired mobility of diaphragm — may be from paralysis of either phrenic nerve, disease in abdomen such as a subdiaphragmatic abscess, pleurisy, pulmonary infarction, etc.

2. Normal Position

Distance from gastric bubble (if it is visible) to diaphragm should be very small.

3. Shape of the Diaphragm.

4. Identification of Left and Right Diaphragms — lateral film.

5. Costophrenic Angles

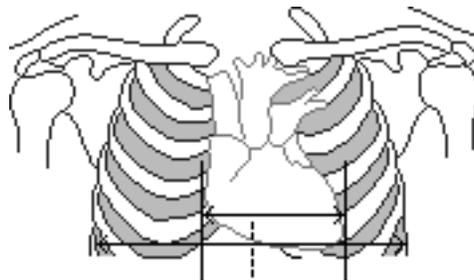
Should be sharp and clear.

No fluid density should be visible.

6. Cardiophrenic angle should be fairly clear.

7. Inferior vena cava adds its own little shadow.

D. Heart and Great Vessels



Size of Heart — measure at widest point; compare to size of thorax; should be no more than $1/2$ the width of the thorax. Using any handy piece of paper, determine the width of the heart. Then decide whether this width exceeds the distance from the midpoint (spine) to the inside of the rib cage (half the transthoracic diameter). Still more simply, you can measure from the midline to the *right* heart border and see whether that distance will fit into the piece of lung field to the *left* side of the heart.

Assessment of the cardiovascular anatomy includes assessment of heart and chamber size as well as the position and size of the great vessels.



1 = right brachiocephalic vessels

2 = ascending aorta and superimposed SVC

3 = right atrium (RA)

4 = inferior vena cava (IVC)

5 = left brachiocephalic vessels

6 = aortic knob/arch

7 = pulmonary trunk

8 = left atrial appendage (LA)

9 = left ventricle (LV)

Note: Normally concave slope between arcs 6 and 9 is often called the "cardiac waistline."

1. Left Atrial Border — PA and lateral views.

2. Left Ventricular Border — PA and lateral.

3. Right Ventricular Border — PA and lateral — anterior structures and border is not normally visualized.

4. Inferior Vena Cava.

5. Right Atrial Border — PA.

Scoliosis, if present, may mask border of the right atrium.

6. Superior Vena Cava — PA.

7. Ascending Aorta — PA and lateral.

8. Aortic Knob — position, calcification.

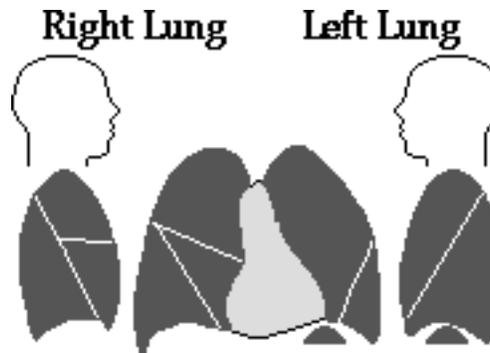
9. Main Pulmonary Artery — lateral.

10. Relative position of left and right main branches of pulmonary arteries — in relation to left and right main bronchi.

11. Esophagus — PA and lateral.

12. Note cardiac size — normal is 1/2 or less of the thoracic width on a PA film.

E. Lungs



1. Trachea and carina — PA and lateral.

2. Major bronchi — PA and lateral.

3. Pleura.

4. Left — upper and lower lobe representation — PA and lateral.

Major fissure on left — between ribs 6 and 8. Only one fissure.

Lingula (tongue-shaped) — area adjacent to LV; not a separate lobe.

5. Right — upper, middle, and lower lobe representation — PA and lateral.

Oblique or major fissure — T₃ ∅ T₁₀.

6. Differences in density, upper and lower lung fields.

In a PA film the peripheral vasculature is normally seen out to the lateral one inch of the films and is more clearly delineated in the lower lobes than the apices.

Upright — most of perfusion goes to lower lungs so you should see it all the way out.

_ PAP ∅ reversal of blood flow with enhancement of apical vascularity.

Older smoker and vasculature not visible all the way out = ? emphysema.

Younger person and not visible all the way out = ? pneumothorax.

Pneumothorax = about the only thing that can be diagnosed with absolute certainty with CXR.

7. Peripheral vasculature — follow it out as far as you can see it.

- Hilum (pl. = hila).

- Position — higher or lower.

- Symmetry

Lung fields — symmetry re: amount of density.

8. **Silhouette Sign**

2 densities that are alike with margins adjacent to each other — borders will be masked.

If margin is obliterated, whatever is masked and it has to be in the same plane.

Masking of RA — would be from R middle lobe.

Masking of posterior diaphragm — would be from R lower lobe.

Masking of LV — would be from L upper lobe (anterior).

Masking of descending aorta — would be from L lower lobe.

Masking of IVC and SVC — would be from R lower and middle lobes.

If you can see heart — comes from posterior.

9. **Air Bronchogram Sign** — "butterfly" distribution of the abnormal densities or an anatomic distribution of abnormal densities restricted to lobar or sublobar portions of the lung.

Temporally rapid (reckoned in days) changes in the appearance of the lung infiltrate.

Indicative of alveolar disease.

See airways out past bifurcation.

Air-filled airway superimposed on air-filled densities.

Demonstration of the air-filled bronchus as a radiolucent "tube" is dependent on its close association with alveoli that are fluid-filled rather than air-filled.

Two contrasting densities make it visible.

Airways OK, surround tissues not OK.

10. **Kerley's Lines**

Kerley's B Lines — short, thin horizontal lines at the periphery of the lung near the costophrenic angles; formed by thickening of the interlobular septa due to fibrosis (e.g., pneumoconiosis), fluid accumulation, or distended lymphatics-venules
Kerley's A Lines — long, linear densities, more centrally located in the upper portions of the lungs near the hila; may be seen in interstitial lung disease and CHF; represent swollen lymphatic channels.

F. **Iatrogenics**

1. ECG leads

2. Endotracheal tube — positioning

3. CVP and PA lines

INTERPRETATION OF CHEST FILMS

I. Skeletal Structures

A. Scapulae

B. Humeri

C. Clavicles — symmetrical spacing on either side of sternum

D. Ribs

II. Soft Tissues — symmetry of density.

A. Chest wall

B. Neck

C. Mediastinum

Trachea — is it midline, not shifted.

Identify bifurcation and position.

Should not be able to follow airways any further out as they are very thin walled; if visible (air bronchogram sign) - ?? pulmonary edema.

D. Breasts — symmetrical in size, shape, position; nipples maybe visible.

III. Diaphragm

A. Difference in the level of the hemidiaphragms.

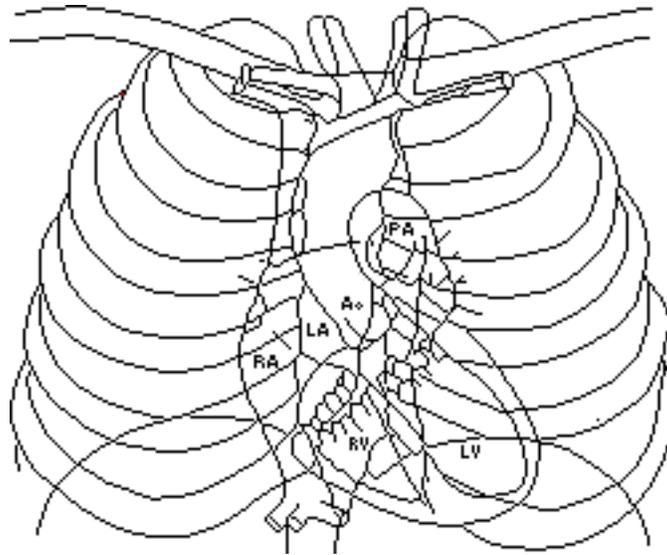
B. Normal position.

C. Shape of the diaphragm.

D. Identification of left and right diaphragms — lateral.

E. Costophrenic angles.

IV. **Heart and Great Vessels** — Assessment of the cardiovascular anatomy includes assessment of heart and chamber size as well as the position and size of the great vessels.



A. Left atrial border — PA and lateral.

B. Left ventricular border — PA and lateral.

C. Right ventricular border — PA and lateral — anterior structures and border is not normally visualized.

D. Inferior vena cava.

E. Right atrial border — PA.

Scoliosis, if present, may mask border of RA.

F. Superior vena cava — PA.

G. Ascending aorta — PA and lateral.

H. Aortic knob — position, calcification.

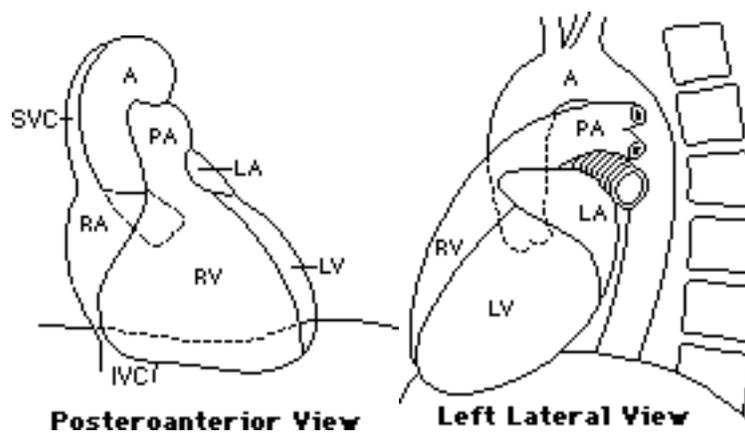
Hypertension can cause a flat, almost absent aortic arch.

Calcification of Aortic Arch



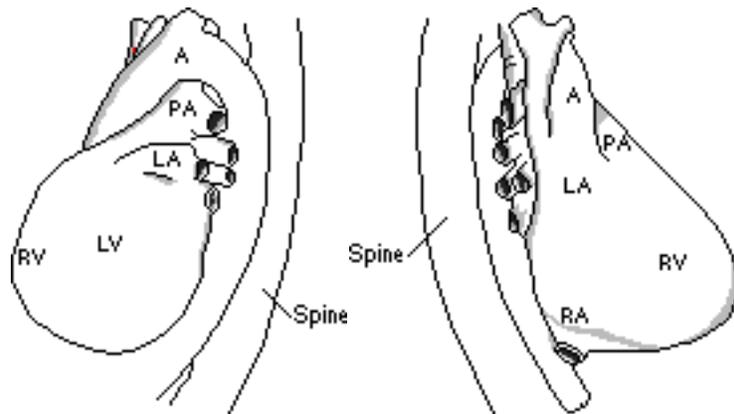
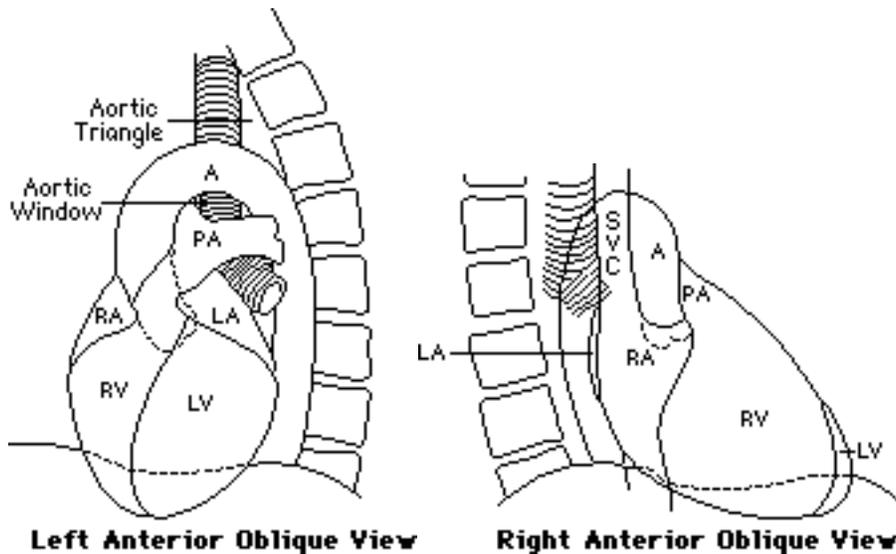
The chest X-ray shows some calcification of the aortic arch consistent with atherosclerosis. No evidence of active pulmonary disease is present.

I. Main pulmonary artery — lateral.



J. Relative position of L and R main branches of pulmonary arteries — in relation to L & R main bronchi

K. Esophagus — PA and lateral



L. **Cardiac Size** — normal is 1/2 or less of the thoracic width on a PA film.

Simulation of cardiac enlargement — PA films made in expiration (high diaphragm \emptyset heart tilted upward bringing apex closer to the lateral chest wall + less flare of ribs which alters the apparent cardiothoracic ratio); also any abdominal distention (late pregnancy, ascites, intestinal obstruction) produces similar results; diaphragm also likely to be higher in supine views; portable chest films and other AP views place heart farther away from the film.

Rotation of the patient produces appearance of widening of the heart and mediastinal shadows.

Deformity of the thoracic cage — severe scoliosis; depressed sternum (pectus excavatum) usually displaces heart to the left + right heart border not visible.

Difference between heart volumes in systole and diastole usually not enough to affect rough estimate of the cardiothoracic ratio in adults.

Simulation of *deceptively small* heart — over distention of the lungs for any reason (dyspneic patient with low diaphragm or emphysematous patient) compresses the heart and mediastinal structures from both sides and narrows their PA shadow.

Mediastinal disease, pulmonary disease, or any density (consolidation, effusions, true mediastinal shift) may render the dimensions of the heart unobtainable.

RADIOLOGIC SIGNS OF CARDIAC DISEASE

Posteroanterior Projection

• The upper right border is formed by the SVC and the lower cardiac border is formed by the RA. The left border has three well-defined segments: The uppermost is formed by the aortic arch, the main pulmonary artery lies immediately below the aortic knob, and the lower left cardiac border is formed by the LV and the apex. The LA appendage lies between the pulmonary artery segment and the LV and is usually not seen as a separate bulge.

Lateral Projection

• RV is the most anterior cardiac chamber and is in direct contact with the lower sternum.

There should be a clear space (lung tissue) between the sternum, the RV outflow tract, and the root of the pulmonary artery, but pectus excavatum as well as RV enlargement can impinge on this space.

The posterior cardiac border is made up of the LA above and the LV below.



1 = right brachiocephalic vessels

2 = ascending aorta and superimposed SVC

3 = right atrium (RA)

4 = inferior vena cava (IVC)

5 = left brachiocephalic vessels

6 = aortic arch

7 = pulmonary trunk

8 = left atrial appendage (LA)

9 = left ventricle (LV)

Technical Factors

- The heart appears larger on AP than PA views.
- Film during expiration — simulates pulmonary edema and the heart appears larger.
- One should check side markers for dextrocardia.

- One should check the clavicles for angulation.
- Overpenetrated films may miss heart failure.

Extracardiac Structures

- *Rib notching indicates coarctation of the aorta.* Rib notching = saucered erosions of the undersurface of the ribs where dilated intercostal arteries have developed as collateral pathways. Seldom present in children younger than 10. Other conditions such as neurofibromatosis can also cause rib notching.
- Pectus excavatum simulates cardiac enlargement by displacing heart to the left. Lateral view shows depression of the sternum at the level of the heart.
→ AP dimension of the chest at heart level and the heart is displaced posteriorly (posterior margin behind the inferior vena cava).
- Straight back is a/w mitral valve prolapse and aortic insufficiency.
- Right-sided pleural effusion occurs with CHF.

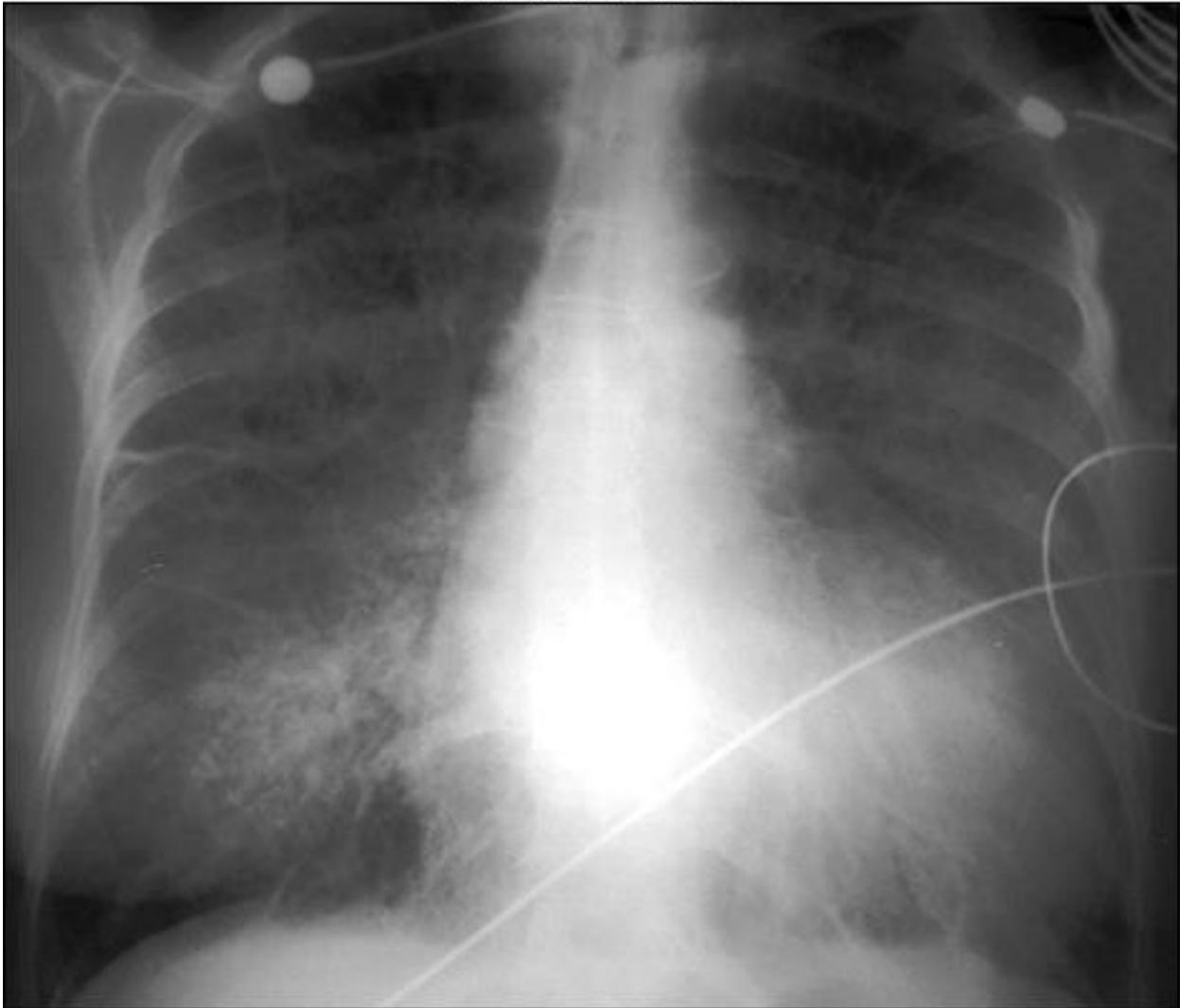
Physiologic Analysis of the Pulmonary Vasculature — appearance of the hilar and pulmonary vessels is an excellent indicator of the physiologic state of the heart.

Congestive Heart Failure

- _ size, shapelessness of heart, + evidence of pulmonary venous engorgement — the vessels are seen to extend farther than normal into the lung field.
- Bronchi become "framed" in the interstitial fluid accumulating around them and, when seen end-on, appear as white rings. This is often called "peribronchial cuffing" and can be observed to decrease as the patient improves.
- Pleural effusion in cardiac failure may be bilateral or unilateral and is more frequent on the right.
- Lungs appear hazy and less radiolucent than normal because of retained water; lattice pattern.
- Kerley's B lines appear — short, horizontal white linear densities very close to the peripheral margin of the lung; have been proven to represent the thickened, edematous interlobular septa; also seen in lymphangitic spread of malignancies within the lung parenchyma and interstitial pulmonary disease.
- Rapid accumulation of fluid spills over into the alveoli and causes the development of alveolar (air-space) **pulmonary edema**.

Pulmonary edema ∅ the so-called "bat-wing" appearance about both hila; superimposed shadows of innumerable fluid-filled alveoli may cause disappearance of the vessels of the hilum; interstitial pulmonary edema ∅ blurring of pulmonary vasculature; perihilar haze; may appear rapidly after sudden LV failure or it may be superimposed on the more gradual CXR findings of CHF.

Pulmonary Edema



The chest X-ray shows a haziness in the perihilar regions and the pulmonary vascular markings are not well-defined. These changes are consistent with bilateral pulmonary edema. EKG leads can be seen in the X-ray.

Pulmonary edema can also occur in noncardiac conditions such as fluid overload, renal failure, heroin overdose, and inhalation injury or burns.

CXR findings can lag behind hemodynamic Δ s but the following patterns can predict pulmonary artery wedge pressure:

- Grade 0: normal — PAWP < 12 mm Hg.
- Grade 1: pulmonary venous HTN, pulmonary vascular redistribution to the apices (venous markings \emptyset into the upper lobes), and loss of the right hilar angle — PAWP 12-19 mm Hg.
- Grade 2: interstitial edema (Kerley's B lines), hilar haze or blurriness, peribronchial vascular thickening — PAWP 20-25 mm Hg.
- Grade 3: generalized or perihilar alveolar edema — PAWP > 25 mm Hg.

Metastatic Disease



Bilateral pleural effusions are present as well as rib fractures and osteolytic lesions which are suggestive of metastatic disease.

• Distinguishing Between Cardiac Hypertrophy, Dilatation, and Pericardial

Effusion:

Plain films may show ventricular enlargement but do not differentiate between hypertrophy and dilatation.

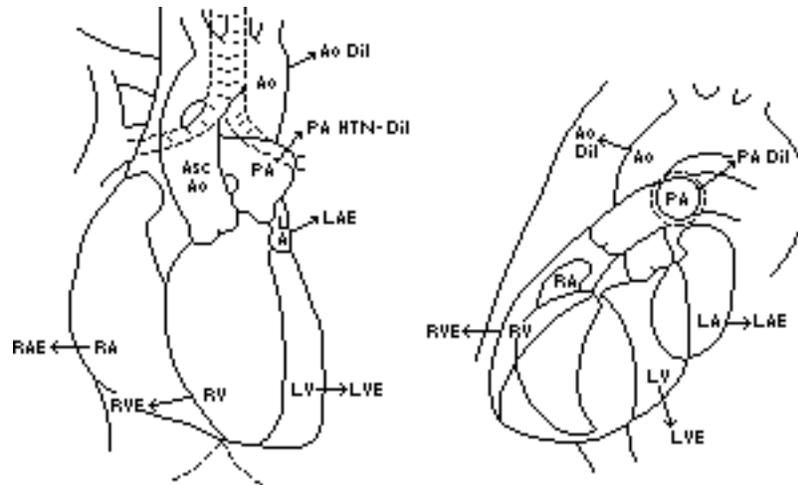
If heart is decompensating, it will tend to shapelessness and extend to both the R and L in the PA view, suggesting either failure or pericardial effusion. A review of the patient's old films is probably the best way to assess development of cardiac enlargement, in and out of failure.

Sudden shapeless _ in size should suggest pericardial effusion.

Section Three

Chamber Enlargement

- The echocardiogram is much more specific for identifying structural abnormalities and chamber enlargement. The echocardiogram also is very important for distinguishing hypertrophy from dilation and recognizing pericardial effusions.



AP View Lateral View

Ao Dil = Aortic Dilatation PA Dil = Pulmonary Artery Dilatation

Asc Ao = Ascending Aorta PA HTN-Dil = Pulmonary Artery Bulging due to

LAE = Left Atrial Enlargement Pulmonary Hypertension

LVE = Left Ventricular Enlargement RVE = Right Ventricular Enlargement

Enlargement of the Left Atrium

- CXR studies are most accurate in detecting enlargement of the LA compared to the other 3 chambers.
- LA = most posterior of the cardiac chambers and lies in the midline below the carina of the trachea and the mainstem bronchus.
- LA has 2 distinct components — a body and an appendage.

The body of the LA is centrally placed and does not form a border on the frontal view.

The LA atrial appendage is to the left of the body, immediately beneath the pulmonary artery segment, and above the LV.

- The most common findings are a double density of the right cardiac shadow, bulging the atrial appendage along the middle of the left cardiac border on the frontal view, and a posterior bulge of the upper cardiac border on the lateral view.



- LA enlargement may eventually extend it to the right so that its margin is visible along the *right* heart border, above the profile of the RA and overlapping it — the "double shadow" frequently referred to as a classic sign of LA enlargement.

- Straightening of the L heart border may be a normal finding; does not always signify increased LA size.

Filling in of the normally concave waistline may be due to fullness that is either posterior (as in LA dilatation) or anterior (as in any condition such as post stenotic dilatation in pulmonic stenosis, or dilatation due to PDA).

- LA enlargement in mitral disease cardiac enlargement — elevation of the L main bronchus just above the L 8th rib, double shadow along the R heart border, ? straightening of L heart border (? due to slight fullness of main pulmonary artery).

Left Ventricular Hypertrophy



There is moderate cardiac enlargement. Pulmonary vascular congestion and mild pulmonary edema are present.

Enlargement of the Left Ventricle

- LV forms the apex of the heart on the frontal view.
- With dilation, the cardiac apex is displaced downward toward the diaphragm and to the left; shadow of aortic arch may be flattened.
- With hypertrophy, the apex becomes rounded.
- LV enlargement often a/w aortic stenosis and chronic HTN both of which may cause enlargement of the aorta.



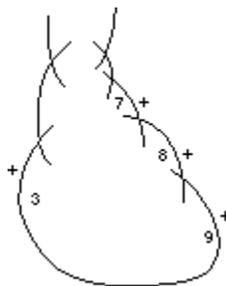
- Lateral film — rounded posterior projection of LV; border of heart is extended posteriorly and low against the diaphragm.

Enlargement of the Right Side — more difficult to recognize.

- RA forms the right lateral cardiac border. The RV is normally an anterior midline chamber located directly behind the sternum.
- RA enlargement fills in the space behind the sternum.
- RV enlargement — enlarges in cor pulmonale and in pulmonic stenosis; CXR (PA) may be deceptively normal or show displacement of normal LV to the left.

Pulmonary artery often enlarged concomitantly.

May also see LV and LA enlargement if Lateral film — filling in of the lower part of the anterior clear space + flat posterior surface of the heart. Heart is *not* extended posteriorly.



Chest X-Ray Findings with Myocardial Dysfunction

- A large heart on CXR films supports the dx. of systolic myocardial dysfunction.
- A lateral view is often helpful to check for right-sided failure. If the space behind the sternum is filled in, right-sided heart failure and RV dilation are possible.

- Echocardiography is most useful for identifying enlargement of a specific chamber and separating dilation from hypertrophy.
- _ vascular markings in the upper lobes are 2° to increased filling pressure of ~ 13-18 mm Hg.
- Interstitial edema (Kerley's B lines) suggests a LV end-diastolic pressure of 19-25 mm Hg.
- Alveolar infiltrates (pulmonary edema) are consistent with a LVEDP > 25 mm Hg.
- Blunting of the margins is due to effusion.
- CXR can help rule in or out other causes of dyspnea such as pulmonary fibrosis or COPD.

Chest X-Ray Findings with Myocardial Ischemia

- Special x-ray imaging (fluoroscopy or CT) can demonstrate coronary artery calcification, but this is an uncertain marker. It has not had the test characteristics that were originally anticipated because calcification of the arterial walls is not necessarily a/w luminal occlusion, particularly in older individuals.

Chest X-Ray Findings with Valvular Dysfunction

- Signs of CHF and chamber enlargement can be detected using chest x-ray studies.
- Valvular calcification can sometimes be seen.

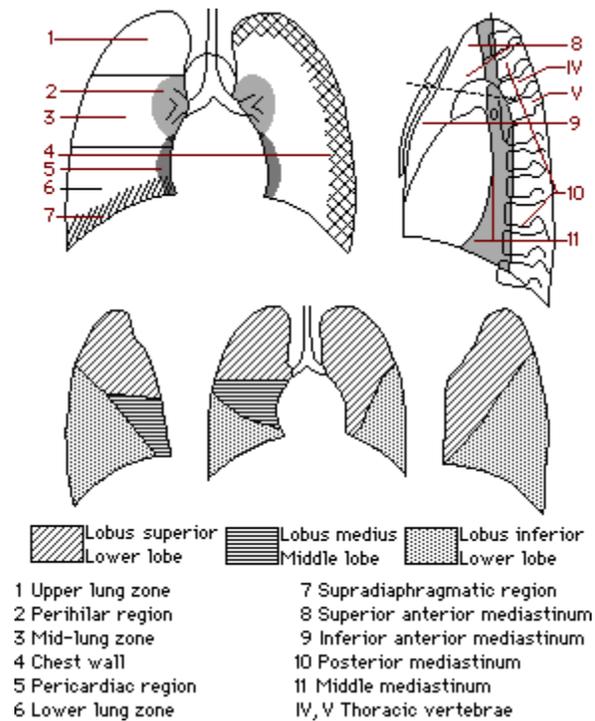
Chest X-Ray Findings with Poor Exercise Capacity

- Signs of pulmonary disease can suggest a noncardiac limitation to exercise and a large heart could suggest cardiac disease.
- Signs of CHF can offer the possibility of a cardiac cause for a change in exercise capacity.

Chest X-Ray Findings with Arrhythmias

- Films are of little use in the diagnosis of arrhythmias. However, finding problems that are often a/w arrhythmias, such as cardiac enlargement and lung disease, should alter one to the possibility of arrhythmias.
- The straight back syndrome or pectus excavatum was thought to be a/w with mitral valve prolapse and arrhythmias.

RADIOLOGIC SIGNS OF PULMONARY DISEASE



1. Trachea and carina — PA and lateral

2. Major bronchi — PA and lateral

3. Pleura

4. Left — upper and lower lobe representation — PA and lateral

5. Right — upper, middle, and lower lobe representation — PA and lateral

6. Differences in density, upper and lower lung fields — reason

7. Peripheral vasculature — in a PA film the peripheral vasculature is normally seen out to the lateral one inch of the films and is more clearly delineated in the lower lobes than the apices

8. Silhouette sign

9. Air bronchogram sign

10. Solitary Pulmonary Nodules

Well-circumscribed, approximately round lesion that is < 4-6 cm. in diameter on CXR.

By definition, it is completely surrounded by aerated lung.

AKA a "coin lesion."

Pulmonary masses are > 4-6 cm. in diameter.

Calcification of the lesion, absence of a history of tobacco use, and age < 35 years are important factors that strongly correlate with benign nodules.

Noncalcified lesions can be benign or malignant.

Even benign calcification does not exclude the presence of coincidental malignancy in adjacent tissue or the subsequent degeneration of a previously benign process into a malignant lesion.

Close observation with serial CXRs every 6 mo. for at least 2 years is prudent.

Cavitating lesions, lesions with multilobulated or spiculated contours, and lesions with shaggy or extremely irregular borders tend to be malignant.

Benign nodules tend to grow at either very slow or very rapid rates.

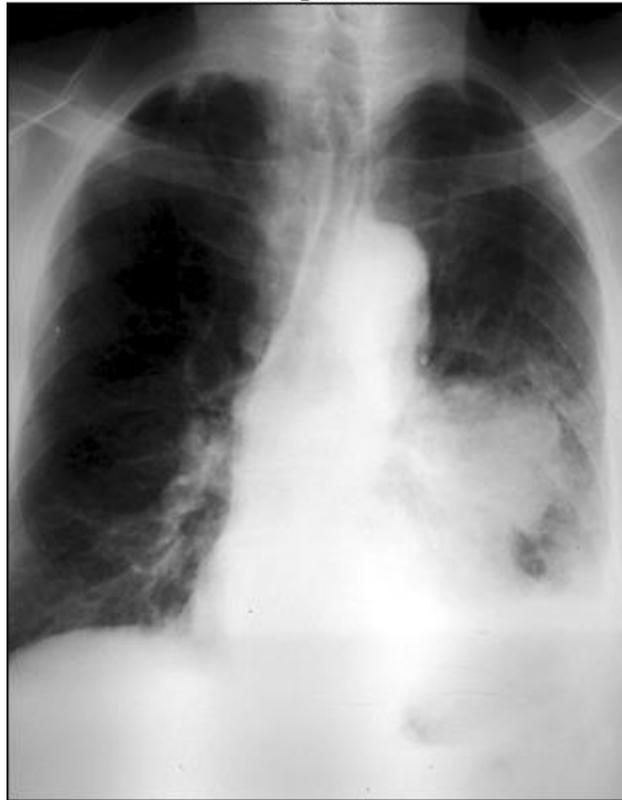
In contrast, malignant processes grow at steady, predictable, exponential rates.

The growth of a nodule is conventionally defined as the doubling time (time required for its *volume* to double) and corresponds to an increase in diameter by a factor of 1.26.

In general, doubling times > 16 months or < 1 month are associated with benign processes.

If a nodule has not increased in size over a 2-year period, the probability that it is benign is > 99%.

Lung Cancer



The chest X-ray shows an irregular left lung mass which the radiologist interpreted as probably due to a primary lung cancer with possible adjacent pneumonia.

SIX COMMON PATTERNS OF CALCIFICATION IN SOLITARY PULMONARY NODULES

Adapted from: Webb, W. R. (1990). Radiologic evaluation of the solitary pulmonary nodule.

American Journal of Radiology, 154, 701-708.



-----A-----B-----C-----D-----E-----F-----
 _____ Diffuse _____ Central _____ Popcorn _____ Laminar _____ Stippled _____ Eccentric _____

Concentric

The first four are almost always benign; the latter two may be benign or malignant.

RADIOLOGIC SIGNS OF ALVEOLAR LUNG DISEASE

• **Hypersensitivity Pneumonitis** (Extrinsic Allergic Alveolitis)

Perihilar haziness and peripheral alveolar infiltrates.

Chronic disease — abnormalities indistinguishable from fibrosing alveolitis are commonly found — reticulonodular parenchymal infiltrates, dense fibrotic areas, and decreased lung volumes.

Hilar adenopathy is not found.

Signs/Symptoms of Acute Exposure — fever, chills, anorexia, shortness of breath, dry cough; tachypnea, pyrexia, tachycardia, dry basilar inspiratory rales without rhonchi; occasionally, cyanosis or restlessness indicating hypoxemia.

Signs/Symptoms of Chronic Exposure — shortness of breath, mild fever, weight loss, fatigue, malaise, dry cough, dyspnea on exertion, tachypnea; above signs + ? cor pulmonale (neck vein distention, hepatojugular reflex, hepatomegaly, ankle edema, ascites, loud P₂, increased RV activity with a parasternal lift and parasternal S₄ gallop).



Section Three



RADIOLOGIC SIGNS OF INTERSTITIAL LUNG DISEASE

• **Reticular** — lung parenchyma replaced by many thin-walled cysts (lesions less than 10 mm in diameter), hence the term "honeycomb" lung, these microcysts may be barely perceptible, round or oval, giving the lung the radiologic appearance of a fine network.

Seen in disseminated interstitial diseases such as eosinophilic granuloma of the lung, scleroderma, pneumoconiosis (diseases caused by inhalation of organic or inorganic matter), idiopathic pulmonary fibrosis, sarcoidosis, and other, less common disorders.

• **Miliary, Nodular** — numerous discrete, tiny (< 5 mm), uniform densities; evenly distributed throughout the lungs; quite uniform in size.

Seen in miliary tuberculosis, other fungal diseases (histoplasmosis), pneumoconiosis, histiocytosis X (early stage), pulmonary hemosiderosis (late stage) and primary amyloidosis.

• **Reticulonodular** — mixture of the two previously described patterns.

May predominate in one or another portion of the lung in the diseases described.

- **Kerley's Lines** — most commonly encountered in CHF and interstitial pulmonary edema; may be quite transient in these conditions.

May represent a constant, irreversible finding in other interstitial disease, esp. pneumoconiosis, lymphatic spread of neoplasm, lymphatic mitral valve disease, and COPD.

Kerley B Lines — usually < 2 cm in length and about 1 mm in thickness.

Not confined to the margins of the lung.

Attributed to increased tissue and/or fluid accumulation in interlobular septa; also referred to as septal lines.

Kerley A Lines — usually ~ 4 cm in length, relatively straight, linear densities.

Tend to be oriented perpendicular to the nearest pleural surface.

Attributed to increased tissue and/or fluid accumulation in communicating lymphatics between veins and bronchi.

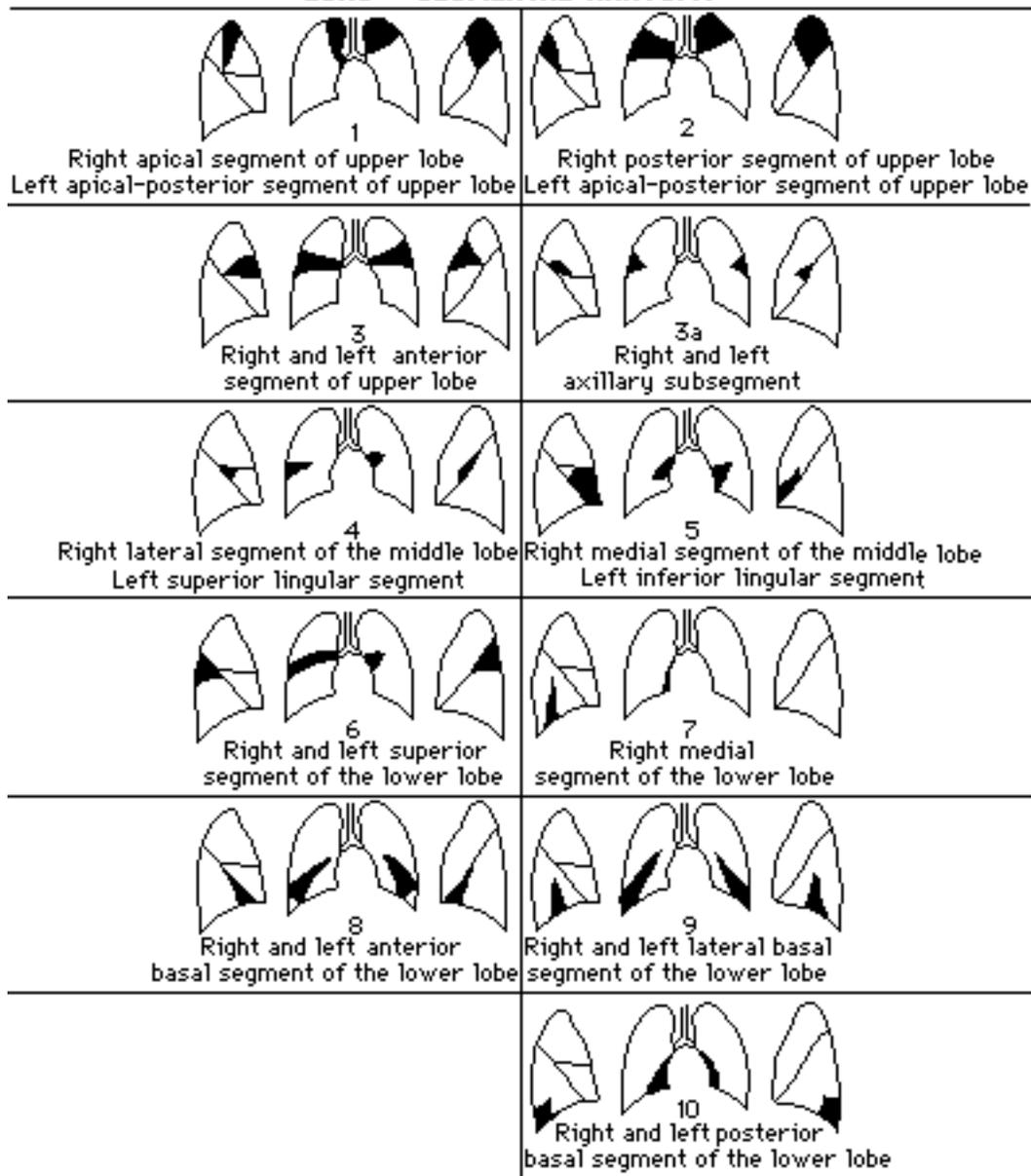
- **Exaggerated Bronchovascular Markings** — ill-reputed sign; lacks specificity in terms of pathologic correlation.

May refer to a lack of crispness of the margins of structures initially giving rise to the linear densities within aerated lung. Caused by excessive tissue or fluid displacing air-filled lung from the interstitial structures.

- Inability to detect radiologic signs of alveolar consolidation on abnormal CXRs such as the air bronchogram sign.

- Majority of interstitial diseases are chronic. Principal exceptions are viral pneumonia, drug-induced pneumonia, and pulmonary edema.

LUNG – SEGMENTAL ANATOMY



• Viral Pneumonia

Patchy alveolar consolidation usually; rarely a predominance of interstitial abnormalities.

• Drug-Induced Pneumonia

Nitrofurantoin-Induced Pneumonia

Interstitial lung changes, principally a basal reticular infiltrate.

Presents acutely with chills, fever, quite severe dyspnea, and nonproductive cough within hours or days of the initiation of nitrofurantoin therapy.

Likely to have moderate peripheral eosinophilia.

Bilateral Interstitial Infiltrate



There is an interstitial infiltrate throughout both lung fields. Hilar lymphadenopathy is also present. The impression of the radiologist included pneumonia, tuberculosis, or other granulomatous disease.

Pulmonary Edema

Mixed alveolar and interstitial edema.

Apical redistribution of blood flow — results in increased size of upper lung vasculature and background veiling of the pulmonary parenchyma initially.

Subpleural edema, peribronchial cuffing, bronchiolar cuffing, hilar haziness, haziness of vessel detail, reticular pattern, and basilar septal lines.

Kerley B lines are present at the periphery of the lung bases and may be quite prominent — represent thickened interlobular septa.

Usually, enlargement of the heart (if cardiogenic in origin) and redistribution of the pulmonary vasculature (appears esp. engorged in the upper lung zones).

• **Idiopathic Pulmonary Fibrosis** (Hamman-Rich disease) Reticular pattern (honeycombing).

Most common "etiology" of disseminated pulmonary fibrosis.

Differential Diagnosis of Interstitial Lung Disease

Pneumoconiosis Primary Lung Diseases

Silicosis

Sarcoidosis

Asbestosis

Histiocytosis X

Coal Worker's pneumoconiosis

Lymphangiomyomatosis

Berylliosis

Lymphangitic carcinomatosis

Organic dusts (pigeons, turkey, duck, chicken, humidifier) Lipoidosis

Emphysema

Drugs

Cystic fibrosis

Chemotherapeutic agents (busulfan, bleomycin, methotrexate)

Antibiotics (nitrofurantoin, sulfonamides, INH)

Alveolar Filling Disease

Diffuse alveolar bleeding (Goodpasture's/Amiodarone syndrome, lupus, mitral stenosis, Penicillamine idiopathic pulmonary hemosiderosis)

Lupus-like reactions (hydralazine, procainamide)

Alveolar proteinosis

Radiation

Alveolar cell carcinoma

Eosinophilic pneumonia

Connective Tissue Disease

Lipid pneumonia

Systemic lupus erythematosus

Rheumatoid arthritis

Infectious Diseases

Scleroderma

Miliary tuberculosis

Polymyositis

Some fungal and viral infections

Other Cardiovascular Diseases

Idiopathic pulmonary fibrosis

Interstitial pulmonary edema

Bronchiolitis obliterans organizing

Pulmonary hemosiderosis 2° to mitral pneumonia stenosis

Lymphocytic interstitial pneumonia

Amyloidosis

• **Pulmonary Sarcoidosis** — lymphadenopathy always precedes or presents concurrently with pulmonary changes of the disease.

± Hilar and paratracheal adenopathy.

Intrathoracic lymphadenopathy (75%)

Diffuse parenchymal disease (50%)

Exclusively hilar lymphadenopathy initially (33%)

Pulmonary disease without hilar lymph node enlargement (25%)

Lung involvement varies from a miliary nodular pattern, to a reticulonodular pattern, to a purely reticular pattern (honeycombing).

Occasionally patients exhibit mx. large granulomas simulating metastatic neoplasm.

Likely that a miliary nodular form precedes the reticular pattern.

Progression to marked pulmonary fibrosis of bullous emphysema with disabling functional impairment, development of cor pulmonale, and death occurs in a small % of cases.

Majority of patients remain relatively asymptomatic.

• **Scleroderma**

Great majority of patients with abnormal pulmonary function studies do not exhibit radiologically

discernible pulmonary changes.

?? Relatively fine network of reticular infiltrates (honeycombing); generally restricted to the lower lung zones.

Radiologic demonstration of abnormalities of esophagus, duodenum, small bowel, or terminal phalanges more likely to be seen.

Recurrent or chronic aspiration of ingested material may be underlying cause of pulmonary fibrosis.

• **Histiocytosis X** — includes Letterer-Siwe disease, Hand-Schüller-Christian disease, and eosinophilic granuloma. Only eosinophilic granuloma occurs in adults.

Coarse, reticular interstitial pattern.

Individual cysts comprising the coarse reticular or honeycomb pattern are generally less than 5 mm in greatest dimension, although large cysts of up to 6 cm in diameter have been reported.

Pneumothorax = relatively frequent complication.

2/3 deny dyspnea; 2/3 have dry cough; systemic symptoms = lassitude, weight loss, and less

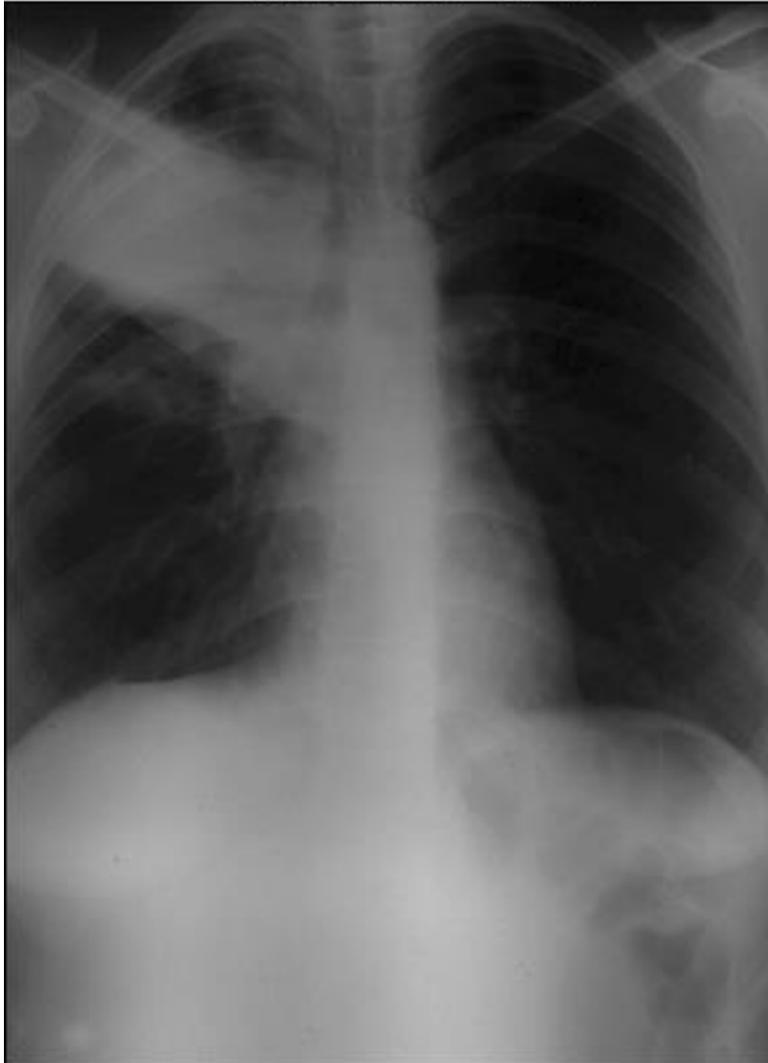
commonly, fever may predominate in 1/3.

Diabetes insipidus may be an associated disorder.

Systemic form — ? involvement of bone, liver, CNS, kidneys, and alimentary tract.

• **Pneumonia**

Bronchopneumonia



A large infiltrate is present in the right upper lung field. This radiographic finding was interpreted as suggestive of bronchopneumonia.

Bilateral Bronchopneumonia



A bilateral infiltrate is present, consistent with bronchopneumonia.

IATROGENIC RADIOLOGIC SIGNS

- A. ECG leads
- B. Endotracheal tube — positioning
- C. CVP and PA lines

GLOSSARY

Air bronchogram — Surrounding consolidation will sometimes allow more peripheral bronchi to be seen as tubular or branching lucencies. Normally only the trachea, mainstem bronchi, and occasionally the origins of the lobar bronchi, are visible on CXRs as air-filled tubular structures. Visualization of the more peripheral bronchi with air in them is usually not possible.

Alveolar (consolidative) densities — An abnormal density caused by the collapse or, more often, the filling of air spaces with abnormal material (blood, pus, water, protein, or cells). Alveolar densities characteristically have irregular, hazy margins except where they are bounded by a pleural surface. (Also referred to as "acinar pattern".) Segmental distribution and air bronchograms are also characteristic of this pattern.

Atelectasis — Collapse and volume loss are synonymous terms. Very small areas of atelectasis often produce a linear shadow, which is often, but not always, horizontal. This is referred to as "plate-like", "linear", or "subsegmental" atelectasis. Lobar and total lung atelectasis also occur. These larger varieties of atelectasis are usually associated with increased density in the involved portion of lung so that there is, in fact, consolidation present as well. To diagnose atelectasis, there must be a specific evidence of volume loss such as displacement of a fissure, the mediastinum, or a hilum. Elevation of the hemidiaphragm and decreased space between ribs can also be signs of atelectasis.

Bleb — A small, thin-walled, air-containing structure. This term is frequently reserved for such small areas which are frequently intrapleural. This term may be used synonymously with "bullae" but often is reserved for smaller air spaces.

Bronchiectasis — Dilatation of a bronchus or bronchi, usually secreting large amounts of offensive pus. Dilatation may be in an isolated segment or spread throughout the bronchi.

Bulla — See "bleb" or "cavity." These abnormal air spaces may or may not be associated with diffuse pulmonary emphysema.

Caseous — cheese-like.

Cavity — Another form of air space in the lung. This term is usually reserved for those which are the result of tissue necrosis, unlike bullae. Thickness and irregularity of the walls often the distinguishing feature separating cavities from bullae or blebs.

Consolidation — Filling of pulmonary air space with some abnormal material. May also be referred to as "alveolar disease."

Density — A nonspecific term that can be used to describe any area of whiteness on the chest film. Normal structures such as the heart as well as abnormalities in the lungs may be called densities. This term is often used when the nature or cause of an abnormal shadow is not known. It is a useful term in that situation, since other terms (e.g., "mass" or "infiltrate") frequently imply more specific entities which may or may not be present.

Extra-pleural — Anything that is outside both the parietal and the visceral pleura but that impinges on the lungs. The heart is the most obvious example. Since normal or abnormal structures in this location are separated by two layers of pleura from the lung, the margins of these densities are characteristically sharp and smoothly tapering.

Hilum (pleural = hila.) — "lung root;" medusa-like tangle of arteries and veins on either side of the heart shadow. Irregular medial shadow in each lung where the bronchi and pulmonary arteries enter. Other structures in these areas, particularly lymph nodes, are normally so small as to be inapparent. The normal hilar shadow is almost entirely composed of the central pulmonary arteries. R hilar vessels seem to extend out farther than those on the L because a part of the L hilum is obscured by the shadow of the more prominent L side of the heart. The L hilum on a normal CXR is a little higher than the R one because of the slightly higher take-off of the L pulmonary artery.

Interminate or mixed lung disease — This category of diffuse lung disease is frequently used when the radiographic criteria to designate a specific pattern (consolidative, interstitial, etc.) may not be present, or when there may be elements of several types of diffuse lung disease in the same patient.

Infiltrate — A poorly defined abnormal pulmonary density or any such density sharply bounded by pleura and fissures. This is a confusing term, since it may be used to indicate any abnormal lung density or, by others, as a synonym for consolidation. Synonymous with "fluid density."

Interstitial — The portion of the pulmonary parenchyma that consists of the actual lung tissue as opposed to the air spaces. Includes alveolar walls, septa, bronchovascular structures, and pleura. Involvement of this tissue is a frequent form of diffuse lung disease.

Kerley's lines — most commonly encountered in CHF and interstitial pulmonary edema; may be quite transient in these conditions; may represent a constant, irreversible finding in other interstitial disease, esp. pneumoconiosis, lymphatic spread of neoplasm, lymphatic mitral valve disease, and COPD.

Kerley B (septal) lines — usually < 2 cm in length and about 1 mm in thickness; *not* confined to the margins of the lung; attributed to tissue and/or fluid accumulation in interlobular septa; thickening of interlobular septa for any reason may allow them to be seen as narrow, straight shadows, especially at the periphery of the bases; another form of interstitial abnormality.

Kerley A lines — Usually ~ 4 cm in length, relatively straight, linear densities; tend to be oriented perpendicular to the nearest pleural surface; attributed to tissue and/or fluid accumulation in communicating lymphatics between veins and bronchi.

kVp — Peak kilovoltage; the peak voltage across the radiographic tube. An increase in this factor allows increased tissue penetration by higher energy roentgens.

Lingula — (tongue-shaped) area of left lung adjacent to the left ventricle not a separate lobe.

Lucency — An increase in blackness of an area on the radiograph. In the lung, it may imply that air is being trapped, that lung tissue has been destroyed, or that there is decreased blood supply. Artifacts, changes in position, and soft tissue abnormalities can also cause areas of lucency.

milliampereseconds (mAs) — This is the amount of current through the radiographic tube. The amount of current and the length of time during which the current flows control the quantity of x-rays generated. Increasing the mA causes an increase in patient exposure to ionizing radiation and produces more x-rays to create an image on the film.

Mass — A solid-appearing, reasonably well-defined soft tissue density usually larger than 3 or 4 cm in diameter.

Mediastinal — Referring to the structures or a lesion between the lungs. Unless the lungs are actually invaded by a mediastinal lesion, the lesion's x-ray shadow will be extra-pleural and, therefore, usually will have sharp demarcation from the lung.

Miliary — A form of diffuse lung disease consisting of countless very tiny nodular densities.

Nodule — A well-defined, more or less round density in the lung; smaller than a mass. No rigid size distinction between a "mass" and "nodule" is possible.

Opacity — Synonym for "density."

Pleural — Refers to an abnormality arising in the pleura or pleural space. Most commonly this is free of loculated fluid.

Pneumothorax — Free air in the pleural space; may be modified by the following descriptive terms "hydro-, pyo-, hemo-, chylo-, tension."

Pulmonary edema — defined radiographically as diffuse, bilateral consolidation by fluid; other materials can fill air spaces bilaterally and give the same radiographic pattern.

Reticular — A fine branching pattern with lines radiating in all directions; one of the signs of the interstitial pattern.

Segmental — Limited to specific bronchopulmonary segments or lobes. Segmental distribution of disease usually indicated bronchial or vascular involvement and is most common in consolidation.

Septal lines — see Kerley B lines.

Silhouette sign — Normally an interface is seen between areas of different density as between shadows of the heart and lung. Loss of air on the pulmonary side, usually because of consolidation, may cause obliteration or "silhouetting" of this normal interface. This sign is useful in localizing an abnormality or confirming the presence of abnormality. Occasionally the silhouette sign will be the only definite indication of consolidation next to the heart or diaphragm.

CHEST RADIOLOGY ARTICLES

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