CHAPTER TWO

CHEST

A system that is useful for interpretation of chest radiographs includes evaluation of the lungs, heart, mediastinum, diaphragm and bony thorax. S. K. Imes, MD, a solid teacher and a product of the University of Colorado originally taught this system to me. To that system I would add 1) the corners of the film and 2) a check of the labels. I also routinely check the medial ends of the clavicles when there are prior studies to compare. This is done not particularly to look for pathology, although occasionally abnormalities are seen, but because the clavicles are the “fingerprints” of the chest radiograph. I can’t tell you how many times I’ve caught another person’s chest film in the wrong envelope by comparing the clavicles. Keep in mind my additions to the checklist, but memorize in some order the basic system, which is:

1. LUNGS
2. HEART
3. MEDIASTINUM
4. DIAPHRAGM
5. BONY THORAX

Now let’s talk for a minute about abnormal patterns in the lungs. You will often get radiology reports describing different types of infiltrates in the lungs. The commonest are interstitial and alveolar. The difference can best be appreciated by looking at a photomicrograph of normal vs. diseased lung. Presented below is a section of normal lung as seen under the microscope. (Figure #4).

*Figure #4. Photomicrograph of a section of normal lung. Red arrow points to a small area of fibrosis in this “normal lung” section. Green arrows show the alveolar walls and the blue arrow points to an alveolus. The black arrow indicates an artery. A bronchiole is not seen in this particular section, but the alveolar walls, the vascular walls and the walls of bronchi and bronchioles constitute the interstices of the lungs which when invaded by inflammatory cells results in (you guessed it!) interstitial infiltrate. Courtesy of MedCenter One, Bismarck, N.Dak., Dept. of Pathology.*
For radiologic-pathologic correlation a PA (posterior-anterior) view of a normal chest is presented in Figure # 4a below.

*Figure # 4a. Normal chest. Note the appearance of the bronchovascular markings (red arrows) just above (cephalad) of the hemidiaphragms. Compare to other abnormal cases presented later in the text. The markings are called bronchovascular because small pulmonary arteries, veins and bronchioles travel together throughout the lungs and cannot be separated grossly in the radiograph unless there is disease present. See text for explanation of silhouetting.*
In the photomicrograph above (figure # 4, page6) you will note the normal relationship of the small bronchioles to the tissue that separates them from the alveolar cells, adjacent vessels etc. This tissue is the interstices of the lungs, and if inflammatory cells such as neutrophils and phagocytes invade it, we see the gross result as interstitial infiltrate, as demonstrated in the photomicrograph below (figure #5).

Figure # 5. Photomicrograph of a section of lung in a patient with acute interstitial pneumonia. Red arrow shows beginning alveolar filling as well, which is what happens as the inflammation progresses. The black arrows show the invasion of the interstices by inflammatory cells. The green arrows point to small arteries. Courtesy of MedCenter One, Bismarck, N.Dak., Dept. of Pathology.

Figure # 5a

Photomicrograph of a patient with chronic or usual interstitial pneumonia. Note the increased amount of fibrosis (red arrow). The black arrows point to deposits of anthracosis. One would not be able to tell the difference from the acute phase on a chest radiograph until comparison films showed the process to have not changed significantly over a period of time. Courtesy of MedCenter One, Bismarck, N.Dak., Dept. of Pathology.
Interstitial infiltrate can be recognized in the chest radiograph by the phenomenon of silhouetting, which is basically a rule that states:

**Any two water density structures that touch each other will obliterate the border between them.**

This rule gives the diagnostic radiologist a tremendous advantage in several areas as we will see later, but in the case of interstitial infiltrate it allows us to recognize it for what it is by the following observations:

1. The bronchovascular markings lose their borders and become fuzzy.

2. The air in a bronchus stands out as an "air bronchogram" because the water density inflammatory cells in the interstices of the lung silhouette out the wall of the bronchus.

**Note the result in the chest radiographs of patients with typical interstitial pneumonia.** In both cases below there are also some alveolar filling. The bright dots over the left side of the chest represent Bb’s or buckshot in the soft tissues. The second case (Fig. 6a) shows an air bronchogram that is typical for pediatric (in this case- adolescent) pneumonia and the student should look for the phenomenon in all sick children.

![Figure # 6](image)

*Figure # 6.* The red arrows point to typical air bronchograms in a patient with a segmental pneumonia. Note there is no silhouetting of the right heart border, indicating the infiltrate is in one of the posterior segments of the right lung base.
A note of caution: If a shallow inspiration radiograph is presented for interpretation the bronchovascular markings might not be separated enough to distinguish a real interstitial infiltrate from silhouetting due to failure to get enough air between them. Also an underpenetrated film may cause you problems. Sometimes it takes a magnifying glass to be sure of the findings, especially in kids, obese patients or women with large breasts. I tell our students that if they can follow a bronchovascular marking out to its termination, then there is no silhouetting and thus no interstitial infiltrate.

Now, if the inflammatory infiltrates in the interstices progress and begin to fill in or “spill over” into the alveolar spaces, the result is an alveolar-filling infiltrate. This reaction results in a whiteout of the alveolar air spaces and is called by radiologists "alveolar filling infiltrate" or "air-space disease". In the example in figure # 7 below is a patient with this phenomenon.
Figure #7. A patient with alveolar filling infiltrate in the right middle lobe. Note the positive silhouette sign obliterating the right heart border in the PA (posterior-anterior) projection (red arrow). The yellow arrows indicate the whiteout of alveolar air spaces resulting in a solid band of consolidation in this patient who likely has some associated atelectasis of the right middle lobe as well.

There are other patterns seen in the lungs in a chest radiograph that effect the air spaces or the interstices or both, but the recognition of these still requires your evaluation of the bronchovascular markings and air spaces. Some of these patterns include disseminated small irregular shadows and are termed reticular, reticulonodular, linear, or ill defined. There are also patterns such as the honeycomb lung (interstitial fibrosis), miliary nodules, nodules (single or multiple), cavitations, interstitial edema, Kerley's lines, masses, hyper lucencies, atelectasis, pneumothorax, etc., which will all fall into place as you gain experience.

The important thing, though, is to be consistent in looking for and recognizing abnormalities, and that requires evaluations of the markings and air spaces. In figure #8 on the next page is an example of a
patient with a reticulonodular pattern. This one happens to have silicosis (occupation: sandblaster), but it could just as easily represent any other pneumoconiosis, sarcoidosis, idiopathic interstitial pulmonary fibrosis (Hamman-Rich), bronchiectasis, or even histiocytosis x. Note what happens to the bronchovascular markings.

Figure # 8 (right). Reticulonodular pattern in a patient with silicosis. Compare to the normal chest bronchovascular markings in Figure 4a (above and page 7).

Figure # 9 (left). Diffuse miliary pattern in a patient with Boek’s sarcoid.
In the case of pulmonary nodules the important things to establish are whether or not the lesion(s) are old or new, and whether or not it (they) contain calcium. The first question is usually easily answered if old studies are available for comparison. The density of the lesion(s) on the radiograph can often answer the second question. If there is still a question after careful analysis, the steps to take include chest fluoroscopy (the simplest and least expensive), plain film tomography, or CT (most expensive).

Sometimes one has to use common sense and a few weeks or month’s follow-up may be the procedure of choice vs. interventional biopsy, especially in the case of the elderly. One should also make sure the nodule in question is indeed within the pulmonary parenchyma and not an artifact, skin lesion, nipple shadow or some other red herring.

These kinds of problems are easily solved by the radiologist using fluoroscopy, repeat films with skin or nipple markers or additional views or imaging. The student also needs to have a basic knowledge of chest anatomy such as the bronchopulmonary segments and location of the fissures. For instance the right middle lobe touches the right heart border and the lingular segment of the left upper lobe is in a similar position with the left heart border. Thus silhouetting phenomena such as occurs with pneumonia will obscure these borders, making the location of the pathology easily identified.

Likewise fluid in the major or minor fissures follows a typical pathway. Illustrated below in figures 10, 11, and 11a and 11B are patients with inter lobar effusions.

Figure # 9a (left. Magnified view of a miliary pattern in the lung of a patient with miliary tuberculosis. Posterior ribs are seen in the background and a portion of the right heart border is seen in the right lower part of the section. Image courtesy of Radiology Central Resource (Brigham. Harvard Radiology. Edu) via the Internet.
Figure #10 (below). Yellow arrow points to a rounded density in the minor fissure that resembles a mass. Actually it represents an intralobar effusion, and therefore could be called a pseudotumor.
Figure # 11 (above). Blue arrows show a typical meniscus of a right pleural effusion. Note the loss of the normal right hemidiaphragm due to the silhouette sign phenomenon. The red arrows show a band of fluid in the major fissure (interlobar effusion). Note also the absence of the right breast shadow and the metastatic mass in the left mid lung field. (yellow arrowhead).

Figure # 11A (left & right). Red arrows point to fluid in the minor fissure and blue arrow shows fluid in a major fissure.
Figure # 11B. Although the patient in figure 11B has metastatic disease (orange arrow) and pneumonia, he also demonstrates a band of fluid in the minor fissure (yellow arrows). The band-like density is more commonly seen in interlobar effusions than the pseudotumor presented in figure 10.

One of the exceptions to the diagnostic triangle of objective findings, differential diagnosis and history is the "Aunt Minnie". I'm not sure who coined the term but it is commonly used by radiologists to refer to a radiograph that conjures up an instant diagnosis. That is, the picture or pattern is instantly recognized for what it is. "It looks like Aunt Minnie therefore it must be Aunt Minnie."

One of the normal "Aunt Minnies" is the aszygous lobe fissure that occurs in a small percentage of the population. Once you see one you will always recognize it for what it is. A patient with an aszygous lobe fissure is presented in figure 12.
Figure 12. Red arrows point to an azygous lobe fissure in an asymptomatic patient.
This case courtesy of The Xray Files: Teaching radiology on the Internet. Thanks to Dr. Andrew Downie. http://www.radiology.co.uk. Credit to Scottish Radiological Society. Reprinted with permission.

Figure 12A (left). Right apex close-up of another azygous lobe fissure). Red arrows point to an azygous lobe fissure, a classic “Aunt Minnie”.
Figure # 12a. Another patient with an azygous lobe fissure (red arrow) who also has pneumonia with consolidation in the azygous lobe (yellow arrows). This is an unusual occurrence and the only case I’ve seen in over 30 years of practice. Courtesy of Dr. Norb O’Keefe.

Figure 12b Classic sail sign of a normal thymus is outlined by the yellow arrows. The sail sign is another normal “Aunt Minnie”.
“Aunt Minnies” also includes some abnormalities. One such case is a chest film showing multiple nodular double densities that at first glance may seem to represent metastatic disease, as in figure 13 below.

Figure # 13. Here’s a case with multiple nodular densities and it’s also an “Aunt Minnie”. Can you spot the abnormalities before referring to the next figure?
Figure # 13a. Note the multiple nodules as indicated by the arrows. The yellow arrows show the nodules best against the fat density background of subcutaneous fat in the axillae and flank, and the red arrows show them against the background of gas in the lungs. These are multiple neurofibromas in a patient with neurofibromatosis (von Recklinghausen’s disease). Not all of the nodules are marked by arrows. The case is a classic “Aunt Minnie”.

Chronic obstructive pulmonary disease or COPD is usually recognized on a radiograph by hyperlucency of the lungs, increased A-P diameter of the chest, bullae which contain no bronchovascular markings and flattened diaphragm, the latter being the only consistent finding. Sometimes the clinical diagnostic findings are much worse than can be imagined by studying the films, since the radiographic changes are typically late in the course of the disease. Shown on the following pages are typical patients with moderately severe COPD.
Figure #14. Emphysema secondary to serum Alpha 1 antitripsin deficiency. This type of COPD is of the Panacinar type, is relatively rare and classically is more pronounced in the lower lobes or zones of the lungs. Note the hyperinflation of the lower lung fields, and attenuation (loss of or diminished) bronchovascular markings in the lower lung fields.

Figure #14a. Red arrow points to the curvilinear medial margin of an emphysematous bleb in this patient with bullous emphysema. If multiple blebs coalesce they represent so-called “vanishing lung”. As they enlarge they also represent a danger of tension pneumothorax should one of them rupture. One of my instructors had that happen while crossing a mountain pass at high altitude, as the trapped air in the bleb expanded. Figure 14a courtesy of embbs.com library via the Internet.
Obviously there are many more findings we could discuss with regards to the lungs, but the scope of this text is not intended to be comprehensive. Three of the things we should probably mention are common occurrences in emergency rooms and should be recognized by the practitioner. They include obstructive emphysema, pneumothorax and pleural based densities.

If you run into a youngster in the ER who is wheezing and short of breath, it may not represent pneumonia, asthma, or bronchitis. With any of the above there may be a normal chest radiograph or minimally hyperinflated lungs at the most. Recognizable radiographic findings are often delayed by several hours in these cases and we need to keep that in mind. One of the things to look for and be suspicious of is obstructive emphysema, a not uncommon occurrence. Evaluate the chest radiograph on the next page before checking the results in the illustration to follow.
Figure # 15. What do you see? Note that the left hemithorax looks darker than the right, which should be your first observation. The rib spaces are further apart on the left and there may be a mediastinal shift to the right. If there is a mediastinal shift there has to be either 1) atelectasis on one side or 2) excess gas (over inflated lung or possibly tension pneumothorax) on the other. Which is it and how do you prove it?
Figure #15a. The same patient as in figure 15, with the film exposed in expiration. This method exaggerates the findings confirming the mediastinal shift. Note the right hemidiaphragm moves cephalad as you would expect with expiration, but that the left hemidiaphragm is relatively immobile. This confirms the diagnosis of obstructive emphysema. The culprit was a foreign body (peanut) in the left main stem bronchus.

Pneumothorax can be recognized by the absence of lung markings peripherally, recognition of a pleural reflection or edge of a partially collapsed lung, mediastinal shift, and frequently, air-fluid levels or subcutaneous emphysema, i.e. air in the soft tissues.

One of the tricks of the trade to confirm your clinical or radiological suspicion of pneumothorax is to take a film in expiration, which exaggerates the findings. Demonstrated on the following pages in figures 16 & 17 are examples of pneumothorax.
Figure # 16. Pneumothorax is not always easily identified in poorly exposed films. Although bright lighting the film may demonstrate a suspected pneumothorax, taking a properly exposed film in expiration is the method of choice. No need for a film in expiration in the case demonstrated above. The edge of the partially collapsed right lung is easily seen (white arrows).

Figure # 17 (left), Using your system what do you see on the portable study to the left? See next page for labeled answers. Ps. We realize the film is overexposed to adequately evaluate the bronchovascular markings. This is one of those you would have to bright light or ask for a light copy.
Figure # 17a. White arrow shows pleural reflection from partially collapsed lung in this patient with a small pneumothorax. There is also a small left pleural effusion (red arrow) in this trauma victim, and I suspect at least one fractured rib (yellow arrows). Additional films would be necessary to confirm the latter. Did you note the metallic density of the tracheotomy tube (blue arrow)?

Pleural based densities are recognized by their peripheral position and include pleural fluid, pleural calcifications, extrapleural lesions and soft tissue masses frequently associated with trauma or rib destruction. Commonly pleural fluid is associated with other radiographic evidence of chest disease such as malignancy, CHF (congestive heart failure), pulmonary infarction, abscesses or trauma.

Another trick of the trade is to obtain films with the patient in a decubitus position, which allows free fluid to layer out and helps differentiate effusion from pleural thickening or solid pleural based density. In figures 18 through 22 are examples of pleural based densities.
Figure # 18. Pleural based density adjacent to the right heart border. Note there is no silhouetting of the right heart border, which indicates the density, is posterior as confirmed in the lateral view (red arrow). This particular density proved to be a loculated pleural effusion.

Figure # 19. Another pleural-based density represents a loculated or encapsulated empyema (green arrows). The red arrows point to the gastric air bubble, which gives you some clue as to where the left hemidiaphragm should be. The pleural fluid silhouettes the left hemidiaphragm out. Note that you can still identify the left heart border, so the fluid must be posterior as confirmed in the lateral projection, although it extends more cephalad than the lateral view alone would suggest.
Figure # 20. Fluid in the left pleural cavity (green arrows). The sharply outlined fluid level under the lateral green arrow suggests there is hydropneumothorax as well. Pneumothorax is also suggested by subcutaneous emphysema as indicated by the pink arrows. A film taken in expiration (not available) would likely confirm the suspected hydropneumothorax. Red arrow points to the gastric air bubble. Note the metallic density of the nasogastric tube (yellow arrows). The right heart border is silhouetted out by atelectatic lung and there is also some fluid in the right chest cavity. See correlating gross pathologic specimen photograph in figure # 21. In this case the pleural-based density is chyrous fluid secondary to lymphomatous involvement of chest lymphatics.

Figure # 21. Pleural cavity is filled with yellowish-tan fluid typical for chylothorax (red arrows). Atelectatic lung is noted in the upper left portion of the specimen photograph (yellow arrow). Figures 20 and 21 are the Courtesy of Edward Klatt MD, U. of Utah Dept. of Pathology, via the Internet.
Since major texts have been written about diseases of the lungs it is obvious that our discussion is cursory at best, but then again we are not attempting to make experts out of you, but only to give you a few tips until you are able to consult with a diagnostic radiologist on any given case. With that in mind, let us turn to the next step in our system of chest evaluation, which is the heart.

This overview should include size and shape of the cardiac silhouette, the outline of the various chambers, a look for calcifications in the valves and pericardium, the cardiac fat pads and the effect of the thoracic cage on the size and shape, variations of which you will see with conditions such as pectus deformities, surgery, COPD, and others.

One of the few measurements still valid in diagnostic radiology is the c-t (cardiac-thoracic) ratio. Most of the abnormal conditions involve cardiac enlargement. In fact you can count on your fingers the conditions that result in a small heart, which include normal variant, wasting diseases, emphysema, adrenal insufficiency, constrictive pericarditis and dehydration. Cardiomegally, on the other hand, has numerous etiologies and include all of the pathologic categories of congenital anomalies, degenerations, inflammations, physical disturbances and tumors.

The cardiac-thoracic ratio or c-t ratio, is a simple rule that says the transverse cardiac diameter should not measure more than 50% of the diameter of the rib cage. The measurement should be taken across the widest part of the heart on a PA view, and the thorax should be measured from the inside of the ribs.

Be sure you are dealing with a standard 72 " target to film distance radiograph to avoid any magnification of the heart which will occur on some portable studies or on films taken with the patient supine or in a sitting position. (The "target" is the point of origin of x-rays in the x-ray tube). Also be sure to give yourself a cm. of leeway when comparing old films to new to account for whether the film was taken with the heart in systole or diastole.

The shape of the cardiac silhouette will become familiar after seeing several normal chest films. Anything out of the ordinary, then, should be evaluated based on the suspected abnormality observed. In order to pin down the etiology of the suspected bulge or deviant outline, one must be familiar with the proportion of the various chambers visible in the PA and lateral projections. Below are photographs of a heart model as viewed from the front (really the back in a posterior-anterior or PA projection), and the side or lateral projections.

Figure # 23. AP view of heart.

Figure # 24. Right lateral view.
Figure # 25. Approximate positions of the various chambers as seen on PA and lateral views of the chest. Red outlines the right ventricle, green-the right atrium, white- the left ventricle, orange-the left atrium, and yellow- the left atrial appendage. Blue suggests the position of the interventricular septum. (PS. Did you see the pulmonary nodule in the right upper lobe? It overlies one of the vertebral bodies’ anterior margin in the lateral view. See white arrows in figure 25a below.)

Figure # 25a White arrows show pulmonary nodule.
Figure # 26. Catheter in the Inferior vena cava (orange arrow) has passed through an atrial septal defect with the tip of the catheter now encroaching on the lateral wall of the left atrium. Right atrium position outlined in green and left atrium in orange.
Figures 27 through 30 to follow show the effects of various chamber enlargements on the cardiac silhouette.

Figure # 27. With barium in the esophagus, left atrial enlargement is easily demonstrated as indicated by the blue arrow.
Figure # 28. Patient with mitral regurgitation. Left atrium enlargement is indicated by orange arrow and can be seen also as a double density in the PA view (green arrows). The transverse cardiac diameter is not particularly enlarged in this gentleman.

Figure 28a (left). Same film as figure 28 above with the contrast manipulated to demonstrate the double density of the enlarged left atrium (green arrow).

Pulmonary stenosis results in right ventricular hypertrophy and decreased pulmonary vascularity as shown above in this infant with tetrology of Fallot. The tetrology consists of 1) pulmonary stenosis; 2) ventricular septal defect; 3) dextroposition of the aorta (green arrow); and 4) right ventricular hypertrophy (yellow arrow). Note the absence of distinct bronchovascular markings, the result of diminished pulmonary blood flow. The condition accounts for about 75% of cyanotic congenital heart disease.
Figures 31 and 32 show pericardial and mitral valvular calcification respectively.

Figure # 31. Blue arrows point to pericardial calcification in a patient with a history of pericarditis.

Figure # 32. Red arrows point to mitral valve calcification, better demonstrated on the KUB than on the chest film.
Note the location and orientation of the mitral and aortic valves best demonstrated by the prosthetic valves in figures 33 and 34.

*Figure # 33 (left).* The red arrow indicates the position of the mitral valve prosthesis. The smaller white arrows point to the slightly enlarged left atrium, the result of the diseased mitral valve prior to replacement.

*Figure # 34 (right).* Note the proximity and orientation of the mitral and aortic valves as seen in a slightly oblique lateral view in a patient who has prostheses of both valves.

*Figure # 34.* Ibid.
Cardiac fat pads seem at first glance to widen the transverse diameter of the cardiac silhouette. Careful scrutiny, however, can usually separate the true outline of the heart border due to the darker density of fat in relation to the water density of heart muscle. Sometimes cardiac coelomic cysts can mimic a cardiac fat pad, especially in an under penetrated film. In that case one must accept both possibilities in the differential diagnosis, but since neither is of great clinical significance the finding is academic and only important in order to exclude pathology such as cardiomegally or tumors of the heart or mediastinum. Note the effect of a prominent fat pad on the cardiac silhouette in figures 35 and 35a.

Figure # 35. Transverse cardiac diameter shown above by the black line is in error because it includes the cardiac fat pad.

Figure 35a. True transverse cardiac diameter does not include the fat pad indicated by the quarter moon. Same radiograph as figure 35 above.
Pectus excavatum can cause a visual loss of the right heart border or an apparent mediastinal shift in the PA projection. If you have only the PA view you have to learn to be suspicious of the cause of the abnormality. You can always get a lateral view to confirm. Note the effect of a pectus deformity on the appearance of the mediastinum and right heart border in the PA view in figure 36 and the confirmation of the cause in the lateral view.

![X-ray images](image)

**Figure # 36.** The cause of the partial loss of the right heart border in the PA view of the chest above is not due to silhouetting. Experienced radiologists recognize this as an almost “Aunt Minnie”. The cause is a pectus excavatum of the sternum (red arrow) which displaces the heart to the left.

The third step in the system to evaluate the chest is the mediastinum, which can be divided into anterior, mid and posterior compartments and for our purposes, subdivided into superior and inferior portions as well.

The anterior compartment can be described as "anterior to a curved vertical line extending along the posterior border of the heart and anterior margin of the trachea" -3. It includes the heart and pericardium, the ascending aorta, thymus, the retrosternal space, various vessels, lymphoid tissue, some bronchial origins, anterior leaf of the diaphragm and on occasion, the thyroid.

The mid mediastinum is simply that area between the anterior and posterior compartments. It contains the arch of the aorta, azygos vein, other bronchial origins, esophagus, thyroid, parathyroids, trachea, vagus and phrenic nerves, vessels etc. The posterior mediastinum lies anterior to the spine but includes the thoracic gutters, and extends to the esophagus. It includes the descending thoracic aorta, posterior leaf of the diaphragm, vessels, nerves etc. It will take scrutiny of numerable films before the student becomes familiar with the normal bulges of the mediastinum. The next few figures illustrate some of the common normal and abnormal bulges we encounter in daily practice.
Figure # 38. Red arrows point to a bulge in the right superior mediastinum, which proved to be a bronchogenic carcinoma after an angiogram eliminated the possibility of a vascular shadow. (Before the days of CT access).

Figure # 39. Mass distorting the normal contour of the left side of the mediastinum (blue arrows) proved to be a non-Hodgkin’s lymphoma in a 26-year-old male. The vertical stripes over the right side of the chest are computer or scanner artifacts.
Figure # 40. Yellow arrow points to another bulge along the right superior mediastinum, but this time representing a normal finding, a prominent azygous vein. The demonstration represents another “Aunt Minnie”, although the index of confidence may not always be high in inexperienced interpreters and additional studies may be necessary to confirm a normal finding.

Figure # 41. Blue arrows point to abnormal bulges of the mediastinum, which proved to be benign teratomas.
Figure # 41. Blue arrows point to full, abnormal hilar shadows, which proved to be hilar adenopathy in a patient with lymphoma. If there is any question as to normal vs. abnormal, the problem is easily solved by a CT study.

Figure # 42. Red arrows point to abnormal mediastinal contour, which proved to be another lymphomatous mass.
Red arrows point to a more subtle abnormality in the anterior mediastinum. Note partial silhouetting of the arch of the aorta. The CT images below confirm the presence of a thymic mass, which proved to be malignant carcinoma.

In figure 45 above the blue arrow indicates the arch of the aorta in this CT study. The aorta is filled with iodinated contrast, which accounts for its bright white appearance. Remember that when you look at a CT (Computerized Tomogram) study, you are observing a cross section of anatomy as if you were standing at the patient’s feet with the patient supine. Thus the patient’s right side will be to your left.

The red arrows point to the thymic mass. Note the encroachment on the arch of the aorta, which accounts for the positive silhouette sign.

Double densities are another thing to explain. For example the figures below show mediastinal densities not seen on a normal radiograph of the chest.

*Figure # 46.* Small black arrows point to gas density overlying the cardiac silhouette. The gas in this case represents gas in the fundus of the stomach and is thus diagnostic of a hiatus hernia. If it had an air fluid level it would be considered an “Aunt Minnie”.

*Figure # 47 (left).* The lateral view of the patient in figure #46 shows the gas bubble in the herniated stomach above the diaphragm (small arrows). The lateral view also shows an air fluid level in the stomach (red arrow) confirming the diagnosis of hiatal hernia. *Images courtesy of embbs.com library via the Internet.*
Figure # 48. **Red arrows point to a “tube” of gas density in the right side of the mediastinum.** Can you offer an opinion as to what it might represent?

Figure # 49. **Actually after you have seen a few of these, they become “Aunt Minnies”.** With barium in the upper GI tract, it is obvious this patient has had a sub-total esophagectomy with a gastric pull-through for carcinoma of the esophagus. The red arrow points to gas in the fundus of the stomach, which you saw on the chest radiograph. One does not ordinarily see gas in the esophagus unless there is an obstruction distally (not uncommon), a severe infection with gas forming organisms (very rare), or in the case of some newborns, a TE fistula.
Figure # 50 (right). Yellow arrow points to a double density along the right border. Can you offer an opinion as to the cause? Do you see any other clues? For answer refer to figure 51 below.

Figure # 51 (left). Red outlined arrow points to a relatively horizontal left mainstem bronchus, which is elevated by an enlarged left atrium, secondary to mitral valvular stenosis. Compare to figure 28.
Figure # 52. Red outlined arrows point to a double mediastinal density. Note that it does not silhouette out the left heart border or left pulmonary artery. What do you need to make the diagnosis?

Figure # 53. The answer to the above question is a lateral view. The red outlined arrows point to the posterior margin of a descending thoracic aortic aneurysm.

Images courtesy of Challenger Corporation via the Internet.
Figure # 54 (right). Red arrow points to another double density in the mediastinum, this time representing gas density, but not in a location for hiatus hernia. Can you offer an opinion as to what it might be? See figure 55 below. For green arrow see text in figure 55 below.

Figure # 55 (left). Barium in the esophagus demonstrates a large diverticulum (red arrows) containing a bezoar (yellow arrow) and air (blue arrow) which accounts for the double density seen on the plain film radiograph. Also note a calcified granuloma (green arrows) which was present in figure 54 but not well demonstrated in the underpenetrated film.
The next item in your system for evaluating the chest is the diaphragm.

Evaluation of the diaphragm is relatively easy compared to the rest of the chest. Remember that you are only seeing the anterior leaf of the diaphragm in the PA projection except for the costophrenic angles and that there is a lot more of the lungs below the anterior leaves. This is where the value of the lateral projection comes in handy to explain any double densities or shadows you are worried about. The silhouette sign is extremely important in assessing for fluid or pleural thickening, and in order to tell the difference a lateral decubitus view will answer the question of free fluid, especially if no prior films are available for comparison.

There is also a variant of the diaphragm with which you should become familiar which is an eventration, simply a weakness of the muscle fibers of the diaphragm usually congenital in origin, and which can effect either leaf. Eventrations cause the hemidiaphragm to appear elevated, but usually are of no clinical significance or importance in asymptomatic adults. Eventrations in the newborn may cause respiratory distress in some cases and are subject to surgical intervention. In utero they may be a precursor to diaphragmatic hernia.

Abnormal defects in the diaphragm include Bochdalek's hernia (remember B for back) in the posterior portion, Morgagni's hernia (which is more anterior), ruptures of the diaphragm and other hernias.

Calcification in the diaphragm is almost pathognomonic for asbestos exposure. Illustrated below are some of these "aunt Minnies".

Figure # 56. Blue outlined arrows point to a gas filled structure superimposing the left heart border in the PA projection and seen to be anterior in the lateral projection. This is a classical presentation of a foramen of Morgagni hernia as confirmed in barium GI series in figure 57.

Images in figures 56 and 57 courtesy of Madigan Army Medical Center via the Internet.
A Bochdalek hernia, demonstrated below, is the most common of the diaphragmatic hernias and the most common surgical emergency of the neonate when it compromises lung capacity.
The last major system to evaluate in the chest radiograph aside from a couple of other tips is the bony thorax. It requires just one rule: Look at every bone! I tell my students that after looking at chest radiographs for 30 years I can usually see everything at once but that it took years of practice and looking at every bone before I felt comfortable with it. I still carefully examine every bone, (now using a magnifying glass) if looking for fractures or metastatic pathology. I further inform them that to reach a level of competence, the practice of scrutinizing each bone is an absolute necessity, and that to program that computer between their ears to easily spot abnormalities of the bony thorax can not be done in a short period of time. Just to illustrate the point, see if you can spot the bony abnormalities in the following figures before reading the answers under each picture.

Figures # 60 & 61 (right and below right).
Red arrows point to diaphragmatic calcifications in this patient with documented asbestos exposure.
Figure #63. See if you can spot any bony abnormalities (subtle) before referring to the sketch below.

Computer sketch of figure 63 (left). Red arrows point to rib notching in this patient with coarctation of the aorta.
The next case (below) demonstrates another bony abnormality that may be difficult to see for the inexperienced eye. See if you can spot it.

*Figure # 63a (left). Here’s another case of rib notching (red arrows) in a patient with coarctation of the aorta. The negative study of an aortic arch angiogram in this same patient shows the coarctation (white arrow) in Figure # 63b (below). Films courtesy of Cornell U. Medical College via the Internet.*

*Figure # 64(above). Look carefully at the bony thorax. Can you spot an abnormality?*
Figure #65. (above). Red arrow points to the inferior margin of the left second rib. There is no discernible inferior cortex. Tomograms of this area shown in figures 66 and 67 on the next page demonstrate the bone destruction caused by metastatic carcinoma.

(A tomogram or laminogram is a technical study that blurs everything on either side of a designated focal point, which can be adjusted from the height of the x-ray table on which the patient lies. Thus by “stepping through” an area of interest fine line detail can be ascertained).
Figures #66 and 67. **Red markers and arrows show the rib destruction caused by metastatic carcinoma.**

Aside from the systems evaluation of the chest radiograph, remember a couple of other important tips: 1) check the patient's ID, 2) compare the ends of the clavicles 3) check the left and right markers, 4) look at the corners of the film.

If you use a system, preferably the one we gave you here, it won’t be long before you will begin to see things that you would have missed before. Remember for the chest it’s:

- **LUNGS**
- **HEART**
- **MEDIASTINUM**
- **DIAPHRAGM**
- **BONY THORAX**
- **CORNERS**
- **ID-CLAVICLES**
- **RIGHT & LEFT MARKERS**