

## **An Introduction to CHEST RADIOGRAPHY For Student radiographers**

Details of the projections mentioned can be found in a selection of text including the latest edition of Clark's Positioning in Radiography which should be the standard for techniques.

Suggested reading for further information the following texts should be consulted.

Radiographic Anatomy of the Chest and Abdomen. (Chesney)

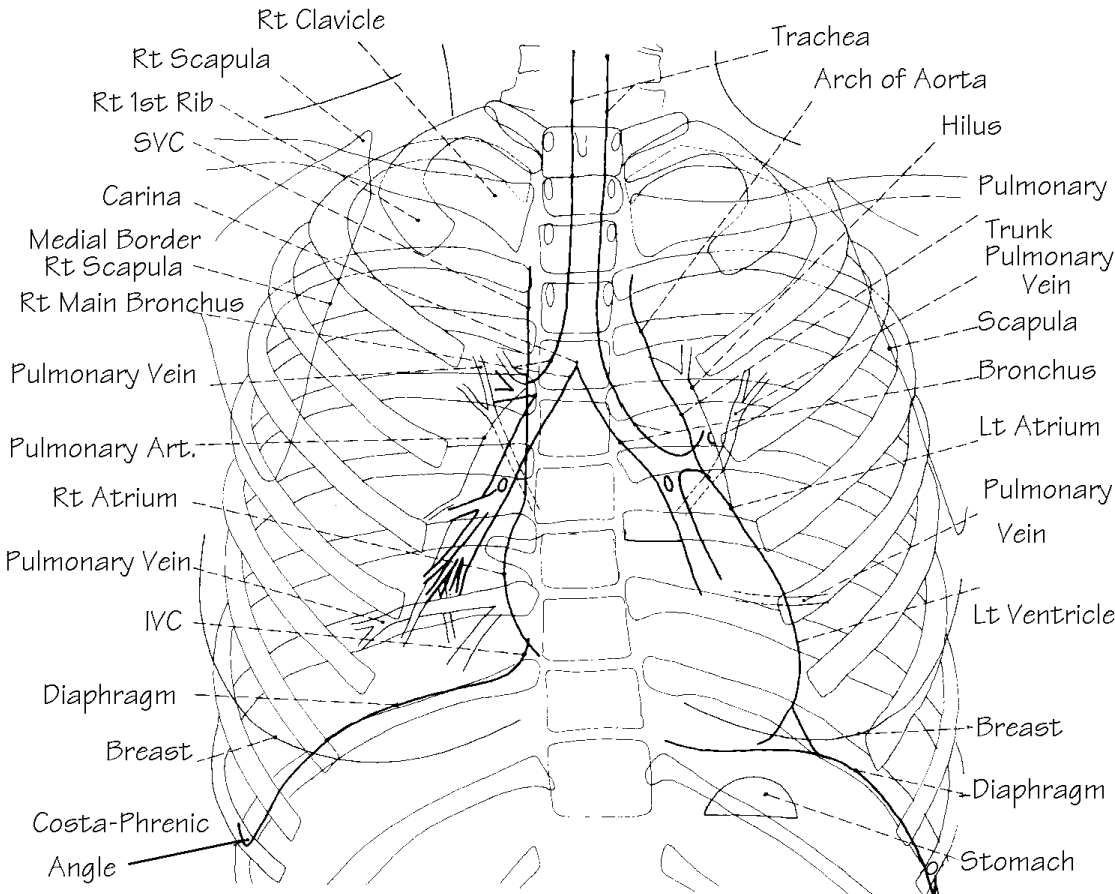
Introduction to Pathology (Prime)

Clinical Radiology for Medical Students (Evans et al.)

Making the best use of a Department of Radiology (RCR)

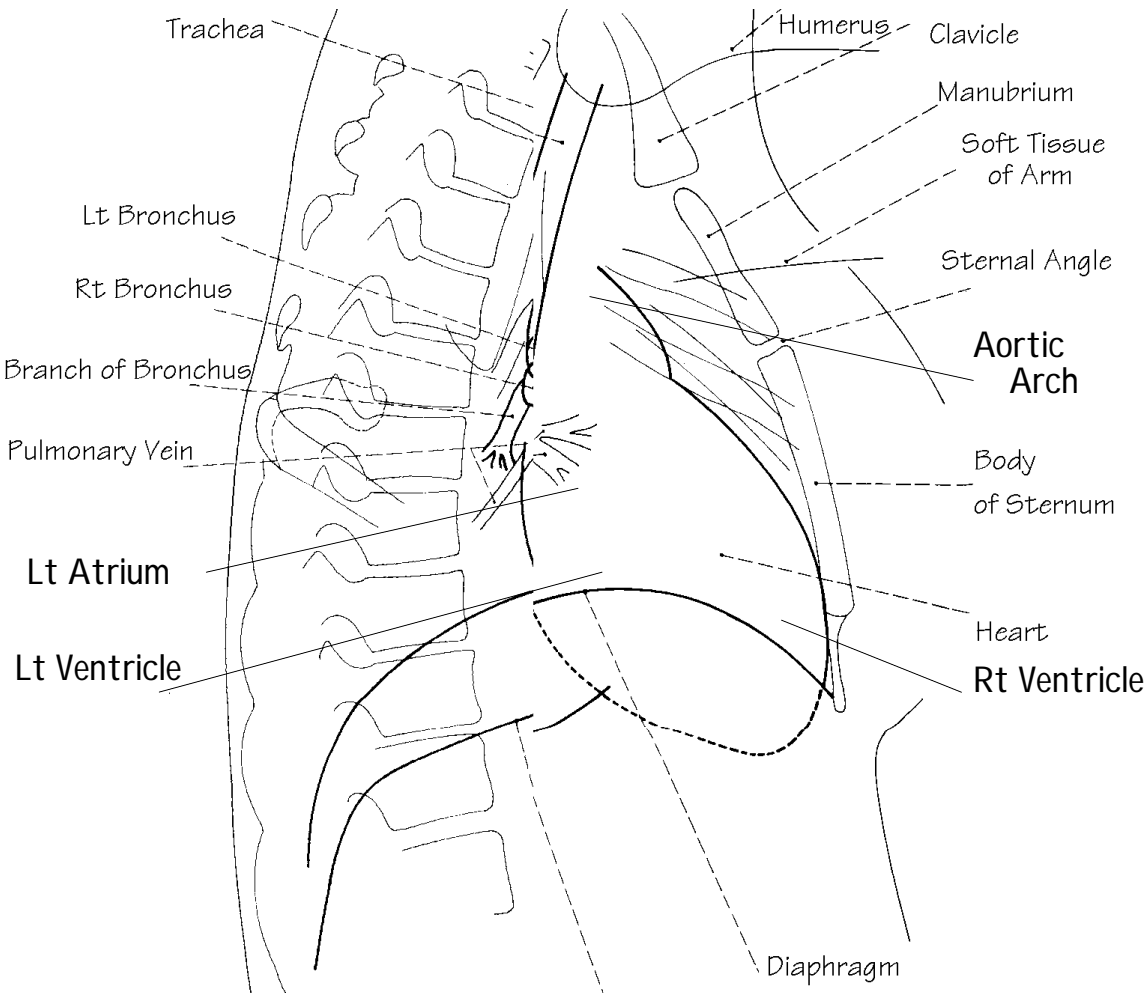
**Basic Anatomy 1)**

**Line Diagram P.A. Chest (Lowther Wicke)**



Basic Anatomy 2)

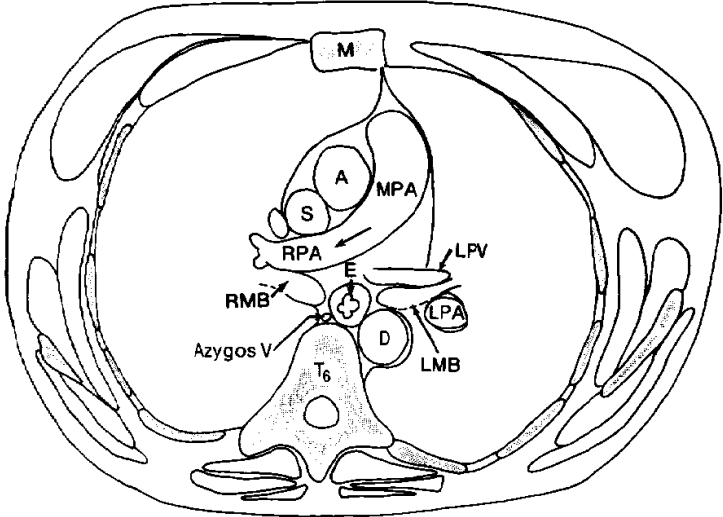
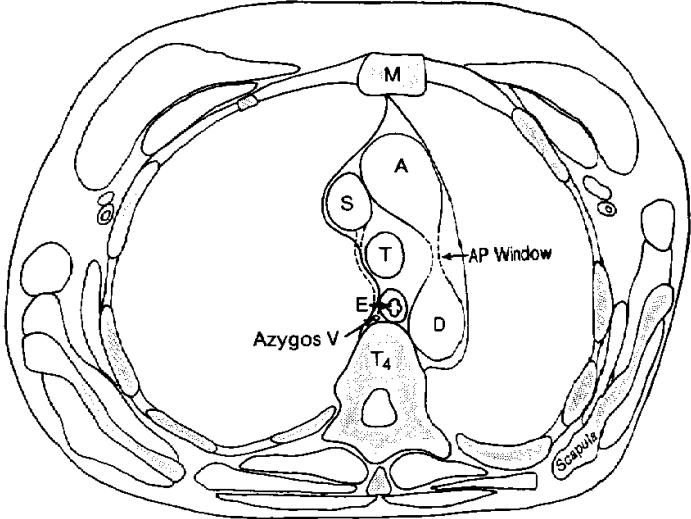
Line Diagram Lt Lateral Chest (Lowther Wicke)



Basic Anatomy 3)

Axial Chest sections at T4 (a) and T6 (b)

(a)



(b)

## ***Diseases of the Lungs and Respiratory System***

### **Signs and symptoms of chest disease.**

Clubbing of the fingers, is associated with chest disease e.g. congenital cardiac abnormalities, bronchial carcinoma and bronchiectasis. On inspection of the hands the nail beds are raised and the nails are rounded.

Cyanosis, peripheral cyanosis may be due to localised vascular problems whilst central cyanosis is indicative of poor oxygenation of the blood due to heart and lung disease.

Breathing, the respiratory rate and the manner of breathing laboured, rasping may also indicate the presence of disease. Dyspnoea may be associated with pneumothorax, effusions and pneumonia.

Sputum, sputum production is always associated with disease process, serous sputum is not infected whilst infected sputum is described as purulent.

Haemoptysis, the colour and amount of blood are indicative of the source, small flecks of blood are indicative of a bronchial carcinoma whilst large frothy volumes are more indicative of pulmonary infarction.

## **Background information of Respiratory System Disorders**

Respiratory diseases affect the RESPIRATORY SYSTEM, which includes the nose, mouth, throat, larynx, trachea, bronchial tubes, and lungs. These diseases may be acute or chronic and result from a variety of causes, including infections, allergies, tumours, and drug reactions. INFECTIONS Viruses Infections are the most common cause of respiratory diseases and may be produced by viruses, bacteria, fungi, protozoa, and micro-organisms known as Mycoplasmas and Rickettsias. Viruses are highly communicable from person to person and cause the common head cold (rhinitis) and chest cold (tracheobronchitis; see COLD, common). Other viruses cause different types of INFLUENZA such as SWINE FLU, Asian flu, Hong Kong flu, and Victoria flu. Viruses also cause PNEUMONIA and many other illnesses, including measles, poliomyelitis, and chicken pox, which may be associated with respiratory tract complications. Bacteria A large number of bacteria, the most common being species of Streptococcus, Staphylococcus, and Hemophilus, may infect any part of the respiratory system, causing such diseases as SINUSITIS, BRONCHITIS, PHARYNGITIS, STREP THROAT, TONSILLITIS, WHOOPING COUGH, and pneumonia. A bacillus, Mycobacterium tuberculosis, causes TUBERCULOSIS, and other Mycobacteria cause diseases with almost identical symptoms. The latter live in soil and water and are not transmitted from person to person as is the tuberculosis bacillus. Fungi Pathogenic fungi can infect the lungs and cause pneumonia like illnesses such as histoplasmosis, blastomycosis, and coccidioidomycosis. Fungi, which live primarily in the soil and are inhaled into the lungs, are not transmissible from person to person. Actinomycosis and nocardiosis are similar diseases, usually grouped with fungus disorders; they are actually caused by bacteria, however. The true fungus diseases are treated with the antibiotic amphotericin B, whereas actinomycosis responds to penicillin and nocardiosis to sulpha drugs (see also FUNGUS DISEASES). Protozoa and Worms Protozoa and other parasites are rare causes of lung diseases in the United States, but an infection known as paragonimiasis, caused by a flatworm known as the lung fluke, is prevalent in the Orient. The hydatid disease, or echinococcosis, is prevalent in Australia, New Zealand, and Argentina and is caused by a cyst-forming tapeworm. A protozoan, Pneumocystis carinii, causes pneumonia in children and occasionally in immuno-suppressed adults. Mycoplasmas and Rickettsias Mycoplasma pneumoniae is a tiny bacteria like organism that causes sinusitis, pharyngitis, bronchitis, and MYCOPLASMAL PNEUMONIA. Infection is spread by close and frequent contact between infected and susceptible individuals; as a result, epidemics tend to occur in schools and military populations. RICKETTSIAS are very small micro-organisms having some characteristics common to both bacteria and viruses. They may cause TYPHUS, and other diseases, most of which may be associated with respiratory tract involvement. Infection is spread by the bite of fleas, lice, ticks, or mites. Allergies are a common cause of respiratory diseases, producing hay fever, asthma, and certain forms of pneumonia. The individual suffering from these conditions has become oversensitive to contact with particular substances such as plant pollen and various types of organic dusts or chemicals. When these agents are inhaled, the body overreacts, producing the symptoms of the specific illness. Allergic pneumonia, also known as hypersensitivity pneumonia, includes such disorders as farmer's lung, caused by exposure to bacteria in mouldy hay; bagassosis, caused by exposure to stored sugarcane fibres that has bacterial growth; and air-conditioner or heating-system disease, caused by exposure to bacteria-contaminated mist from humidifiers (see DISEASE, OCCUPATIONAL). Other forms of hypersensitivity pneumonia are pigeon breeder's or parakeet fancier's disease, caused by exposure to a bird protein.

An ADENOMA is a non malignant tumour of glandular tissue. It can occur in mucous glands of the gastrointestinal and respiratory tracts and in endocrine glands. Although adenomas are not likely to become malignant, they can cause medical problems. For example, adenoma in the stomach is associated with vague stomach pain, lack of stomach hydrochloric acid, and pernicious anaemia. Bronchial adenoma is associated with the coughing up of blood and with repeated pulmonary infections. Adenoma in the endocrine glands can result in excessive secretion of endocrine hormones by these glands, which affects numerous body organs.

APNOEA, in medicine, is a temporary cessation of breathing. When periods of apnoea alternate with periods of hyperpnea (increased rate and depth of inspiration), the syndrome is known as Cheyne-Stokes respiration. The rate and depth of inspiration are controlled by the relative levels of oxygen and carbon dioxide in the blood. If the level of carbon dioxide becomes too high, the level of oxygen falls too low (anoxia), and apnoea or Cheyne-Stokes breathing can result. Apnoeic spells may also arise from interferences with the respiratory centres of the brain. Such interferences include physical trauma, diabetic coma, intoxication (with alcohol, tranquillisers, or barbiturates), and the effects of metabolic toxins arising from liver or kidney damage or from congestive heart failure. Researchers think that respiratory-centre lapses are also involved in obstructive sleep apnoea, a recently recognised

condition in which the upper air passages in the throat are blocked by soft tissues during inspiration. These blockages lead to loud snoring and from 30 to several hundred apnoeic spells per night. Patients complain of insomnia and daytime sleepiness and sometimes fall asleep suddenly during conversations or while at work. Treatment consists of weight loss or of surgery to correct abnormalities in the soft tissues. Apnoeic spells may also be part of the sudden infant death syndrome (see CRIB DEATH), although their origin is not yet understood. Infants may be fitted with so-called apnoea monitors, which sound an alarm when children stop breathing for longer than a preset time. The effectiveness of these devices is a matter of controversy.

ASTHMA is a respiratory disorder marked by breathing difficulty caused by temporary narrowing of the bronchi, the airways branching from the trachea to the lungs. Attacks usually are brought on by allergic reaction to ANTIGENS such as grass and tree pollens, mould spores, fungi, animal dander, and certain foods but may also be caused by chemical irritants in the atmosphere or by infections of the respiratory tract (see BRONCHITIS). Susceptibility to an asthma attack is based on hyperactivity of the bronchial muscles, which constrict on exposure to one or another of these agents. Episodes of asthma vary widely in severity and may last from a few minutes to several days. They may begin at any age but usually occur in childhood. In children, asthma often is associated with eczema, a skin inflammation that may reflect the tendency of the child to develop hypersensitivity reactions. The attacks usually become less frequent and less severe over the years and disappear in about half of all affected children before adulthood. In one form of asthma, called intrinsic asthma, however, the attacks become less frequent and less severe, but recovery between them is less complete. The bronchi in such patients become chronically narrowed, causing a progressive loss of capacity for physical exertion. The prevalence of asthma is only about 1 or 2 percent world-wide but varies greatly from country to country. In the United States, asthma affects about 6.9 percent of children. Typically, an asthma attack begins within minutes after exposure to a triggering agent. Symptoms include a sensation of tightness in the chest, coughing and wheezing, and difficulty in breathing. Persons having attacks usually find it more difficult to exhale than inhale, which causes over inflation of the chest and impaired lung functions. The breathing difficulty is alleviated somewhat by leaning forward and supporting the trunk with the arms on some object. Attacks that last several hours or more, even several days, despite treatment are called status asthmaticus. Patients with this condition develop a rapid pulse as the heart attempts to compensate for the lack of oxygen in the blood by beating faster. They also develop signs of exhaustion and dehydration. On a long-term basis, asthma usually is managed by determining the agent responsible for the attacks so that the patient can avoid it. When avoidance of allergens is not feasible, patients can sometimes be desensitised by injections of graded doses of the allergen at regular intervals. Relaxation and breathing exercises have also been found helpful. Most asthma attacks can be controlled by the administration of appropriate drugs by injection, orally, or by inhalation of aerosols. Occasionally, oxygen administration or use of a respirator may be required. Asthma attacks can result in death.

ASPERGILLOSIS is a common bird infection caused by the fungus *Aspergillus fumigatus*. It infrequently occurs in humans, where the infection, caused by *A.niger*, is called otomycosis and is primarily limited to the outer ear. Primary bronchopulmonary infection is the most severe form of aspergillosis. Symptoms include severe cough, fever, and sputum tinged with blood and signs of fungus material; thus it is clinically similar to TUBERCULOSIS

BRONCHITIS is an INFLAMMATION of the membrane that lines the air passages, or, bronchial tubes, of the LUNGS and results in the narrowing of these air passages. This disorder may be of either an acute or chronic type. Irritation of mucus-producing glands within the membrane results in the production of excess bronchial secretions. The main symptoms of bronchitis are cough and increased expectoration of sputum, with or without associated wheezing and shortness of breath.

Acute bronchitis is usually caused by infection by one of the many viruses that cause the common COLD or INFLUENZA and is frequently associated with MEASLES. The patient may suffer from additional symptoms, such as chest discomfort, fever, and aching, that are characteristic of these diseases. WHOOPING COUGH is a form of severe bronchitis caused by the bacterium *Hemophilus pertussis*. Treatment of a pure viral infection is directed toward the relief of symptoms, but frequently secondary infections by bacteria complicate the condition. In such a case the patient's sputum may turn from white to yellow (purulent, or pus containing), and treatment with various antibiotics is recommended. Acute chemical bronchitis may be caused by the inhalation of irritating fumes, such as smoke, chlorine, ammonia, and ozone.

Chronic bronchitis results from prolonged irritation of the bronchial membrane, causing cough and the excessive secretion of mucus for extended periods. By far the most common cause of chronic

bronchitis is cigarette SMOKING, but air pollution and industrial fume and dust inhalation are also important irritants. Patients with chronic bronchitis are subject to recurrent infections with H. influenza and pneumococci. Pulmonary EMPHYSEMA often coexists, and over a long period of time the patient may suffer from increasing breathlessness, decreasing exercise tolerance, and, finally, total disability. In the most severe forms of the disease, the patient may have a blue, bloated appearance, and a fatal heart disease, known as COR PULMONALE.

BRONCHIECTASIS is the abnormal dilation of one or more bronchi, usually resulting from weakening of the bronchial wall by infection. This condition may follow pneumonia, whooping cough, or tuberculosis, or may be hereditary. Patients with bronchiectasis usually suffer from a chronic cough, copious sputum production, and occasionally Haemoptysis (expectoration of blood).

BYSSINOSIS, is an occupational disease that involves allergic reaction to dust or fungi on inhaled particles of natural fibres (see DISEASES, OCCUPATIONAL). Textile mill workers who are exposed to cotton, flax, or soft hemp dust are susceptible to this RESPIRATORY SYSTEM DISORDER. The disease is also known as Monday fever, because the symptoms are most evident early in the work week. Tissue reaction to small particles of dust in the lungs causes the accumulation of thick mucus, with a resulting constriction of air passages. The constriction may destroy air sacs, or alveoli, in the lungs, leading to breathing difficulty. Symptoms include wheezing, shortness of breath, dizziness, and headaches, and lung tissue takes on the discoloration that gives the disorder its name. If environmental conditions are corrected the symptoms may subside, but continued exposure to fibre dust can cause permanent damage to the lungs and bring on life-threatening chronic BRONCHITIS, EMPHYSEMA, or COR PULMONALE. Prevention of brown lung includes adequate ventilation of textile mills

COR PULMONALE is a chronic or acute disease of the heart, resulting from certain lung diseases, including emphysema, fungal and parasitic diseases, chronic bronchitis, tuberculosis, and diseases caused by prolonged inhalation of certain kinds of dust such as silicosis, a disease that afflicts miners and stonecutters. Pathological changes in these lung diseases increase the resistance to blood flow in the lungs, leading to pulmonary hypertension. As a result, the right ventricle of the heart, which pumps blood to the lungs through the pulmonary arteries, must work harder. To compensate for the inefficient pulmonary circulation the right heart enlarges, but eventually compensation reaches its limit and heart failure results.

An EMBOLISM is an obstruction of a blood vessel by an embolus, which is any foreign substance a blood clot, a fat globule (from a broken bone), an air bubble, a clump of dislodged tumour cells that is swept along in the bloodstream until it lodges in a vessel and blocks the flow of blood beyond that point. A thrombus, by contrast, is a blood clot that obstructs a blood vessel by forming at a site because of injury, stagnation of blood flow (as in chronic bed rest), or arteriosclerosis, which is known as hardening of the arteries. A dislodged thrombus swept along in the bloodstream is called a thromboembolism. The effects of an embolism vary according to the part of the body deprived of blood and may be fatal. Especially critical embolisms are cerebrovascular thromboembolisms, blood clots in an artery that serves the brain; and PULMONARY EMBOLISMS, blood clots in the pulmonary artery that feeds blood to the lungs from the heart. Pulmonary embolism is a leading cause of death among hospital patients and occurs most often in patients who have suffered heart attacks or have undergone surgery. Air embolisms may occur in deep-sea divers who ascend too quickly, causing nitrogen bubbles in the blood to lodge in tiny arteries. A slow ascent, or decompression, in a special hyperbaric (high-pressure) chamber permits the safe release of the nitrogen bubbles through the lungs. Fat embolisms are a rare complication of fracture of the long bones. Fat droplets released from the bone marrow may coalesce and obstruct tiny arteries.

EMPHYSEMA is a disease of the LUNGS characterised by structural changes in the small air sacs (alveoli) where exchange of oxygen and carbon dioxide takes place with the blood. The alveoli become dilated, and the alveolar walls undergo dissolution, causing the formation of larger and larger air spaces within the lungs. As alveolar walls are destroyed, they no longer act to hold the small airways, or bronchial tubes, open. These changes result in a reduction of the total functioning surface for gas (oxygen and carbon dioxide) exchange. There is also obstruction to the flow of air out of the lungs, as the bronchioles tend to collapse during the act of expiration. Because BRONCHITIS often coexists with emphysema, obstruction to airflow may be further compounded by a swelling of the membrane lining the airways, which causes a further narrowing of the bronchial lumen. In addition, the process results in the unequal involvement of tissue, and hence mal distribution of air within the lungs. Generally, there is diminished oxygen supply to vital organs and the retention of excessive carbon dioxide in the blood. Airway obstruction, the predominant feature of emphysema, results in the trapping of too much air within the enlarged air spaces, and over inflation of the lungs occurs until the patient's chest takes on a barrel-shaped appearance. Shortness of breath is the outstanding symptom, and the disease often progresses until the patient is incapable of the slightest exertion. Death may eventually result from accompanying infections, respiratory failure, or cardiac complications. The exact cause of pulmonary emphysema is unknown. Cigarette smoking is closely associated with the disease, and industrial pollution may play a role. In some cases a genetic link is suspected, in that a significant number of persons with emphysema lack a gene that controls the liver's production of a protein called alpha-1 antitrypsin, or AAT. This protein normally degrades an enzyme called neutrophil elastase, produced by white blood cells, but when the enzyme goes undegraded it eats away at alveolar tissue. Injections of AAT are costly, but researchers are working to develop more direct genetic-engineering solutions to the problem. Progression of emphysema can be retarded by abstinence from smoking, and symptomatic relief can be in some cases be provided by drugs that dilate the bronchi. Prompt treatment of infections is vital. Certain types of emphysema may be localised to a portion of one or both lungs and can be treated by surgical removal.

EMPHYEMA, describes the condition of pus in the pleural cavity, this is usually the result from a sub phrenic abscess or other lung abscess.

HISTOPLASMOSIS A systemic pulmonary infection, histoplasmosis is marked by transitory flu like or chronic tuberculosis like symptoms. It is caused by *Histoplasma capsulatum*, a highly infectious fungus that grows in the moist soil of certain geographic areas, such as the Ohio-Mississippi basin. People who inhale the fungal spores usually develop mild, self-limiting infections. If the individual's natural resistance is low, however, more-severe infections may develop, and in some cases the condition is fatal. Amphotericin B is used to treat the condition.

HAEMOTHORAX a pneumothorax where the air in the pleural space is replaced by blood.

PNEUMOCONIOSES Diseases due to inhalation of non allergenic inorganic dusts are classified as pneumoconioses: silica causes silicosis; coal dust causes BLACK LUNG, or coal worker's pneumoconiosis; asbestos fibres cause asbestosis; and beryllium causes berylliosis. These dusts directly injure the tissues of the lungs and often result in pulmonary fibrosis (scar formation) with resulting impairment of lung function and progressive disability. The pneumoconioses are primarily related to such occupations as mining, sandblasting, and the use of the above substances in manufacturing processes.

PNEUMONIA, bronchopneumonia affects the whole lung fields whilst lobar pneumonia affects distinct lobes.

Pneumonia is caused by a wide range of bacteria and or viruses, pneumonia is a common side effect of other disease. Age and previous health of the patient may determine the type and severity of pneumonia. Elderly people in general ill health confined to bed are frequently the victims of pneumonia, as are neonates and patients on ventilators.

Legionnaire s disease is a type of pneumonia due to legionella pneumophila bacteria, the pneumonia is severe and causes extensive damage to the lungs.

Aspiration pneumonia, occurs following aspiration of food, aspirated food will form the foci of infection and the aspiration of hydrochloric acid from the stomach causes damage to the alveoli. This can occur from severe gastro oesophageal reflux, oesophageal diverticulae, overspill of gastric contents following drug overdose, alcohol abuse anaesthesia or coma.

Other causes include fungal pneumonia e.g. Aspergillus and chemical induced pneumonia from inhalation of chlorine gas and petrol and smoke fumes.

Lung abscess, abscess cavity is puss filled and surrounded by fibrous tissue, abscess cavity formation is called cavitation.

Lung abscesses may be caused by:

Aspiration of infected material.

Post pneumonic infection. e.g. tuberculosis,

Bronchial obstruction.

Blood borne infection.

Following pulmonary embolus.

PNEUMOTHORAX when air enters the pleural space the lung collapses. There are two types, spontaneous pneumothorax which mainly affects fit healthy males and develops from an air leakage through the apex of the lungs.

Tension pneumothorax is a more acute condition where injury to the chest wall punctures the pleural space but causes a valve only allowing air into the space and trapping it.

PYOPNEUMOTHORAX bacterial infection containing pus replacing the air in the pleural space.

Haemopneumothorax, may occur following trauma to the chest where there is bleeding into the pleural space.

R.D.S. RESPIRATORY DISTRESS SYNDROME, affects many new-born babies most commonly premature babies, lack of surfactants at birth producing poor expansion of the lungs which prevents gaseous exchange.

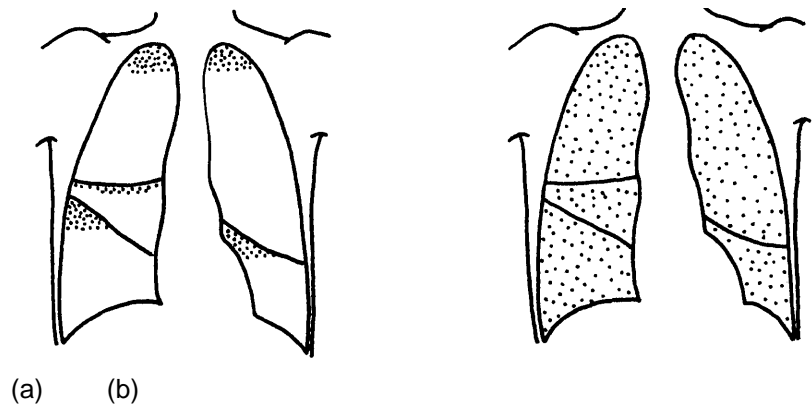
A.R.D.S. Adult Respiratory Distress Syndrome, a similar condition to that described for babies but produced usually following trauma to the chest.

SILICOSIS, one of the oldest known occupational diseases (see DISEASE, OCCUPATIONAL), is caused by the inhalation of small particles of silica, or quartz dust (silicon dioxide). In the lungs the particles are taken up by scavenging macrophages, which then die and accumulate near blood vessels. The connective tissue collagen forms around these masses, producing fibrous nodules in the lungs (pulmonary fibrosis). Respiratory problems usually develop 20 to 30 years following initial exposure, sometimes resulting in EMPHYSEMA. Extremely high levels of silica, however, can cause respiratory symptoms much earlier, and in such cases the disease is frequently fatal. Development of concurrent tuberculosis (silico tuberculosis) is also often deadly. Industries whose workers exhibit high rates of occurrence of silicosis include the mining, quarrying, and tunnel-drilling industries and those which use processes involving sandstone abrasives or ground quartz, as in the manufacture of ceramics, paint, paper, plastics, and rubber.

No cure has been found for the disease; preventive measures include the use of face masks and, when possible, the substitution of less hazardous materials for silica. Clinical tests are now being made of various substances including a polymer called PVNO developed in West Germany that seem to

halt the progress of the disease.

TUBERCULOSIS, is an ineffective disease caused by the bacillus mycobacterium tuberculosis.



**Diagrams of the infection patterns of T.B confined to the apical portions of lobes (a) and Miliary T.B (b) (From Prime)**

Tuberculosis, cont.

The characteristic lesion consists of the Ghon Focus a microscopic collection of epitheloid cells and mycobacterium surrounded by lymphocytes and fibroblasts.

The **primary** focus is usually in the lungs with local lymph node reaction. In the majority of patients the primary site heals often leaving a scar which may calcify.

However an unhealed lesion may lead to progressive pulmonary T.B. a lesion may burst into the blood stream from an adjacent lymph node causing widespread dissemination, this is known as **miliary** T.B.

**Post primary** T.B. occurs following the apparent healing of disease.

TUMOURS can occur in a variety of sites in the chest but the more common sites include carcinoma of the bronchus, thymic tumours and widespread secondary cannon ball secondaries.

Pleural Tumours are often of metastatic in origin and are known as mesotheliomas.

## **Background Information.**

### **HEART DISEASE**

HEART diseases, broadly classified into congenital and acquired disorders, constitute a large proportion of illness and death, especially in industrialised countries. Acquired heart disease includes diseases affecting the pericardium, the myocardium, and the heart valves; disorders involving the coronary arteries; abnormalities of the pacemaker tissue that regulates heart contractions; and congestive HEART FAILURE. Most heart diseases are associated with inadequate blood supply to body tissue or overwork of the heart muscle.

#### **CONGENITAL DISORDERS**

Congenital heart disease implies failure of the foetal heart to develop normally, leading to many mechanical imperfections, some of which are fatal and others of which cause disability. Most birth defects of the heart develop during the first trimester of pregnancy. The pregnant woman, for example, may contract an infection, such as GERMAN MEASLES (rubella), have malnutrition, or smoke heavily, all of which may be associated with foetal heart defects.

When congenital defects prevent blood from being pumped normally through the lungs, CYANOSIS, or BLUE BABY syndrome, occurs. The congenital abnormality in this case can be an opening between the right and left sides of the heart (septal defect), together with the obstruction of blood flow into the lungs. The infant's body tissue receives unoxygenated blood, the symptom of which is blue coloration of the skin.

Other congenital defects do not cause cyanosis but may increase the work the heart must do as a result of ineffectual blood shunting or the obstruction of blood flow. For example, a malformation known as patent ductus arteriosus can occur, in which a small foetal vessel connecting the aorta and the pulmonary artery fails to close after birth. As a result, the lungs receive excessive blood flow, and the heart overworks to pump a limited supply of oxygenated blood to other body tissues. The development of sophisticated diagnostic tools, including cardiac catheterisation and angiocardiography, coupled with development of open-heart surgery, has alleviated many problems that may arise because of these defects.

### **ACQUIRED DISORDERS**

#### **Pericardium**

Certain acquired disorders involve the pericardium, which comprises two thin layers of tissue that surround the heart, or the myocardium, which is the muscular tissue of the heart. The two layers of the pericardium are separated and lubricated by a small amount of fluid. PERICARDITIS, an inflammation of these tissues, may be caused by such specific diseases as TUBERCULOSIS and RHEUMATIC FEVER and by some viruses. Increased fluid secretion, called pericardial effusion, and the unusual thickening of the pericardium during the healing of pericarditis can hamper the heart's pumping action.

#### **Myocardium**

Heart diseases of the myocardium can involve the myocardium directly (cardiomyopathy) or may be secondary to stress imposed on that layer by faulty valves, high blood pressure, or inadequate blood supply. Cardiomyopathy may take the form of a dilated heart that contracts weakly and therefore does not pump an adequate blood supply to the body. This disorder can result from DIPHTHERIA, rheumatic fever, viruses, and perhaps some toxins, such as alcohol. Cardiomyopathy is known as myocarditis when it is an acute form resulting from infection. In secondary cardiomyopathy, the myocardium fails to produce an effective cardiac output because of continued overwork beyond its reserves or inadequate nutrients supplied by coronary arteries. Hypertrophic cardiomyopathy, considered to be an inherited disease, is an excess growth of heart muscle, creating problems with the pumping action of the heart.

#### **Endocardium**

Acquired endocardial disease is mainly rheumatic heart disease, involving the impaired function of cardiac valves. Acute rheumatic fever can cause immediate crisis and death as a result of inflammatory effects to the myocardium and pericardium. The major medical impact of rheumatic fever, however, is the possible deformity of heart valves. Rheumatic fever follows acute

## **Background Information**

### **CARDIOVASCULAR DISEASES**

Cardiovascular diseases include the wide range of disorders that afflict the HEART and the blood vessels, the components of the CIRCULATORY SYSTEM that pump BLOOD and convey it throughout the body. Such diseases are the leading cause of death world-wide. They are the product of many influences, which range in nature from hereditary and nutritional to environmental.

The circulatory system consists of two interconnected systems, both originating in the heart: the systemic circulation and the pulmonary circulation. In the systemic, or greater, circulation, blood is pumped from the left ventricle of the heart into the AORTA. It is then distributed by a series of increasingly smaller arteries (see ARTERY) into the tiny CAPILLARIES in which the blood circulates through the body tissues. From the capillaries in the tissues the blood is then collected in veins (see VEIN) of increasing diameter, finally entering the right atrium of the heart.

In the pulmonary, or lesser, circulation, blood is pumped from the right ventricle into the pulmonary arteries and courses through the LUNG capillaries; there it is reoxygenated and collected again in veins to enter the left atrium. Because capillaries are the site where oxygen and foodstuffs enter body cells and waste products are removed by the bloodstream, any peripheral vascular disease is certain to affect the function of the tissues supplied by the capillaries; in fact, cardiovascular diseases can cause disease in all other tissues and organs of the body. For a discussion of diseases of the heart itself, see HEART DISEASES.

#### Arterial Diseases

Many diseases affect the arteries, but the single major cause of disease is the thickening and hardening of artery walls by deposits of fatty materials, known as ARTERIOSCLEROSIS. In major vessels such as the aorta, this process is called ATHEROSCLEROSIS. Several conditions are thought to contribute to the development of such deposits, including excessive fats in the diet (see NUTRITION, HUMAN), high BLOOD PRESSURE (see HYPERTENSION), and genetic factors.

Other major diseases of the aorta include true ANEURYSMS and so-called dissecting aneurysms. The former are balloon-like swellings that result from weakening of the aorta wall, most commonly because of atherosclerosis or syphilis. Dissecting aneurysms are usually the result of an inherited degeneration of the middle layer of the aorta wall, leading to a separation of the layers by blood, under high pressure, pouring through a tear in the inner layer. Syphilitic and dissecting aneurysms are usually found in the first portion of the aorta, near its origin in the left ventricle, whereas atherosclerotic aneurysms occur somewhat more frequently farther from this portion. A danger in any aneurysm is rupture and sudden death. True aneurysms, in particular, may cause severe pressure symptoms on nearby structures. These aneurysms may so dilate the aortic valves of the heart as to render them incompetent, and HEART FAILURE and death result. Aneurysms are often repaired by replacement.

Atherosclerosis may result in occlusion or blockage of an artery. In many cases the proximate cause of the blockage is clot formation in a narrowed atherosclerotic area. In the coronary arteries this is the major cause of myocardial infarctions, or HEART ATTACKS. In peripheral arteries such as those of the legs, untreated narrowing may result in gangrene and require amputation. (Since the condition appears to be accelerated in patients with DIABETES mellitus, gangrene of the lower extremity is a significant danger for such persons.) Bypass surgery is used for arterial narrowing in coronary arteries; elsewhere, replacement of the narrowed segment is the usual procedure. Alternative therapies include dilating the narrowed segment with a tiny balloon delivered by catheter (see ANGIOPLASTY). Catheters may also be used to deliver materials that convert plasminogen, a normal constituent of the blood, into plasmin, which is a dissolver of clots. This procedure is effective if done within three hours. Arteriosclerotic changes in smaller arteries are not amenable to the therapies that are used in larger arteries.

A disorder of the small arteries in the extremities known as RAYNAUD S DISEASE, leads to numbness of the fingers and toes. The disorder is often of unknown origin but may also be secondary to some known disorder, and it is usually not serious. In some cases, however, the disease may grow progressively worse and lead to blood clots and the onset of gangrene.

#### Veinous Disease

The most important peripheral vascular disease of the veins is thrombophlebitis (see PHLEBITIS).

This disorder involves the formation of a blood clot (or clots) in large veins, usually in the leg or pelvis. Any or all of three major factors can cause such clots: slowing of the bloodstream (or even stoppage for a short period of time), increase of coagulability of the blood, and injury to the lining of the vein. The disorder can cause local inflammation, redness, and swelling, but it may also be entirely free of local symptoms. In either case, but particularly in the latter one, the clot may break off and travel to the right side of the heart. From there it is pumped to the lung, only to be trapped at the pulmonary artery branches and narrows, blocking the blood supply to a portion of the lung, a process called pulmonary infarction. The immediate SHOCK may be fatal and is one of the major causes of sudden death in postoperative hospitalised patients. To prevent such an occurrence postoperative patients are constantly monitored and encouraged to walk as soon as possible.

A distressing but usually minor disorder of the veins, known as VARICOSE VEIN, results from a failure of valves in the veins to keep blood flowing back toward the heart. In some cases, however, the condition can lead to varicose ulcers or the inflammation of vein walls, with resulting development of clots and of thrombophlebitis.

### Hypertension

High blood pressure is a common disorder that affects up to 20 percent of the adult population in the United States. By far the most common type is essential hypertension, the causes of which are unknown. The remaining cases of high blood pressure are secondary to at least 30 different conditions. Blood pressure depends on the volume and speed with which blood is ejected with each beat of the heart, the frequency of the beats, and the tension in the arteries to which the blood is delivered. All of these factors are modulated by the nervous system, and a number of hormones including rennin from the kidney may play a determining role in the disorder. Untreated hypertension can cause severe kidney damage, precipitate a cerebral haemorrhage (see STROKE), or result in heart failure. A number of drugs for treating essential hypertension have been introduced over the past few decades; they vary in effectiveness. Two more recent additions to the drug list are the calcium channel blockers and the angiotensin-converting enzyme inhibitors. The former drugs decrease the inflow into cells of the calcium needed for contraction of smooth muscle, thus relaxing the arteries an advantage in treating both hypertension and angina pectoris. The latter drugs decrease excessive formation of a normal hypertensive agent known as angiotensin III.

Another form of hypertension, called pulmonary hypertension (see COR PULMONALE), is caused by various conditions that result in lung scarring and consequent obstruction of branches of the pulmonary artery. Such conditions include chronic bronchitis, silicosis, and cystic fibrosis. Severe back-pressure from narrowing of the mitral valve (mitral stenosis) or from certain spinal deformities results in damage to the vascular system of the lungs. Obstruction leads to increased pressure in the pulmonary artery, the right ventricle of the heart, and the veins draining into the right atrium, with consequent leakage of fluid through the walls of the veins into surrounding tissues. This condition, called OEDEMA, occurs chiefly in the liver, abdominal cavity, and legs.

## Historical Background

Physicians of ancient Egypt and China had already recognised the PULSE and were using it as a diagnostic tool but the true nature of the circulatory system was not understood until the Renaissance and the anatomical discoveries of such scientists as Michael SERVETUS and Hieronymus FABRICIUS AB AQUAPENDENTE. Their work culminated in the experimental demonstration of blood circulation by the English physician William HARVEY in the 17<sup>th</sup> century, and Harvey's work in turn led directly to such developments as French physician Raymond Vieussen's correlation of abnormalities of the heart valves with types of heart failure, and English physiologist Stephen HALES's measurement of blood pressure and the velocity of blood circulation.

Modern drug therapy of cardiac illnesses began with the discovery of DIGITALIS in a folk-medicine herbal mixture by the English physician William Withering in the 18<sup>th</sup> century. In the early 19<sup>th</sup> century the invention of the STETHOSCOPE by the French physician Rene LAENNEC and the refinement of methods of physical examination by Joseph Skoda and his colleagues in Vienna created the speciality of cardiology. This new field was quickly placed on a firm experimental and clinical basis by such physicians as Jean Bouillaud of France, Ludwig Traube of Germany, and William Stokes and John Corrigan of Ireland. The German scientist Rudolph VIRCHOW, in particular, was able to correlate clinical facts with pathological findings, facilitating the proper diagnosis and prognosis of cardiovascular and other illnesses.

In the late 19<sup>th</sup> and the early 20<sup>th</sup> century, the study and treatment of cardiovascular disease was advanced by developments such as the X-Ray, the ELECTROCARDIOGRAPH, and the cardiac catheter; the invention of the catheterisation process won the 1956 Nobel Prize for physiology or medicine for D.W. RICHARDS, Andre COURNAND, and Werner Forssmann. Remarkable advances were also made in SURGERY, such as the replacement of damaged arteries and the repair of congenital deformities of the heart and the large blood vessels.

Among the many other technological developments that should be mentioned are the RADIOLOGY imaging techniques of angiocardiology, echocardiography, ULTRASONICS, computerised X-Ray tomography (see CAT SCAN), and magnetic resonance imaging (see NUCLEAR MAGNETIC RESONANCE IMAGING). These methods not only define defects but also enable the positioning of catheters through which procedures can be performed and drugs administered.

## **An ABC of Chest Disease**

ADAM S STOKES attack transient loss of consciousness due to loss of blood to the brain, sometimes due to ventricular tachycardia or fibrillation.

ANGINA PECTORIS occurs when the blood supply to the myocardium is compromised due to arteriosclerosis of the coronary arteries, the waste products of muscle metabolism i.e. lactic acid build up causing painful cramp.

ANEURYSMS are localised dilations of a vessel or chamber, of which there are two types, true & false aneurysms.

True = dissecting, saccular and fusiform

False = developed from perforation of the wall of an artery due to trauma.

ATRIAL FIBRILLATION irregular atrial impulses >250 BPM.

ATRIAL SEPTAL DEFECT. (ASD) In the foetus the right and left sides of the heart are in direct communication via the foramen ovale which closes at birth. The ASD is the failure of this foramen to close

BRADYCARDIA resting sinus rhythm of <60 BPM.

COARCTATION of the aorta is an acute narrowing of the aorta usually just beyond the exit of the left subclavian artery in the first part of the descending aorta.

CORONARY HEART DISEASE the most common form of acquired heart disease caused primarily by arteriosclerosis of the coronary arteries.

DEXTRACARDIA. Complete mirror image of the together with the abdominal viscera, the incidence rate is approximately 1:5000.

### **FALLOT S TETRALOGY**

A combination of 4 cardiovascular anomalies,

- 1 Pulmonary stenosis
- 2 Ventral septal defect
- 3 Dextra position of the aorta
- 4 Right ventricular hypertrophy.

HEART SIZE, cardio thoracic ratio, this is the ratio of the maximum width of the cardiac shadow on a radiograph as a ratio of the maximal chest width, normally the ratio should be 1:2 or less.

HYPERTENSION is classified as the prolonged rise in the systemic blood pressure above 140 mmHg systolic and 90 mmHg diastolic.

Hypertension is further classified Primary or Secondary as benign or malignant.

MYOCARDIAL INFARCTION is the death of a part of the myocardium due to severe and prolonged ischaemia due to arteriosclerosis of the coronary arteries.

PATENT DUCTUS ARTERIOSIS. (PDA) In the uterus oxygenated blood passes from the pulmonary circulation into the aorta via the ductus arteriosus sited between the aortic arch and the pulmonary trunk. After birth this duct seals off in most patients but can remain as a duct causing blood to flow from the aorta into the pulmonary vessels causing pulmonary hypertension.

RHEUMATIC HEART DISEASE is an uncommon condition now though previously i.e. 75 years ago was relatively frequent, it is an immunological disease that develops after infection with a group A Haemolytic streptococci, which lead to damage to the connective tissues within the heart.

TACHYCARDIA a resting sinus rhythm of >100 BPM

VENTRAL SEPTAL DEFECT. (VSD) This a defect in the wall between the right and left ventricles which may be major and life threatening or minor and cause little more than an asymptomatic murmur.

VENTRICULAR TACHYCARDIA >200 BPM



## **Indications For radiography of the Chest.**

Chest pain,

Investigation of repeated or persistent chest infection,

Chest trauma.

Evidence of metastatic disease.

Biopsy localisation.

Inhalation of foreign bodies,

Investigation of any of the conditions mentioned in the text earlier.

## **Contra Indications:**

There are few if any contra indications other than that alternative forms of imaging may be preferable or the fact that X-Ray imaging may be considered inappropriate in some cases where treatment will not be affected by the result of X-Ray examination.

A contra indication to the use of ionising radiation is the use of imaging in order to reduce the possibility of medico legal litigation and for psychological reassurance of the patient.

## **Patient Preparation:**

The patient strips to the waist and wears a starch free examination gown.

Basic psychological preparation with reassurance and explanation of technique.

Normal patient examination interview.

Ensure long hair is out of the primary beam,

Remove any monitor lines if possible, check with ward staff.

Rehearsal of respiratory manoeuvres if required.

## **Equipment:**

High power generator and matched tube, 80 kW + with Automatic exposure control.

Erect film support,

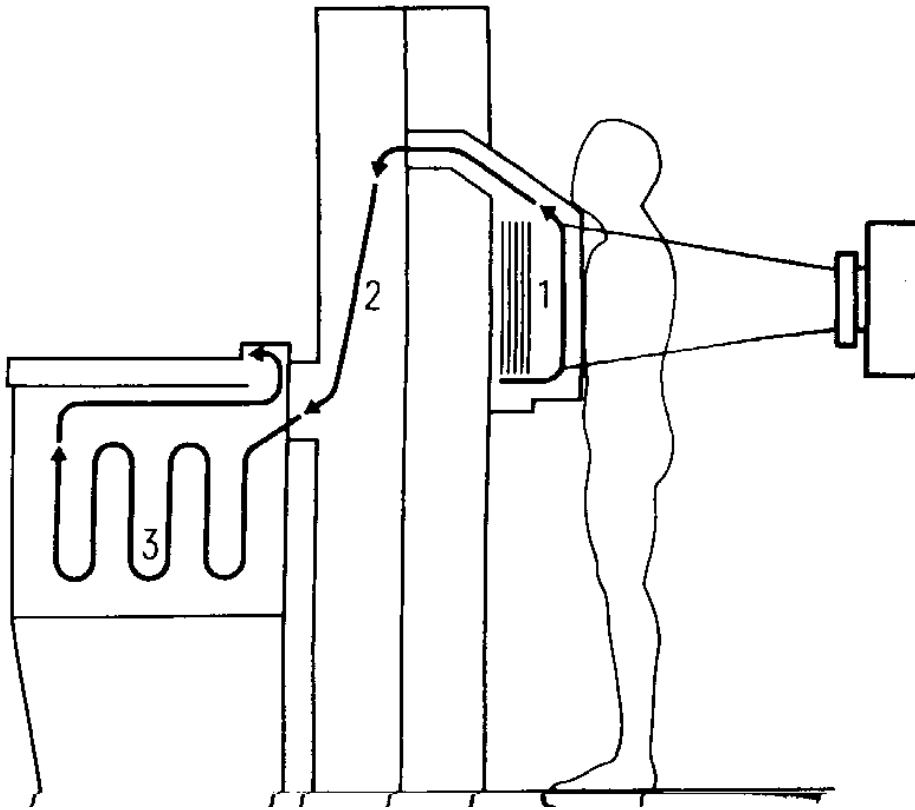
Erect bucky

Ceiling suspended or column mounted tube.

Dedicated chest imaging equipment, e.g. Siemens Thoromat with attached film processor.

Recent advances in chest imaging include the Kodak Amber system.

## **Equipment:**



Siemens Thoromat

## Projections used in chest radiography

Projection	Indication
Erect P.A.	Routine for fit and able bodied persons
Lateral	To localise opacity
Erect A.P	Mobile and the infirm
Supine A.P	Very ill patients and those with multiple injuries

## Additional Projections:

Projection	Indication
Penetrated P.A.	Useful for cardiac chamber visualisation and Lt lower lobe visualisation
Expiratory	Shallow pneumothorax may become more obvious Children with suspected FB inhalation causing bronchial obstruction.
Decubitus	To visualise small effusions, & determine solid / fluid.
Tomography	To investigate lesions obscured by overlying shadows

## Essential differences between AP and PA chest radiographs

Structure	PA Radiograph	AP Radiograph
Heart	Little Magnification	Magnified image
Scapulae	Rotated away from lungs fields	Superimposed on lung fields.
Clavicles	2 inches below apex	Above Apex

## Accessories:

Fine and standard/regular resolution, film speed screen combinations in an assortment of sizes.

Pads and immobilisation aids.

Chest stand,

Hand grips e.g. dripstand

Contrast agents and drugs:

Non.

Typical Exposure Values: (\*Dose = Typical Dose from NRPB)

Projection kV mAs F.D. Focus Grid Dose Film/Screen P.A. Chest 70 5180 cm Finex Regular P.A.  
Chest 90 2180 cm Finex Regular Lateral Chest 80 12120 cm Fine Ö Regular

Kilo voltage selection.

Generally the kV should be high enough to result in sufficient contrast to demonstrate the many levels of grey needed to visualise the finer lung markings. Thus in general chest radiography uses the low contrast extended grey scale exposure factors associated with high kV s typically around 90kV. Lower kv yielding high contrast will not usually provide enough penetration to adequately visualise the fine lung markings behind the heart. Too high contrast is evident when the lung fields are correctly exposed but the mediastinum appears under penetrated. As a general rule exposures with kV s over 100 kV will require a grid either moving or stationary.

Exposure time and mAS

Generally chest imaging requires high mA values and short exposure times, typically 500+mA and <0.03S. to minimise the chance of movement unsharpness and the resultant loss of sharpness.

Sufficient mAS should be used to see a faint outline of the vertebra at least T6 and the medial ends of the ribs through the heart and other mediastinal structures.

Film Sequence:

An appropriate sequence of projections should be determined to minimise patient discomfort and maximise examination speed.

Radiation Protection:

In addition to all normal good techniques for radiation protection.

Direct lead rubber gonad protection when the primary beam is directed towards the gonads.

To protect the patient from back scatter from the cassette and chest stand a wrap round lead rubber apron to include both the posterior and anterior aspects of the patient is recommended.

Patient Aftercare:

General psychological reassurance.

Check patient understands how to receive the results.

Replace any splints and dressings removed.

Ensure patient understands any preparation instructions are finished

Escort to changing rooms/waiting area and bid good-bye.

### **Additional Imaging Techniques:**

Radionuclide imaging especially suitable for detection of pulmonary embolus, and myocardial blood perfusion studies.

Computer tomography is the imaging mode of choice for mediastinal imaging, and biopsy guide.

Angiography for heart studies.

Magnetic resonance.

## **Image Evaluation (Positioning)**

Evaluation of exposure as described earlier.

P.A. projection

No rotation, both sterno clavicular joints should be the same distance from the vertebral column, the distance from the lateral borders of the ribs to the vertebral column should be the same on both sides.

Scapulae should be clear of the lung fields.

Entire lung fields must be included on the film.

Full inspiration, should result in 10 posterior rib ends visible above the diaphragm.

Image must include lung apices to costaphrenic angles, anterior and posterior skin surfaces.

T6/7 should be projected to the centre of the collimation infero-Superiorly.

Lateral projection.

No rotation, posterior ends of the ribs behind the vertebral column should be superimposed.

Costaphrenic angles should be aligned and superimposed.

The sternum should be projected in lateral profile.

Image must include lung apices to costaphrenic angles.

T6/7 should be projected to the centre of the collimation infero-superiorly.

The hilar region should be projected to the centre of the image.

Lung markings should be visible through the heart and mediastinum.

### Radiographic Appearances, Normal Variations:

Feature	Normal Appearances	Variations
Diaphragm	Smooth outline convex upwards  Sharply Define Costophrenic Angles  Shadow at the level of 6 <sup>th</sup> rib  Rt dome 2cm above left	Elevation of left dome is often due to stomach gas.  Frequent hump on right dome in the elderly  Fat pad in obese people
Heart	Assessment of heart size difficult  Overall diameter >16cm  2/3 of heart lies left of midline	Geometric enlargement on A.P.  Apparent enlargement on expiration  Depressed sternum displaces heart.
Lung fields	Similar transradiency	Rotation may change density.  Absence of breast shadow will produce differences.
Fissures	Horizontal fissure at 6 <sup>th</sup> rib Rt.	Accessory fissures e.g. azygos
Trachea	Central	Displaced Rt by unfolded aorta
Hilar	Lt 1cm above right	Obscured by heart
Thoracic cage	Calicification in costal cartilage s is insignificant	Cervical rib & minor rib anomalies are common.
Soft tissue shadows	Breast & nipples	Plaits, hair, artefacts

## ***Chest Radiography, Reading the Film.***

Check:

### IDENTIFICATION

Patients name and Registration details?

(Name, date, ID number)

Correct Right or Left Anatomical Marker?

Patient positioning legend if present,

ERECT P.A. = Normal.(No legend).

Are the full limits of the examination present ?

Lateral chest walls, lung apices and costaphrenic angles.

Image Quality, are all areas correctly exposed?

### EXPOSURE

Density, Max. Approx. 1 in the lung fields.

Contrast, are all regions adequately visualised i.e. lung fields, soft tissues and bony structures.

Penetration, Are the outlines of the vertebra visible through the mediastinum?

### POSITIONING / TECHNIQUE

No Rotation,

Medial end of clavicles equidistant from midline.

Scapulae Clear,

Medial borders of scapulae clear of lung fields.

Full Inspiration,

9 Posterior intercostal spaces visible.

No Artefacts

Erect P.A.

No evidence of lordosis, medial ends of clavicles at the level of T4.

No evidence of movement unsharpness.

### COLLIMATION

Are collimation delineation marks visible or inferiorly is there evidence of the use of lead rubber gonad protection.

Lateral collimation may not be present if there is any danger of missing the limits of the examination.

## Chest Radiograph Interpretation

Follow a systematic method in inspecting the chest radiograph, after checking all the previous criteria which may affect the appearance of the film if deficient in some way, i.e. an under penetrated and under exposed film may mimic pulmonary oedema, whilst over exposure may mimic emphysema. A film taken with poor inspiration may give the appearance of disease process e.g. cardiomegaly.

### General Check List a)

- 1) Check the bony skeleton, ribs clavicles scapula etc. are normal.
- 2) Check the diaphragm is normal in position, the right side may be normally 2.5cm higher than the left.  
Check the costophrenic angles are clear.
- 3) Check the superior mediastinum for widening, or the presence of masses.  
Check the trachea for position.
- 4) Check the heart and great vessels for abnormalities, the cardiac diameter should be less than half the width of the chest.
- 5) All markings in normal lung tissue are vascular.  
The hilar shadows should show individual vessels, the left is normally higher than the right.  
Remember pulmonary changes may be secondary to cardiac pathology.

### Further Check List b)

- 6) Cardiothoracic ratio raised.  
Cardiomyopathy, general pericardial perfusion.
- 7) Specific Enlargement  
Elongated Apex of left ventricle, hypertension, ischaemia aortic valve disease
- 8) Enlarged left atrium  
Mitral valve disease
- 9) Lung fields  
Lung outline within chest = Pneumothorax
- 10) Lobar pathology, usually consolidation which implies fluid in the alveolar
- 11) Diffuse lung disease, over inflation ? asthma
- 12) Non central trachea, ? space occupying lesion
- 13) Widened mediastinum, ? Sarcoidosis
- 14) Apices clear and even if not ? Pneumothorax, mass pancoast tumour
- 15) ?hilar point present? if not ? mass
- 16) Bony skeleton, rib notching = coarctation of aorta.
- 17) ? Mastectomy, ? metastases.

Remember DO NOT STOP HALF WAY chest disease may not be a singular factor so complete all film examinations even after any obvious anomaly is found.

A normal chest X-Ray does not exclude developing pulmonary disease abnormalities on a radiograph[h may take longer to develop than clinical signs.

The following charts give basic radiographic appearances and their common aetiologies that may be seen on a P.A. radiograph.

Radiological Feature:

**Unilateral Opacification**

Displacement of the mediastinum and structures towards the opacified side,

Opacification of particular lobes,

Elevation of the hemi diaphragm,

Displacement of the hilum or fissure towards the collapse.

Pleural effusion

The presence of a large pleural effusion without mediastinal shift indicates underlying lung collapse

Unilateral pleural effusion.

**Large opacities within the lungs**

Left ventricular enlargement point downwards and Lateraly

Diffuse opacification, bats wing appearance

Distension of the upper lobe veins

Septal lines

Pleural effusion

Opacities of varying size, may be ill defined but limited to lobar segments.

Peripheral opacities, linear or wedge shaped

General round opacities of varying size

Nodular opacities coalescing in upper lobes

Causes

Pulmonary collapse secondary to bronchial obstruction

Inhalation of foreign body, especially children,

Carcinoma of the bronchus,

Post operative mucus plug

Benign tumour.

Congestive cardiac failure

Malignancy, carcinoma of the bronchus,

Tuberculous infection

Trauma

Pulmonary infarction

Pulmonary oedema

Mitral and or aortic valve disease

Lobar or bronchopneumonia

Pulmonary infarction

Metastases

Progressive Massive fibrosis

**Well defined rounded Opacities**

Frequently rounded, slightly spiculated possible eccentric cavitation

Frequently contains calcification

Fungus ball often with air rim

Single cystic opacity

Multiple opacities varying in size

Background of nodular shadows

**Small opacities**

ill defined small opacities (acute history)

Opacities the size of millet grains

Plus hilar / mediastinal enlargement

Small opacities plus upper lobe fibrosis, possible calcification in hilar nodes

Small nodular opacities throughout the lungs

Malignant disease

Tuberculoma

Mycetoma,

Hydatid cyst

Metastases

Pneumoconiosis

Silicosis

Sarcoidosis

Bronchopneumonia

Millary T.B.

Sarcoidosis

Pneumoconiosis

Allergic alveolitis, farmers lung

### **Linear Opacities**

Short non branching septal lines in periphery of lung fields (Kerley s Lines)

Tubular shadows seen end on as ring shadows

Thickened bronchial walls and extensive inflammation

Longer and thicker than septal lines

### **Localised areas of Transradiancy in the lungs**

Cavities in the upper lobes with possible calcification in ill defined opacities

Small eccentric cavities within lesions

Thin walled bullae at apices

Multiple thin walled in lower lobes

### **Large areas of transradiancy**

Increased transradiancy of one lung

Obstructive over distension

Low flattened diaphragm, thin vertical heart, few or absent vessels

Air within pleural cavity, lung vessels not reaching chest wall

Left heart failure, interstitial pulmonary oedema, mitral valve disease.

Infection, chronic bronchitis

Cystic fibrosis

Scars from infection and infarction

Tuberculosis

Bronchogenic carcinoma

Obstructive airways disease

Cystic bronchiectasis

Compensatory over distension of the opposite lung following surgery or bronchial obstruction

Inhaled F.B. producing valve effect

C.O.A.D.

Pneumothorax

