



# **Revised European Training Charter for Clinical Radiology**

## **Curriculum for the Initial Structured Common Training Programme (Years 1–3)**

## **Curriculum for Special Interest Subspecialty Training (Years 4–5)**

**Revised May 2012  
By Birgit Ertl-Wagner,  
ESR Education Committee Chairperson**

# **THORACIC RADIOLOGY**

## **Cardiac and Chest Radiology**

**Initial Structured Common Training Programme (Years 1-3)**

**Special Interest Subspecialty Training (Years 4-5)**

# **THORACIC RADIOLOGY**

## **Cardiac and Chest Radiology**

### **Initial Structured Common Training Programme (Years 1-3)**

# **Cardiac, Vascular and Lymphatics**

## **Core knowledge**

- Normal anatomy of the heart and vessels including the lymphatic system as demonstrated by radiographs, echocardiography and Doppler, contrast-enhanced CT and MRI
- General principles and classification of congenital heart disease and the diagnostic features on conventional radiographs
- Natural history and anatomical deformities causing central cyanosis
- Radiological and echocardiographic features and causes of cardiac enlargement, including acquired valvular disease
- Diagnosis of ischaemic heart disease, including radionuclide imaging and the basics of coronary angiography
- Diagnostic features of vasculitis, atheroma, thrombosis and aneurysmal dilatation of arteries and veins
- Radiological and ultrasound diagnosis of pericardial disease

## **Core skills**

- Reporting radiographs relevant to cardiovascular disease
- Performing ultrasound of arteries and veins
- Managing and reporting CT and MRI of the vascular system under supervision including image manipulation
- Diagnosing deep venous thrombosis on Doppler ultrasound
- Performing femoral artery and venous puncture techniques
- Diagnosing and treating femoral artery pseudoaneurysm

# Chest Radiology

## Core knowledge

- Anatomy of the respiratory system, heart and vessels, the mediastinum and the chest wall on radiographs, CT and MRI
- Significance of generic signs on chest radiographs and CT
- Features on radiographs and CT and the differential diagnosis of diffuse infiltrative and alveolar lung disease, airways and obstructive lung disease
- Solitary and multiple pulmonary nodules, benign and malignant neoplasms, hyperlucencies and their potential aetiology and evaluation
- Thoracic diseases in immunocompromised patients and congenital lung disease
- Disorders of the pulmonary vascular system and great vessels, including the diagnostic role of radiographs, radionuclides, CT and MRI in diagnosis
- Abnormalities of the chest wall, mediastinum and pleura

## Core skills

- Managing and reporting under supervision radiographs, chest radiographs, ventilation/perfusion imaging, thoracic CT, high-resolution chest CT, and the CT pulmonary angiography (CTPA) technique and interpretation
- Positioning/views of chest radiographs and of chest CT examinations for adults, newborns, infants and children
- Knowing the mean exposure doses of chest radiographs and of chest CT examinations and techniques to reduce this dose
- Using ultrasound in the diagnosis and aspiration of pleural effusions
- Knowing the principles of digital imaging and image processing pertinent to chest radiology
- Protocolling CT examinations of the thorax, including appropriate application of intravenous contrast, high resolution, inspiration/expiration and reconstruction technique
- Recommending appropriate biopsy routes and techniques

# **THORACIC RADIOLOGY**

## **Cardiac and Chest Radiology**

### **Special Interest**

### **Subspeciality Training (Years 4-5)**

# Cardiac Radiology

## Introduction

Cardiac radiology is an important and rapidly developing field in radiology. The use of non-invasive cardiac imaging has progressed over the last decade to involve virtually all techniques in diagnostic radiology. Interventional techniques in the heart have also progressed, and whether or not a radiologist is involved in cardiac intervention, it is important that there is an understanding of the clinical and diagnostic implications of these techniques. The heart is not an isolated organ, and it is equally important that the relationship between the heart and the cardiovascular and cardiopulmonary systems are understood. Incidental radiological findings that may have major clinical implications are an important aspect of cardiac imaging and radiologists are best equipped in these interpretations. No cross-sectional cardiac imaging studies should be performed or reported without the input of a supervising radiologist. Knowledge of the principles of radiation protection and their application to cardiac imaging is an essential component of training.

## Core knowledge

The learning objectives for radiology trainees should include:

### ***Background***

- Cardiac anatomy by CT
- Common congenital and acquired cardiac conditions (basic understanding), in particular, atherosclerotic heart disease
- Role of alternative cardiac assessment tools (basic understanding, including radiological (MRI, SPECT) and non-radiological (stress test, echo)
- Cardiac CT image acquisition
- Cardiac CT image post-processing
- Cardiac CT clinical application and image interpretation

### ***Image acquisition***

- Patient preparation for cardiac CT including indications, venous access and beta-blocking
- Multidetector CT acquisition set-up for cardiac CT
- ECG gating for cardiac CT
- Contrast bolus timing as it pertains to cardiac CT

### ***Image post-processing***

- Axial, multiplanar reconstructions (MPR), maximum intensity projection (MIP) and volume rendering principles
- How to display the major coronary anatomy using 3D CT
- How to perform coronary calcification scoring

### ***Clinical application and image interpretation***

- Common congenital heart diseases
- Coronary artery disease
- Congenital anomalies
- Acquired atherosclerosis – coronary calcification and coronary CTA
- Pericardial disease
- Myocardial disease
- Valvular heart disease

### ***Other knowledge***

- Congenital and acquired cardiovascular disease (basic clinical, pathological and pathophysiological knowledge)
- Principles and practice of screening techniques and risk factors in cardiac disease
- Indications, contraindications and potential hazards (especially radiation hazards) of procedures and techniques relevant to cardiovascular disease
- Cardiovascular anatomy in clinical practice relevant to clinical radiology
- Normal variants of cardiac and coronary artery anatomy, in particular those that may mimic disease
- Manifestations of cardiovascular disease, including trauma, as demonstrated by conventional radiography, CT, MRI, angiography, radionuclide investigations and ultrasound
- Differential diagnosis relevant to clinical presentation and imaging features of cardiovascular disease
- Calcium scoring, imaging principles, techniques of measurement, limitations and the epidemiological implications
- Cardiac anatomy, and the relevant embryological principles
- Clinical aspects of cardiac disease including pathophysiological and biochemical correlates (working knowledge)
- Management of procedural complications in the diagnosis and treatment of cardiac disease
- Pathophysiology, differential diagnosis and treatment of pseudoaneurysm formation following invasive cardiac procedures
- Role of the varying treatments available for both congenital and acquired cardiac disease, including coronary artery disease

### ***Clinical cardiac radiology***

The general radiological training curriculum should include knowledge of the following disease categories:

- Coronary artery disease, including acute coronary syndromes:
  - Myocardial ischaemia
  - Myocardial infarction
  - Post-myocardial infarction syndrome
  - The radiological appearances of ventricular aneurysm
  - Coronary artery calcium scoring
  - Unusual causations of coronary artery disease, including various forms of arteritis
  - Hibernating/stunned myocardium

- Disease patterns that are age- or gender-related, including sudden death syndrome in young men
- Valve disease:
  - Rheumatic or post-rheumatic valve disease
  - Stenosis and incompetence of cardiac valves
  - Endocarditis
  - Sub- and supra-avalvular disease
  - Subvalvular apparatus disease
  - The pericardium
- Cardiac tumours:
  - Working knowledge of clinical presentation
  - Intracardiac tumours, i.e. myxomas, haemangiomas and sarcomas
  - Primary tumours, i.e. myxomas, haemangiomas and sarcomas
  - Secondary tumours
  - Metastatic cardiac tumours
  - Cardiomyopathy:
    - Working knowledge of clinical manifestation
    - Acute myocarditis
    - Dilated cardiomyopathy
    - Restrictive and obstructive cardiomyopathy
    - Cardiomyopathy related to systemic disease
    - Infiltrative cardiomyopathy
  - Diabetic and renal cardiac disease
  - Athlete's heart
- Congenital heart disease (also under "*Coronary artery disease, including acute coronary syndromes*"):
  - Neonatal heart disease
  - Congenital disease in childhood
  - Adult congenital heart disease
- Major vessel disease:
  - Thoracic aneurysm
  - Classification of aortic dissection
  - Imaging findings of acute and chronic dissection
  - Clinical and radiological manifestations of Marfan's syndrome
  - Clinical and radiological manifestations of Takayasu's disease
  - Causes and radiological appearances of acute pericarditis
  - Causes and radiological appearances of chronic pericarditis
  - Malignant pericardial disease
- Expected imaging findings after:
  - By-pass grafts
  - Valve replacement
  - Aortic replacement
  - Ventricular surgery
  - Pericardiectomy
  - Principles, uses and limitations of nuclear cardiac imaging
  - Principles of intravascular imaging
- Stress testing:
  - Principles of exercise stress testing, uses and limitations
  - Methods of stress testing as applied to cardiac imaging
  - Patient management of stress testing for cardiac imaging

## ***Molecular imaging***

Principles of molecular imaging as applied to cardiac radiology include its role in:

- Myocardial ischaemia and viability
- Heart failure and heart graft rejection
- Cardiac stem cell and gene therapy

### **Core skills**

- Supervising technical staff to ensure that appropriate images are obtained
- Discussing significant or unexpected radiological findings with referring clinicians and knowing when to contact a clinician
- Recommending the most appropriate imaging technique, appropriate to patients' symptoms or pathological features or a request from the referring clinician
- Developing skills in forming protocols, monitoring and interpreting cardiac studies appropriate to the patient's history and other clinical information
- Presenting effectively cardiac imaging in a conference setting
- Providing a coherent report on imaging studies of cardiovascular disease

# Chest Radiology

## Core knowledge

### *Normal anatomy*

- Lobar and segmental bronchi
- Relationships of the hilar vessels and bronchi
- Secondary pulmonary lobule and its component parts
- Correct terminology for describing the site of mediastinal and hilar lymph nodes
- Normal variants of aortic arch branching, including the common origin of the brachiocephalic and left common carotid arteries ("bovine arch"), and separating the origin of the vertebral artery from the arches

### *Generic signs on chest radiographs*

- The following structures on postero-anterior (PA) and lateral chest radiographs:
  - Right upper, middle and lower lobes; left upper and lower lobes; and lingula
  - Fissures – major, minor and azygos
  - Airway – trachea, main bronchi, posterior wall of the intermediate bronchus and lobar bronchi
  - Heart – position of the atria, ventricles, left atrial appendage and the location of the four cardiac valves
  - Pulmonary arteries – main, right, left and interlobar
  - Aorta – ascending, arch and descending aorta
  - Arteries – brachiocephalic (innominate), carotid and subclavian arteries
  - Veins – superior and inferior vena cava, azygos, left superior intercostal ("aortic nipple"), and left brachiocephalic (innominate) veins
  - Components of the thoracic skeleton
  - Mediastinal stripes and interfaces
  - Aortopulmonary window
  - Both hemidiaphragms
- Significance of the following chest radiography signs:
  - Silhouette sign – loss of the contour of the heart or diaphragm indicating an adjacent abnormality (e.g. atelectasis of the right middle lobe obscures the right-hand side of the heart's border)
  - Air bronchogram – indicates airless alveoli and, therefore, a parenchymal process as distinguished from a pleural or mediastinal process
  - Air crescent sign – indicates solid material in a lung cavity, often due to a fungus ball, or crescentic cavitation in invasive fungal infection
  - Cervicothoracic sign – a mediastinal opacity that projects above the clavicles, situated posterior to the plane of the trachea, while an opacity projecting at or below the clavicles is situated anteriorly
  - Tapered margins – a lesion in the chest wall, mediastinum or pleura may have smooth tapered borders and obtuse angles with the chest wall or mediastinum, while parenchymal lesions usually form acute angles
  - Gloved finger sign – indicates bronchial impaction, e.g. in allergic bronchopulmonary aspergillosis, or other chronic obstructive processes

- Golden sign – indicates lobar collapse with a central mass, often due to an obstructing bronchogenic carcinoma in an adult
- Deep sulcus sign on a supine radiograph – indicates pneumothorax
- Following structures on chest CT:
  - All pulmonary lobes and segments
  - A pulmonary lobule and associated structures
  - Fissures – major, minor, azygos and common accessory fissures
  - Extrapleural fat
  - Inferior pulmonary ligaments
  - Airway – trachea, carina, main bronchi, lobar bronchi and segmental bronchi
  - Heart – left and right ventricles, left and right atria, atrial appendages
  - Pericardium – including superior pericardial recesses
  - Pulmonary arteries – main, right, left, interlobar, segmental
  - Aorta – sinuses of Valsalva, ascending, arch and descending aorta
  - Arteries – brachiocephalic (innominate), common carotid, subclavian, axillary, vertebral, internal mammary arteries
  - Veins – pulmonary, superior vena cava, inferior vena cava, brachiocephalic, subclavian, internal jugular, external jugular, azygos, hemi-azygos, left superior intercostal, internal mammary
  - Oesophagus
  - Thymus
  - Normal mediastinal and hilar lymph nodes
  - Azygo-oesophageal recess
  - Inferior pulmonary ligaments
- Chest CT protocol optimised to evaluate each of the following, taking into account the patient's age:
  - Thoracic aorta and great vessels
  - Superior vena cava and brachiocephalic vein stenosis or obstruction
  - Pulmonary embolism
  - Diffuse lung disease
  - Tracheobronchial tree
  - Bronchiectasis
  - Small airway disease
  - Lung cancer staging
  - Oesophageal cancer staging
  - Superior sulcus tumour
  - Pulmonary metastases
  - Pulmonary nodule on a radiograph
  - Shortness of breath
  - Haemoptysis

### ***Alveolar lung diseases and atelectasis***

- The four common causes of segmental consolidation
- Five of the most common causes of adult (acute) respiratory distress syndrome
- The four predisposing causes of or associations with organising pneumonia
- Most common causes of bronchiectasis
- Centrilobular, paraseptal and panacinar emphysema and their patterns on chest radiographs and CT

- Imaging findings used to identify surgical candidates for giant bullectomy or lung volume reduction surgery

### ***Solitary and multiple pulmonary nodules***

- Definition of a solitary pulmonary nodule and a pulmonary mass
- Four most common causes of a solitary pulmonary nodule, cavitary pulmonary nodules and multiple pulmonary nodules
- Strategy for managing a solitary pulmonary nodule detected incidentally or at screening
- Role of contrast-enhanced CT and integrated PET-CT in the evaluation of a solitary pulmonary nodule
- Features that indicate benignity of a solitary pulmonary nodule and their limitations
- Complications of percutaneous lung biopsy and their frequency
- Indications for chest tube placement as a treatment for pneumothorax related to percutaneous lung biopsy

### ***Benign and malignant neoplasms of the lung***

- The four major histological types of bronchogenic carcinoma, and the difference in treatment between non-small-cell and small-cell lung cancer
- TNM classification for staging non-small-cell lung cancer, including the components of each stage
- Staging of bronchogenic cancer
- Abnormal contralateral mediastinal shift on a post-pneumonectomy chest radiograph and two possible aetiologies for the abnormal shift
- Acute and chronic radiographic and CT appearance of radiation injury in the thorax (lung, pleura, pericardium) and the temporal relationship with radiation therapy
- Roles of CT and MRI in lung cancer staging
- Role of positron emission tomography (PET) and integrated PET-CT in lung cancer staging
- Manifestations and the role of imaging in thoracic lymphoma

### ***Thoracic disease in immunocompetent, immunocompromised and post-transplant patients***

- Radiographic manifestations of pulmonary mycobacterial infections on a radiograph and CT
- Various types of pulmonary aspergillosis, understanding that they form part of a continuum, and recognising these entities on chest radiographs and chest CT
- Major categories of disease-causing chest radiography or chest CT abnormalities in the immunocompromised patient
- Two infections and two neoplasms in patients with AIDS and chest radiography or chest CT abnormalities
- Chest radiography and chest CT appearances of *Pneumocystis jiroveci* pneumonia
- The three most important aetiologies of hilar and mediastinal adenopathy in patients with AIDS

- Differential diagnoses for widespread consolidation in an immunocompromised host
- Chest radiography and chest CT findings of post-transplant lymphoproliferative disorders
- Chest radiography and chest CT findings of graft-versus-host disease

### ***Congenital lung disease***

- Components of pulmonary venolobar syndrome (scimitar syndrome) on a frontal chest radiograph, chest CT and chest MRI
- Signs of intralobar pulmonary sequestration and cystic adenomatoid malformation on chest radiographs and chest CT

### ***Pulmonary vascular disease***

- Five of the most common causes of pulmonary artery hypertension and signs on chest radiography and chest CT
- Role of CT pulmonary angiography (CTPA), MRI/MRA and lower extremity venous studies in the evaluation of a patient with suspected venous thromboembolic disease, including the advantages and limitations of each test

### ***Pleura and the diaphragm***

- Chest radiography and chest CT findings of malignant mesothelioma

### ***Mediastinal and hilar disease***

- The most common causes of an anterior mediastinal mass and localising a mass to the anterior mediastinum on chest radiographs, chest CT and chest MRI
- The three most common causes of a middle mediastinal mass and localising a mass to the middle mediastinum on chest radiographs, chest CT and chest MRI
- The most common cause of a posterior mediastinal mass and localising a mass to the posterior mediastinum on chest radiographs, chest CT and chest MRI
- The most common causes of bilateral hilar lymph node enlargement
- The most common causes of "egg-shell" calcified lymph nodes in the chest
- The most common causes of a mass arising in the thymus
- Imaging features and common associations of thymoma
- The three types of malignant germ cell tumour of the mediastinum
- Mechanisms and signs of pneumomediastinum

### ***Thoracic aorta and the great vessels***

- Normal dimensions of the thoracic aorta
- Stanford A and B classification of aortic dissection and the implications of the classification for medical versus surgical management
- Significance of a right aortic arch with mirror image branching versus an aberrant subclavian artery
- Advantages and disadvantages of CT, MRI/MRA and trans-oesophageal echocardiography in the evaluation of the thoracic aorta
- The terms "aneurysm" and "pseudoaneurysm"

## ***Chest trauma***

- The three common causes of abnormal lung opacity following trauma on chest radiographs or chest CT
- The three common causes of abnormal lung opacity following trauma on chest radiographs or chest CT
- The three most common causes of pneumomediastinum following trauma
- Monitoring and support devices – “tubes and lines”

## ***Molecular imaging***

Principles of molecular imaging as applied to chest radiology include its role in:

- Lung inflammatory diseases and lung transplants
- Chest tumours and lymphomas
- Gene therapies for tumours

## **Core skills**

- Applying inspiratory and expiratory imaging, multiplanar reconstructions as applied to pulmonary disease
- Recognising the effects of various pathological processes on the component parts of the pulmonary lobule, as seen on high-resolution CT (HRCT)
- Identifying the pathophysiology of the following patterns:
  - Lung consolidation
  - Ground glass opacity, linear and reticular pattern
  - Honeycombing nodular pattern
  - Bronchiolar opacities (“tree-in-bud”)
  - Air trapping
  - Cysts
  - Mosaic attenuation pattern
- Identifying thickening of the interlobular septa and the possible causes
- Making a specific diagnosis of interstitial lung disease (ILD) when HRCT appearances are characteristic
- Recognising the spectrum of changes of heart failure on chest radiographs, notably:
  - Pleural effusions
  - Vascular redistribution on erect chest radiographs
  - Features of interstitial and alveolar oedema
- Defining the terms “asbestos-related pleural disease” and “asbestosis”, and identifying the imaging findings
- Recognising progressive massive fibrosis/conglomerate masses secondary to silicosis or coal worker’s pneumoconiosis on radiography and chest CT

## ***Differential diagnosis of diffuse infiltrative lung disease***

The trainee radiologist should develop a differential diagnostic list for the following patterns, taking into account the anatomical and imaging distribution of the signs and the clinical information:

- On chest radiographs (according to whether the pattern is predominantly in the upper, mid or lower zone; or shows central or peripheral predominance):
  - Lung consolidation
  - Ground glass opacity
  - Nodular pattern
  - Reticular pattern
  - Cystic pattern
  - Widespread septal lines
- On HRCT (according to whether the pattern is predominantly in the upper, mid or lower zone; or shows perihilar or subpleural predominance; or shows a vascular or perivascular airway, a lymphatic or perilymphatic or an interstitial distribution):
  - Septal thickening/nodularity
  - Ground glass opacity
  - Reticular pattern
  - Honeycombing
  - Nodular pattern
  - Air space consolidation
  - Tree-in-bud pattern
  - Mosaic attenuation pattern
  - Cyst and cyst-like pattern

### ***Alveolar lung diseases and atelectasis***

- Recognising segmental and lobar consolidation
- Recognising partial or complete atelectasis of single or combined lobes on chest radiographs and listing the likely causes
- Recognising complete collapse of the right or left lung on a chest radiograph and listing the appropriate causes of the collapse
- Distinguishing lung collapse from massive pleural effusion on a frontal chest radiograph
- Recognising the halo sign and suggesting a diagnosis of invasive aspergillosis in an immunosuppressed patient
- Recognising the signs of bronchiectasis on chest radiographs and chest CT
- Recognising the HRCT signs of small airways disease and differentiating between the direct signs (tree-in-bud, centrilobar changes) of exudative bronchiolitis and the indirect signs (mosaic pattern, air-trapping) of obliterative bronchiolitis (bronchiolitis obliterans)
- Recognising the typical appearance of cystic fibrosis on chest radiographs and chest CT
- Recognising tracheal and bronchial stenosis on chest CT and naming the most common causes
- Recognising the signs of panacinar emphysema on chest radiographs and CT

### ***Airways and obstructive lung disease***

- Diagnosing bronchiectasis
- Identifying features of air trapping
- Recognising emphysema and the various patterns to include panacinar, bullus and paraseptal emphysema

- Understanding tracheal abnormalities, to include tracheomalacia, tracheal stenosis, and tracheobronchomegaly

### ***Unilateral hyperlucent lung/haemothorax***

- Recognising a unilateral hyperlucent lung on chest radiographs or chest CT and giving an appropriate differential diagnosis

### ***Benign and malignant neoplasms of the lung***

- Naming the four most common extrathoracic metastatic sites for non-small-cell lung cancer and for small-cell lung cancer

### ***Congenital lung disease***

- Recognising bronchial atresia on a chest radiograph and chest CT, and stating the most common lobes of the lungs in which it occurs

### ***Pulmonary vascular disease***

Recognising:

- Enlarged pulmonary arteries on a chest radiograph and distinguishing them from enlarged hilar lymph nodes
- Acute and chronic lobar and segmental pulmonary emboli on CT angiography
- Vascular redistribution seen in raised pulmonary venous pressure

### ***Pleura and the diaphragm***

Recognising:

- Typical chest radiography appearances of pleural effusion on erect, supine and lateral decubitus chest radiographs, and the four causes of a large unilateral pleural effusion
- Appearance of pleural effusion on ultrasound
- Pneumothorax on an upright and supine chest radiograph
- A pleural-based mass with bone destruction or infiltration of the chest wall on a radiograph or chest CT, and naming four likely causes
- Various forms of pleural calcification on a chest radiograph or chest CT and suggesting the diagnosis of asbestos exposure, or old TB, old empyema, or old haemothorax
- Unilateral elevation of one hemidiaphragm on chest radiographs and list five causes (e.g. subdiaphragmatic abscess, diaphragm rupture and phrenic nerve involvement with lung cancer, post-cardiac surgery, eventration)
- Tension pneumothorax
- Diffuse pleural thickening and four causes
- Split pleura sign in empyema

### ***Mediastinal and hilar disease***

Recognising:

- Normal vessels or vascular abnormality on chest CT and chest MRI that may mimic a solid mass
- Mediastinal and hilar lymphadenopathy on chest radiographs, chest CT and chest MRI
- Imaging signs of a benign cystic teratoma
- Signs of an intrathoracic thyroid mass
- Cystic mass and suggesting the possible diagnosis of a bronchogenic pericardial, thymic or oesophageal duplication cyst

### ***Thoracic aorta and the great vessels***

Recognising:

- Findings of, and distinguishing between, each of the following on chest CT and chest MRI:
  - Aortic aneurysm
  - Aortic dissection
  - Aortic intramural haematoma
  - Penetrating atherosclerotic ulcer
  - Ulcerated plaque
  - Ruptured aortic aneurysm
  - Sinus of Valsalva aneurysm
  - Subclavian or brachiocephalic artery aneurysm
  - Aortic coarctation
  - Aortic pseudocoarctation
  - Cervical aortic arch
- Two standard types of right aortic arch and a double aortic arch on chest radiographs, chest CT and chest MRI
- An aberrant subclavian artery on chest CT
- Findings seen in arteritis of the aorta on chest CT and chest MRI

### ***Chest trauma***

- Identifying a widened mediastinum on chest radiographs taken for trauma and stating the possible causes (including aortic/arterial injury, venous injury, fracture of sternum or spine)
- Identifying the indirect and direct signs of aortic injury on contrast-enhanced chest CT
- Identifying and stating the significance of chronic traumatic pseudoaneurysm on chest radiographs, chest CT or chest MRI
- Identifying fractured ribs, clavicle, spine and scapula on chest radiographs or chest CT
- Recognising an abnormally positioned diaphragm or loss of definition of a diaphragm on chest radiographs following trauma and suggesting the diagnosis of a ruptured diaphragm
- Recognising a pneumothorax and pneumomediastinum following trauma on chest radiographs

- Recognising a cavitory lesion following trauma on chest radiographs or chest CT and suggesting the diagnosis of laceration with pneumatocele formation, haematoma or abscess secondary to aspiration
- Recognising and distinguishing between pulmonary contusion, laceration and aspiration
- Identifying and stating the preferred placement of the following devices and lines; listing the complications associated with the malpositioning of each of the following:
  - Endotracheal tube
  - Central venous catheter
  - Swan–Ganz catheter
  - Nasogastric tube
  - Chest tube/drain
  - Intra-aortic balloon pump
  - Pacemaker and pacemaker leads
  - Implantable cardiac defibrillator
  - Left ventricular assistant device
  - Atrial septal defect closure device (“clamshell device”)
  - Pericardial drain
  - Extracorporeal life support cannulae
  - Intra-oesophageal manometer, temperature probe or pH probe
  - Tracheal or bronchial stent
- Performing the following imaging-guided transthoracic interventions under appropriate supervision, and knowing the indications, contraindications, and management of complications:
  - Paracentesis and drainage of pleural effusions
  - Percutaneous lung biopsy
  - Paracentesis of mediastinal and pericardial fluid collections
  - Drainage of refractory lung abscess

### ***Postoperative chest***

Identifying normal postoperative findings and complications of the following procedures on chest radiographs, chest CT and chest MRI:

- Wedge resection mastectomy, lobectomy
- Pneumonectomy
- Coronary artery bypass graft surgery
- Cardiac valve replacement
- Aortic graft
- Aortic stent
- Transhiatal oesophagectomy
- Lung transplant
- Heart transplant
- Lung volume reduction surgery