

B-I:
**LEVEL I
TRAINING
(YEARS 1-3)**

LEVEL I TRAINING (YEARS 1-3)

The subject content of the curriculum for Level I Training includes the following elements:

B-I-1 Breast Radiology

B-I-2 Cardiac and Vascular Radiology

B-I-3 Chest Radiology

B-I-4 Emergency Radiology

B-I-5 Gastrointestinal and Abdominal Radiology

B-I-6 Gynaecological and Obstetric Radiology

B-I-7 Head and Neck Radiology

B-I-8 Interventional Radiology

B-I-9 Musculoskeletal Radiology

B-I-10 Neuroradiology

B-I-11 Paediatric Radiology

B-I-12 Urogenital Radiology

B-I-13 Nuclear medicine as basic training

B-I-14 Radiation Protection Education and Training

B-I-15 Principles of Imaging Technology & Molecular Imaging

B-I-16 Principles of Medical Imaging Informatics

B-I-17 Communication and Management

B-I-18 Research and Evidence-Based Medicine

B-I-1 BREAST RADIOLOGY

INTRODUCTION

The aim of this curriculum in breast imaging is to ensure that the trainee develops core knowledge of imaging normal breast and breast diseases that will form the basis for further training (if desired). It will also provide transferable skills that will equip the trainee for working as a specialist in any branch of radiology.

Physics and radiation protection are covered in separate courses and are not covered in detail unless specific to breast imaging.

KNOWLEDGE

- To understand the anatomy of the female breast, axilla and associated structures and how they change with age
- To describe normal variants and abnormalities of the female breast
- To understand clinical practice relevant to breast imaging
- To describe radiographic techniques employed in diagnostic mammography
- To describe the principles of digital imaging and image processing pertinent to mammography, including standard cranio-caudal and medio-lateral oblique views, additional views, and tomosynthesis
- To understand physics of image production in mammography, particularly how they affect image quality
- To analyse and explain principles of current practice in breast imaging and breast cancer screening
- To know the risk/benefit analysis associated with breast cancer screening
- To describe the proper application of other imaging techniques in this specific field, such as ultrasound, MRI, or radionuclide imaging and to put these into a correct diagnostic pathway
- To describe the indications and contraindications for image-guided interventional breast procedures (fine needle aspiration, core needle biopsy, vacuum-assisted biopsy, presurgical localization)
- To recognise the different presentation of normal breast patterns at mammography, ultrasound, and MRI
- To distinguish the appearance of common benign diseases and of breast cancer on mammography, ultrasound, and MRI
- To understand principles and basic application of a standardized diagnostic categorization systems such as the ACR Breast Imaging Reporting and Data System (BI-RADS®) with reference to mammography, ultrasound, and MRI
- To describe the principles of communication specifically related to the breaking of bad news and consent
- To understand the impact of radiological diagnosis on the treatment (breast conserving/mastectomy)
- To understand the presence of pathological lymph nodes and the significance for further procedures (sentinel/lymphadenectomy)

SKILLS

- To perform ultrasound examinations of the breast under supervision
- To perform interventional breast procedures under ultrasound and X-ray guidance under supervision
- To perform mammography exams under supervision
- To know how to correctly position the breast in the different projections

COMPETENCES AND ATTITUDES

- To justify diagnostic imaging examinations of the breast
- To choose the best-suited method for evaluating disorders of the breast
- To communicate with the patient in order to obtain informed consent prior to interventional procedures of the breast
- To choose optimal imaging parameters for mammography
- To apply techniques to reduce exposure doses of mammography
- To supervise and teach technical staff to ensure that appropriate images are obtained
- To report mammography, breast ultrasound, and breast MRI with respect to common breast diseases, using descriptors and diagnostic categories according standardised systems such as BI-RADS®
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interpreting and reporting breast images
- To communicate with patients and their relatives in order to explain the nature of benign breast disease
- To observe bad news being given to patients and their relatives
- To communicate with patients and their relatives to give bad news
- To participate in and to perform under supervision at multi-disciplinary breast conferences and tumour boards

B-I-2 CARDIAC AND VASCULAR RADIOLOGY

KNOWLEDGE

- To describe the normal anatomy of the heart and vessels including the lymphatic system as demonstrated by radiographs, contrast-enhanced CT and MRI
- To describe normal variants of the cardiac, vascular and lymphatic systems
- To understand the mean exposure doses of radiographs and of CT examinations cardiac and vascular systems
- To describe the principles of digital imaging and image processing pertinent to radiology of the cardiac and vascular systems
- To understand the general principles and classification of congenital heart disease and the diagnostic features on conventional radiographs
- To comprehend the natural history and anatomical deformities causing central cyanosis
- To differentiate radiological features and causes of cardiac enlargement, including acquired valvular disease
- To identify the typical features of deep venous thrombosis on Duplex ultrasound
- To identify the typical feature of arterial stenosis and femoral artery pseudoaneurysm on Duplex ultrasound
- To analyse and explain the diagnostic evaluation of ischaemic heart disease, including radionuclide imaging and the basics of coronary angiography
- To differentiate the diagnostic features of vasculitis, atheroma, thrombosis and aneurysmal dilatation of arteries and veins
- To understand the radiological features of pericardial disease

SKILLS

- To perform ultrasound examinations of arteries and veins under supervision
- To plan and to protocol a CT examination of the cardiac and vascular systems and to adapt it to the individual situation under supervision
- To plan and to protocol an MRI examination of the cardiac and vascular systems and to adapt it to the individual situation under supervision
- To perform proper common post-processing tasks for thoracic imaging studies, including multi-planar reformations (MPR), maximum intensity projections (MIP), minimum intensity projections (MinIP), quantitative functional cardiac image analysis and vessel analysis tools
- To perform femoral artery and venous puncture techniques under supervision
- To treat femoral artery pseudoaneurysm under supervision

COMPETENCES AND ATTITUDES

- To justify diagnostic imaging examinations and/or interventional procedures of the cardiac and vascular systems under supervision
- To choose the best-suited method for evaluating disorders of the cardiac and vascular systems under supervision
- To communicate with the patient in order to obtain informed consent prior to diagnostic imaging and interventional procedures of the cardiac, vascular and lymphatic systems
- To choose optimal imaging parameters for radiographic, ultrasonographic, CT and MRI examinations of the cardiac and vascular systems under supervision
- To apply techniques to reduce exposure doses for radiographic and CT examinations of the cardiac and vascular systems under supervision
- To supervise and teach technical staff to ensure that appropriate images are obtained
- To report radiographic, ultrasonographic, CT and MRI examinations of the cardiac and vascular systems with respect to common diseases under supervision
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interpreting and reporting images of the cardiac and vascular systems
- To identify urgent and/or unexpected findings in imaging examinations of the cardiac and vascular systems and to communicate these timely and properly
- To communicate with patients and their relatives in order to explain their imaging findings of the cardiac and vascular systems
- To participate in and to perform under supervision at multi-disciplinary conferences and tumour boards for diseases of the cardiac and vascular systems

B-I-3 CHEST RADIOLOGY

KNOWLEDGE

- To describe the anatomy of the respiratory system, heart and vessels, the mediastinum and the chest wall on radiographs, CT and MRI
- To describe normal variants of the respiratory system, heart and vessels, the mediastinum and the chest wall
- To understand the mean exposure doses of chest radiographs and of chest CT examinations
- To understand techniques to reduce exposure doses of chest radiographs and of chest CT examinations
- To describe the principles of digital imaging and image processing pertinent to chest radiology
- To understand the significance of generic signs on chest radiographs and CT

GENERIC SIGNS ON CHEST IMAGING

- To confidently identify 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
- To have an in-depth understanding of the 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
- To describe monitoring and support devices (“tubes and lines”) and to confidently identify them on imaging studies

- To describe the imaging features and the preferred placement of the following devices and lines and to list 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
- To describe the typical chest radiography appearances of pleural effusion on erect, supine and lateral decubitus chest radiographs, and to list four causes of a large unilateral pleural effusion
- To describe the imaging features of pleural-based masses with bone destruction or infiltration of the chest wall on a radiograph or chest CT, and to list four likely causes
- To describe the imaging features of a unilateral elevation of one hemidiaphragm on chest radiographs and to list five causes (e.g. subdiaphragmatic abscess, diaphragm rupture and phrenic nerve involvement with lung cancer, post-cardiac surgery, eventration)
- To describe the imaging features and clinical features of tension pneumothorax
- To describe the normal dimensions of the thoracic aorta
- To have an in-depth understanding of the Stanford A and B classification of aortic dissection and the implications of the classification for medical versus surgical management
- To comprehend the features on radiographs and CT and the differential diagnosis of diffuse interstitial and alveolar lung disease, airways and obstructive lung disease
- To differentiate solitary and multiple pulmonary nodules, benign and malignant neoplasms, hyperlucencies and their potential aetiology and evaluation
- To differentiate thoracic diseases in immunocompromised patients and congenital lung disease
- To analyse and explain disorders of the pulmonary vascular system and great vessels
- To understand the diagnostic role of radiographs, radionuclides, CT and MRI in the diagnostic evaluation of disorders of the pulmonary vascular system and great vessels
- To differentiate abnormalities of the chest wall, mediastinum and pleura

SKILLS

- To plan and to supervise the proper acquisition of radiographs, chest radiographs, ventilation/perfusion imaging, thoracic CT, high-resolution chest CT, and the CT pulmonary angiography (CTPA)
- To perform proper positioning of chest radiographs and of chest CT examinations for adults, newborns, infants and children
- To plan and to protocol a CT examination of the chest and to adapt it to the individual situation
- To plan and to protocol an MRI examination of the chest and to adapt it to the individual situation
- To perform proper common post-processing tasks for thoracic imaging studies, including multi-planar reformations (MPR), maximum intensity projections (MIP), minimum intensity projections (MinIP), and vessel analysis tools
- To perform ultrasonographic examinations in the diagnosis
- To perform aspirations of pleural fluid under image-guidance

COMPETENCES AND ATTITUDES

- To justify diagnostic imaging examinations and/or interventional procedures of the chest
- To choose the best-suited method for evaluating disorders of the chest
- To communicate with the patient in order to obtain informed consent prior to diagnostic imaging and interventional procedures of the chest
- To choose optimal imaging parameters for radiographic, ultrasonographic, CT and MRI examinations of the chest
- To design imaging protocols for CT examinations of the thorax, including the appropriate application of intravenous contrast, spatial and temporal resolution, inspiration/expiration and reconstruction/reformatting techniques
- To apply techniques to reduce exposure doses for radiographic and CT examinations of the chest
- To supervise and teach technical staff to ensure that appropriate images are obtained
- To interpret and report radiographs, chest radiographs, ventilation/perfusion imaging, thoracic CT, high-resolution chest CT and CT pulmonary angiography (CTPA) with respect to common diseases
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interpreting and reporting images of the chest
- To identify urgent and/or unexpected findings in imaging examinations of the chest and to communicate these timely and properly
- To communicate with patients and their relatives in order to explain their imaging findings of the chest
- To choose optimal biopsy routes and techniques
- To participate in and to perform under supervision at multi-disciplinary conferences and tumour boards for diseases of the chest

B-I-4 EMERGENCY RADIOLOGY

INTRODUCTION

The aim of this curriculum in Emergency Radiology (ER) is to ensure that the trainee develops core knowledge, skills, competences and attitudes mainly in imaging and when appropriate, in interventional handling of the various traumatic and non-traumatic emergencies. ER understands itself as a circumstance, condition and disease based subspecialty, which has relevant overlap with organ based as well as with modality based knowledge, skills, competences and attitudes and is mainly embedded in a multidisciplinary context. As a consequence, the curriculum will sometimes refer to transferable content from other subspecialty curricula but on the other hand will also equip the trainee for working as a specialist in any branch of radiology. A special focus lies on emergency topics with potentially life threatening conditions and those where fast and precise radiological input may have particular and immediate high impact on best possible outcome and on preparing the trainee as fast as possible to act appropriate and accordingly during night shifts. It also aims to form the basis for further ER Level III subspecialty training.

KNOWLEDGE

- To describe epidemiological data regarding emergencies
- To understand the common mechanisms of injury including acting forces and their distribution in / over human bodies
- To understand principles and basic application of estimating emergency severity such as the Injury Severity Score (ISS) for trauma cases and pain rating scales with regard to the region of pain in non-traumatic cases
- To describe potentially critical legal aspects
- To describe hygiene regulations
- To describe guidelines and corresponding institutional Standard Operating Procedures/algorithms regarding emergency cases
- To describe relevant normal anatomy of the brain, spine, musculoskeletal system, lung, heart, mediastinum, diaphragm, abdominal organs and spaces, genito-urinary tract, venous and arterial system including topographic relationships and cross-sectional appearance
- To describe common normal variants and distinction from acute pathology
- To describe the various radiological modalities and techniques employed in ER including their respective strengths, weaknesses, opportunities and threats regarding ER
- To describe factors and effects of radiation dose as well as techniques for dose reduction
- To describe criteria for good, reasonable/acceptable, poor and insufficient image quality
- To understand the potential risks and benefits of modality dependent contrast media including effects of oral, rectal bladder or filling
- To describe the various phases of intravenous contrast media application (plain, arterial, portal, delayed, hepatobiliary, urographic) and their respective values according to the clinical problem

- To identify the typical appearance of pericardial effusion, pleural effusion, pneumothorax and free abdominal fluids in extended Focused Assessment with Sonography for Trauma (eFAST)
- To describe respective imaging algorithms for various non traumatic emergency cases
- describe respective imaging algorithms for low-energy and high-energy traumatic emergencies
- To describe the relevant pathophysiology, clinical presentation and modality dependent imaging findings of fractures, hypovolemic shock, pneumothorax, pulmonary oedema, pericardial tamponade, obstructive and paralytic ileus, hollow organ perforation or anastomotic insufficiency, organ laceration or rupture (heart, liver, spleen, kidney, pancreas), ischemia, embolism, thrombosis, arterial dissection or rupture, urinary calculi, acute cholestasis, acute neurological deficits, severe inflammatory conditions (such as meningitis, acute osteomyelitis, abscesses, severe pneumonia, cholecystitis, appendicitis, ...), ovarian and testicular torsion
- As far as not covered by content above: To describe additional knowledge content of other subspecialty curricula in cases where patients may often present initially to those experts such as musculoskeletal, paediatric, neurological, gynecological / obstetrical and male genitourinary emergencies
- To describe the relevant modality dependent imaging findings of tubes, drains and catheters, especially with regards to positions
- To describe radiological standard procedures in polytrauma cases, CT under resuscitation and mass casualty incidents
- To describe theory, indications and contraindications for image-guided interventional procedures in emergency settings

SKILLS

- To assess current guidelines provided by national and international ER and other relevant subspecialty bodies
- To properly perform or supervise patient positioning and protocol choice including the application of techniques to reduce dose exposure
- To perform under supervision or assist in:
 - » e-FAST
 - » sonography and contrast-enhanced ultrasonography of emergency cases
 - » femoral artery and venous puncture techniques
 - » image guided drainage of fluid collections
 - » percutaneous transhepatic drainage of the biliary tract
- other interventional emergency procedures under imaging guidance, particularly in bleeding control
- To identify modality and body region dependent common imaging findings in emergency cases such as fracture patterns, luxations, cartilage injury, ileus signs, free air and fluids, bleedings, infarctions, embolism
- To classify modality dependent imaging findings to be potentially acutely life-threatening, in principal but not immediately life-threatening, severe but not life-threatening or other
- To interpret the relevant modality dependent imaging findings of iatrogenic placement regarding tube, drainage or catheter ocation
- To assist in image interpretation or therapy of >1500 emergency cases (>500 CR, >100 eFAST, >200 US, >500 CT including >25 polytrauma cases and cardiovascular emergency cases, >50 MRI, >10 embolisations, >10 PTD, >30 drainage of fluid collections). These cases have to be distributed proportionally over the body regions and the more common pathologies

COMPETENCES AND ATTITUDES

- To obtain and interpret relevant clinical information
- To differentiate high-risk from low-risk patients before imaging
- To differentiate and prioritise findings with respect to their urgency after imaging
- To be able to 'screen' as fast as possible for life-threatening findings (e.g. for CT: <10 min after scan start) using an optimised infrastructure and selective image reading in case of high-risk patients
- To understand the respective advantages and disadvantages of different imaging options in emergency cases
- To choose the best-suited imaging modality and protocol parameters and, if necessary, to put imaging techniques into the most appropriate diagnostic pathway considering advantages and limitations of the different modalities, diagnostic accuracy and speed, amount of radiation exposure and ethically motivated individual risk/benefit-analysis with respect to case severity, time-to-diagnose/therapy, patient age and sex
- To communicate as fast as possible and effectively with referring physicians and supervisory staff
- To participate at multi-disciplinary treatment, morbidity and mortality conferences
- To participate in Quality Assessment and Quality Monitoring for emergency care
- To participate at multi-disciplinary meetings to discuss challenging emergency cases
- To communicate with patients and their relatives with respect to consent as well as bringing bad news in a multidisciplinary context
- To demonstrate a responsible work ethic
- To appreciate own limitations and to identify when it is appropriate to add further imaging and/or obtain assistance in image interpretation
- To understand principles, physical properties, toxic effects, anaphylactoid reactions and biological effects of imaging contrast media
- To outline the best contrast material and its optimal use according to the imaging technique and the clinical problem
- To describe the various timing phases of contrast media application and their respective values according to the clinical problem
- To describe the fundamentals of intravascular bolus kinetics and constant rate input
- To describe the physiology of renal excretion of contrast medium
- To describe enhancement curves within renal compartments after injection of contrast agents
- To list concentrations and doses of contrast agents used intravenously
- To define the nephrotoxicity of contrast media
- To list risk factors of contrast media nephrotoxicity

B-I-5

GASTROINTESTINAL AND ABDOMINAL RADIOLOGY**KNOWLEDGE**

- To describe the normal anatomy of the abdomen and the main variants of the internal viscera, abdominal organs, omentum, mesentery and peritoneum, abdominal wall and pelvic floor on abdominal radiographs, contrast studies, CT, ultrasound and MRI
- To describe the arterial, venous and lymphatic drainage of the relevant organs in the abdomen
- To understand the principal aspects of embryology of the oesophagus, stomach, duodenum, small bowel, appendix, colon, rectum, anus, pancreas, liver, biliary tract and spleen
- To describe the main anatomical variants that may mimic disease in abdominal imaging
- To describe the clinical presentation and natural history of the most common and/or severe diseases of the abdomen and pelvis and the principles of their treatment
- To know the diagnostic features of common benign abnormalities related to the abdominal solid organs and bowel.
- To understand normal post-procedure imaging related to the commonest surgical and interventional radiology procedures
- To describe the imaging features of abdominal trauma and acute conditions, including perforation, haemorrhage, inflammation, infection, obstruction, ischaemia and infarction affecting the abdominal solid organs and gastrointestinal tract on radiographs, ultrasound and CT
- To describe the imaging features of the most common and/or severe chronic diseases of the abdomen
- To describe the patterns of growth and spread of the commonest tumours of the solid abdominal organs and gastrointestinal tract
- To identify imaging features in regard to the stage and extent of tumours, including features that indicate nonresectability
- To describe the basic principles and standards of post-therapy imaging evaluation (tumour, inflammation)
- To understand the main indications and techniques of interventional radiology as applied to abdominal diseases
- To understand the mean exposure doses of abdominal radiographs and of abdominal CT examinations
- To understand techniques to reduce exposure doses of abdominal radiographs and of abdominal CT examinations
- To understand both the technique and the role of associated examinations like endoscopy, endoscopic ultrasound and nuclear medicine (including SPECT, and hybrid imaging SPECT/CT, PET/CT, PET/MRI)
- To have a basic understanding of radiotracers used in hybrid imaging in gastrointestinal and abdominal diseases
- To understand both the technique and the role of associated examinations like endoscopy, endoscopic ultrasound and nuclear medicine (including SPECT, PET and hybrid imaging)
- To understand the basic principles and the main applications of quantification and functional imaging in abdominal diseases, such as quantification of liver fat, iron or fibrosis, tumour perfusion and bowel inflammation
- To describe the rationale and basic principles of diffusion-weighted imaging in abdominal diseases

SKILLS

- To recognise proper positioning of abdominal radiographs for adults, newborns, infants and children
- To plan a CT examination of the abdomen and to adapt it to the individual clinical condition in regard to intravenous contrast medium, contrast phase and intraluminal contrast medium application, with a dose as low as reasonably achievable
- To perform trans-abdominal ultrasound examinations of the gastrointestinal system, abdominal viscera and their vessels, including Doppler sonography
- To observe contrast-enhanced ultrasound studies of the abdominal viscera
- To observe angiography and vascular and non-vascular-interventional techniques in gastrointestinal disease
- To observe CT colonography examinations
- To perform common post-processing tasks for abdominal imaging studies, including multi-planar reformations (MPR), maximum intensity projections (MIP), minimum intensity projections (MinIP), and vessel analysis tools

COMPETENCES AND ATTITUDES

- To justify diagnostic imaging examinations and/or interventional procedures of the abdomen and/or gastrointestinal system
- To choose the most appropriate modality for evaluating disorders of the abdomen and/or gastrointestinal system
- To communicate with the patient in order to obtain informed consent prior to diagnostic imaging and interventional procedures of the abdomen and/or gastrointestinal system
- To choose optimal imaging parameters for radiographic, ultrasonographic CT and MRI of the abdomen and/or gastrointestinal system
- To interpret and report abdominal radiographs, ultrasonographic examinations, abdominal CT studies and MRI examinations of the upper abdomen, small bowel, rectum and anal canal
- To report oncological studies according to international standards (RECIST, WHO) applicable to the specific situation
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interpreting and reporting images of the abdomen and gastrointestinal system
- To identify urgent and/or unexpected findings in imaging examinations of the abdomen and gastrointestinal system and to communicate these in a timely fashion and properly
- To communicate with patients and their relatives in order to explain their imaging findings in the abdomen and gastrointestinal system
- To participate in and to perform under supervision at multi-disciplinary conferences and tumour boards for diseases of the abdomen and gastrointestinal system

B-I-6 GYNAECOLOGICAL AND OBSTETRIC RADIOLOGY

KNOWLEDGE

- To describe the normal anatomy of the female reproductive organs
- To understand the physiological changes affecting normal imaging anatomy of the female reproductive organs throughout the lifespan
- To understand the physiological changes of the female reproductive organs during pregnancy
- To understand the mean exposure doses of radiographs, hysterosalpingography and CT examinations of the female reproductive organs
- To understand techniques to reduce exposure doses of radiographs and CT examinations of the female reproductive organs
- To describe the clinical presentation and natural history of the most common and/or severe diseases of the female reproductive organs
- To understand normal post-procedure imaging of the female reproductive organs related to previous treatment such as surgery or interventional radiology
- To differentiate imaging features of tumours of the female reproductive organs
- To identify imaging features in regard to the stage and extent of tumours of the female reproductive organs, including features that indicate non-resectability
- To understand the imaging features of common disorders associated with pregnancy and delivery
- To understand the main indications and techniques of interventional radiology as applied to the female reproductive organs

SKILLS

- To perform a transabdominal and, where possible, transvaginal ultrasound in common gynaecological disorders
- To plan a CT examination in patients with common gynaecological disorders and to adapt it to the individual situation with a dose as low as reasonably achievable
- To plan an MRI examination of the female reproductive organs and to adapt it to the individual situation, also in regard to the potential use of intravenous contrast
- To perform imaging examinations for infertility work-up
- To perform proper common post-processing tasks for imaging studies of the female reproductive organs

COMPETENCES AND ATTITUDES

- To justify diagnostic imaging examinations and/or interventional procedures of the female reproductive organs
- To choose the best-suited method for evaluating disorders of the female reproductive organs
- To communicate with the patient in order to obtain informed consent prior to diagnostic imaging and interventional procedures female reproductive system
- To choose optimal imaging parameters for radiographic, ultrasonographic, CT and MRI examinations of the female reproductive organs
- To apply techniques to reduce exposure doses for radiographic and CT examinations of the female reproductive organs
- To choose the optimally suited imaging modality for pregnant patients
- To design imaging protocols for CT examinations of the female reproductive organs and for staging in patients with tumours of the female reproductive organs
- To design imaging protocols for MRI examinations of the female reproductive organs including the appropriate application of intravenous contrast and spatial and temporal resolution
- To supervise and teach technical staff to ensure that appropriate images of the female reproductive organs are obtained
- To interpret and report radiographs, CT and MRI examinations of patients with disorders of the female reproductive system
- To report oncological studies in patients with tumours of the female reproductive system according to FIGO stage
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interpreting and reporting images of the female reproductive system
- To identify urgent and/or unexpected findings in imaging examinations of the female reproductive system and to communicate these timely and properly
- To communicate with patients and their relatives in order to explain their imaging findings in disorders of the female reproductive system
- To participate in and to perform under supervision at multi-disciplinary conferences and tumour boards for diseases of the female reproductive system

B-I-7 HEAD AND NECK RADIOLOGY

The aim of this curriculum in Level I head and neck radiology is to ensure that the trainee develops core knowledge of head and neck diseases that will form the basis for further training (if desired). It will also provide transferable skills that will equip the trainee for working as a specialist in any branch of radiology.

The head and neck imaging curriculum describes:

- The knowledge-based objectives for general head and neck radiology including maxillofacial and dental radiology
- The appropriate technical and communication skills

Physics, radiography and contrast media are generally covered in separate courses, and therefore are not included in this document, but physics and radiography topics specific to head and neck should be included in head and neck radiology training, particularly:

- Positioning/views of radiographs for adults, newborns, infants and children
- Mean exposure doses at skin entrance, KVp, antiscatter techniques
- Principles of digital image processing pertinent to head and neck and maxillofacial dental radiology radiology

KNOWLEDGE

- To describe the normal anatomy of the head and neck, including skull base, temporal bone, paranasal sinuses, the oral cavity, pharynx and larynx, the inner ear, salivary glands, thyroid and parathyroid glands, thoracic inlet, orbit, teeth and the temporomandibular joint
- To recall common congenital lesions of the head and neck, including the skull base, temporal bone, paranasal sinuses, the oral cavity, pharynx and larynx, the inner ear, orbit, teeth and the temporomandibular joint
- To understand common manifestations of diseases of the eye and orbit including trauma, foreign bodies, inflammation and tumours
- To understand common imaging manifestations of maxillo-facial trauma and tumours and disorders of the teeth
- To understand common imaging manifestations of lesions and abnormal function of the temporomandibular joint
- To understand common imaging manifestations of disorders of the thyroid, parathyroid and salivary glands
- To be aware of the role of radionuclide imaging in disorders of the thyroid and parathyroid glands
- To be aware of the role of radionuclide imaging in the functional evaluation of endocrine abnormalities
- To understand common imaging manifestations of trauma, inflammation, infection and tumours of the skull base, temporal bone, paranasal sinuses, oral cavity, larynx and pharynx, thyroid and parathyroid, and salivary glands
- To understand the role of ultrasound- and CT-guided puncture of salivary glands, lymph nodes and the thyroid gland

SKILLS

- To perform fluoroscopic examinations of the head and neck region, including barium swallows and sialography
- To observe and perform under supervision ultrasound examinations of the neck, including thyroid, parathyroid lymph nodes and salivary glands
- To plan a CT and a cone beam CT examination in patients with common disorders of the head and neck region and to adapt it to the individual situation with a dose as low as reasonably achievable
- To plan an MRI examination of the head and neck region for the most common indications and to adapt it to the individual situation
- To perform proper common post-processing tasks for imaging studies of the head and neck region including multi-planar reformations (MPR) and maximum intensity projections (MIP)
- To observe image-guided interventional techniques of the head and neck region, e.g. fine needle aspiration biopsy of the thyroid gland

COMPETENCES AND ATTITUDES

- To justify diagnostic imaging examinations and/or interventional procedures of the head and neck
- To choose the best-suited method for evaluating disorders of the head and neck
- To communicate with the patient in order to obtain informed consent prior to diagnostic imaging and/or interventional procedures of the head and neck
- To choose optimal imaging parameters for radiographic, ultrasonographic, CT, cone beam CT and MRI examinations of the head and neck
- To apply techniques to reduce exposure doses for radiographic and CT examinations of the head and neck
- To supervise and design imaging protocols for CT and cone beam CT examinations of the head and neck, including staging examinations in tumours of the head and neck region and to adapt the examination depending on the imaging findings
- To supervise pre-defined imaging protocols for MRI examinations of the head and neck and to design MRI protocols for common indications
- To supervise and teach technical staff to ensure that appropriate images of the head and neck region are obtained
- To recognise suboptimal image quality and its causes
- To interpret and report radiographs, ultrasonographic examinations, CT studies, cone beam CT studies and MRI examinations for common diseases of the head and neck region
- To report oncological studies of the head and neck region according to international standards (TNM) applicable to the specific situation
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interpreting and reporting images of the head and neck region
- To identify urgent and/or unexpected findings in imaging examinations of the head and neck region and to communicate these timely and properly
- To communicate with patients in order to explain common imaging findings in the head and neck and to observe how to communicate bad news
- To attend as an observer multi-disciplinary conferences and tumour boards for diseases of the head and neck region

B-I-8 INTERVENTIONAL RADIOLOGY

It is important for radiology trainees to develop a thorough knowledge of the performance and interpretation of diagnostic vascular and non-vascular techniques and an understanding of common interventional procedures, irrespective of whether they specialise in interventional radiology.

KNOWLEDGE

- To describe the normal anatomy, including common normal variants of the relevant organ, lymphatic, arterial and venous systems and its relevance to interventional radiology
- To describe typical access approaches to common disorders in vascular and non-vascular interventional radiology including biopsy and drainage
- To know the role of different imaging modalities in planning and guiding interventional procedures
- To know how to optimise patient and staff safety during interventional procedures, including understanding of the CIRSE checklist
- To understand the range of treatment strategies for common interventional radiological procedures.
- To describe typical approaches for image-guided ablative techniques
- To understand the risk involved in common interventional techniques and their basic management
- To understand the use, dosage and administration of local anaesthetics
- To understand the pharmacology, administration and patient supervision in relation to intravenous administration of sedation
- To describe the standard procedure in emergency situations, including resuscitation techniques
- To describe typical catheterisation techniques and the principles of selective catheterisation and embolisation
- To understand the indications for nephrostomy drainage, abscess drainage and pleural drainage

SKILLS

- To perform basic arterial and venous catheterisation techniques under supervision
- To perform peripheral arteriography and angioplasty under supervision
- To perform image-guided placement of abscess drainages
- To perform image-guided nephrostomy of dilated renal collecting systems
- To perform image-guided biopsies (at least of superficial structures)
- To perform emergency procedures in life-threatening disorders, including cardio-pulmonary resuscitation

COMPETENCES AND ATTITUDES

- To justify indications for interventional radiological procedures
- To choose the best access routes for an interventional procedure
- To be able to carry out informed consent prior to an interventional procedure
- To use imaging appropriately for interventional procedures
- To optimise techniques to minimise radiation doses for interventional procedures, both for the patient and for the radiologist and staff
- To supervise and teach technical staff to ensure that appropriate support is provided for interventional procedures
- To safely use sedo-analgesia for pain management in patients undergoing interventional radiological procedures
- To ensure adequate monitoring of patients during procedures.
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interventional procedures
- To manage and coordinate emergency situations arising from and/or during interventional procedures
- To communicate with patients and their relatives in order to explain the outcome of the interventional procedure
- To be involved in multi-disciplinary team meetings for patients with potential indications for interventional procedures
- To be able to review and manage patients following interventional radiological procedures
- To be involved with and carry out clinical consultations of patients pre and post procedures.

B-I-9 MUSCULOSKELETAL RADIOLOGY

KNOWLEDGE

- To describe the normal anatomy of the musculoskeletal system
- To be familiar with normal skeletal variants that mimic disease
- To describe common congenital dysplasias of the musculoskeletal system
- To appreciate the value of different imaging techniques in musculoskeletal disorders
- To understand common imaging presentations of trauma involving the skeleton and soft tissue
- To understand the imaging presentation of degenerative disorders of the musculoskeletal system and to appreciate their clinical relevance
- To understand the imaging manifestations of musculoskeletal infection and inflammation
- To understand the imaging manifestations of metabolic diseases, including osteoporosis
- To describe the typical radiographic features of common bone tumours

SKILLS

- To perform ultrasound examinations of the musculoskeletal system for common musculoskeletal disorders
- To plan a CT examination in patients with common disorders of the musculoskeletal system and to adapt it to the individual situation with a dose as low as reasonably achievable
- To plan an MRI examination of the musculoskeletal system and to adapt it to the individual situation
- To perform proper common post-processing tasks for imaging studies of the musculoskeletal system including multi-planar reformations (MPR) and maximum intensity projections (MIP)
- To perform image-guided application of intraarticular contrast media for MR arthrography or CT arthrography under supervision

COMPETENCES AND ATTITUDES

- To justify diagnostic imaging examinations of the musculoskeletal system
- To choose the best-suited method for evaluating disorders of the musculoskeletal system
- To communicate with the patient in order to obtain informed consent prior to diagnostic imaging of the musculoskeletal system
- To choose optimal imaging parameters for radiographic, ultrasonographic, CT and MRI examinations of the musculoskeletal system
- To apply techniques to reduce exposure doses for radiographic and CT examinations of the musculoskeletal system
- To design imaging protocols for CT examinations of the musculoskeletal system
- To design imaging protocols for MRI examinations of the musculoskeletal system
- To supervise and teach technical staff to ensure that appropriate images of the musculoskeletal system are obtained
- To interpret and report radiographs, ultrasonographic examinations, CT studies and MRI examinations of the musculoskeletal system
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interpreting and reporting images of the musculoskeletal system
- To identify urgent and/or unexpected findings in imaging examinations of the musculoskeletal system and to communicate these timely and properly
- To communicate with patients and their relatives in order to explain the musculoskeletal procedures and imaging findings
- To participate in and to perform under supervision at musculoskeletal multi-disciplinary conferences

B-I-10 NEURORADIOLOGY

INTRODUCTION

The aim of this curriculum in Neuroradiology is to ensure that the trainee develops core knowledge, skills, competences and attitudes in diagnostic and interventional neuroradiology.

Neuroradiology is defined as a radiological subspecialty that uses imaging as a fundamental component in diagnostic, functional and interventional procedures for patients with diseases of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system.

KNOWLEDGE

- To describe normal anatomy and normal variants of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system
- To describe the normal anatomy of the cranio-cervical and spinal arterial and venous system, and its relevance to diagnostic and interventional neuroradiology
- To describe characteristic endovascular and percutaneous approaches to common disorders in interventional neuroradiology (brain, skull, skull base, extracranial head, and spine/spinal cord)
- To recall common congenital lesions of the brain, skull, skull base, extracranial head, spine and spinal cord
- To understand the rationale for selecting certain imaging techniques, and the use of contrast administration, in diagnosing and monitoring diseases of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system
- To describe the potential risks and benefits of modality dependent contrast media
- To understand the role of advanced CT and MR techniques, including perfusion CT and MR, diffusion tensor imaging, functional MR imaging and proton MR spectroscopy in diagnosing and monitoring diseases of the central and peripheral nervous system, skull, skull base, extracranial head, and spine.
- To understand imaging features of ischaemic and haemorrhagic stroke and other common vascular lesions of the brain and spinal cord and to differentiate these from other disorders
- To understand imaging features of traumatic brain injury and spinal trauma and to comprehend their neurological sequelae
- To understand imaging features and differential diagnoses of metabolic, infectious, inflammatory, toxic, and degenerative diseases involving the nervous system
- To understand imaging features of degenerative disease of the spine
- To understand imaging features of benign and malignant tumours of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system
- To appreciate the role of nuclear medicine, including SPECT and hybrid imaging techniques (PET-CT, PET-MR) in the diagnostic evaluation of disorders involving the brain, skull, skull base, extracranial head, and spine
- To have a basic understanding of radiotracers used in neuro imaging

SKILLS

- To perform ultrasonographic examinations of the carotid arteries, including Doppler-sonographic studies
- To observe ultrasonographic and Doppler-sonographic studies of intracranial vessels
- To perform basic vascular catheterisation and percutaneous techniques under supervision
- To observe diagnostic and interventional supraaortic, intracranial, and spinal digital subtraction angiographies
- To observe image-guided puncture of the spine with and without contrast media application (myelography, diagnostic lumbar puncture)
- To plan CT examinations in patients with common disorders of the brain, skull, skull base, extracranial head, and spine and to adapt them to the individual situation with a dose as low as reasonably achievable, including the decision for or against contrast administration
- To plan MRI examinations in patients with common disorders of the brain, skull, skull base, extracranial head, and spine and to adapt them to the individual situation, including the decision for or against contrast administration
- To perform proper common post-processing tasks for imaging studies of the brain spine/spinal cord, skull base, extracranial head, and peripheral nervous system, including multi-planar reformations (MPR), maximum intensity projections (MIP) and vessel analysis tools

COMPETENCES AND ATTITUDES

- To justify diagnostic imaging examinations and/or interventional procedures of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system
- To choose the best-suited method for evaluating disorders of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system
- To communicate with the patient in order to obtain informed consent prior to diagnostic imaging and/or interventional procedures of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system
- To choose optimal imaging parameters for X-ray, ultrasound / Doppler-ultrasound, CT and MRI examinations of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system.
- To apply techniques to reduce radiation dose for X-ray and CT examinations of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system
- To design imaging protocols for CT examinations of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system
- To design imaging protocols for MRI examinations of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system
- To supervise and teach technical staff to ensure that appropriate images of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system are obtained
- To interpret and report X-ray, ultrasound / Doppler-ultrasound, CT and MRI examinations of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system
- To report oncological studies of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system according to international standards (TNM) applicable to the specific situation

- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interpreting and reporting images of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system
- To identify urgent and/or unexpected findings in imaging examinations of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system and to communicate these timely and properly
- To communicate with patients and their relatives in order to explain their imaging findings of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system
- To participate in and to perform under supervision at multi-disciplinary conferences, for diseases of the brain, skull, skull base, extracranial head, spine and spinal cord, and peripheral nervous system

B-I-11 PAEDIATRIC RADIOLOGY

KNOWLEDGE

- To describe normal paediatric anatomy and normal variants, with particular relevance to normal maturation and growth
- To understand imaging features of common disease entities specific to the paediatric age group
- To be familiar with principles of establishing a child-friendly environment
- To have an in-depth understanding of the relative values of and indications for ultrasound, CT and MRI in children
- To understand the increased vulnerability of children to ionising radiation
- To have an in-depth understanding of the ALARA principle and the special requirements for radiation safety and contrast material dosage in relation to body mass for the paediatric population
- To recall common congenital disorders of the different body regions and their respective relevance for the child's further development
- To be familiar with the imaging features of common disorders of the brain and spine in neonates, infants and children, including traumatic brain injury (accidental and non-accidental), congenital disorders of the brain and spine, hypoxic injury to the brain, brain haemorrhage and brain tumours
- To be familiar with the imaging features of common disorders of the chest in the paediatric population including bronchiolitis, pneumonia, pleural effusion, pneumothorax, foreign body aspiration, mediastinal masses, thymus and variants, malformations of the airways and oesophageal atresia
- To be familiar with the imaging features of common disorders of the abdomen including intestinal obstruction, necrotising enterocolitis, blunt trauma, pneumoperitoneum and abdominal masses
- To be familiar with the imaging presentation of various grades of vesico-ureteral reflux and urethral anomalies
- To be familiar with the imaging features of gastro-oesophageal reflux, malrotation, Hirschsprung's disease, and anal imperforation
- To be familiar with imaging features of common disorders of the skeletal system in the paediatric population including fractures (accidental and non-accidental), bone dysplasia, tumours, osteomyelitis, joint effusion, Legg-Calvé-Perthes disease and slipped capital femoral epiphysis

SKILLS

- To perform ultrasound examinations of the head in hydrocephalus, subependymal and intraventricular haemorrhage, periventricular leukomalacia and tumours in newborns and infants under supervision
- To perform ultrasound examinations of the chest for evaluating pleural effusion, chest consolidation and normal thymus in newborns, infants and children under supervision
- To perform ultrasound examinations of the abdomen for hypertrophic pyloric stenosis, acute intestinal intussusception, acute appendicitis, intestinal obstruction and volvulus, inguinal hernia, in newborns, infants and children under supervision
- To perform ultrasound examinations of the abdomen for abdominal and pelvic masses, uretero-hydronephrosis, urolithiasis and nephrocalcinosis and cystic disease of the kidney in newborns, infants and children under supervision
- To perform ultrasound examinations of the pelvis for acute pelvic pain in female infants, children and adolescents under supervision
- To perform ultrasound examinations of the scrotum for acute scrotal pain, scrotal masses in male infants, children and adolescents under supervision
- To perform ultrasound examinations of the hip in congenital hip dysplasia and transient synovitis in newborns, infants and children under supervision
- To perform routine fluoroscopic contrast medium studies of the gastrointestinal system and urinary tract including voiding cysturethrography in newborns, infants and children under supervision
- To plan and to supervise the proper acquisition of radiographs, CT, and MRI in newborns, infants and children
- To perform proper positioning of radiographs in newborns, infants and children
- To plan and to protocol CT examinations in newborns, infants and children and to adapt it to the individual situation with special consideration of radiation protection in the paediatric population
- To plan and to protocol MRI examinations in newborns, infants and children and to adapt it to the individual situation
- To perform proper common post-processing tasks for paediatric imaging studies, including multi-planar reformations (MPR)
- To observe interventional techniques in paediatric radiology, e.g. management of intussusception

COMPETENCES AND ATTITUDES

- To justify diagnostic imaging examinations in neonates, infants and children
- To choose the best-suited method for evaluating common disorders in the paediatric population
- To communicate with the parents / caretakers in order to obtain informed consent prior to diagnostic imaging in neonates, infants and children
- To choose optimal imaging parameters for radiographic, ultrasonographic / Doppler-sonographic, CT and MRI examinations of neonates, infants and children
- To apply techniques to reduce exposure doses for radiographic and CT examinations of neonates, infants and children
- To design optimised imaging protocols for CT examinations of neonates, infants and children
- To design optimised imaging protocols for MRI examinations of neonates, infants and children
- To supervise and teach technical staff to ensure that appropriate images of neonates, infants and children are obtained
- To interpret and report radiographs, ultrasound examinations, CT studies and MRI examinations of neonates, infants and children in regard to common disorders in this age group
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interpreting and reporting images of neonates, infants and children
- To identify urgent and/or unexpected findings in imaging examinations of the neonates, infants and children and to communicate these timely and properly
- To communicate with parents / caregivers in order to explain the imaging findings of their children
- To communicate with children and adolescents in an age-appropriate manner in order to explain diagnostic or interventional procedure or imaging findings
- To participate in and to perform under supervision at multi-disciplinary paediatric conferences and paediatric tumour boards

B-I-12 UROGENITAL RADIOLOGY

KNOWLEDGE

(SEE ALSO B-I-6 GYNAECOLOGICAL AND OBSTETRIC RADIOLOGY)

- To describe normal anatomy and normal variants of the kidneys, ureters, bladder and urethra
- To describe normal anatomy and normal variants of the retroperitoneum and the male and female pelvis
- To understand the principles of renal function
- To be familiar with typical imaging features of renal parenchymal diseases, including infection and renovascular disease
- To understand contrast medium management in renal failure
- To be familiar with typical imaging features and with the appropriate imaging investigation algorithm of calculus disease
- To understand the imaging features of urinary tract obstruction and reflux
- To understand imaging features and to differentiate tumours of the kidney and urinary tract
- To understand the typical imaging features of renal transplants
- To understand imaging features and differential diagnoses of pathologies of the prostate, seminal vesicles and testes/scrotum
- To be familiar with urogenital emergencies including management

SKILLS

- To perform transabdominal ultrasound examinations of the urinary tract and testes
- To plan CT examinations in patients with common disorders of the urogenital system and to adapt the examination protocol to the individual situation with a dose as low as reasonably achievable, including the decision for or against contrast administration
- To plan MRI examinations in patients with common disorders of the urogenital system and to adapt the examination protocol to the individual situation, including the decision for or against contrast administration
- To perform proper post-processing tasks for imaging studies of the urogenital system, including multi-planar reformations (MPR) and maximum intensity projections (MIP)
- To perform ascending urethrograms and micturating cysto-urethrograms under supervision

COMPETENCES AND ATTITUDES

- To justify diagnostic imaging examinations of the urogenital system
- To choose the best-suited method for evaluating disorders of the urogenital system
- To communicate with the patient in order to obtain informed consent prior to diagnostic imaging of the urogenital system
- To choose optimal imaging parameters for radiographic, ultrasonographic / Doppler-sonographic, CT and MRI examinations of the urogenital system
- To apply techniques to reduce exposure doses for radiographic and CT examinations of the urogenital system
- To design imaging protocols for CT examinations of the urogenital system
- To design imaging protocols for MRI examinations of the urogenital system
- To supervise and teach technical staff to ensure that appropriate images of the urogenital system are obtained
- To interpret and report radiographs, ultrasonographic / Doppler-sonographic examinations, CT studies and MRI examinations of the urogenital system
- To report oncological studies of the urogenital system according to international standards (RECIST, WHO) applicable to the specific situation
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interpreting and reporting images of the urogenital system
- To identify urgent and/or unexpected findings in imaging examinations of the urogenital system and to communicate these timely and properly
- To communicate with patients and their relatives in order to explain their imaging findings of the urogenital system
- To participate in and to perform under supervision at multi-disciplinary conferences and tumour boards for diseases of the urogenital system

B-I-13 NUCLEAR MEDICINE AS BASIC TRAINING

It is recommended that a three-month period of training in nuclear medicine (hybrid imaging) should be a component of the radiology curriculum during the first three years in order to gain a familiarity with this specialty. To acquire the basic knowledge of nuclear medicine with focus on hybrid imaging and to understand the role of these techniques within the diagnostic imaging algorithms should be an educational priority. This recommended three-months training period by no means implies a full training in nuclear medicine.

KNOWLEDGE

- To describe basic principles of physics including the basic atomic structure, principles of radioactivity and basic of radioactive decay
- To be familiar with basic principles of the production of radionuclides, manufacturing, desirable characteristics and physiological distributions of radiopharmaceuticals and positron emission tomography (PET)-tracers
- To explain the principles of biological and effective half-life
- To understand the principles of quantification of PET studies including standardized uptake values (SUV)
- To describe the basic physical principles of nuclear medicine imaging technology, including gamma cameras, single photon emission computed tomography (SPECT), and PET
- To understand the basic physical principles of hybrid imaging, including SPECT/CT, PET/CT, and PET/MR
- To be familiar with imaging performance parameters, including uniformity of response, system sensitivity, spatial resolution, spatial linearity, count rate performance, and image quality
- To understand safety aspects in nuclear medicine and hybrid imaging, including patient dosimetry, staff dosimetry, contamination, monitoring, choice of equipment, quality control and safety/risk management

SKILLS

- To observe nuclear imaging studies with gamma cameras, SPECT, and PET/CT

COMPETENCES AND ATTITUDES

- To apply the appropriateness criteria and indications for nuclear medicine and hybrid imaging procedures under supervision
- To assist referring physicians in selecting the best-suited nuclear medicine or hybrid imaging examination for common indications
- To communicate with the patient in order to inform them about the procedures and obtain informed consent prior to nuclear medicine or hybrid imaging studies
- To choose optimal imaging protocols for nuclear medicine and hybrid imaging examinations under supervision
- To apply techniques to reduce exposure doses for nuclear medicine and hybrid imaging studies under supervision
- To interpret and report common nuclear medicine and hybrid imaging studies under supervision
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interpreting and reporting nuclear medicine and hybrid imaging examinations
- To identify urgent and/or unexpected findings in nuclear medicine and hybrid imaging examinations and to communicate these timely and properly
- To communicate with patients and their relatives in order to explain their imaging findings of nuclear medicine studies under supervision
- To participate in multidisciplinary clinical reviews and tumour boards under supervision

B-I-14

RADIATION PROTECTION EDUCATION AND TRAINING**KNOWLEDGE**

- To list the sources and properties of ionising radiation
- To list and explain mechanisms of interaction between ionising radiation and matter/tissues
- To list and explain mechanisms of radioactive decay
- To explain the phenomena of X-ray interaction with matter and the consequences for image generation, image quality and radiation exposure
- To list and explain definitions, quantities and units of kerma, absorbed energy dose (Gy), organ and effective doses (Sv), as well as exposure rate and dose rate
- To understand the mechanism of X-ray production
- To list the components of an X-ray unit and explain the process of X-ray generation
- To explain the function of filters and diaphragms
- To list the common analogue and digital detectors, explain their function and their relative pros and cons
- To explain the role of screens (in analogue radiography) and grids and their effect on image quality and exposure
- To describe radiation effects on cells and DNA
- To describe cellular mechanisms of radiation response, repair and cell survival
- To describe radiation effects upon tissues and organs
- To explain differences in radiation response between healthy tissue and tumours as basis for radiation treatment
- To define and explain stochastic, deterministic and teratogenic radiation effects
- To describe types and magnitudes of radiation risk from radiation exposure in medicine
- To describe the basic principles of radiation protection, as outlined by the ICRP (International Commission on Radiological Protection)
- To specify types and magnitudes of radiation exposure from natural and artificial sources
- To describe concepts of dose determination and dose measurement for patients, occupationally exposed personnel and the public
- To explain the nature of radiation exposure and the relevant dose limits for the worker, including organ doses and dose limits for pregnant workers, comforters, careers, and the general public
- To define As Low As Reasonably Achievable (ALARA) and its applicability to diagnostic radiology settings
- To explain the concepts and tools for dose management in diagnostic radiology with regard to adult and paediatric patients
- To explain the factors influencing image quality and dose in diagnostic radiology
- To describe the methods and tools for dose management in diagnostic radiology: radiography, fluoroscopy, CT, mammography, and those for paediatric patients
- To explain the basic concepts of patient dose measurement and calculation for the different modalities in diagnostic radiology
- To describe the key considerations relevant to radiation protection when designing a diagnostic radiology department
- To list diagnostic procedures performed outside the radiology department with relevant radiation protection considerations

- To list expected doses (reference person) for frequent diagnostic radiology procedures
- To explain quantitative risk and dose assessment for workers and the general public in diagnostic radiology
- To define Quality Assurance (QA) in radiology, QA management and responsibilities, outline a QA and radiation protection programme for diagnostic radiology
- To list the key components of image quality and their relation to patient exposure
- To explain the principle of diagnostic reference levels (DRLs)
- To list national and international bodies involved in RP regulatory processes
- To specify the relevant regulatory framework (ordinances, directives, etc.) governing the medical use of ionising radiation in the respective country and the EU
- To specify the relevant regulatory framework governing the practice of diagnostic radiology in the respective country and in the EU
- To understand the effects of poor-quality images

SKILLS

- To apply radiation physics to optimally select the best imaging modality
- To apply radiation physics to optimise the protocols, using minimal exposure to reach the image quality level needed for the task
- To use the laws of physics to minimise scatter and optimise contrast
- To use the correct terms to characterise exposure in daily radiograph fluoroscope and CT examinations and define organ risk, and estimate the genetic and cancer risk
- To use the technical features of the specific equipment and take advantage of all quality-improving and dose-reducing capabilities while recognising the limits of the machine
- To communicate the radiation risk to the patient at an understandable level, whenever there is a significant deterministic or stochastic risk, or when the patient has a question
- To communicate with the referrer regarding justification, and, if necessary, to suggest a different test
- To apply the three levels of justification in daily practise, with respect to existing guidelines, but also to individual cases (e.g. polymorbidity)
- To optimise imaging protocols by using standard operating procedures (SOPs) and by adapting these to the specific patient's size
- To use specific paediatric protocols, by taking into consideration the physics of small size, but also the elevated risk, vulnerability and specific pathology of each age group
- To choose the best compromise between risk-benefit-ratio, image quality and radiation exposure on a case-by-case basis
- To supervise the use of personal protective equipment
- To support monitoring of the workplace and individuals
- To support exposure assessment, investigation and follow up, health surveillance, and records
- To apply and advise on the use of radiation protection measures in diagnostic radiology (radiography, fluoroscopy-intervention, CT, mammography and paediatric patients)
- To stay within guidance/reference levels in daily practice
- To set up size-specific protocols for high-dose procedures

- To estimate organ doses and effective doses for diagnostic radiology examinations, based on measurable exposure parameters (KAP, DLP)
- To apply standards of acceptable image quality
- To perform retake analyses

COMPETENCES AND ATTITUDES

- To continuously check image quality in order to recognise and correct technical defects
- To demand the best in image quality, technical innovation and exposure reduction for the lowest cost
- To coordinate the commissioning of new equipment with the other members of the core team (radiographer, medical physicist)
- To develop an organisational policy to keep doses to the personnel as low as reasonably achievable (ALARA)
- To avoid unnecessary radiation exposure during pregnancy (warning signs, questionnaire) by optimising the technique (size and positioning of the x-ray field, gonad shielding, tube-to-skin distance, correct beam filtration, minimising and recording the fluoroscopy time, excluding non-essential projections, avoiding repeat radiographs)
- To find and apply the relevant regulations for any clinical situation in radiology
- To choose the best equipment for the patient spectrum based on the resources available
- To take responsibility for choosing the best imaging modalities for the individual patient (radiography, CT, alternatives such as ultrasound or MRI) by taking into consideration the risk of the disease, patient, age and size, the dose level of the procedure, and exposure of different critical organs
- To consult both the patient and staff on pregnancy related concerns in radiation protection
- To take responsibility for patient dose management in different imaging modalities
- To advise patients on the radiation-related risks and benefits of a planned procedure
- To take responsibility for the justification of radiation exposure for every individual patient, with special consideration for pregnant patients
- To take responsibility for choosing and performing the diagnostic procedure with the lowest dose for a given referrer's request
- To take responsibility for optimising the radiographic technique/protocol used for a given diagnostic procedure based on patient-specific information
- To take responsibility for applying the optimal size-adapted and problem-adapted individual protocol for high-dose procedures (CT, fluoroscopy-intervention)
- To supervise quality control procedures on all equipment related to patient exposure
- To take responsibility for the establishment of formal systems of work (Standard Operating Procedures) for radiation protection
- To take responsibility for organisational issues and implementation of responsibilities and local rules in regard to radiation protection
- To take responsibility for compliance with regulatory requirements concerning occupational and public radiation exposures
- To take responsibility for compliance with ALARA principles concerning occupational and public radiation exposures
- To take responsibility for conforming with patient protection regulations (including diagnostic reference levels, where applicable)

B-I-15 PRINCIPLES OF IMAGING TECHNOLOGY & MOLECULAR IMAGING

KNOWLEDGE

RADIOGRAPHY

- To explain the relative value of a radiographic examination for the various organ systems and indication
- To have an in-depth understanding of the physical basis of image formation of conventional X-ray
- To explain the concept of electromagnetic waves
- To describe X-ray production, with emphasis on the effects on dose and image quality of altering kV and mA and on the trade-off between diagnostic quality imaging and minimising the effective dose
- To describe the interaction between X-rays and matter
- To describe the structure, role and function of filters, collimators and grids
- To explain the principles of radiographic image acquisition
- To explain the principles of digital image acquisition / digital radiography
- To list and describe the factors affecting image quality in conventional and digital radiography
- To describe the indications for the use of X-ray contrast media in the study of various organs / organ systems
- To describe the principles of fluoroscopy
- To describe the indications for fluoroscopy including the principles of contrast application and to list optimized protocols
- To list techniques to enhance image quality and to reduce radiation in fluoroscopy
- To describe the principles of soft tissue radiography, e.g. in mammography
- To explain the principles of specimen radiography
- To have an in-depth understanding of dosimetry
- To have an in-depth understanding of radiation biology

COMPUTED TOMOGRAPHY - CT

- To explain the relative value of a CT examination for the various organ systems and indications
- To have a good understanding of the physical basis of image formation of computed tomography and of the physics of helical and multidetector CT
- To have a basic understanding of dual-source CT
- To list the major sources of artefacts in CT
- To define the scale of Hounsfield units and to explain the principle of window centre and width
- To list the optimal setting of window centre and width for various organs and tissues
- To list the normal levels of attenuation (in HU) for the various organs and pathological processes in the body
- To describe the principles of optimising sequence protocols for a variety of CT scanner types
- To understand the principles of perfusion imaging with CT

- To understand the principles of CTA protocols, including contrast materials used and reconstruction techniques
- To define CT protocols for the various organs and pathological processes in the body
- To explain the principles of reconstruction algorithms and kernels
- To describe the indications for the use of CT contrast media in the study of various organs / organ systems
- To have a good understanding of CT-dosimetry

MAGNETIC RESONANCE IMAGING - MRI

- To explain the relative value of an MRI examination for the various organ systems and indications
- To explain the fundamentals of MR physics
- To have an appreciation of the hardware associated with an MRI system
- To have a basic understanding of the physical basis of image formation in MRI
- To explain the principles of pulse sequences and relaxation times
- To explain the principles of spin echo and gradient echo sequences and their fast variants,
- To describe the principles and main diagnostic applications for the most commonly used sequences in MRI, including T2-weighted sequences, T1-weighted sequences, inversion recovery sequences, and T2*- / susceptibility weighted sequences
- To describe the typical appearance of tissues, organs and pathological processes on these MR sequences
- To understand the sequence technology for MR angiography (MRA) including time of flight (TOF) , phase contrast (PC), other non-(exogenous) contrast enhanced MRA techniques and contrast-enhanced MRA
- To discuss the advantages and disadvantages of different contrast agents used for MRA
- To discuss the differences between the various MRA techniques
- To discuss advantages and disadvantages of MRA compared with other techniques
- To explain the principles of dynamic contrast-enhanced (DCE) MRI
- To explain the principles of diffusion-weighted imaging (DWI) and diffusion tensor imaging (DTI)
- To have an appreciation of the principles of functional MRI (fMRI) using the BOLD contrast mechanism
- To outline the principles of spectroscopy using ^1H
- To describe typical artefacts on MR imaging and to discuss their respective causes and solutions where possible
- To describe the indications/contra-indications for the use of MR contrast agents in the study of various organs / organ systems
- To explain the contraindications to MR imaging and how to conduct MR examinations of patients with MR conditional active or passive implants
- To have detailed appreciation of the safety issues associated with MRI with regard to both patients and staff

ULTRASOUND

- To explain the relative value of an ultrasound examination for the various organ systems and indications
- To describe the nature of ultrasound waves, their propagation, velocity, intensity and the equations that describe them
- To describe the principles of acoustic impedance and to list the tissue properties that determine it
- To describe the frequency of transmission to achieve satisfactory imaging

- To describe the physical principles of the piezoelectric phenomenon
- To list factors that determine the resonance frequency of the piezoelectric element
- To explain the principles of continuous and pulsed emission ultrasound
- To list the factors that focus and unify the ultrasound beam
- To describe the differences between the A, B and TM modes of ultrasound
- To explain the principles of spatial and temporal resolution of ultrasound images as applied to good image formation
- To explain the principles of the Doppler effect and the application of angled beam and direction of flow
- To describe the application of pulsed and continuous wave Doppler and spectral waveform analysis
- To describe the thermal and mechanical biological effects of ultrasound waves, including production of the cavitation phenomenon
- To describe the different types of transducers in ultrasound imaging
- To list the appropriate transducers according to the organs imaged
- To explain the relative value of transcutaneous vs. endoluminal sonography
- To describe criteria for a good ultrasound image
- To describe the major artefacts on ultrasound imaging including reflection, diffusion and speckle and to list their respective causes
- To describe the indications for the use of ultrasound contrast media in the study of various organs / organ systems

CONTRAST MEDIA /AGENTS

- To understand the molecular structure, pharmacology, classification, dose and side effects of all radiographic, MRI and ultrasound contrast media
- To explain the principles of contrast ultrasound media and the relation between the ultrasound beam and microbubbles
- To explain the principle of ionic and non-ionic contrast agents
- To describe the physiological principles, physical properties, toxic effects, anaphylactoid reaction and biological effects of iodinated contrast media
- To describe the physiological principles, physical properties, toxic effects, anaphylactoid reaction and biological effects of MRI contrast agents
- To outline the best contrast material and its optimal use according to the imaging technique and the clinical problem
- To describe the various timing phases of contrast media application and their respective values according to the clinical problem
- To describe the fundamentals of intravascular bolus kinetics and constant rate input
- To describe the physiology of renal excretion of contrast medium
- To describe enhancement curves within renal compartments after injection of contrast agents
- To list concentrations and doses of contrast agents used intravenously
- To define the nephrotoxicity of contrast media

- To list risk factors of contrast media nephrotoxicity
- To identify patients at risk of contrast media nephrotoxicity
- To list methods to reduce the risk of contrast nephrotoxicity
- To describe precautions in diabetics taking metformin and requiring intravascular administration of contrast media
- To list measures to reduce the risk of contrast media nephrotoxicity
- To have an in-depth understanding of nephrogenic systemic fibrosis (NSF) including the definition of NSF, the clinical features and the risk factors
- To describe the use of Gadolinium-based contrast agents in patients at risk

SIGNAL PROCESSING AND POST-PROCESSING

- To have a basic understanding of the principles of signal processing
- To describe the principles of linear systems including convolution, Fourier transformation, Nyquist, image restoration, and deconvolution
- To describe the principles of image display
- To have a good understanding of image quality, including noise, contrast, resolution, and noise amplification during processing
- To be familiar with the principles of quantification including ROI analyses, time-activity curves and factorial analysis
- To understand the principles of image processing including edge, enhancement, smoothing, segmentation, image reconstruction, image fusion, registration, and display

MOLECULAR IMAGING

- To have an understanding of basic principles of cell biology and biochemistry including DNA and RNA activity, metabolism, apoptosis and hypoxia
- To have a basic understanding of stem cell migration and stem cell differentiation
- To understand the basic principles of the most commonly used molecular imaging methods, including nuclear medicine (PET, micro-PET, micro-SPECT) and optical imaging (fluorescence, bioluminescence)
- To have a basic understanding of principles of targeted contrast agents
- To have a basic understanding about demand on pharmacology and pharmacokinetics for a diagnostic probe
- To list the most common molecular targets for imaging
- To list the most commonly used tracers in molecular imaging
- To have an appreciation of the methods of molecular imaging, including its potential application to oncology, cardiovascular imaging, neurology and drug delivery
- To have a basic understanding of the strategies of gene therapy, including gene replacement, gene repair and silencing, and of cell therapy
- To have an understanding about chemistry and biotechnology methods relevant for probe development
- To understand PET image analysis and data processing
- To have an appreciation of hybrid imaging, e.g. PET/CT, PET/MR

SKILLS

- To choose the optimal contrast medium for common clinical indications for all types of imaging studies
- To be able to perform an emergency treatment for adverse reactions to contrast media when required
- To identify patients at risk of contrast media nephrotoxicity
- To take measures to reduce the risk of contrast nephrotoxicity
- To take precautions in diabetics taking metformin and requiring intravascular administration of contrast media
- To take measures to reduce the risk of contrast media nephrotoxicity
- To identify patients at risk to develop NSF
- To choose optimal exposure parameters for radiographic imaging
- To choose optimal acquisition parameters for common CT applications
- To choose optimal MR sequences for common indications for MR imaging
- To choose the appropriate ultrasound transducer according to the organ imaged
- To choose optimal imaging parameters in ultrasound and Doppler sonography
- To obtain Doppler spectra on the various vessels of the body

COMPETENCES AND ATTITUDES

- To choose optimal imaging parameters for all imaging technologies
- To make informed purchasing decisions for imaging equipment for a radiological department respecting imaging technology, radiation protection and budget restrictions
- To devise strategies to reduce artefacts on conventional radiography, fluoroscopy, CT, MRI and ultrasound
- To appreciate the effect of the properties of the machine/scanner on image quality and to optimise the image quality for the machine/scanner available for all common imaging indications
- To appreciate the effect of the properties of image recording and display and to optimise the image quality in the available setting for all common imaging indications
- To appreciate the impact that image quality has on clinical performance and to enhance image quality to the best extent possible
- To confidently devise and conduct quality assurance programmes

B-I-16

PRINCIPLES OF MEDICAL IMAGING INFORMATICS**KNOWLEDGE**

- To understand the basic techniques of PACS, automated dictation (speech recognition), and medical information systems (EMR and HIS)
- To list the informatics standards, including DICOM, HL7 and their appropriate accomplishment following IHE recommendations; to be aware of the role of the IHE in using such standards
- To know the medical digital image formats
- To have a basic knowledge of monitor requirements for different imaging modalities.
- To have a basic knowledge of network of computers, digital networks and cloud services, including security issues.
- To have a basic knowledge of databases.
- To have a basic knowledge of different options for long-term storage of digital data.
- To have a basic knowledge of image processing (3D, multiplanar, MIP, volume rendering...)
- To have a basic knowledge of digital structured reporting and structured report coding
- To have a basic knowledge of principles and regulations of data privacy
- To have a knowledge of online searches with Pubmed, Google scholar
- To have a knowledge of web-portals for patients and their application for radiology
- To know how to secure communication by e-mail and dedicated messaging services
- To have a knowledge of safe and secure use of social networks (social media) with knowledge of privacy issues
- To have a basic knowledge of online CME
- To know basic principles of digital radiography, computed radiography and digital image acquisition
- To know how to implement image distribution using portable media
- To know how to explain e-learning tools
- To discuss relevant aspects of teleradiology and telemedicine
- To have an understanding of structured reporting

SKILLS

- To develop general computer skills
- To know how to use electronic communication skills
- To know how to use of computers for clinical presentations
- To know how to use of structured reporting applications
- The know the use of RIS and HIS for accessing patients' clinical data and prior examinations
- To know how to use advanced postprocessing (e.g. 3D reconstruction) workstation functions
- To ensure that the PACS monitor is displaying the data appropriately
- To know how to communicate with the technological support when systems fail (diagnostic equipment, workstations, servers, RIS/PACS, etc.)
- To know how to use e-learning tools
- To know how to route studies and manual sending of images

COMPETENCES AND ATTITUDES

- To know how to use these tools to improve images and facilitate diagnosis
- To know how to use these tools in the benefit of the patients
- To know how to use these tools to provide an actionable report

B-I-17 COMMUNICATION AND MANAGEMENT

KNOWLEDGE

- To be familiar with the principles of communicating bad news
- To have an in-depth understanding of the nature, structure and medicolegal aspects of radiological reporting
- To understand the importance of timely communication with referring doctors with regard to imaging reports
- To understand the important role of the radiologist in multidisciplinary meetings and tumour boards
- To know the basic principles of communication in multidisciplinary meetings, including an appreciation of the transfer of knowledge, demonstration of imaging findings, and awareness of treatment consequences
- To understand the basic didactic principles of teaching radiology
- To describe the principles of administration and management as applicable to a clinical imaging department with multidisciplinary staff and high-cost equipment
- To be familiar with the procedures, legalities, critical evaluation processes and priorities required for systems purchase
- To understand the principles of teleradiology and its potential role and legal implications
- To understand the methodology and principles of the clinical audit with honesty and integrity, full agreement and confidentiality
- To understand the concept of measured performance and the comparison with target standards
- To interpret the results of audit measurements, the process of implementing change and the re-measurement of performance
- To understand the limitations of the selection of appropriate target standards
- To describe relevant country-specific legal implications of audits
- To appreciate the concepts of consensus statements from learning bodies and the methodology for sourcing them
- To understand the medico-legal implications of radiological practice
- To understand the concept of perceptual errors
- To be aware of the risk and consequences of missed radiographic diagnoses
- To be familiar with concepts to minimise radiological risk
- To have an in-depth understanding of more common radiological pitfalls
- To be familiar with the concepts of uncertainty and error in radiological practice
- To describe the concept of hindsight bias
- To understand the importance of the comparison with previous examinations
- To be aware of the specific liabilities relating to screening
- To have a basic understanding of health economics

SKILLS

- To formulate a comprehensive radiological report according to accepted standards
- To use an adequate terminology for the respective clinical question
- To perform cost-benefit and cost-efficiency evaluations for common imaging strategies
- To perform audits of structure, process and outcome
- To teach undergraduate students or other trainees relevant radiological knowledge and skills

COMPETENCES AND ATTITUDES

- To relate to the patient and their families with respect, honesty and confidentiality
- To be able to explain diagnostic imaging examinations and interventional procedures to the patient and to obtain informed consent
- To be able to explain examination results to patients and/or their families when appropriate
- To properly communicate with referring clinical colleagues
- To distinguish between routine methods of communication, and the necessity for immediate reporting of emergency, life-threatening or unexpected findings
- To timely and adequately communicate urgent or unexpected findings

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RESEARCH AND EVIDENCE-BASED MEDICINE**KNOWLEDGE**

- To understand the basic elements of scientific methods and evidence-based medicine
- To have an in-depth understanding of design and data analysis for technical and diagnostic performance studies, including the influence of disease prevalence and spectrum on sensitivity, specificity, accuracy, and predictive values as well as the use of ROC analysis in radiological studies
- To understand the statistics necessary for critical assessment of published radiological primary and secondary studies (i.e. meta-analyses, cost-effective analyses)
- To describe basic statistics used in studies comparing treatments (i.e. randomised controlled trials)
- To understand the principles and practice of clinical audit
- To have a basic understanding of didactic methods to teach radiology

SKILLS

- To present studies from the radiological literature in departmental meetings
- To perform basic biostatistical tests relevant to the radiological literature
- To perform a focussed literature search of the relevant radiological literature
- To perform clinical audit in a radiological department

COMPETENCES AND ATTITUDES

- To appraise the relevant radiological literature in a critical manner
- To plan and conduct research studies under supervision in a methodologically sound manner
- To understand the value and methods of evolving imaging technologies