

B-II:
**LEVEL II
TRAINING
(YEARS 4-5)**

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INTRODUCTION

Level II Training should be interpreted as a continuum of radiology training. During these two years it is envisaged that the trainee should spend approximately 50% of the time in general radiology, with 50% exposure to a maximum of two subspecialty areas. One of these subspecialty areas may remain general radiology.

The curricular content for Level II Training comprises the following subject areas:

B-II-1 Breast Radiology

B-II-2 Cardiac and Vascular Radiology

B-II-3 Chest Radiology

B-II-4 Emergency Radiology

B-II-5 Gastrointestinal and Abdominal Radiology

B-II-6 Gynaecological and Obstetric Radiology

B-II-7 Head and Neck Radiology

B-II-8 Interventional Radiology

B-II-9 Musculoskeletal Radiology

B-II-10 Neuroradiology

B-II-11 Oncologic Imaging

B-II-12 Paediatric Radiology

B-II-13 Urogenital Radiology

B-II-14 Medical Imaging Informatics

B-II-1 BREAST RADIOLOGY

KNOWLEDGE

- To have an in-depth understanding of epidemiological data regarding breast cancer
- To identify major risk factors of breast cancer, including familial-genetic predisposition and previous thoracic radiation therapy
- To understand principles of risk stratification and the indications for genetic counselling
- To appreciate the principles and objectives of population screening
- To be aware of the masking effect of breast density determining a reduced sensitivity of mammography
- To know the relative role of breast density as a risk factor for breast cancer
- To describe the structure and management of a national or regional screening programme (if it exists)
- To identify the risks and benefits of screening to the population and the individual, including those related to subject age, family and personal history
- To understand screening theory and to describe lead time bias, length bias, survival versus mortality rates, prevalence versus incidence screening, definition of lead time and interval cancer rate, overdiagnosis and overtreatment
- To describe the European guidelines for breast cancer screening and diagnosis (<http://www.euref.org/european-guidelines>)
- To know the potential of tomosynthesis in the screening setting for increasing the detection rate and reducing the recall rate
- To describe the principles and techniques used in screening audit, desirable goals for positive predictive value, percentage of stage 0 (ductal carcinoma in situ) and stage I tumours, minimal carcinomas, node positivity, prevalent and incident cancer rates, recall rates, interval cancers, sensitivity, specificity and false-negative rate, and the importance of data collection
- To analyse controversies regarding mammographic screening and related research, including the current debate on the estimate of overdiagnosis/overtreatment
- To describe normal embryology, anatomy and physiology of the breast, axilla and associated structures and to particularly understand changes due to age, lactation, hormonal status, hormone replacement therapy, surgery (including breast reduction/augmentation as well as oncoplastic reconstruction), radiotherapy etc.
- To have an in-depth understanding of benign diseases of the breast and of how these diseases manifest, both clinically and on imaging
- To have an in-depth appreciation of borderline or high-risk breast lesions (those defined to imply an uncertain potential for malignancy), and of their clinical and pathological significance
- To have an in-depth understanding of malignant diseases of the breast, axilla and associated structures, of genetic subtypes, of histological prognostic factors and of the TNM classification
- To know the standardised evaluation of the imaging-based oncologic status of breast cancer patients according to RECIST 1.1 criteria
- To be familiar with cytological and pathological reporting of breast diseases

- To be familiar with the biomolecular classification of breast cancer and to be able to understand the imaging implications of that classification
- To know methods of radiologic-pathologic correlation of breast lesions
- To be familiar with the principles and indications for breast-conserving surgery and sentinel node biopsy
- To describe the indications for neoadjuvant chemotherapy and to understand the clinical and imaging evaluation of response to treatment
- To be familiar with adjuvant therapy options for breast cancer and with methods for surveillance after treatment
- To be familiar with radiation therapy options including methods for partial breast irradiation as well as with typical radiological findings associated with those therapies
- To have an in-depth understanding of the radiological methods for evaluating lesion tumour extent and searching for additional ipsilateral malignant lesions or contralateral malignant lesions, including potential advantages and disadvantages of preoperative MRI
- To have an in-depth understanding of extramammary staging of breast cancer and evaluation of distant metastases
- To be familiar with minimally invasive therapy options for distant metastases
- To appreciate imaging appearance of local recurrence of breast cancer
- To understand the clinical management and radiological evaluation of patients presenting with a palpable breast mass, mastodynia, breast trauma, inflammatory findings, nipple discharge, nipple or skin retraction, nipple thickening and axillary adenopathy
- To understand the imaging work-up and main pathological conditions that can be detected in male patients, children and adolescents, and in pregnant and lactating women
- To have an in-depth understanding of the planning, implementation, supervision and interpretation of all imaging techniques used in breast imaging, as well as potential complications, including indications and contraindications to the various imaging methods
- To have an in-depth understanding of standardised lexicon and categories of breast imaging reporting with reference to lesion, breast, or patient (ACR BI-RADS® or other standardized classification methods)
- To know the advantages, potential indications and limitations of new technologies, such as CAD, tomosynthesis and other digital applications of mammography, elastography, diffusion-weighted MR imaging and MR spectroscopy, different contrast materials for contrast-enhanced MRI, and systems for breast lesion radiofrequency-based excision
- To know indications for tomosynthesis in the clinical setting and the potential of 2D mammograms reconstructed from tomosynthesis dataset
- To have a basic understanding of MR-guided focused ultrasound and other new therapeutic imaging-guided techniques (radiofrequency ablation, cryoablation, electroporation etc) of breast cancer or breast benign diseases
- To know the relative costs of the various imaging examinations utilised in the management of breast diseases
- To appreciate the central role of the multidisciplinary team in planning investigations, treatment and in outcome review for breast cancer patients, being informed about recommendations of the European Parliament in favour of the breast unit model for treating breast cancer
- To have an in-depth understanding of the communication principles of breaking news and the psychosocial consequences of doing so improperly
- To understand legal liability in breast imaging

SKILLS

- To take a detailed history of patients in regard to disorders of the breast and relevant risk factors
- To perform physical examinations of the breast, axilla and associated structures
- To perform radiologic-pathologic correlation of breast lesions
- To supervise the imaging quality of the radiography of surgical specimens and communicate with the surgeon accordingly
- To participate in double reading of screening examination discussing cases of disagreement and getting a feedback after final decision and/or final assessment after recall
- To perform fine needle aspiration at least of cysts which require treatment aspirations
- To perform image-guided fine needle aspiration cytology (free-hand and/or image-guided) or core needle biopsy under ultrasound guidance, including sampling of breast lesions and of suspicious axillary lymph nodes
- To perform mechanical and vacuum-assisted core biopsy (free-hand and/or image-guided) under mammographic stereotactic guidance and under MRI guidance
- To perform image-guided localisation or tomosynthesis
- To perform abscess management

COMPETENCES AND ATTITUDES

- To choose the best-suited method for evaluating disorders of the breast for a variety of clinical indications
- To justify and optimise all relevant diagnostic imaging examinations and/or interventional procedures of the breast, including minimization of x-ray exposure in mammography and choice of optimal imaging parameters for mammography, ultrasound and MRI of the breast
- To confidently judge the quality of the imaging examinations in breast imaging and to devise strategies to improve image quality
- To supervise and teach technical staff to ensure that appropriate images of the breast are obtained
- To interpret and report mammograms, including those obtained with tomosynthesis, breast ultrasound and breast MRI examinations using a standardised diagnostic categorisation system such as the ACR Breast Imaging Reporting and Data System (BI-RADS®); this competence should be acquired by means of performance/reporting (under supervision) of at least 800 mammograms, 500 ultrasound, 50 breast MR studies and 50 interventional procedures during the two years
- To communicate with patients and their relatives in order to explain their imaging findings in disorders of the breast
- To communicate with the patient in order to obtain informed consent prior to interventional procedures of the breast
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interpreting and reporting images of the breast
- To identify urgent and/or unexpected findings in all types of imaging examinations of the breast and to communicate these timely and properly
- To appreciate and respect the roles and responsibilities of other members of the breast imaging team, e.g. clerical officers, radiographers, nurses, support staff, secretaries etc.
- To appreciate and respect the roles and responsibilities of other members of the multidisciplinary breast care team, being an integral part of the team in planning investigations, treatment and in outcome review
- To perform at multi-disciplinary conferences and tumour boards for diseases of the breast

B-II-2 CARDIAC AND VASCULAR RADIOLOGY

KNOWLEDGE

ANATOMY & NORMAL VARIANTS

- To have an in-depth knowledge of cardiovascular anatomy in CT
- To describe the major coronary anatomy using 3D CT
- To have an in-depth knowledge of cardiovascular anatomy in MRI
- To have an in-depth knowledge of normal variants of cardiac and coronary artery anatomy, in particular those that may mimic disease

CONGENITAL

- To have a basic understanding of the relevant embryological principles of the cardiovascular system
- To describe the imaging features and basic clinical features of congenital heart disease including neonatal heart disease, congenital heart disease in childhood and adult congenital heart disease
- To describe the imaging features of congenital vascular anomalies of the cardiovascular system

IMAGE ACQUISITION AND POSTPROCESSING

- To have an in-depth knowledge of the indications, contraindications and potential hazards (especially radiation hazards) of procedures and techniques relevant to cardiovascular disease
- To describe the role of alternative cardiac assessment tools, including SPECT, stress test, echocardiography
- To describe the principles, uses and limitations of nuclear cardiac imaging
- To describe the principles, uses and limitations of intravascular imaging in cardiovascular disorders
- To describe the principles, uses and limitations of cardiac stress testing including exercise stress testing, stress testing in cardiac imaging
- To describe the principles of Cardiac CT acquisition
- To describe the principles of ECG gating for cardiac CT and MRI
- To describe contrast bolus timing as it pertains to cardiac CT and MRI
- To understand axial, multiplanar reconstructions (MPR), maximum intensity projection (MIP) and volume rendering principles as they apply to cardiac CT and MRI
- To describe the principles and techniques of coronary calcification scoring (calcium scoring)
- To understand the limitations of coronary calcification scoring and the epidemiological implications
- To understand the necessary imaging prerequisites and possible risks of any MRI investigation in patients with active cardiovascular implants

CORONARY ARTERIES AND MAJOR ARTERIES

- To describe the imaging features and basic clinical features of coronary artery disease, including acute coronary syndromes, myocardial ischaemia, myocardial infarction, post myocardial infarction syndromes, ventricular aneurysms, common and unusual causes of coronary artery disease including various forms of arteritis, hibernating/stunned myocardium
- To describe the imaging presentations of atherosclerosis, including coronary calcification on coronary CTA
- To have a basic pathological and pathophysiological understanding of acquired cardiovascular disease
- To describe the manifestations of cardiovascular disease, including trauma, as demonstrated by conventional radiography, CT, MRI, angiography, radionuclide investigations and ultrasound
- To describe the differential diagnosis relevant to clinical presentation and imaging features of cardiovascular disease
- To describe the imaging features and basic clinical features of diseases of the major vessels, including thoracic aneurysm, popliteal aneurysms, acute and chronic aortic dissection (including classification), Marfan's syndrome, and Takayasu disease
- To describe atherosclerotic disease of the extracranial carotid arteries including grading of carotid artery stenosis by duplex ultrasound, CTA and MRA
- To describe the imaging features and basic clinical features of diseases of the visceral arteries including acute and chronic mesenteric ischaemia
- To describe the imaging features and basic clinical features of peripheral arterial occlusive disease, including the classification of Fontaine, critical limb ischemia, peripheral embolic disease and entrapment syndrome
- To describe the imaging features and basic clinical features of thoracic outlet syndromes

MYOCARDIUM, PERI- AND ENDOCARDIUM, HEART VALVES

- To describe the imaging features and basic clinical features of cardiac tumours including intracardiac tumours (myxomas, haemangiomas, sarcomas), primary cardiac tumours (myxomas, haemangiomas, sarcomas), secondary/metastatic cardiac tumours
- To describe the imaging features and basic clinical features of cardiomyopathy including acute myocarditis, dilated cardiomyopathy, restrictive and obstructive cardiomyopathy, cardiomyopathy related to systemic disease, infiltrative cardiomyopathy
- To describe the imaging features and basic clinical features of diabetic and renal heart disease
- To describe age- and gender-related cardiac syndromes, including sudden-death syndromes in young men
- To describe the imaging features and basic clinical features of heart valve disease including rheumatic or post-rheumatic valve disease, stenosis and incompetence of cardiac valves, endocarditis, sub- and supravulvar disease, subvalvular apparatus disease
- To describe the pretreatment requisites in case of planned minimal invasive valvular repair (TAVI)
- To describe the imaging features and basic clinical features of pericardial disease
- To describe the imaging features and basic clinical features of athlete's heart
- To have a knowledge of the clinical aspects of cardiac disease including pathophysiological and biochemical correlates
- To describe the principles and practice of screening techniques and risk factors in cardiac disease

POST-PROCEDURAL CARDIAC AND VASCULAR RADIOLOGY

- To describe the pathophysiology, differential diagnosis and treatment of pseudoaneurysm formation following invasive cardiac procedures
- To describe the role of the varying treatments available for both congenital and acquired cardiac disease, including coronary artery disease and valvular disease
- To describe the typical imaging features and basic clinical features after by-pass grafts, valve replacement, aortic replacements, ventricular surgery, pericardiectomy
- To describe the imaging features and basic clinical features of pericardial disease including acute and chronic pericarditis and malignant cardiac disease
- To describe the typical imaging features and basic clinical features after peripheral bypass graft surgery, peripheral stent placement and surgical patch placement

SKILLS

- To prepare a patient for cardiac CT including indication, venous access and beta-blocking
- To choose optimal acquisition parameters for cardiac CT
- To choose optimal post-processing tools for cardiac and vascular CT
- To prepare a patient for cardiac MRI including indication, venous access and medication (e.g. stress testing)
- To choose optimal acquisition parameters for cardiac MRI
- To choose optimal post-processing tools for cardiac and vascular CT
- To apply ECG gating for cardiac CT and MRI
- To perform an optimal contrast bolus timing for vascular CT and MRI
- To perform coronary calcification scoring
- To manage procedural complications in the diagnosis and treatment of cardiac disease
- To manage patients undergoing stress testing for cardiac imaging
- To confidently perform ultrasound examinations of arteries and veins
- To independently perform post-processing tasks for cardiac and vascular imaging studies, including multiplanar reformations (MPR), maximum intensity projections (MIP), minimum intensity projections (MinIP), volume rendering tools (VRT) and vessel analysis tools
- To confidently perform femoral artery and venous puncture techniques
- To confidently treat femoral artery pseudoaneurysm
- To perform dynamic examinations to rule out or diagnose thoracic outlet syndromes and entrapment syndromes

COMPETENCES AND ATTITUDES

- To confidently justify diagnostic imaging examinations (including CT and MRI) and/or interventional procedures of the cardiac and vascular systems
- To confidently choose the best-suited method for evaluating disorders of the cardiac and vascular systems
- 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 protocols for radiographic, ultrasonographic, CT and MRI examinations of the cardiac and vascular systems
- To create and apply protocols and standard operating procedures to reduce exposure doses for radiological examinations of the cardiac and vascular systems
- To confidently supervise and teach technical staff to ensure that appropriate images are obtained for all radiological methods pertaining to cardiac and vascular imaging
- To confidently judge the quality of the imaging examinations in cardiac imaging and to devise strategies to improve image quality
- To confidently interpret and report cardiac and vascular CT for common clinical indications
- To interpret and report cardiac and vascular CT under supervision for rare clinical indications
- To confidently interpret and report cardiac and vascular MR for common clinical indications
- To interpret and report cardiac and vascular MRI under supervision for rare clinical indications
- To confidently report radiographic examinations of the cardiac and vascular systems for common and rare diseases
- 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 confidently 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 communicate with referring clinicians to discuss radiological findings of the cardiac and vascular systems
- To perform at multi-disciplinary conferences and tumour boards for diseases of the cardiac and vascular systems

B-II-3 CHEST RADIOLOGY

KNOWLEDGE

NORMAL ANATOMY

- To describe the anatomy of the lobar and segmental bronchi
- To describe the topographic relationships of the hilar vessels and bronchi
- To describe the pulmonary lobule and its component parts
- To describe the terminology for describing the site and size (adenopathy, enlarged lymph node, normal lymph node) of mediastinal and hilar lymph nodes
- To describe the normal variants of aortic arch branching, including the common origin of the brachiocephalic and left common carotid arteries ("bovine arch"), and separating the origin of the vertebral artery from the arches
- To confidently identify the following structures on chest CT:
 - » All pulmonary lobes and segments
 - » A pulmonary lobule and associated structures
 - » Fissures - major, minor, azygos and common accessory fissures
 - » Extrapleural fat
 - » Inferior pulmonary ligaments
 - » Airway - trachea, carina, main bronchi, lobar bronchi and segmental bronchi
 - » Heart - left and right ventricles, left and right atria, atrial appendages
 - » Pericardium - including superior pericardial recesses
 - » Pulmonary arteries - main, right, left, interlobar, segmental
 - » Aorta - sinuses of Valsalva, ascending, arch and descending aorta
 - » Arteries - brachiocephalic (innominate), common carotid, subclavian, axillary, vertebral, internal mammary arteries
 - » Veins - pulmonary, superior vena cava, inferior vena cava, brachiocephalic, subclavian, internal jugular, external jugular, azygos, hemi-azygos, left superior intercostal, internal mammary
 - » Oesophagus
 - » Thymus
 - » Normal mediastinal and hilar lymph nodes
 - » Azygo-oesophageal recess

ALVEOLAR LUNG DISEASES AND ATELECTASIS

- To list four common causes of segmental consolidation
- To list five of the most common causes of adult (acute) respiratory distress syndrome
- To list four predisposing causes of or associations with organising pneumonia
- To describe the most common causes of bronchiectasis
- To describe the imaging features and basic clinical features of centrilobular, paraseptal and panacinar emphysema
- To describe the imaging findings used to identify surgical candidates for giant bullectomy or lung volume reduction
- To describe the imaging patterns of segmental and lobar consolidation
- To describe the imaging features of partial or complete atelectasis of single or combined lobes on chest radiographs and to list the likely causes
- To describe the imaging features of complete collapse of the right or left lung on a chest radiograph and to list the appropriate causes of the collapse
- To distinguish lung collapse from massive pleural effusion on a frontal chest radiograph
- To recognise the halo sign and its association with a diagnosis of invasive aspergillosis in an immunosuppressed patient
- To describe the imaging features of bronchiectasis on chest radiographs and chest CT
- To describe the HRCT signs of small airways disease and to differentiate between the direct signs (tree-in-bud, centrilobar changes) of exudative bronchiolitis and the indirect signs (mosaic pattern, air-trapping) of obliterative bronchiolitis (bronchiolitis obliterans)
- To describe the typical imaging patterns and basic clinical features of cystic fibrosis
- To describe the typical imaging patterns of tracheal and bronchial stenoses and to list the most common causes
- To describe the typical imaging patterns and basic clinical features of centrilobular emphysema on chest radiographs and CT
- To recognise a unilateral hyperlucent lung on chest radiographs or chest CT and to list an appropriate differential diagnosis
- To recognise the effects of various pathological processes on the component parts of the pulmonary lobule, as seen on high-resolution CT (HRCT)
- To describe the pathophysiology of the following imaging patterns:
 - » Ground glass opacity and lung consolidation
 - » Linear and reticular pattern
 - » Nodular pattern
 - » Honeycombing pattern
 - » Mosaic attenuation pattern
 - » Air trapping
 - » Cysts and cyst-like structures
 - » Centrilobular opacities and tree-in-bud
 - » Crazy-paving pattern
- To describe the typical imaging features of thickening of the interlobular septa and the possible causes

SOLITARY AND MULTIPLE PULMONARY NODULES

- To describe the definitions of a solitary pulmonary nodule and a pulmonary mass
- To list the most common causes of a solitary pulmonary nodule, cavitory pulmonary nodules and multiple pulmonary nodules
- To describe the strategy for managing a solitary pulmonary nodule detected incidentally or at screening
- To have an in-depth understanding of the roles of contrast-enhanced CT and integrated PET/CT in the evaluation of a solitary pulmonary nodule
- To understand the features that indicate benignity of a solitary pulmonary nodule and their limitations
- To describe the complications of percutaneous lung biopsy and their frequency
- To describe the indications for chest tube placement as a treatment for pneumothorax related to percutaneous lung biopsy

BENIGN AND MALIGNANT NEOPLASMS OF THE LUNG

- To list the four major histological types of bronchogenic carcinoma, and the difference in treatment between non-small-cell and small-cell lung cancer
- To describe the TNM classification for staging non-small-cell lung cancer, including the components of each stage
- To identify abnormal contralateral mediastinal shift on a post-pneumonectomy chest radiograph and to list two possible aetiologies for the abnormal shift
- To describe the acute and chronic radiographic and CT appearance of radiation injury in the thorax (lung, pleura, pericardium) and to identify the temporal relationship with radiation therapy
- To have an in-depth understanding of the roles of CT and MRI in lung cancer staging
- To describe the role of positron emission tomography (PET) and integrated PET-CT in lung cancer staging
- To describe the manifestations and the role of imaging in thoracic lymphoma
- To list the four most common extrathoracic metastatic sites for non-small-cell lung cancer and for small-cell lung cancer

THORACIC DISEASE IN IMMUNOCOMPETENT, IMMUNOCOMPROMISED AND POST-TRANSPLANT PATIENTS

- To describe the radiological manifestations of pulmonary mycobacterial infections on a radiograph and on CT
- To list the various types of pulmonary aspergillosis, to understand that they form part of a continuum, and to recognise these entities on chest radiographs and chest CT
- To describe the major categories of disease-causing chest radiography or chest CT abnormalities in the immunocompromised patient
- To list two typical infections and two typical neoplasms in patients with AIDS and to describe the imaging features on chest radiography and chest CT To describe the typical imaging features and basic clinical features of *Pneumocystis jiroveci* pneumonia
- To list the three most important aetiologies of hilar and mediastinal adenopathy in patients with AIDS

- To describe the relevant differential diagnoses for widespread consolidation in an immunocompromised host
- To describe the typical imaging features and basic clinical features of post-transplant lymphoproliferative disorders
- To describe the typical imaging features and basic clinical features of graft-versus-host disease

CONGENITAL LUNG DISEASE

- To describe the typical imaging features and basic clinical features of pulmonary venolobar syndrome (scimitar syndrome)
- To describe the typical imaging features and basic clinical features of intralobar pulmonary sequestration and cystic adenomatoid malformation
- To describe the typical imaging features and basic clinical features of bronchial atresia on a chest radiograph and chest CT, and to list the most common lobes of the lungs in which it occurs

PULMONARY VASCULAR DISEASE

- To list five of the most common causes of pulmonary artery hypertension and to describe the typical signs on chest radiography and chest CT
- To understand the role of CT pulmonary angiography (CTPA), MRI/MRA and lower extremity venous studies in the evaluation of a patient with suspected venous thromboembolic disease, including the advantages and limitations of each test
- To describe the typical imaging features of enlarged pulmonary arteries on a chest radiograph and to distinguish them from enlarged hilar lymph nodes
- To describe the typical imaging features and basic clinical features of acute and chronic lobar and segmental pulmonary emboli on CT angiography
- To describe the typical imaging features of vascular redistribution seen in raised pulmonary venous pressure

AIRWAYS AND OBSTRUCTIVE LUNG DISEASE

- To describe the typical imaging features and basic clinical features of bronchiectasis
- To list the typical imaging features of air trapping
- To describe the typical imaging features and basic clinical features of emphysema and the various patterns to include centrilobular, bullous and paraseptal emphysema
- To describe the typical imaging of tracheal abnormalities, including tracheomalacia, tracheal stenosis, and tracheobronchomegaly

INTERSTITIAL LUNG DISEASE

- To describe the imaging patterns of interstitial lung disease on chest radiographs according to whether the pattern is predominantly in the upper, mid or lower zone; or shows central or peripheral predominance
- To describe typical imaging patterns of interstitial lung disease on chest radiographs including lung consolidation, ground glass opacities, nodular patterns, reticular patterns, cystic patterns and widespread septal lines
- To describe typical imaging patterns of interstitial lung disease on HRCT according to whether the pattern is predominantly in the upper, mid or lower zone; or shows perihilar or subpleural predominance; or shows a vascular or perivascular airway, a lymphatic or perilymphatic or an interstitial distribution
- To describe typical imaging patterns of interstitial lung disease on HRCT according to whether the pattern is fibrotic or non-fibrotic, predominantly septal thickening / nodularity, ground glass opacity, reticular pattern, honeycombing, nodular pattern, air space consolidation, tree-in-bud pattern, “crazy-paving” pattern, cyst and cyst-like pattern
- To know the main CT presentations of the most frequent ILD (sarcoidosis, usual interstitial pneumonia, nonspecific interstitial pneumonia, hypersensitivity pneumonitis)

PLEURA AND THE DIAPHRAGM

- To describe the typical appearance of pleural effusion on ultrasound
- To describe the typical imaging features of pneumothorax on upright and supine chest radiographs
- To describe the typical imaging features and basic clinical features of malignant mesothelioma
- To describe the imaging features related to heart failure including pleural effusions, vascular redistribution on erect chest radiographs, interstitial and alveolar oedema
- To define the terms “asbestos-related pleural disease” and “asbestosis”, and to describe the respective imaging findings
- To describe the imaging features and basic clinical features of progressive massive fibrosis and conglomerate masses secondary to silicosis and coal worker’s pneumoconiosis
- To describe the imaging features of various forms of pleural calcification on a chest radiograph or chest CT and its association with asbestos exposure, old TB, old empyema, or old haemothorax
- To describe the imaging features of diffuse pleural thickening and to list four causes
- To describe the imaging features of split pleura sign in empyema

MEDIASTINAL AND HILAR DISEASE

- To list the most common causes of an anterior mediastinal mass and to confidently identify a mass in the anterior mediastinum on chest radiographs, chest CT and chest MRI
- To list the three most common causes of a middle mediastinal mass and to confidently identify a mass in the middle mediastinum on chest radiographs, chest CT and chest MRI
- To list the most common causes of a posterior mediastinal mass and to confidently identify a mass in the posterior mediastinum on chest radiographs, chest CT and chest MRI

- To list and describe the most common causes of bilateral hilar lymph node enlargement
- To list and describe the most common causes of “egg-shell” calcified lymph nodes in the chest
- To list and describe the most common causes of a mass arising in the thymus
- To describe the typical imaging features, basic clinical features and common associations of thymoma
- To list and describe the three types of malignant germ cell tumour of the mediastinum
- To describe the mechanisms and signs of pneumomediastinum
- To describe the imaging appearances of normal vessels or vascular abnormalities that may mimic a solid mass
- To describe the imaging features of mediastinal and hilar lymphadenopathy on chest radiographs, chest CT and chest MRI
- To describe the imaging signs of a benign cystic teratoma
- To describe the imaging signs of an intrathoracic thyroid mass
- To describe the imaging features of cystic mediastinal masses and to describe the differential diagnoses of a bronchogenic pericardial, thymic or oesophageal duplication cyst

THORACIC AORTA AND THE GREAT VESSELS

- To describe the significance of a right aortic arch with mirror image branching versus an aberrant subclavian artery
- To have an in-depth understanding of the advantages and disadvantages of CT, MRI/MRA and trans-oesophageal echocardiography in the evaluation of the thoracic aorta
- To define the terms “aneurysm” and “pseudoaneurysm” of the aorta
- To describe the imaging features and basic clinical features and to distinguish each of the following on chest CT and chest MRI: aortic aneurysm, aortic dissection, aortic intramural haematoma, penetrating atherosclerotic ulcer, ulcerated plaque, ruptured aortic aneurysm, sinus of Valsalva aneurysm, subclavian or brachiocephalic artery aneurysm, aortic coarctation, aortic pseudocoarctation, and cervical aortic arch
- To describe the imaging features of the two standard types of right aortic arch and double aortic arch on chest radiographs, chest CT and chest MRI
- To describe the imaging features of an aberrant subclavian artery on chest CT
- To describe the imaging features seen in arteritis of the aorta on chest CT and chest MRI

CHEST TRAUMA

- To list three common causes of abnormal lung opacity following trauma on chest radiographs or chest CT
- To list the three most common causes of pneumomediastinum following trauma
- To describe the imaging features of a widened mediastinum on chest radiographs taken for trauma and to list the possible causes (including aortic/arterial injury, venous injury, fracture of sternum or spine)
- To describe the indirect and direct signs of aortic injury on contrast-enhanced chest CT
- To describe the imaging features and basic clinical features and to understand the significance of chronic traumatic pseudoaneurysm on chest radiographs, chest CT or chest MRI
- To describe the imaging features of fractured ribs, clavicle, spine and scapula on chest radiographs or chest CT
- To describe the imaging features of an abnormally positioned diaphragm or loss of definition of a diaphragm on chest radiographs following trauma and the association with a ruptured diaphragm

- To describe the imaging features of a pneumothorax and pneumomediastinum following trauma on chest radiographs
- To describe the imaging features of a cavitory lesion following trauma on chest radiographs or chest CT and to describe the association with laceration and pneumatocele formation, haematoma or abscess secondary to aspiration
- To describe the imaging features and to distinguish between pulmonary contusion, laceration and aspiration

POSTOPERATIVE CHEST

- To identify normal postoperative findings and complications of the following procedures on chest radiographs, chest CT and chest MRI:
 - » Wedge resection mastectomy, lobectomy
 - » Pneumonectomy
 - » Coronary artery bypass graft surgery
 - » Cardiac valve replacement
 - » Aortic graft
 - » Aortic stent
 - » Transhiatal oesophagectomy
 - » Lung transplant
 - » Heart transplant
 - » Lung volume reduction surgery

SKILLS

- To prepare a patient for chest CT including indication, venous access and beta-blocking
- To choose optimal acquisition parameters for chest CT
- To choose optimal post-processing tools for chest CT
- To manage procedural complications in the diagnosis and treatment of chest disease
- To design and optimize CT protocols and to adapt these protocols to evaluate each of the following, taking into account the patient's age:
 - » Thoracic aorta and great vessels
 - » Superior vena cava and brachiocephalic vein stenosis or obstruction
 - » Pulmonary embolism
 - » Diffuse lung disease
 - » Tracheobronchial tree
 - » Bronchiectasis
 - » Small airway disease
 - » Lung cancer staging
 - » Oesophageal cancer staging
 - » Superior sulcus tumour
 - » Pulmonary metastases
 - » Pulmonary nodule on a radiograph
 - » Shortness of breath
 - » Haemoptysis
- To confidently perform a radiological staging of bronchogenic cancer

- To perform the following imaging-guided transthoracic interventions under appropriate supervision, to understand the indications and contraindications, and to manage the complications:
 - » Paracentesis and drainage of pleural effusions
 - » Percutaneous lung biopsy
 - » Paracentesis of mediastinal and pericardial fluid collections
 - » Drainage of refractory lung abscess
- To apply inspiratory and expiratory imaging depending on the clinical indication
- To independently perform post-processing tasks for chest imaging studies, including multi-planar reformations (MPR), maximum intensity projections (MIP), minimum intensity projections (MinIP), volume rendering tools (VRT) and vessel analysis tools

COMPETENCES AND ATTITUDES

- To confidently justify diagnostic imaging examinations (including CT and MRI) and/or interventional procedures of the chest
- To confidently 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 protocols for radiographic, ultrasonographic, CT and MRI examinations of the chest
- To create and apply protocols and standard operating procedures to reduce exposure doses for radiological examinations of the chest
- To confidently supervise and teach technical staff to ensure that appropriate images are obtained for all radiological methods pertaining to chest imaging
- To confidently judge the quality of the imaging examinations in chest imaging and to devise strategies to improve image quality
- To confidently interpret and report chest CT for common clinical indications
- To interpret and report chest CT under supervision for rare clinical indications
- Making a specific diagnosis of interstitial lung disease (ILD) when HRCT appearances are characteristic
- To confidently interpret and report chest MRI for common clinical indications
- To interpret and report chest MRI under supervision for rare clinical indications
- To confidently report radiographic examinations of the chest for common and rare diseases
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interpreting and reporting images of the chest
- To confidently 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 communicate with referring clinicians to discuss radiological findings of the chest
- To perform at multi-disciplinary conferences and tumour boards for diseases of the chest

B-II-4 EMERGENCY RADIOLOGY

KNOWLEDGE

For this stage, the trainee is expected to have more in-depth understanding of the knowledge acquired in the first 3 years of training, to such an extent that more independent functioning is possible and that knowledge can be taught to junior trainees in years 1-3. The required knowledge domains remain the same, however to a more profound level. More in-depth understanding therefore is needed in the aspects of.

- To understand epidemiological data regarding emergency pathologies
- To be familiar with the common mechanisms of injury including acting forces and their distribution in/over human bodies
- To understand the 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 and clinical appearance in non-traumatic emergencies legal issues and hygiene regulations
- To have a basic knowledge of the guidelines and corresponding institutional Standard Operating Procedures/ algorithms regarding emergency cases
- To describe the various radiological modalities and techniques employed in ER including their respective strengths, weaknesses, opportunities and threats regarding ER factors and effects of radiation dose as well as techniques for dose reduction good, reasonable/acceptable, poor and insufficient image quality
- To have a basic understanding of the workflow chain of digital imaging, image processing, reading, reporting and the distributing report/images in ER
- To be familiar with the potential risks and benefits of modality dependent contrast media including effects of oral, rectal, bladder or filling
- To describe respective imaging algorithms for low-energy and high-energy traumatic emergencies
- To describe respective imaging algorithms for various non traumatic emergency cases
- To understand the relevant modality dependent imaging findings of tubes, drains and catheters, especially with regards to positioning
- To describe the radiological standard procedures in polytrauma cases, CT under resuscitation and mass casualty incidents indications and contraindications for image-guided interventional procedures in emergency settings

ANATOMY

- To describe and have an in-depth understanding of 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 and have an in-depth understanding of common and uncommon normal variants and distinction from acute pathology

CENTRAL NERVOUS SYSTEM AND BRAIN

The trainee is required to be able to describe the imaging features and basic clinical findings of:

- skull fractures
- intracranial haemorrhages (subdural, epidural, subarachnoidal, parenchymal)
- parenchymal injuries (cortical contusion, diffuse axonal injury, deep gray matter injury, brainstem injury)
- extra- and intracranial vascular injuries
- penetrating injuries
- increased intracranial pressure and herniation syndromes
- arterial cerebral infarction (including the description of particular technical issues such as MR-DWI, MR-perfusion, MRA, CE-MR, TOF, CT-perfusion, CTA)
- central nervous system infections (meningitis, encephalitis, abscess/cerebritis, subdural empyema, spinal epidural abscess, osteomyelitis/discitis)
- dural sinus thrombosis

FACE AND SKULL

The trainee is required to be able to describe the imaging features and basic clinical findings of:

- facial fractures (orbital blow-in and blow-out fractures, nasal fractures, naso-orbital-ethmoid fractures, frontal fractures, maxillary fractures, dentoalveolar fractures, Le-Fort fractures, mandible fractures)
- orbital injuries (post bulbar emphysema and haemorrhage)
- of ocular injuries (rupture, laceration, lens dislocation, vitreous haemorrhage, subchoroidal haemorrhage)
- trauma to the larynx, pharynx and upper oesophagus
- orbital, epidural, subdural or other abscesses / empyema
- infections of the paranasal sinuses (acute, fungal, chronic sinusitis, complications)
- infections of the suprahyoid neck (retropharyngeal and paravertebral abscess, tonsillitis and peritonsillar abscess, odontogenic infections, submandibular and sublingual abscess, parotitis, sialoadenitis, cervical necrotising fasciitis)
- acute infections of the infrahyoid neck (epiglottitis, lymphadenitis, jugular thrombophlebitis)
- external and internal ear infection and mastoiditis (cholesteatoma, apical petrositis)
- orbital infections and optic neuritis

SPINE

- To describe the evaluation criteria of low-risk and high-risk patients and of patients with neurological deficits (such as prediction rules, Nexus, CCR)
- To describe the imaging features and basic clinical features of spinal/plexus trauma (spinal cord contusion, spinal epidural hematoma, nerve root avulsion, plexus injuries)
- To describe the assessment of instability of fractures
- To describe and have an in-depth understanding of different mechanisms of injury such as hyperextension/hyperflexion injury including the description of frequently associated injuries
- To describe the imaging features and basic clinical features of different vertebral injuries (occipital condyle fracture, Jefferson burst fracture, atlanto-axial rotary fixation, Hangman's fracture, whiplash injury, wedge compression, burst compression, flexion tear drop fracture, bilateral facet dislocation, chance fracture, complex fracture, pathological fracture, injuries to intervertebral disks)
- To describe the imaging features and basic clinical features of disc herniation
- To describe the imaging features, basic clinical features and common causing pathogens of infections (osteomyelitis, discitis, spondylodiscitis, epidural abscess)

CHEST, CARDIO-VASCULAR

The trainee is required to be able to describe the imaging features and basic clinical findings of:

- chest trauma (rib fractures, sternal and manubrial fractures, hemothorax, pneumothorax, pneumomediastinum, pulmonary contusion/laceration/hematoma, pneumatocele, tracheal and bronchial injury, oesophageal injury, diaphragm injury)
- acute pulmonary infections including the various etiologies and causing pathogens as well as aspiration pneumonia
- airway foreign bodies
- severe obstructive airway disease
- ARDS
- emergencies of the heart (myocardial infarction, myocardial laceration or contusion, pericardial effusion or tamponade, pericardial laceration, pneumopericardium, cardiac valve injury, endo- and myocarditis)
- aortic emergencies (thoracic aortic trauma, supra-aortic injuries including carotid and vertebral injuries, aortic dissection, aortic aneurysms, aortitis)
- of pulmonary oedema including the various etiologies
- thromboembolic disease including the fat embolism syndrome
- To describe and have an understanding of combination protocols in CT for concurrent ruling out of multiple life-threatening causes of chest pain

ABDOMEN

The trainee is required to be able to describe the imaging features and basic clinical findings of:

- hemoperitoneum and intraperitoneal fluids
- retroperitoneal haemorrhage
- intraperitoneal and retroperitoneal gas collections
- active arterial extravasation
- organ injuries (liver, spleen, adrenal, kidney, pancreas, gallbladder, bowel)
- abdominal wall injuries
- aortic and major vessel trauma
- emergencies related with the peritoneal cavity (peritonitis, abdominal abscess, insufficient bowel anastomosis, hollow organ perforation, ascites)
- liver and biliary tract including obstructive and non-obstructive jaundice and cholecystitis
- pancreatitis
- the urinary tract (urinary stones, infection, pyelonephritis, renal abscess, renal infarction)
- adrenal haemorrhage
- non-traumatic emergencies of the gastrointestinal tract (gastrointestinal haemorrhage, bowel obstruction, bowel perforation, bowel infarction, omental infarction, appendicitis, diverticulitis, infectious enteritis and colitis, epiploic pseudo-appendicitis, inflammatory bowel disease, Crohn's disease, ulcerative colitis, abdominal compartment syndromes and hernia complications)

GYNECOLOGY / OBSTETRICS

The trainee is required to be able to describe the imaging features and basic clinical findings of:

- foeto-placental trauma
- ovarian torsion
- pelvic inflammatory disease and abscesses
- acute abdominal disease in pregnancy
- major and minor trauma in pregnancy
- ectopic pregnancy

MALE GENITOURINARY

The trainee is required to be able to describe the imaging features and basic clinical findings of:

- urethral and penile trauma
- urethral stones and foreign bodies
- scrotal and testicular trauma
- testicular torsion of the epididymal appendix
- epididymitis and orchitis
- testicular infarction of scrotal abscess
- Fournier gangrene

PELVIS

The trainee is required to be able to describe the imaging features and basic clinical findings of:

- pelvic ring fractures and disruptions
- isolated fractures without pelvic ring involvement
- of bladder injury

Furthermore, the trainee is able to describe the supportive interventional procedures in bleeding control

EXTREMITIES (INCLUDING SHOULDER AND HIP)

The trainee is required to be able to describe the imaging features and basic clinical findings of:

- fractures including stress and insufficiency fractures and their classification
- luxations and their classification
- chondral and osteochondral lesions and their classification
- ligament tears or ruptures and their classification
- meniscal and labral tears and their classification
- tendon and muscular injuries and their classification
- acute inflammatory diseases
- avascular necrosis
- acute compartment syndromes

PAEDIATRIC, INTERVENTIONAL, MUSCULOSKELETAL AND OTHERS

- As long as not mentioned so far: To describe the imaging features and basic clinical features as provided in the corresponding emergency sections of the respective subspecialty curricula
- As long as not mentioned so far: To describe the interventional procedures as provided in the corresponding emergency sections of the respective subspecialty curricula

SKILLS

- To use and optimise efficiency enhancing technical equipment for initial interpretation of CT studies (e.g. dedicated CT workstation)
- To independently perform the following, while acknowledging own limitations and indication to call in expertise of supervisor:
 - e-FAST
 - abdominal sonography and contrast-enhanced sonography of emergency cases
 - femoral artery and venous puncture techniques
- To perform under supervision:
 - image guided drainage of fluid collections
 - percutaneous transhepatic drainage of the biliary tract
 - other interventional emergency procedures under image guidance, particularly in bleeding control
- To confidently identify modality dependent imaging findings of misplacement of devices such as tubes, drains and catheters
- To confidently identify modality and body region dependent common imaging findings in emergency cases such as fracture patterns, ileus and small bowel obstruction, free air and fluid, bleeding, infarction, organ injury
- To confidently classify modality dependent imaging findings as acute life-threatening, in principal but not immediately life-threatening, severe but not life-threatening or self-limiting acute conditions
- To confidently classify modality dependent imaging findings according to curricular content provided by other subspecialties
- To perform image interpretation or therapy of >1500 emergency cases (>500 CR, >100 eFAST, >200 US, >500 CT including >25 polytrauma cases and cardiovascular emergencies cases, >50 MRI, >10 embolisations, >10 PTD, >30 drainage of fluid collections). These cases have to be distributed proportionally over the body regions and typical pathologies
- To interpret, report, communicate and demonstrate common and typical findings
- To interpret, report, communicate and demonstrate rare findings under supervision
- To supervise the imaging quality of emergency CT, radiographic and MRI examinations including image postprocessing
- To manage procedural complications of imaging in the emergency setting

COMPETENCES AND ATTITUDES

- To confidently differentiate high-risk from low-risk patients before imaging
- To confidently differentiate and prioritise findings with respect to their urgency after imaging
- To confidently '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 have an in-depth understanding of the respective advantages and disadvantages of different imaging options in emergency cases
- To be able to choose and to justify 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 including pregnant patients
- To be integral and active part of continuous workflow optimisation with particular respect to ethical considerations, improvement of diagnostic accuracy and shortening of the time-to-diagnose/therapy
- To chair at multi-disciplinary treatment, morbidity and mortality conferences
- To supervise, teach and train technical staff to ensure with respect to appropriate emergency workflow and imaging
- To communicate timely and properly with patients (if possible), their relatives (if needed) and the involved other medical disciplines in order to explain imaging findings of disorders and to rapidly evaluate adequate therapy with respect to best possible outcome.
- To participate in Quality Assessment and Quality Monitoring
- To appreciate own limitations and to respect the roles and responsibilities of other members of the multidisciplinary emergency team, being an integral part of the team in decision-making.

B-II-5 GASTROINTESTINAL AND ABDOMINAL RADIOLOGY

KNOWLEDGE

IMAGING TECHNIQUES – GENERAL REQUIREMENTS

- To describe the indications and contraindications for the various imaging examinations in abdominal imaging
- To describe the relative costs of the various imaging examinations in abdominal imaging
- To describe the indications and contraindications for enema techniques and the optimal contrast material and technique to be used in each clinical situation
- To list the indications for a contrast-enhanced ultrasound study of the liver
- To describe the techniques for quantification of diseases using ultrasound, CT and MRI, and their clinical role and limitations in abdominal imaging
- To list the strengths and limitations of endosonography in abdominal imaging
- To describe the techniques for CT colonography, CT/MR enterography and CT/MR enteroclysis
- To describe the techniques and role for post-processing images including endoluminal reconstructions, fusion images and postprocessing of functional studies in abdominal imaging
- To describe the technique of PET-CT, the most important tracers (FDG, choline) and the development of new tracers, and sensitivity and specificity of PET-CT in most common abdominal tumours, including liver metastases of extra-abdominal origin
- To understand the principles and limitations of single and double studies of the gastrointestinal tract and to appreciate their advantages and disadvantages compared with endoscopy
- To describe the main indications, contraindications and basic technique for ablation of liver tumours using ultrasound and/or CT guidance
- To describe the technique of trans-jugular liver biopsy
- To describe the basic principles of balloon angioplasty and stenting of abdominal visceral arteries for the treatment of stenosis and aneurysms
- To describe the rationale, technique, principle and results of therapeutic embolisation and transarterial chemoembolisation in the abdomen

ANATOMY AND PHYSIOLOGY

- To understand the indication and techniques for interventional procedures within the abdomen, including hepatobiliary intervention and luminal stenting
- To describe normal post-therapeutic imaging related to previous surgery, intervention or radiation therapy in the abdomen

OESOPHAGUS

- To describe the imaging features of oesophageal cancer, diverticulum, extrinsic compression, submucosal masses, fistulae, hiatus hernia, oesophageal varices, benign strictures, benign tumours, varices and oesophagitis on examinations of the oesophagus
- To understand the significance of Barrett's oesophagus and the clinical manifestations of this disease
- To describe the appearance of common motility disorders of the oesophagus
- To understand the role of PET or PET-CT in the staging of oesophageal cancer
- To have a basic understanding of the surgical techniques in oesophageal surgery and post-surgical appearances on imaging examinations
- To describe the imaging features of oesophageal cancer on CT and to describe the criteria for non-resectability and lymph node involvement
- To understand the use of endoscopic ultrasound in the staging of oesophageal cancer and the technique of endoscopic ultrasound-guided biopsy

STOMACH AND DUODENUM

- To describe the most appropriate imaging examination and contrast medium use in suspected perforation of the stomach and postoperative follow-up and to list the limitations of each examination for these specific conditions
- To understand the role of endoscopic ultrasound and PET or PET-CT in the staging of gastric cancer
- To describe a CT protocol tailored for gastric cancer staging
- To have a basic understanding of the surgical procedures for the treatment of obesity and the radiological postoperative appearance and complications
- To have a basic understanding of the imaging features of a variety of conditions of the stomach and duodenum such as benign and malignant tumours, infiltrative disorders, e.g. linitis plastica, gastric ulcers and positional abnormalities, including gastric volvulus
- To describe the imaging features of duplication cysts of the upper gastrointestinal tract on CT
- To describe rotational abnormalities of the duodenum and the appearance of annular pancreas, submucosal tumours, papillary tumours, and inflammatory disease including ulceration

SMALL BOWEL

- To describe the most appropriate imaging examination for small bowel obstruction, inflammatory disease, infiltrative disease, small bowel perforation and ischaemia, cancer, lymphoma, carcinoid tumour and postoperative follow-up; and to list the limitations of each examination for these clinical scenarios
- To describe the MRI and CT techniques of enterography and enteroclysis
- To describe the indications for capsule endoscopy and to list the limitations and potential complications of the examination
- To describe the imaging features of the following disorders on a small bowel series: adenocarcinoma, polyposis, stromal tumour, lymphoma, carcinoid tumour, Crohn's disease, adhesion, haematoma, internal hernia, malrotation, lymphoid hyperplasia, Whipple's disease, amyloidosis, radiation-induced injury, malrotation, Meckel's diverticulum, coeliac disease, diverticulosis, fistula and systemic sclerosis
- To understand the principles of the interpretation of CT examination of the small bowel
- To describe the interpretation of MRI of the small bowel, especially in cases of inflammatory bowel diseases

COLON AND RECTUM

- To describe the optimal imaging examination and outline the technique for study of the colon according to the suspected disease (obstruction, volvulus, diverticulitis, benign tumour, inflammatory disease, cancer, lymphoma, uncommon lesions of the colon and rectum, perforation, postoperative evaluation) and to list the limitations of each technique
- To understand the current indications for CT colonography, including its potential role in colorectal cancer screening
- To describe the TNM classification of colon cancer and its prognostic value, the technique and the value of MDCT, MRI and endosonography, in the staging of rectal cancer
- To describe the CT imaging features of colon cancer and signs that assess local extent (enlarged lymph nodes, peritoneal carcinomatosis, hepatic metastases)
- To describe the MRI technique for rectal cancer
- To describe the staging of the tumour according to the tumour proximity with the mesorectal fascia and distance to the sphincter and to describe the potential limitations of MRI for lymph node staging
- To describe imaging patterns and modalities used to assess for locally recurrent or metastatic colorectal cancer
- To describe the criteria that may help in differentiating between postoperative fibrosis and rectal tumour recurrence in the pelvis
- To describe the appearances and differential diagnosis of retrorectal cysts
- To describe the most common diseases of the rectum and the anus and the most frequent operative techniques that may be used to treat them
- To have a basic understanding of the MRI technique that is used to search for a pelvic/perianal fistula and to describe the appearance of fistulae on MRI
- To describe the appearances of anal sphincter tears and perianal sepsis
- To describe the basic imaging features of functional and anatomical disorders on both fluoroscopic and MR proctography and the appearance of pelvic floor muscle tears and atrophy using MRI

PERITONEUM AND ABDOMINAL WALL

- To describe the types of abdominal wall hernias and imaging features of hernial strangulation on CT and on ultrasound
- To describe the imaging features of mesenteric tumour and its location on ultrasound, CT and MRI
- To describe the imaging features of mesenteric cysts on ultrasound, CT and MRI
- To describe the imaging features and basic clinical features of the following peritoneal diseases on CT and MRI: peritonitis, peritoneal carcinomatosis, peritoneal tuberculosis, mesenteric lymphoma, mesenteric and greater omental infarction

ABDOMINAL VESSELS

- To describe the respective roles of angiography and CT angiography in acute gastrointestinal haemorrhage and the advantages and limitations of the techniques

LIVER

- To have a detailed understanding of liver anatomy and segmentation and vessel anatomy, including variants in vascular anatomy that may affect surgical planning
- To describe the most common surgical procedures for hepatectomy and liver transplantation
- To describe the imaging features and basic clinical features of vascular diseases of the liver, including Budd-Chiari Syndrome, Osler-Weber disease, portal thrombosis
- To describe the imaging features of hydatid cysts on ultrasound, CT and MRI
- To differentiate between amoebic abscess and pyogenic abscess of the liver in regard to appearance, evolution, treatment, and indication for drainage
- To describe the imaging features of hepatic adenoma including subtypes on ultrasound, Doppler, contrast-enhanced ultrasound, CT and MRI, including hepato-biliary contrast agents
- To describe the imaging features of homogeneous and heterogeneous liver steatosis on ultrasound, CT and MRI (including imaging quantification)
- To describe the natural history of hepatocellular carcinoma (HCC), the major techniques and the indications for treatment (surgical resection, chemo- or radioembolisation, percutaneous ablation, liver transplantation, oral targeted therapy)
- To describe the staging of HCC in order to discuss indications for treatment
- To describe the typical imaging features of benign and malignant focal liver lesions on MRI with hepato-biliary contrast agents
- To describe the imaging features of peripheral cholangiocarcinoma, and to describe the staging and features that influence treatment (surgery vs. palliation)
- To describe the principles and methods for fibrosis quantification using ultrasound and MRI
- To describe rare tumours types affecting the liver and their radiological appearance
- To describe the imaging appearance and quantification of liver iron overload
- To describe the technique for percutaneous image-guided liver biopsy and its most common indications

- To describe the complications of percutaneous image-guided liver biopsy and to precisely evaluate the occurrence of morbidity and mortality
- To describe the role of hepato-biliary contrast media
- To describe current application of diffusion-weighted imaging of the liver

BILIARY TRACT

- To know the strengths and weaknesses of different imaging methods for the detection of gall bladder and common bile duct stones
- To describe unusual features of cholecystitis like gangrenous, emphysematous and acalculous cholecystitis on ultrasound and CT
- To describe the imaging features of cholangiocarcinoma of the liver hilum (Klatskin's tumour) and to describe the tumour staging and features that influence treatment (surgery vs. palliation)
- To describe the imaging features of ampullary carcinoma on ultrasound, CT and MRI, including magnetic resonance cholangiopancreatography (MRCP) and endoscopic ultrasound
- To describe the know the natural history and risk of malignancy of sclerosing cholangitis and typical imaging features on ultrasound, CT and MRI, including MRCP
- To describe the main techniques for surgery of the bile duct and its common complications
- To describe the imaging features of biliary leaks on imaging examinations

PANCREAS

- To describe the natural history of chronic pancreatitis and to list the common causes
- To describe the imaging features of pancreatic calcifications on ultrasound and CT
- To describe the tumour staging for pancreatic adenocarcinoma including criteria for unresectability
- To describe the typical imaging features of cystic tumours of the pancreas, including serous and mucinous cystadenoma, intraductal mucinous tumours; the indications and modalities used for tumour characterization and the indication for follow-up imaging for IPMN
- To describe the main techniques for pancreatic surgery and to list their potential complications
- To describe the imaging features of a pancreatic pseudocyst and to discuss the advantages and limitations of different treatments (follow-up, interventional procedure, percutaneous or endoscopic surgery)
- To list the indications and rationale for functional examinations of the pancreas (e.g. MRCP following secretin stimulation)

SPLEEN

- To describe optimal imaging techniques depending on the clinical situation (e.g. trauma, staging of lymphoproliferative disorders, investigation of a focal lesion etc.)
- To list the causes and imaging features of focal splenic abnormalities, including infection and both benign and malignant masses
- To describe the causes of splenic calcification

SKILLS

- To choose the most appropriate imaging examination according to the clinical problem in abdominal imaging
- To choose the most suitable contrast material and its optimal use according to the imaging technique and the clinical problem in abdominal imaging
- To plan an MRI examination of the upper abdomen and to adapt it to the individual clinical indication in regard to the potential use of intravenous contrast medium, intraluminal contrast medium, contrast medium phase (e.g. arterial phase or delayed imaging), magnetic resonance cholangiopancreatography (MRCP), and quantification of liver fat/iron
- To plan an MRI examination of the rectum and anal canal and to adapt it to the individual clinical indication
- To plan an MRI examinations of the small bowel and to assist in performing the proper preparation
- To perform contrast medium examinations of the pharynx, oesophagus, stomach, and the bowel
- To perform video-fluoroscopy of the swallowing mechanism
- To perform contrast studies of the upper gastrointestinal tract with the most appropriate contrast material
- To perform both single and double contrast studies as well as motility assessments of the gastrointestinal tract
- To perform small bowel follow-through and enteroclysis, including catheter placement beyond the ligament of Treitz
- To perform a motility assessment and a single contrast enema
- To catheterise a stoma for colon opacification and to perform pouchograms and loopograms
- To confidently plan a CT examination of the abdomen and to tailor it to the individual situation in regard to intravenous contrast medium, rate of injection, dose and delay of the contrast medium and to a potential intraluminal contrast medium application, with a dose as low as reasonably achievable
- To confidently plan an MRI examination of the upper abdomen and to tailor it to the individual situation in regard to the potential use of intravenous contrast medium, rate of injection, dose and delay of the contrast medium, potential intraluminal contrast medium, magnetic resonance cholangiopancreatography (MRCP)
- To confidently plan an MRI examinations of the small bowel, rectum and anal canal and to adapt it to the individual situation, including the application of endoluminal contrast
- To apply techniques for quantification of diseases using ultrasound, CT and MRI, based on an in-depth understanding of their clinical role and limitations.
- To perform MRI and CT enterography and enteroclysis
- To perform ultrasound examinations of the liver, gall bladder, biliary tree, pancreas and spleen
- To perform ultrasound examinations of the gastrointestinal tract and to identify the various portions (stomach, duodenum, small bowel, appendix and colon)
- To perform advanced post-processing tasks for abdominal imaging studies, including endoluminal reconstructions, and fusion images in abdominal imaging
- To supervise and teach technical staff to ensure that appropriate images are obtained

Competency or experience in all of the following interventional procedures is unlikely to be achieved by many radiologists.

However, practical experience in at least 3 of the following examinations is expected:

<ul style="list-style-type: none">• To perform percutaneous image-guided liver biopsy under supervision
<ul style="list-style-type: none">• To perform biopsy of abdominal tumours with an easy access route under ultrasound or CT guidance
<ul style="list-style-type: none">• To drain abdominal abscesses with an easy access route under ultrasound or CT guidance
<ul style="list-style-type: none">• To assist and/or perform under supervision image-guided interventions in colon cancer, e.g. colonic stent placement in the case of colonic obstruction
<ul style="list-style-type: none">• To assist and/or perform under supervision percutaneous gastrostomy under image guidance
<ul style="list-style-type: none">• To assist and/or perform under supervision percutaneous cholecystostomy under supervision
<ul style="list-style-type: none">• To assist and/or perform under supervision percutaneous biliary interventions
<ul style="list-style-type: none">• To assist and/or perform under supervision radiologically guided stenting of the biliary system and gastrointestinal system, using polytetrafluoroethylene and expandable metal stents
<ul style="list-style-type: none">• To assist and/or perform under supervision the ablation of liver tumours using ultrasound and/or CT guidance
<ul style="list-style-type: none">• To assist and/or perform under supervision trans-jugular liver biopsies
<ul style="list-style-type: none">• To assist and/or perform under supervision balloon angioplasty and stenting of the mesenteric arteries for the treatment of stenosis and aneurysms
<ul style="list-style-type: none">• To perform under supervision transarterial chemoembolisation and simple embolisation for acute abdominal bleeding control
<ul style="list-style-type: none">• To assist radio-embolisation

COMPETENCES AND ATTITUDES

- To confidently justify diagnostic imaging examinations and/or interventional procedures of the abdomen and/or gastrointestinal system
- To confidently choose the best method 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 confidently choose optimal imaging parameters for radiographic, ultrasonographic, CT and MRI examinations of the abdomen and/or gastrointestinal system
- To confidently apply techniques to reduce exposure doses for radiographic and CT examinations of the abdomen
- To confidently design imaging protocols and standard operating procedures for CT examinations of the abdomen and gastrointestinal system, including the appropriate application of intravenous and/or intraluminal contrast, spatial and temporal resolution, and inspiration/expiration/breathhold techniques
- To confidently design imaging protocols and standard operating procedures for MRI examinations of the upper abdomen and gastrointestinal system, including the appropriate application of intravenous and or intraluminal contrast, spatial and temporal resolution, and inspiration/expiration/breathhold techniques
- To supervise and teach technical staff to ensure that appropriate images are obtained in abdominal imaging
- To confidently judge the quality of the imaging examinations in abdominal imaging and to devise strategies to improve image quality
- To confidently report abdominal radiographs in cases of acute abdomen
- To confidently 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 of the abdomen 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 confidently identify urgent and/or unexpected findings in imaging examinations of the abdomen and gastrointestinal system and to communicate these timely and properly
- To communicate under supervision with patients and their relatives in order to explain their imaging findings of the abdomen and gastrointestinal system
- To perform under supervision multi-disciplinary conferences and tumour boards for diseases of the abdomen and gastrointestinal system

B-II-6 GYNAECOLOGICAL AND OBSTETRIC RADIOLOGY

KNOWLEDGE

ANATOMY

- To have a detailed understanding of the normal anatomy of the female reproductive organs
- To have a detailed understanding of the physiological changes affecting normal imaging anatomy of the female reproductive organs throughout the lifespan
- To have a detailed understanding of the physiological changes of the female reproductive organs during pregnancy
- To describe the dimensions of the uterus and ovaries with ultrasound
- To understand the variations of the uterus and ovaries during genital life
- To understand the variations of the uterus and ovaries during the menstrual cycle
- To list the normal pelvic compartments
- To describe the normal pelvic organs and boundaries on CT and MRI
- To describe the role of the levator ani in the physiology of the pelvic floor

CONGENITAL

- To list congenital malformations of the uterus, including uterus septatus, uterus bicornis (unicollis and bicollis) and uterus didelphys
- To describe the typical imaging features of congenital malformations of the uterus, including uterus septatus, uterus bicornis (unicollis and bicollis) and uterus didelphys

UTERUS

- To describe the indications and contraindications of transvaginal sonography and hysterosonography
- To describe the imaging features and basic clinical features of benign tumours of the myometrium
- To describe the imaging features and basic clinical features of malignant tumours of the myometrium
- To describe the imaging features and basic clinical features of tumours of the endometrium
- To describe the imaging features and basic clinical features of adenomyosis uteri
- To describe the imaging features and basic clinical features of cervical inflammation
- To describe the imaging features and basic clinical features of cervical cancer
- To describe the imaging features and basic clinical features of functional disorders of the cervix
- To describe the imaging features and basic clinical features of endometriosis
- To describe the imaging features and clinical features of uterine leiomyomas of different sizes
- To describe the image-guided therapeutic approaches to uterine leiomyomas
- To describe typical imaging features of the uterus after different types of gynaecological surgeries
- To describe typical imaging features of the uterus after different types of image-guided therapies

PREGNANCY

- To describe the imaging features and basic clinical features of uterine disorders associated with pregnancy
- To describe the imaging features and basic clinical features of uterine disorders during delivery
- To describe the imaging features and basic clinical features of uterine disorders in the post-partum period
- To describe the image-guided therapeutic approaches in severe post-partum bleeding
- To describe imaging strategies in pregnant patients with symptoms of an acute abdomen
- To describe typical imaging and clinical features in pregnant patients with symptoms of an acute abdomen
- To describe the principles of MR pelvimetry
- To list the relevant parameters of MR pelvimetric measurements
- To describe the principles of fetal MR imaging technology
- To have a basic understanding of the various stages of embryonic and fetal development and their respective appearance on MR imaging

OVARIES / ADNEXE / INFERTILITY

- To describe the procedure, possible complications, choice of contrast agent, indications and contraindications of hysterosalpingography
- To describe the different phases of hysterosalpingography
- To describe the imaging features and basic clinical features of ovarian cysts
- To describe the imaging features and basic clinical features of benign ovarian tumours
- To describe the imaging features and basic clinical features of malignant ovarian tumours
- To describe the imaging features and basic clinical features of functional disorders of the ovaries
- To describe the imaging features and basic clinical features of inflammatory disorders of the tubes
- To describe the imaging features and basic clinical features of tumours of the tubes
- To describe the imaging work-up and features of infertility
- To describe the imaging features and basic clinical features of ovarian torsion
- To describe the imaging features and basic clinical features of changes and disorders of the ovaries associated with pregnancy and the post-partum period
- To describe typical imaging features of the ovaries after different types of gynaecological surgeries
- To describe typical imaging features of the ovaries after different types of image-guided therapies

PELVIC FLOOR

- To list imaging techniques that can be used to visualise the female pelvic floor
- To describe the imaging features and basic clinical features of descensus uteri and pelvic prolapsed
- To describe factors responsible for female urinary incontinence

SKILLS

- To choose the most appropriate imaging examination according to the clinical problem in gynaecological and obstetric radiology
- To choose the most suitable contrast material and its optimal use according to the imaging technique, the clinical problem and the age in gynaecological and obstetric radiology
- To confidently perform a transabdominal and/or transvaginal ultrasound in gynaecological disorders
- To confidently perform a transabdominal and/or transvaginal ultrasound in pregnant patients
- To perform hysterosalpingography
- To confidently plan a CT examination in gynaecological and obstetric radiology and to tailor it to the individual situation with a dose as low as reasonably achievable
- To confidently plan an MRI examination in gynaecological and obstetric radiology and to tailor it to the individual situation of the patient in regard to the potential use of intravenous contrast medium and spatial resolution
- To perform a pelvimetric MR examination in the pregnant patient
- To observe and/or perform under supervision image-guided biopsies, e.g. of kidney masses
- To observe and/or perform under supervision image-guided drainage procedures in the urogenital tract
- To observe and/or perform under supervision percutaneous nephrostomy
- To confidently perform proper post-processing tasks of examinations in paediatric urogenital radiology, including multi-planar reformations (MPR), maximum intensity projections (MIP), minimum intensity projections (MinIP), and fusion images

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 of the female reproductive organs
- 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 and/or intraluminal 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 international standards (FIGO, 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 female reproductive system
- To confidently identify urgent and/or unexpected findings in imaging examinations of the female reproductive system and to communicate these timely and properly
- To emphatically communicate with patients and their relatives in order to explain imaging findings in disorders of the female reproductive system
- To perform at multi-disciplinary conferences and tumour boards for diseases of the female reproductive system

B-II-7 HEAD AND NECK RADIOLOGY

KNOWLEDGE

NORMAL ANATOMY

- To have a good knowledge of the anatomy and function of the temporal bone and its structures, skull base, cranial nerves, orbits and visual pathways, facial skeleton, sinuses, pharynx, oral cavity, mandible, teeth, temporomandibular joints, salivary glands, larynx, neck, deep spaces of the face and neck, thoracic inlet and brachial plexus, as well as the thyroid gland and parathyroid glands
- To be able to describe typical normal variants of the temporal bone, skull base, cranial nerves, orbits and visual pathways, facial skeleton, sinuses, pharynx, oral cavity, mandible, teeth, temporomandibular joints, salivary glands, larynx, neck, deep spaces of the face and neck, thoracic inlet and brachial plexus, as well as the thyroid gland and parathyroid glands and to differentiate these from disease
- To describe the terminology for the site of lymph nodes in the head and neck region

TEMPORAL BONE

- To describe typical imaging features of congenital disorders leading to deafness (e.g. cochlear aplasia/hypoplasia, Mondini malformation, large endolymphatic sac anomaly (LESA) / large vestibular aqueduct syndrome (LVAS))
- To describe typical imaging features of disorders leading to secondary deafness including otosclerosis, Menière's disease, and temporal bone inflammatory disease and tumours of the cerebellopontine angle
- To describe typical imaging features and basic clinical features of tumours of the temporal bone and cerebellopontine angle and to distinguish these from each other
- To describe typical imaging features and basic clinical features of traumatic lesions of the temporal bone
- To describe typical imaging features and basic clinical features of cholesteatoma
- To describe typical pathologies of the external auditory canal, including atresia and tumourous lesions
- To differentiate typical pathologies of the middle ear
- To have a basic understanding of the different types of cochlea implants and their respective MRI compatibility/non-compatibility (including specific precautions)
- To list the various causes of vascular tinnitus and to describe their respective imaging features

FACIAL SKELETON, SKULL BASE AND CRANIAL NERVES

- To list the different neoplasms of the clivus and to describe their typical imaging appearance, including meningioma, macroadenoma and clivus chordoma
- To describe the typical imaging features and basic clinical features of lesions of the jugular foramen, including glomus tumour / paraganglioma, jugular bulb pseudolesion, jugular bulb diverticulum, dehiscent jugular bulb, jugular foramen schwannoma, and jugular foramen meningioma
- To describe the typical imaging features and basic clinical features of diffuse diseases of the skull base, including fibrous dysplasia, plasmocytoma, Langerhans cell histiocytosis, chondrosarcoma and metastases
- To list and categorise typical traumatic lesions of the facial skeleton and to be familiar with complications and therapeutic consequences
- To describe the typical imaging features of neoplasms of the mandible and maxilla
- To understand the typical imaging features of dentigerous cysts and odontogenic keratocysts
- To understand the imaging features of infectious and inflammatory lesions of the mandible, maxilla and skull base, including osteomyelitis

ORBIT AND VISUAL PATHWAYS

- To describe the typical imaging features and basic clinical features of congenital lesions of the orbit, including coloboma
- To describe the typical imaging features and basic clinical features of typical tumours of the orbit in children including dermoid and epidermoid cysts, cavernous haemangioma, lymphangioma, rhabdomyosarcoma and retinoblastoma
- To describe the typical orbital manifestations of neurofibromatosis type I
- To describe the typical imaging features and basic clinical features of infectious and inflammatory disorders of the orbits including optic neuritis, abscesses, sarcoidosis and idiopathic inflammatory disorders
- To describe the typical imaging features and basic clinical features of benign tumours of the orbits including meningioma, optic/chiasmal glioma, orbital haemangioma, and benign mixed tumour of the lacrimal gland
- To describe the typical imaging features and basic clinical features of malignant tumours of the orbits including ocular melanoma, orbital lymphoma, higher grade optic / chiasmal glioma, adenoid cystic carcinoma of the lacrimal glands

NOSE, NASOPHARYNX AND PARANASAL SINUSES

- To describe the typical imaging features and basic clinical features of congenital lesions of the paranasal sinuses including choanal atresia and frontoethmoidal encephalocele
- To differentiate typical normal variants of the nose and paranasal sinuses from pathology
- To describe the typical imaging features and basic clinical features of infectious and inflammatory disorders of the nose and paranasal sinuses including acute and chronic rhinosinusitis, fungal sinusitis, sinonasal polyposis, sinonasal mucocele and sinonasal granulomatosis with polyangiitis

- To be aware of typical complications of infectious and inflammatory disorders of the nose and paranasal sinuses
- To list and describe the typical surgical approaches to the nose and paranasal sinuses including functional endoscopic sinus surgery (FESS)
- To describe the common imaging features and basic clinical features of benign and malignant neoplasms of the nose and paranasal sinuses including inverted papilloma, juvenile angiofibroma, sinonasal hemangioma, sinonasal osteoma, sinonasal fibrous dysplasia, sinonasal squamous cell carcinoma, sinonasal adenocarcinoma, sinonasal melanoma, esthesioneuroblastoma, and sinonasal lymphoma
- To describe the typical imaging features of the nose and paranasal sinuses after surgery
- To describe the typical imaging features and basic clinical features of the nasopharyngeal pathologies including Thornwaldt cyst, inflammatory and infectious lesions and neoplasms

MASTICATOR SPACE, PAROTID SPACE AND CAROTID SPACE

- To describe the anatomical delineations of the masticator space, parotid space and carotid space
- To describe pseudolesions of the masticator space, including denervation atrophy, benign muscle hypertrophy and asymmetries of the pterygoid venous plexus
- To describe the typical imaging features of abscess formations of the masticator space
- To describe the typical imaging features and basic clinical features of benign and malignant neoplasms of the masticator space including peripheral nerve sheath tumours of the trigeminal nerve
- To describe the typical imaging features and basic clinical features of infectious and inflammatory lesions of the parotid space including parotitis, Sjogren syndrome and benign lymphoepithelial lesions in patients with HIV
- To describe the typical imaging features and basic clinical features of benign and malignant neoplasms of the parotid space including Warthin tumour, benign mixed tumour, adenoid cystic carcinoma, mucoepidermoid carcinoma, lymphoma, lymph node metastases and malignant tumors of the skin
- To describe the typical imaging features and basic clinical features of vascular lesions of the carotid space including ectatic carotid arteries, carotid artery pseudoaneurysm, carotid artery dissection, and jugular venous thrombosis
- To describe the typical imaging features and basic clinical features of neoplasms of the carotid space including carotid body paraganglioma, glomus vagale paraganglioma, schwannoma, and neurofibroma

LYMPH NODES OF THE HEAD AND NECK REGION

- To have an in-depth understanding of the nomenclature of the lymph nodes and nodal regions
- To describe the typical imaging features and basic clinical features of infectious and inflammatory disorders of the lymph nodes
- To describe the typical imaging features and basic clinical features of neoplastic disorders of the lymph nodes, including lymphoma (Hodgkin and Non-Hodgkin) and nodal metastases
- To be familiar with PET-CT imaging findings in benign and malignant lymph nodes

ORAL CAVITY, OROPHARYNX AND RETROPHARYNGEAL SPACE

- To describe the typical imaging features and basic clinical features of congenital lesions of the oral cavity and oropharynx, including dermoid and epidermoid cysts, accessory salivary tissue, lymphangioma and lingual thyroid gland
- To describe the typical imaging features and basic clinical features of inflammatory and infectious lesions of the oral cavity and oropharynx, including abscesses, retention cysts, sialoceles, sialadenitis and ranula
- To describe the typical imaging features and basic clinical features of benign and malignant neoplasms of the oral cavity and oropharynx, including benign mixed tumours, squamous cell carcinoma, malignant tumours of the minor salivary glands
- To describe the typical imaging features and clinical presentation of retropharyngeal abscesses

HYPOPHARYNX AND LARYNX

- To describe the typical imaging features and basic clinical features of neoplasms of the hypopharynx and larynx, including squamous cell carcinoma of the hypopharynx, squamous cell carcinomas of the supraglottic, glottic and subglottic regions, and chondrosarcoma of the larynx
- To describe the typical imaging features of the hypopharynx and larynx after surgery and after radiation
- To describe the typical imaging features of vocal cord paralysis
- To describe the potential effects and the respective imaging features of laryngeal trauma
- To list the typical imaging features, causes and clinical consequences of tracheal stenoses
- To describe the typical imaging features of laryngoceles and pharyngoceles
- To describe typical functional abnormalities of the larynx and hypopharynx during impaired swallowing including primary and secondary aspiration and dysfunction of the crico-pharyngeal muscle
- To be familiar with typical PET-CT findings in head and neck tumours involving the pharynx, larynx and oral cavity and to understand common pitfalls of image interpretation

THYROID AND PARATHYROID GLANDS AND VISCERAL LESIONS

- To describe the typical imaging features and basic clinical features of thyroiditis, multinodular goiter, benign and malignant neoplasms of the thyroid and parathyroid glands, including thyroid and parathyroid adenomas, different types of thyroid carcinoma, and thyroid lymphoma
- To describe the typical imaging features and basic clinical features of cervical oesophageal carcinoma
- To describe the imaging features and basic clinical features of a Zenker diverticulum and the typical approaches to therapy
- To be familiar with the most important findings of Tc-99m-scintigraphy in various diseases of the thyroid gland

CONGENITAL AND TRANSSPATIAL LESIONS

- To have a basic understanding of the embryology of the head and neck region
- To describe the typical imaging features and basic clinical features of branchial cleft cysts
- To describe the typical imaging features and basic clinical features of thyroglossal duct cysts
- To describe the typical imaging features and basic clinical features of thymus cysts
- To describe the typical imaging features and basic clinical features of vascular lesions including malformations of the head and neck region
- To be familiar with the imaging manifestations of neurocutaneous syndromes, including neurofibromatosis type I, in the head and neck colli

SKILLS

- To choose the most appropriate imaging examination according to the clinical problem in head and neck imaging
- To perform dynamic functional studies including video-fluoroscopy of the swallowing mechanism
- To ascertain correct positioning for imaging studies of the skull, sinus, skull base, and facial bones including special views
- To confidently perform ultrasound including Doppler sonography of the neck, tongue, thyroid and salivary glands
- To confidently perform percutaneous biopsy, guided by ultrasound or CT in straightforward/technically easy cases
- To confidently perform fine needle aspiration biopsy in easy head and neck cases
- To observe and/or perform under supervision percutaneous biopsy and fine needle aspiration biopsy guided by ultrasound, CT and/or MRI in more complex head and neck cases
- To confidently plan a CT examination of the head and neck, including a perfusion acquisition and to tailor the CT to the individual situation with regard to intravenous contrast medium, rate of injection, dose and delay of the contrast medium, with a dose as low as reasonably achievable
- To confidently plan an MRI examination of the head and neck including diffusion and perfusion sequences and to tailor the MRI examination to the individual situation with regard to the potential use of intravenous contrast medium, rate of injection, dose and delay of the contrast medium, and spatial resolution
- To confidently plan a cone beam CT examination of the head and neck
- To apply basic techniques for quantification in head and neck disorders with ultrasound, CT and MRI, based on an understanding of their clinical role and limitations, such as measuring tumour volume, ADC values and obtaining semi-quantitative perfusion graphs
- To perform proper post-processing tasks for head and neck imaging studies, including multi-planar reformations (MPR), maximum intensity projections (MIP), minimum intensity projections (MinIP), vessel analysis tools, endoluminal reconstructions, 3D reconstructions including volume rendering and virtual endoscopy and multimodality fusion of images

COMPETENCES AND ATTITUDES

- To confidently justify diagnostic imaging examinations and/or interventional procedures of the head and neck region
- To confidently choose the best-suited method for evaluating disorders of the head and neck region
- To communicate with the patient in order to obtain informed consent prior to diagnostic imaging and interventional procedures of the head and neck region
- To confidently choose the optimal imaging parameters for radiographic, ultrasonographic, CT, cone beam CT and MRI examinations of the head and neck region
- To confidently apply techniques to reduce exposure doses for radiographic, CT and cone beam CT examinations of the head and neck region
- To confidently design imaging protocols and standard operating procedures for CT and cone beam CT examinations of the head and neck region, including the appropriate application of intravenous contrast, spatial and temporal resolution
- To confidently design imaging protocols and standard operating procedures for MRI examinations of the head and neck region, including the appropriate application of intravenous contrast, spatial and temporal resolution
- To judge the quality of the imaging examinations in the head and neck and to devise strategies to improve image quality
- To confidently interpret and report radiographs, ultrasonographic examinations, CT studies, cone beam CT studies and MRI examinations of the most common and typical head and neck pathologies
- To report oncological studies of the head and neck region according to international standards (e.g. 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 confidently identify urgent and/or unexpected findings in imaging examinations of the head and neck region and to communicate these timely and properly
- To empathically communicate with patients and their relatives in order to explain the imaging findings of the head and neck region, in particular also when dealing with “bad news”
- To take an active part in multi-disciplinary conferences and tumour boards for diseases of the head and neck region

B-II-8 INTERVENTIONAL RADIOLOGY

In the subsequent sections the trainee should, in addition to the knowledge, competencies and skills detailed in section B1-8, have in depth knowledge of the following:

Normal anatomy and common variants of the relevant body systems

Common complications of procedures, including allergic reactions and their management

Pre-procedure planning/workup (including the CIRSE checklist) i.e. blood coagulation, antibiotics, fluid management and plans for post-procedural care

To know how to use the common pre/peri- and post-procedural drugs

To know the indications and contra-indications for the relevant procedures

To know the outcomes of common procedures in particular, technical and clinical success rate and where appropriate recurrence

NON-INVASIVE VASCULAR IMAGING

- To know the role of the different non-invasive imaging modalities in managing patients with vascular disease such as PAD, stroke, trauma and GI bleeding i.e. Duplex/MR/CT/ nuclear imaging including PET CT
- To describe the vascular anatomy on Duplex ultrasound, including both arterial and venous examinations
- To describe the characteristics of normal and abnormal Doppler waveforms
- To describe the typical imaging features on Doppler sonography of atherosclerotic disease, vasculitis, aneurismal disease, thrombosis, embolism and other vascular pathological conditions
- To describe the relevant acquisition parameters of CTA, including contrast materials used and reconstruction techniques
- To be aware of the radiation doses for CTA and to describe methods of reducing these
- To discuss advantages and disadvantages of CTA versus other techniques
- To describe the imaging features on CTA of atherosclerotic disease, vasculitis, aneurismal disease, thrombosis, embolism and other vascular pathological conditions
- To understand the physical principles of MR angiography (MRA) techniques
- To discuss the advantages and disadvantages of different contrast agents used for MRA
- To discuss the differences between MRA techniques
- To discuss the advantages and disadvantages of MRA compared with other techniques
- To have an in-depth understanding of nephrogenic systemic fibrosis (NSF)
- To describe the typical imaging features on MRA of atherosclerotic disease, vasculitis, aneurismal disease, thrombosis, embolism and other vascular pathological conditions

DIAGNOSTIC ANGIOGRAPHY/VENOGRAPHY

- To describe the basic chemistry of the different iodinated contrast materials used, and to discuss the advantages/disadvantages of each agent for angiography
- To describe mechanisms to minimise nephrotoxicity in at-risk patients, such as patients with diabetes or renal impairment
- To describe the standard groin anatomy, including the position of the inguinal ligament and the femoral nerve, artery and vein
- To describe the Seldinger technique of arterial and venous puncture

- To describe the mechanisms for guidewire, sheath and catheter insertions into the groin or other access sites
- To describe the mechanisms of puncture site haemostasis, including manual compression and common closure devices
- To know about micro-access systems for arterial puncture
- To describe alternative sites of arterial puncture, such as radial, brachial, axillary and popliteal arteries
- To list guidewires, sheaths and catheters used for common diagnostic angiographic procedures
- To describe digital subtraction angiography techniques, bolus chase techniques, road mapping and pixel shift techniques
- To describe the principles of peripheral vascular angiography
- To describe the principles of mesenteric, coeliac and renal angiography
- To describe the principles of abdominal aortography
- To describe the principles of thoracic aortography
- To describe the principles of carotid, vertebral and subclavian angiography
- To describe the principles of venous venography
- To describe the imaging features on diagnostic angiography of atherosclerotic disease, vasculitis, aneurismal disease, thrombosis, embolism and other vascular pathological conditions
- To describe the principles of corticosteroid prophylaxis

VASCULAR INTERVENTION

ARTERIAL

- To list the medical risk factors for atherosclerotic diseases
- To describe the clinical symptoms of peripheral arterial disease
- To describe the angioplasty balloon dynamics and the mechanism of action of angioplasty
- To list the drugs and dosages used during angioplasty
- To describe the principles of intra-arterial pressure studies
- To describe common angioplasty procedures, such as renal, iliac and femoral angioplasties
- To describe the basic mechanisms for stent deployment and to list the materials used for stent construction
- To list the indications for stent placement versus angioplasty
- To know about the use of stentgrafts in the treatment of aneurysm disease in small and large vessels
- To know the role of embolisation in different elective and emergency clinical situations i.e. Obstetrics/ Gynaecology for fibroid embolisation and obstetric haemorrhage, traumatic, gastrointestinal, thoracic and other causes of haemorrhage, vascular malformations and prostate artery embolisation
- To describe the technique of selective angiography
- To list embolisation materials and their specific use
- To describe the relevant catheters and microcatheters used for embolisation
- To list the endpoints of embolisation
- To describe the treatment of post-embolic pain and post-embolic syndrome

VENOUS

- To describe the indications, types and techniques for the insertion of peripherally inserted central catheter (PICC) lines, Hickman catheters, dialysis catheters and ports
- To list the indications for use of the above venous access catheters
- To describe the technique of access to jugular and subclavian veins
- To know the role of IR in superior vena cava syndrome
- The role of IR in thrombo-embolic disease including pulmonary embolism and acute DVT
- The role of IR in gonadal vein embolisation.
- To list the indications for caval filter placement
- To describe the different filter types available, including the difference between permanent and retrievable filters

HAEMODIALYSIS

- To describe the technique of haemodialysis shunt interventions
- To describe the techniques of venoplasty and stenting
- To list the success rates and complications of venoplasty and stenting
- To describe the post-procedural care after venoplasty and stenting

TIPS

- To be familiar with indications for transjugular intrahepatic portosystemic shunt (TIPS), the technique and complications

NON-VASCULAR INTERVENTIONS IN THE CHEST, GASTRO-INTESTINAL TRACT AND HEPATOBILIARY SYSTEM

- To list needles used for biopsy procedures, including fine gauge needles, large gauge needles and trucut biopsy
- To list the indications for fine needle biopsy versus large gauge or core biopsy
- To know the patient selection criteria for image-guided drainage procedures in different organ systems
- To know the range of percutaneous drainage systems available and how to use them
- To know about the different drainage catheter fixation systems and how to use them
- To describe how to carry out an abdominal, pelvic and organ abscess drainage
- To interpret Gram stain results
- To describe the methods of chest tube placement
- To describe underwater seal drainage systems
- To list fibrinolytic agents used in patients with loculated or complex empyemas or abscess
- To describe the trocar and Seldinger techniques for catheter placement
- To list situations where more than one catheter is required
- Biliary drainage and stenting
- To describe the integration of ultrasound, CT and MRCP to plan an appropriate biliary drainage procedure
- To describe the performance of percutaneous transhepatic cholangiography

- To describe the types and method of use of coaxial access systems for biliary drainage
- To list the catheters used for biliary decompression
- To describe the technique of percutaneous biliary drainage.
- To know about the use of the different biliary stents
- To describe the technique for biliary stent placement
- Gastro-intestinal interventions
- The use of different stents covered and uncovered stents used in the palliation of Oesophageal, stomach, small bowel and large bowel obstructions
- The role of percutaneous gastrostomy and jejunostomy for nutrition

INTERVENTIONS IN THE GENITO-URINARY TRACT AND RENAL TRANSPLANT

- To describe the integration of ultrasound, CT and urographic studies to plan an appropriate nephrostomy
- To describe the pre-procedural work-up including coagulation screens and antibiotic regimens
- To describe the ultrasound/fluoroscopic guidance mechanisms for percutaneous nephrostomy
- To list the catheters used for percutaneous nephrostomy
- To describe the placement of percutaneous nephrostomy tubes
- To describe the complications of percutaneous nephrostomy
- To describe the aftercare, including catheter care and removal To describe antegrade ureteric stenting
- To know about the management of stone disease
- To understand the role for the different imaging modalities in transplant patients
- To know about the role of IR in patients following transplantations

INTERVENTIONAL RADIOLOGY OF THE MUSCULOSKELETAL SYSTEM

- To know the role of intra-articular joint injections
- To know about percutaneous osteoplasty
- To know about percutaneous ablation of bone and soft tissue lesions
- To know about interventional procedures in the vertebral body for fractures
- To know about spinal procedures for disc, nerve and facet joints

INTERVENTIONAL ONCOLOGY

- To know the different relevant tumour classification systems
- To know the patterns of tumour recurrence and nodal spread
- To know the different available options in treatment i.e Ethanol, Cryotherapy, Radio-frequency ablation, irreversible electroporation, laser, HIFU etc
- To know about the role of embolisation techniques
- To know about portal vein embolisations

SKILLS

- To confidently treat both minor and major allergic reactions to iodinated contrast materials
- To treat potential groin complications
- To perform duplex ultrasound, including both arterial and venous examinations
- To perform common Doppler examinations, including carotid Doppler, hepatic and renal Doppler studies and lower extremity venous duplex examinations
- To perform the Seldinger technique of arterial and venous puncture
- To perform guidewire, sheath and catheter insertions into the groin
- To perform puncture site haemostasis, including manual compression and common closure devices
- To perform arterial puncture at alternative sites, such as radial brachial, axillary and popliteal arteries.
- To carry out common diagnostic angiographic procedures
- To perform digital subtraction angiography techniques, bolus chase techniques, road mapping and pixel shift techniques
- To perform peripheral vascular angiography
- To perform mesenteric, coeliac and renal angiography
- To perform abdominal aortography
- To perform thoracic aortography
- To perform under supervision carotid, vertebral and subclavian angiography
- To perform venography
- To perform common angioplasty procedures, such as iliac, femoral and popliteal angioplasties under supervision
- To perform intra-arterial pressure studies
- To perform arterial stenting under supervision
- To observe and/or perform under supervision the placement of peripherally inserted central catheter (PICC) lines, Hickman catheters, dialysis catheters and ports
- To observe and/or perform under supervision haemodialysis shunt interventions
- To observe and/or perform under supervision venoplasty and stenting
- To observe and/or perform under supervision caval filter placement
- To observe and/or perform under supervision embolisation for indications such as acute bleeding, tumour therapy, AVM treatment
- To perform selective angiography
- To effectively treat post-embolic pain and post-embolic syndrome
- To observe and/or perform under supervision transjugular intrahepatic portosystemic shunt (TIPS)
- To perform transcutaneous, image-guided biopsy procedures, including fine gauge needle biopsies, large gauge needle biopsies and trucut biopsy
- To perform chest drainage, fluid aspiration and abscess drainage
- To use underwater seal drainage systems
- To apply fibrinolytic agents in patients with loculated or complex empyemas
- To perform the trocar and Seldinger techniques for catheter placement
- To perform abdominal and pelvic abscess drainage

- To perform transhepatic cholangiography
- To perform under supervision biliary drainage
- To perform under supervision biliary decompression with catheters
- To perform emergency procedures in life-threatening disorders, including cardio-pulmonary resuscitation

COMPETENCES AND ATTITUDES

- To appropriately select patients for a requested interventional procedure through a review of available history, imaging, laboratory values, and proposed or expected outcomes of the procedure
- To confidently identify features in the history or physical findings that would require pre-procedure assistance from other specialty disciplines, such as cardiology, anaesthesia, surgery or internal medicine
- To confidently identify risk factors from the patient's history, physical or laboratory examinations that indicate potential risk of bleeding, nephrotoxicity, cardiovascular problems, breathing abnormalities, or adverse drug interactions during or after the procedure
- To obtain informed consent after discussion of the procedure with the patient, including a discussion of risks, benefits and alternative therapeutic options
- To correctly manage the monitoring of the patient during the radiological intervention and to recognize abnormalities and physical signs or symptoms that need immediate attention during the procedure
- To reduce accidental exposure to blood and body fluids in the interventional radiology suite
- To appreciate own limitations and to identify when it is appropriate to obtain assistance in interventional procedures
- To effectively 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 perform at multi-disciplinary conferences for patients with potential indications for interventional procedures

B-II-9 MUSCULOSKELETAL RADIOLOGY

KNOWLEDGE

- To have an in-depth knowledge of the normal anatomy of all structures relevant to musculoskeletal imaging
- To have an in-depth knowledge of normal skeletal variants that may mimic disease
- To have an in-depth understanding of the development of the immature skeleton
- To have a basic understanding of the embryology of the skeleton
- To list the indications, contraindications and potential hazards (especially radiation hazards) of procedures and techniques relevant to musculoskeletal disease and trauma
- To have a basic clinical knowledge of medical, surgical and pathological conditions as well as pathophysiology related to the musculoskeletal system
- To describe the distinctive imaging features and clinical manifestations of musculoskeletal disease and trauma, as demonstrated by conventional radiography, CT, MRI, arthrography, radionuclide investigations and ultrasound
- To discuss differential diagnoses relevant to the clinical presentation and imaging appearance of musculoskeletal disease and trauma

TRAUMA – ACUTE AND CHRONIC

- To list the types and general classifications of fractures and dislocations
- To describe the typical imaging features and basic clinical features of fractures and dislocations in the adult skeleton
- To describe the typical imaging features and basic clinical features of fractures and dislocations in the immature skeleton
- To describe the typical imaging features and basic clinical features of articular fractures and dislocations including chondral and osteochondral lesions and osteochondritis dissecans
- To describe the distinctive imaging features and basic clinical features of healing and complications of fractures and dislocations, including delayed union, non-union, avascular necrosis, reflex sympathetic dystrophy / complex regional pain syndrome, and myositis ossificans
- To describe the typical imaging features and basic clinical features of stress fractures, including fatigue and insufficiency fractures
- To describe the typical imaging features and basic clinical features of avulsion fractures
- To describe the typical imaging features, imaging strategies and basic clinical features of pathological, and non-accidental injury
- To describe the typical imaging features and basic clinical features of skull and facial bone fractures
- To describe the typical imaging features and basic clinical features of spinal fractures, including spondylolysis

- To describe the typical imaging features and basic clinical features of fractures and dislocations of the shoulder girdle, including sternoclavicular and acromioclavicular dislocations, clavicular fractures, scapular fractures, and shoulder dislocation/instability
- To describe the typical imaging features and basic clinical features of fractures and dislocations of the upper limb including humeral fractures, elbow fractures and dislocations, proximal and distal forearm fractures and dislocations, wrist joint fractures/dislocations, and hand fractures and dislocations
- To describe the typical imaging features and basic clinical features of fractures and dislocations of the pelvis including associated soft tissue injuries
- To describe the typical imaging features and basic clinical features of fractures and dislocations of lower limb including hip fractures and dislocations, femoral fractures, tibial and fibular fractures (including the ankle joint), hindfoot fractures, tarso-metatarsal fractures and dislocations and forefoot fractures and dislocations
- To describe the typical imaging features and basic clinical features of soft tissue injuries of the shoulder, including rotator cuff injuries, glenoid labrum injuries and biceps tendon injuries
- To describe the typical imaging features and basic clinical features of soft tissue injuries of the wrist including injuries of the triangular fibrocartilage complex
- To describe the typical imaging features and basic clinical features of soft tissue injuries of the knee, including meniscal injury, cruciate ligament injury, and collateral ligament injury
- To describe the typical imaging features and basic clinical features of soft tissue injuries of the ankle including injuries of the principal tendons and ligaments

INFECTIONS

- To describe the typical imaging features and basic clinical features of acute, subacute and chronic osteomyelitis of the appendicular skeleton and of the spine
- To describe the typical imaging features and basic clinical features of post-traumatic and postoperative osteomyelitis
- To describe the distinctive imaging features and basic clinical features of tuberculosis of the musculoskeletal system
- To describe the typical imaging features and basic clinical features of infections of the spine
- To describe the typical imaging features and basic clinical features of infections of the appendicular skeleton
- To describe have a basic understanding of the imaging features of rarer infections (e.g. leprosy, brucellosis)
- To describe the typical imaging features and basic clinical features of infections with more common parasites worldwide (e.g. echinococcus)
- To describe the typical imaging features and basic clinical features of soft tissue infections
- To describe the typical imaging features and basic clinical features of HIV-associated infections

TUMOURS AND TUMOUR-LIKE LESIONS

- To understand and describe the typical imaging features, principles of tumour characterisation and staging of bone-forming tumours including osteoma and bone islands, osteoid osteoma and osteoblastoma and osteosarcoma (typical and common variants)
- To understand and describe the typical imaging features, principles of tumour characterisation and staging of cartilage-forming tumours including osteochondroma, enchondroma, chondroblastoma, chondromyxoid fibroma, and chondrosarcoma (central and peripheral)
- To understand and describe the typical imaging features, principles of tumour characterisation and staging of tumours of fibrous origin including fibrous cortical defects and non-ossifying fibroma, fibrous dysplasia, fibrosarcoma and malignant fibrous histiocytoma
- To understand and describe the typical imaging features, principles of tumour characterisation and staging of haematopoietic and reticuloendothelial tumours including giant cell tumour, Langerhans cell histiocytosis, malignant round cell tumours (Ewing's sarcoma, lymphoma and leukaemia), myeloma and plasmocytoma
- To understand and describe the distinctive imaging features, principles of tumour characterisation and staging of tumour-like lesions including simple bone cysts and aneurysmal bone cysts
- To understand and describe the typical imaging features, principles of tumour characterisation and staging of metastases
- To confidently recognize "don't touch" lesions
- To understand and describe the typical imaging features, principles of tumour characterisation and staging of chordoma
- To understand and describe the typical imaging features, principles of tumour characterisation and staging of adamantinoma
- To understand and describe the typical imaging features, principles of tumour characterisation and staging of tumours of fat origin, including lipoma and liposarcoma
- To understand and describe the typical imaging features, principles of tumour characterisation and staging of tumours of neural origin including neurofibroma and schwannoma
- To understand and describe the typical imaging features, principles of tumour characterisation and staging of tumours of vascular origin, including haemangioma
- To understand and describe the typical imaging features, principles of tumour characterisation and staging of soft tissue sarcomas

HAEMATOLOGICAL DISORDERS

- To describe the imaging features and basic clinical features of haemoglobinopathies including sickle cell disease and thalassaemia
- To describe the imaging features and basic clinical features of myelofibrosis

METABOLIC, ENDOCRINE AND TOXIC DISORDERS

- To describe the imaging features and basic clinical features of rickets and osteomalacia
- To describe the imaging features and basic clinical features of primary and secondary hyperparathyroidism (including chronic renal failure)
- To describe the imaging features and basic clinical features of osteoporosis (including basic concepts of bone mineral density measurements), and fluorosis

JOINTS

- To have an in-depth knowledge of the imaging features and clinical features of degenerative disease of the spine, disc and facet joints
- To have an in-depth knowledge of the imaging features and clinical features of degenerative disease of the peripheral joints
- To have an in-depth knowledge of the imaging features and clinical features of inflammatory joint disease, including rheumatoid arthritis, juvenile rheumatoid arthritis, ankylosing spondylitis, psoriatic arthritis, enteropathic arthropathies, and infective arthritis (pyogenic and tuberculous)
- To describe the imaging features and basic clinical features of crystal arthropathies, including pyrophosphate arthropathy, hydroxyapatite deposition disease, and gout
- To describe the imaging features and basic clinical features of masses of the joints, including, ganglion, synovial chondromatosis, and pigmented villonodular synovitis
- To describe the imaging features and basic clinical features of neuroarthropathy, including diabetic foot, Charcot's joints, Pseudo-Charcot joint (steroid-induced)
- To describe the imaging features and basic clinical features of complications of prosthetic joint replacement (hip and knee)

CONGENITAL, DEVELOPMENTAL AND PAEDIATRIC

- To describe the imaging features and basic clinical features of congenital disorders of the spine, including scoliosis (congenital and idiopathic), and dysraphism
- To describe the imaging features and basic clinical features of congenital disorders of the shoulder, including Sprengel's deformity
- To describe the imaging features and basic clinical features of congenital disorders of the hand and wrist, including Madelung deformity (idiopathic and other causes)
- To describe the imaging features and basic clinical features of congenital disorders of the hip, including developmental dysplasia, irritable hip, Perthes disease, slipped upper femoral epiphysis
- To describe the imaging features and basic clinical features of femoroacetabular impingement
- To describe the imaging features and basic clinical features of congenital disorders of the ankle and foot
- To describe the imaging features and basic clinical features of congenital tarsal coalition
- To describe the imaging features and basic clinical features of bone dysplasias
- To describe the imaging features and basic clinical features of congenital disorders of multiple epiphyseal dysplasia

- To describe the imaging features and basic clinical features of congenital disorders of achondroplasia
- To describe the imaging features and basic clinical features of congenital disorders of osteogenesis imperfecta
- To describe the imaging features and basic clinical features of congenital disorders of the sclerosing disorders of the bone, including osteopetrosis, melorheostosis and osteopoikilosis
- To describe the imaging features and basic clinical features of tumour-like lesions in the paediatric age group, including diaphyseal aclasis and Ollier's disease
- To describe the imaging features and basic clinical features of the musculoskeletal manifestations of neurofibromatosis

MISCELLANEOUS

- To describe the imaging features and basic clinical features of Paget's disease
- To describe the imaging features and basic clinical features of sarcoidosis
- To describe the imaging features and basic clinical features of hypertrophic osteoarthropathy
- To describe the imaging features and basic clinical features of transient or regional migratory osteoporosis
- To describe the imaging features and basic clinical features of osteonecrosis
- To describe the principles of characterisation of soft tissue calcification/ossification

SKILLS

- To choose the most appropriate imaging examination according to the clinical problem in musculoskeletal imaging
- To choose the most suitable contrast material and its optimal use according to the imaging technique and the clinical problem in musculoskeletal imaging
- To perform dynamic functional studies of the spine and joints
- To perform a correct positioning for radiography of the spine and of the extremities including special views
- To perform ultrasound of the musculoskeletal system
- To perform image-guided biopsies in the musculoskeletal system in easy cases
- To observe and/or perform under supervision image-guided biopsies in the musculoskeletal system in more complex cases
- To confidently plan a CT examination of the musculoskeletal system and to tailor it to the individual situation, with a dose as low as reasonably achievable
- To confidently plan an MRI examination of the musculoskeletal system and to tailor it to the individual situation in regard to the potential use of intravenous contrast medium and spatial resolution
- To perform contrast injections in various joints, including the hip, shoulder and wrist for MR arthrography or CT arthrography
- To observe and/or to perform under supervision discography, facet joint injections and vertebroplasty
- To observe and/or to perform under supervision image-guided bone biopsy and drainage of the musculoskeletal system
- To confidently perform proper post-processing tasks of musculoskeletal imaging studies, including multi-planar reformations (MPR), maximum intensity projections (MIP), minimum intensity projections (MinIP), and fusion images

COMPETENCES AND ATTITUDES

- To confidently justify diagnostic imaging examinations and/or interventional procedures of the musculoskeletal system
- To confidently 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 and interventional procedures of the musculoskeletal system
- To confidently choose optimal imaging parameters for radiographic, ultrasonographic, CT and MRI examinations of the musculoskeletal system
- To confidently apply techniques to reduce exposure doses for radiographic and CT examinations of the musculoskeletal system
- To confidently design imaging protocols and standard operating procedures for CT examinations of the musculoskeletal system, including the appropriate application of intravenous contrast, positioning, spatial and temporal resolution
- To confidently design imaging protocols and standard operating procedures for MRI examinations of the musculoskeletal system, positioning, including the appropriate application of intravenous contrast, spatial and temporal resolution
- To supervise and teach technical staff to ensure that appropriate images of the musculoskeletal system are obtained
- To confidently judge the quality of imaging examinations in musculoskeletal imaging and to devise strategies to improve image quality
- To confidently interpret and report radiographs, ultrasonographic examinations, osteodensitometric studies, CT studies and MRI examinations of the musculoskeletal system
- To report oncological studies of the musculoskeletal 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 musculoskeletal system
- To confidently 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 their imaging findings of the musculoskeletal system
- To perform at multi-disciplinary conferences and tumour boards for diseases of the musculoskeletal system

B-II-10 NEURORADIOLOGY

KNOWLEDGE

NORMAL ANATOMY

- To have an in-depth understanding of the normal anatomy of the brain, skull, skull base, brain, extracranial head, spine, spinal cord and peripheral nervous system
- To confidently detect and describe normal imaging findings of the brain and spine on X-ray, ultrasound, CT and MRI
- To confidently delineate and describe the skull, skull base, and spine on conventional radiography
- To confidently delineate the cortex, white matter, basal ganglia, ventricles, cisterns and cranial nerves on CT and/or MRI of the brain
- To have knowledge of the functional anatomy of the motor, sensory and visual systems
- To have knowledge of the functional anatomy of the cognition and memory
- To have knowledge of the glymphatic system
- To confidently delineate the orbit and its contents, paranasal sinuses, temporal bone, salivary glands, neck lymph nodes, larynx, pharynx, thyroid and parathyroid glands, skull, skull base, and deep spaces of the neck on CT and/or MRI of the brain
- To confidently delineate the vertebral bodies, spinal canal, intervertebral discs, dural sac, spinal cord and cauda equina on CT and/or MRI of the spine
- To confidently delineate the aortic arch, carotid and vertebral arteries, intracranial arteries and the circle of Willis, spinal and spinal cord vascularisation on X-ray angiography, CT angiography and MR angiography
- To describe the normal imaging features of Virchow-Robin spaces
- To describe normal variants of skull, skull base, brain, extracranial head, spine, and spinal cord and differentiate these from pathology

CONGENITAL AND DEVELOPMENTAL ABNORMALITIES

- To describe the imaging features of malformations of the skull base and craniovertebral junction
- To describe anomalies of the oro-pharyngeal apparatus including branchial cleft cysts, and thyroglossal duct cysts
- To describe the imaging features of malformations of cortical development, including focal cortical dysplasia, polymicrogyria, heterotopia (subependymal, focal subcortical, laminar), lissencephaly / pachygyria, (hemi) megalencephaly, microlissencephaly, schizencephaly
- To describe the imaging features of agenesis and dysgenesis of the corpus callosum and of holoprosencephaly (lobar, alobar, semilobar)
- To describe the imaging features of hindbrain and posterior fossa malformations, including the Chiari malformations, the Dandy Walker spectrum and the molar tooth malformations (including Joubert syndrome)
- To describe the imaging features of white matter injury of the premature brain / periventricular leukodystrophy (PVL)

- To describe the imaging features of intracranial and spinal arachnoid cysts
- To describe the imaging features of hypoxic ischemic encephalopathy of the mature infant after severe acute asphyxia
- To describe the imaging features of hypoxic ischemic encephalopathy of the mature infant after prolonged partial hypoxia
- To describe the neuro-imaging features, extracranial manifestations, diagnostic criteria and clinical features of tuberous sclerosis, Sturge-Weber diseases, neurofibromatosis type I and II, and other common phakomatoses
- To describe the common imaging features of segmental vascular syndromes
- To describe the common imaging features of inherited metabolic conditions and leukodystrophies

NEUROVASCULAR

- To list the stroke subtypes and their causative mechanism in adults and paediatric patients
- To describe the relevance of the “time is brain” approach to the imaging evaluation of patients with stroke
- To describe comprehensive stroke evaluation parameters for MRI and CT, including diffusion-weighted imaging, CT perfusion, MR perfusion, CT angiography and MR angiography
- To list the CT and MR perfusion parameters relevant for stroke imaging and to describe their relevance and limitations
- To list and describe the main neuroradiological interventions in patients with acute ischaemic stroke
- To describe the diagnostic and therapeutic approach in patients with ischemic strokes of the posterior circulation / basilar artery occlusion
- To describe interventional approaches to intracranial and extracranial stenoses
- To describe the imaging features, relevant clinical features and imaging algorithm in patients with venous stroke / intracranial venous thrombosis
- To describe the imaging and clinical features in patients with subarachnoid haemorrhage (SAH)
- To describe the standard imaging evaluation algorithm in patients with spontaneous SAH
- To list the major complications and describe their respective imaging features in patients with spontaneous SAH
- To describe intracranial collateral circulation and their relevance in ischaemic stroke
- To describe the imaging features and relevant haemodynamic parameters in patients with vasospasm
- To describe the imaging features of atherosclerotic and hypertensive small vessel diseases
- To describe the imaging features of genetically determined small vessel diseases (CADASIL, Susac, Fabry, HERNS)
- To describe the imaging features of cerebral amyloid angiopathy and cerebral amyloid angiopathy-related inflammation
- To describe the imaging features of arterial vessel wall abnormalities in atherosclerotic diseases of the intracranial and extracranial vessels
- To describe common imaging features in patients with migraine
- To differentiate atypical and typical intracerebral haemorrhages
- To list the major causes for atypical and typical intracerebral haemorrhages
- To describe the imaging algorithms in patients with atypical and typical intracerebral haemorrhages
- To list the different types of intracranial and extracranial vascular malformations
- To describe the imaging features and therapeutic approaches in patients with intracranial vascular malformations including arteriovenous malformations, dural arterio-venous fistulas, and carotid-cavernous sinus fistulas
- To describe the imaging features, differential diagnoses and relevance of developmental venous anomalies
- To describe the imaging features, differential diagnoses and relevance of cavernous malformations
- To describe the imaging features, differential diagnoses and relevance of capillary telangiectasias
- To describe the imaging features of the different types of intracranial aneurysms: secular, dissecting, fusiform, giant, infectious
- To describe the imaging features of intra/extracranial arterial dissections

- To describe the imaging features of posterior reversible encephalopathy syndrome
- To describe the imaging features of reversible cerebral vasoconstriction syndrome
- To describe the imaging features and basic clinical features of primary and systemic central nervous system vasculitis
- To describe cerebrovascular lesions related to arterial hypertension
- To describe the standard imaging evaluation and features of brain death
- To describe the imaging and clinical features in patients with venous occlusive disease
- To describe the imaging features of Moyamoya syndrome and Moyamoya disease

NEUROTRAUMA

- To list the typical imaging algorithms for patients with acute traumatic injury to the brain
- To describe the typical imaging features and basic clinical features of epidural hematoma
- To describe the typical imaging features and basic clinical features of subdural hematoma
- To describe the typical imaging features and basic clinical features of traumatic subarachnoidal hemorrhage
- To describe the imaging algorithms and imaging features of traumatic CSF leaks
- To describe the characteristic imaging features and basic clinical features of brain contusions
- To describe the characteristic imaging features and basic clinical features of diffuse axonal injury
- To describe the characteristic imaging features and warning signs for elevated intracranial pressure
- To describe the characteristic imaging features of fractures of the skull and skull base including the temporal bone, facial bones, the paranasal sinuses and the orbit
- To describe the characteristic imaging features and clinical features in children with non-accidental injury
- To describe the characteristic imaging features of vascular traumatic injury of the intra- and extracranial vessels

INTRACRANIAL TUMOURS

- To list the most common intracranial and extracranial tumours
- To have a good knowledge of the WHO classification of CNS tumours including their molecular parameters
- To describe the typical imaging manifestations of intracranial metastases of various primary tumours
- To describe the imaging features and basic clinical features of diffuse astrocytic and oligodendroglial tumors
- To describe the imaging features and basic clinical features of pilocytic astrocytomas,
- To describe the imaging features and basic clinical features of pleomorphic xanthoastrocytoma
- To describe the imaging features, basic clinical features, location and association of subependymal giant cell astrocytomas
- To describe the imaging features, basic clinical features, and location of neuronal and mixed neuronal-glial tumors including ganglioglioma, gangliocytoma, dysembryoplastic neuroepithelial tumour (DNET), dysplastic cerebellar gangliocytoma, desmoplastic infantile, desmoplastic infantile astrocytoma and ganglioglioma, rosette-forming glioneuronal tumor, neurocytoma and paraganglioma
- To properly identify tumour response and recurrence
- To describe the imaging features and basic clinical features of CNS tumours treatment-related (pseudoprogression and pseudoresponse)
- To list the characteristic imaging features and locations of the various forms of brain stem tumours
- To describe the imaging features and basic clinical features of optic pathway gliomas
- To describe the imaging features and basic clinical features of ependymal tumors
- To describe the imaging features and basic clinical features of the different genetic defined medulloblastomas and other embryonal tumours such as CNS neuroblastoma and atypical teratoid and rhabdoid tumors (ATRT)
- To describe the imaging features and basic clinical features of choroid plexus tumors
- To describe the imaging features and basic clinical features of primary and secondary lymphoma of the brain
- To describe the imaging features of leukemic involvement of the central nervous system
- To describe the imaging features of post-transplantation lymphoproliferative disease

- To describe the imaging features, basic clinical features and differential diagnosis of sellar and suprasellar region such as craneopharyngiomas, and tuber cinereum hamartomas
- To describe the imaging features and basic clinical features of pituitary microadenomas and macroadenomas
- To describe the imaging features and basic clinical features of tumours of the pineal region
- To describe the imaging features and basic clinical features of typical and atypical meningiomas, and malignant meningiomas
- To describe imaging features of mesenchymal, non-meningothelial tumours, such as angiosarcomas, hemangiopericytomas, chondromas, chondrosarcomas, osteomas, osteosarcomas and hemangioblastomas
- To describe the imaging features and basic clinical features of histiocytic tumours including Langerhans cell histiocytosis, Erdheim-Chester disease, Rosai-Dorfman disease, juvenile xanthogranuloma and histiocytic sarcoma.
- To describe the imaging features and basic clinical features of germ cell tumours such as germinomas, embryonal carcinomas and teratomas
- To describe the imaging features and basic clinical features of cranial nerves tumours including vestibular schwannoma/"acoustic neuroma", trigeminal schwannoma and facial nerve schwannoma
- To describe the imaging features and basic clinical features of perineural spread of malignant tumors
- To describe the imaging features and dissemination pathways of malignant and benign tumours of the suprahyoid neck, and paranasal sinuses, including their potential spread patterns through the skull base
- To describe the imaging features and basic clinical features of orbital tumours
- To describe the imaging features and basic clinical features of temporal bone tumours
- To describe the imaging features and basic clinical features of salivary gland tumours
- To describe the imaging features and basic clinical features of thyroid and parathyroid tumours
- To describe the imaging features of chordoma of the clivus and other tumours of the skull base
- To describe the imaging features of tumours of the skull

NEUROINFLAMMATORY, NEUROINFECTIOUS AND NEURODEGENERATIVE DISORDERS

- To describe the imaging features of age-related changes of the brain
- To describe the typical and atypical imaging features and clinical features of multiple sclerosis (MS) and its variants, acute disseminated encephalomyelitis (ADEM) and neuromyelitis optica spectrum disorders (NMOSD)
- To differentiate the appearance of demyelinating lesions from age-related changes
- To describe the characteristic imaging features of treatment-related effects in patients with multiple sclerosis
- To describe the imaging features and clinical features of CLIPPERS
- To describe the imaging features and clinical features of neurosarcoidosis
- To describe the imaging features and clinical features of IRIS (immune reconstitution inflammatory syndrome)
- To describe the characteristic imaging features and clinical features of patients with dementia of the Alzheimer type, as well as of other primary neurodegenerative diseases, such as multi-system atrophy, and fronto-temporal dementia
- To describe the characteristic imaging features of treatment-related effects in patients with Alzheimer disease

- To have a basic understanding of the imaging features in Parkinson's disease and in atypical Parkinson syndromes, and other movement disorders such as progressive supranuclear palsy
- To describe the imaging features and basic clinical features of amyotrophic lateral sclerosis
- To describe the imaging features and basic clinical features of degenerative ataxia disorders
- To describe the typical CNS imaging features and basic clinical features of Wilson disease
- To describe the imaging features and basic clinical features of acute and chronic hepatic encephalopathy, and chronic renal failure
- To describe the imaging features and basic clinical features of exogenous toxic (carbon monoxide poisoning, recreational drugs, ethanol abuse, organic solvents), and acquired metabolic conditions (osmotic demyelination syndrome, hyper/hypoglycemia, iron and B12/copper deficiency)
- To have an in-depth understanding of the typical and atypical imaging features of herpes simplex virus (HSV) infections of the brain, and understand the therapeutic concepts and urgency of HSV infections of the brain
- To describe the imaging features and the limitations of imaging in patients with meningitis
- To list the typical complications of meningitis and to describe their imaging features
- To describe the typical imaging features and basic clinical features of the different stages of intracranial abscess formation
- To describe the characteristic imaging features and basic clinical features of tuberculous meningitis and intracranial tuberculomas
- To describe the characteristic imaging features and basic clinical features of hemophagocytic lymphohistiocytosis
- To describe the characteristic imaging features and basic clinical features of hypophysitis
- To describe the characteristic imaging features and basic clinical features of IgG4 related disorders
- To have a basic understanding of congenital infections of the brain including toxoplasmosis, CMV, rubella and HSV
- To describe the characteristic imaging features and basic clinical features of sarcoidosis
- To describe the characteristic intracranial imaging features and basic clinical features of HIV infection of the brain
- To describe the characteristic intracranial imaging features and basic clinical features of typical complications of HIV infections
- To describe the characteristic imaging features and basic clinical features of prion infections
- To describe the characteristic imaging features and basic clinical features of fungal infections
- To describe the characteristic imaging features and causes of therapy induced lesions to the CNS, (e.g. after radiation therapy and after chemotherapy) such as radiation-induced leukoencephalopathy, radiation induced tumours, radiation necrosis, and SMART syndrome
- To describe the characteristic imaging features of autoimmune-mediated encephalitis

HYDROCEPHALUS

- To have a basic understanding of the production, flow and resorption of CSF,
- To list and to differentiate the different types of hydrocephalus and their respective causes

- To describe the characteristic imaging features and clinical features of normal pressure hydrocephalus
- To describe the characteristic imaging features, causes and clinical features of non-communicating hydrocephalus.
- To describe the characteristic imaging features, causes and clinical features of benign intracranial hypertension
- To describe the characteristic imaging features, causes and clinical features of CSF hypotension
- To describe the characteristic imaging features and list the major causes of aqueductal stenosis
- To describe the methods of qualitative and quantitative imaging-based flow assessment of the CSF
- To have a basic understanding of the different therapeutic approaches to hydrocephalus, including shunt placement and third ventriculostomy

SPINE AND SPINAL CORD

- To describe the imaging features and basic clinical features of spinal malformations including spina bifida aperta, spina bifida occulta, meningocele, dermal sinus, split cord malformations, scoliosis
- To differentiate stable and unstable fractures of the spine
- To describe the characteristic imaging features and clinical features in spinal cord trauma
- To differentiate between benign and malignant vertebral compression fractures
- To describe the imaging features of myelopathy and to list its common causes
- To describe the characteristic imaging features of spinal instability
- To describe the characteristic imaging features of inflammatory condition of the spine: enthesopathies, DISH, Bechterew
- To describe the characteristic imaging features of spinal metastases including the criteria for cord compression
- To describe the characteristic imaging features of osteoporosis and metabolic diseases involving the spine
- To describe the characteristic imaging features and clinical features in spinal cord ischemia
- To describe the characteristic imaging features and clinical features of Hirayama disease
- To describe the characteristic imaging features and clinical features of transdural spinal cord herniation
- To list the most common intraspinal tumours
- To describe the imaging features and basic clinical features of spinal cord tumours (ependymoma, astrocytoma, haemangioblastoma)
- To describe the imaging features and basic clinical features of intradural spinal tumours (meningioma, neurinoma)
- To describe the imaging features and basic clinical features of transverse myelitis (TM)
- To describe the imaging features and basic clinical features of spinal manifestations of MS, acute disseminated encephalomyelitis (ADEM), and neuromyelitis optica spectrum disorders (NMOSD)
- To describe the imaging features and basic clinical features of infectious diseases of the spine and spinal cord including discitis and spondylodiscitis
- To describe the imaging features and basic clinical features of spinal vascular malformations
- To describe the imaging features and basic clinical features of syrinx formation and hydromyelia
- To describe the imaging features of chordomas and other primary tumours of the spine
- To have an in-depth knowledge of the imaging features of degenerative diseases of the spine disc and facet joints
- To describe percutaneous and endovascular interventional procedures of the spine/spinal cord

EPILEPSY

- To list the major causes of seizures in paediatric and adult population
- To describe the characteristic imaging evaluation algorithm in patients with seizures
- To describe the imaging features of mesial temporal sclerosis
- To describe the imaging features of status epilepticus
- To describe the value of neurofunctional imaging feature sin the assessment of epilepsy

PERIPHERAL NERVOUS SYSTEM

- To describe the characteristic imaging evaluation algorithm and features of brachial plexopathy
- To describe the characteristic imaging evaluation algorithm and features of lumbosacral plexopathy
- To describe the characteristic imaging evaluation algorithm in patients with entrapment neuropathies
- To describe the imaging features of tumoral lesions of the peripheral nerves
- To describe the imaging features of inflammatory lesions of the peripheral nerves, including chronic inflammatory demyelinating polyradiculoneuropathy
- To describe the imaging features of hereditary motor and sensory neuropathies

SKILLS

- To choose the most appropriate imaging examination according to the clinical problem in neuroradiology
- To choose the most appropriate imaging strategy in the monitoring of CNS tumours
- To choose the most appropriate imaging strategy in the monitoring of multiple sclerosis
- To choose an appropriate interventional procedure (endovascular or percutaneous) according to the clinical problem in neuroradiology
- To choose the most suitable contrast material and its optimal use according to the imaging technique and the clinical problem in neuroradiology
- To observe and/or perform under supervision ultrasound of brain in the infant
- To observe and/or perform under supervision Doppler sonography of the intracranial vessels
- To observe and/or perform under supervision diagnostic neuroangiography
- To observe and/or perform under supervision intraarterial thrombectomy and other recanalization procedures in patients with ischaemic stroke
- To observe and/or perform under supervision neurointerventional therapy in patients with acute basilar artery occlusion
- To observe and/or perform under supervision endovascular treatment of intracranial aneurysms
- To observe and/or perform under supervision spinal angiography
- To observe and/or perform under supervision percutaneous interventional procedures of the extracranial head
- To observe and/or perform under supervision disk, vertebral and facet interventional procedures included discography and biopsy
- To observe and/or to perform under supervision discography, facet joint injections and vertebroplasty
- To confidently plan a CT examination of the brain and spine and to tailor it to the individual situation, with a dose as low as reasonably achievable

- To confidently plan an MRI examination of the brain and spine and to tailor it to the individual situation in regard to the potential use of intravenous contrast medium and spatial resolution
- To plan and perform advanced CT and MRI examinations including perfusion CT and MR, diffusion tensor imaging, functional MR imaging (task-related and resting-state), and proton MR spectroscopy
- To confidently perform proper post-processing tasks of neuroradiological studies, including multi-planar reformations (MPR), maximum intensity projections (MIP), minimum intensity projections (MinIP), tractography, functional MRI and fusion images
in regard to the potential use of intravenous contrast medium and spatial resolution
- To plan and perform advanced CT and MRI examinations including perfusion CT and MR, diffusion tensor imaging, functional MR imaging, and proton MR spectroscopy
- To confidently perform proper post-processing tasks of neuroradiological studies, including multi-planar reformations (MPR), maximum intensity projections (MIP), minimum intensity projections (MinIP), DTI, functional MRI and fusion images

COMPETENCES AND ATTITUDES

- To confidently justify diagnostic imaging examinations and/or interventional procedures of the brain, skull, skull base, spine, spinal cord, extracranial head, and peripheral nervous system
- To confidently choose the best-suited method for evaluating disorders of the brain, skull, skull base, spine, spinal cord, extracranial head, and peripheral nervous system
- To communicate with the patient in order to obtain informed consent prior to diagnostic imaging and interventional procedures of the brain, skull, skull base, spine, spinal cord, extracranial head, and peripheral nervous system
- To confidently choose optimal imaging parameters for X-ray, ultrasound, CT and MRI examinations of the brain, skull, skull base, spine, spinal cord, extracranial head, and peripheral nervous system
- To confidently apply techniques to reduce exposure doses for X-ray and CT examinations of the brain, skull, skull base, spine, and extracranial head.
- To design a time-saving imaging algorithm and to define standard operating procedures for imaging patients with stroke
- To confidently perform and interpret a comprehensive imaging evaluation in patients with acute stroke
- To confidently design imaging protocols and standard operating procedures for CT examinations of the brain, skull, skull base, extracranial head, spine, spinal cord, peripheral nervous system, including the appropriate application of intravenous contrast, positioning, spatial and temporal resolution
- To confidently design imaging protocols and standard operating procedures for MRI examinations of the brain and spine, including the appropriate application of intravenous contrast, spatial and temporal resolution
- To supervise and teach technical staff to ensure that appropriate images of the brain, skull, skull base, spine, spinal cord, extracranial head, and peripheral nervous system are obtained
- To confidently judge the quality of imaging examinations in neuroradiology and to devise strategies to improve image quality
- To confidently interpret and report X-ray, ultrasound, CT and MRI examinations of the brain, skull, skull base, spine, spinal cord, extracranial head, and peripheral nervous system

- To confidently use structured reporting in common clinical situations (eg. stroke, multiple sclerosis, brain tumours, dementia...)
- To confidently use visual scales to report global and regional brain atrophy
- To confidently use visual scales to report white matter abnormalities
- To report oncological studies according to international standards 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, spinal cord, and peripheral nervous system
- To confidently identify urgent and/or relevant unexpected findings in imaging examinations of the brain, skull, skull base, extracranial head, spine, 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, spine, spinal cord, extracranial head, and peripheral nervous system
- To participate in and/or conduct multi-disciplinary conferences, vascular boards, and tumour boards for diseases of the brain, skull, skull base, extracranial head, spine, spinal cord, peripheral nervous system

B-II-11 ONCOLOGIC IMAGING

KNOWLEDGE

CANCER: BIOLOGY & TREATMENT

- To develop an understanding of oncogenesis, angiogenesis, lymphangiogenesis and metastasis including genomics and proteomics
- To understand the principles of treatment including surgery, locoregional therapies, chemotherapy (including systemic and targeted therapies; adjuvant and neoadjuvant) bone marrow/stem cell transplantation, immunotherapy and radiotherapy (conventional, brachytherapy, and stereotactic)
- To develop core knowledge of the biology of different tumour types, particularly the most common cancers: lung, breast, colorectal, and prostate.
- To understand the treatment strategies of different tumour types, particularly the most common cancers: lung, breast, colorectal, and prostate
- To describe the acute and chronic complications of oncologic treatment and their imaging features

IMAGING TECHNIQUES IN ONCOLOGIC IMAGING

- To describe indications and contraindications for the various imaging examinations in oncologic imaging for staging and response assessment
- To describe the most appropriate imaging examination for oncologic imaging according to the clinical problem: ultrasound, CT, MRI, and hybrid techniques (PET-CT, PET-MRI, SPECT-CT)
- To understand the strengths and limitations of each imaging technique in oncologic imaging
- To understand the role of endocavitary/endoscopic US techniques for tumour characterization and staging
- To recommend appropriate endocavitary/endoscopic US investigations
- To describe the best contrast material and its optimal use according to the imaging technique and the clinical problem in oncologic imaging
- To understand the relative costs of the various imaging examinations in oncologic imaging
- To know the radiation burden and risks of different investigations in oncologic imaging
- To describe techniques for post-processing images in view of obtaining reformat, MIP, MinIP, vessel analysis, 3D analysis, including endoluminal reconstructions, fusion images, as well as acquisition and treatment of functional studies in oncologic imaging
- To have detailed knowledge of US, CT, MRI, nuclear medicine and hybrid imaging techniques PET/CT, PET/MRI, findings and pitfalls in diagnosis in those cancers frequently referred for imaging
- To have a basic understanding of radiotracers used in hybrid imaging in oncology
- To understand the indications for functional imaging techniques in oncologic imaging

PRINCIPLES OF ADVANCED IMAGING TECHNIQUES AND CONTRAST AGENTS IN ONCOLOGIC IMAGING

- To understand the principles of PET-CT for oncologic imaging
- To develop knowledge of the most important PET tracers with fluorine 18, gallium 68 or carbon 11 including FDG, DOTATATE/DOTATOC, DOPA, choline, PSMA, FLT, F-MISO, acetate
- To describe PET imaging protocols, methods of PET image analysis and data processing and possible pitfalls and limitations of this technique in oncologic imaging
- To understand the principles of advanced MRI techniques used in oncologic imaging including:
 - Dynamic contrast-enhanced (DCE) MRI, Diffusion-weighted imaging (DWI), Spectroscopy using 1H, 31P, 13C, Targeted contrast agents and fMRI (BOLD)
- To understand the principles of advanced CT techniques including dynamic contrast enhanced CT (perfusion CT) and Dual-energy computed tomography (DECT) in oncologic imaging
- To understand the principles of contrast-enhanced ultrasound (CEUS) in oncologic imaging
- To describe the imaging protocols and methods of image analysis and data processing for the different MRI, CT and US techniques in oncologic imaging

CANCER STAGING

- To describe the imaging anatomy and the pathways of spread for the common cancer types
- To describe the common staging systems for common cancer types: current TNM and clinical staging classification and to know their limitations
- To describe the application of imaging techniques including ultrasound, computed tomography, magnetic resonance imaging, nuclear medicine and hybrid techniques PET/CT and PET/MRI for cancer staging
- To have an understanding of the appropriate choice of imaging techniques and/or the appropriate sequence of imaging techniques in the investigation of specific clinical problems in oncologic imaging
- To have an appreciation of common imaging 'false positives' and 'false negatives' in cancer staging, and the role of different imaging techniques for lesion characterisation
- To know the national and international guidelines for staging common cancer types
- To understand the principles of structured and criteria-based reporting

TREATMENT PLANNING IN ONCOLOGIC IMAGING

- To understand the role of imaging in treatment planning e.g. surgery, radiotherapy
- To have awareness of national and international guidelines in treatment planning in oncologic imaging

CANCER RESPONSE ASSESSMENT & CLINICAL TRIALS

- To describe the principles of response assessment and an appreciation of the advantage and limitations of the different response criteria e.g. RECIST, combined size and enhancement criteria, iRECIST, PET criteria for evaluation of lymphoma
- To understand the concept of clinical trials, including main endpoints for evaluation of treatments like response rate, disease control rate, time to progression, disease-free and progression-free survival, best overall response
- To understand the concepts of the following: baseline examination, nadir, tumour response, tumour progression, stable disease, target lesion, non-target lesions, new lesions, pseudoprogression
- To understand the advantages and limitations of each imaging method for response evaluation (ultrasound, CT, MRI, nuclear medicine and PET/CT, PET/MRI)
- To understand the role of advanced techniques in response assessment: DCE-MRI, DW-MRI, MR-Spectroscopy, PET/CT, PET/MRI, Perfusion CT
- To understand the challenges of advanced imaging biomarker development in clinical trials: generalizability, standardization, QA, QC
- To have awareness of national and international guidelines in cancer response assessment and clinical trials

CANCER SCREENING & SURVEILLANCE

- To understand the principles of screening and the organisation of screening using breast, lung and colorectal cancer as core examples and to have awareness of national and international guidelines in this field
- To appreciate the main advantages and drawbacks of a screening programme
- To describe the role for different imaging techniques in surveillance in different cancer types
- To describe the patterns of recurrence in common cancers
- To describe the role of imaging in assessing suspected disease recurrence, and the advantages and limitations of different techniques
- To understand the potential of advanced techniques for surveillance: whole body MRI, PET/CT with different tracers

INTERVENTIONAL ONCOLOGY

- To describe the basic principles of safe interventional technique; the anatomy relevant to the procedure; recognised complications of the procedures
- To be familiar with the wide range of interventional techniques used in oncological radiology
- To describe the common image-guided interventional oncologic procedures including; percutaneous fine needle aspiration, biopsy or drainage and local tumour treatments
- To know the potential risks and complications of common procedures in interventional oncology
- To be aware of the pharmacological actions of the agents used in analgesia and sedation and the necessary monitoring required to perform this safely
- To describe the processes and actions required in intermediate life support and management of anaphylaxis

SKILLS

- To justify, protocol, conduct and supervise oncological imaging examinations to a high standard
- To confidently tailor examinations appropriately to the clinical question in oncologic imaging
- To confidently interpret all images relevant in the diagnosis, staging, assessment of response and detection of recurrent disease of the common cancers
- To develop resources to be able to diagnose, stage, assess response of unusual tumour types using all imaging modalities
- To accurately assess response to treatment according to recognised objective response criteria in oncologic imaging
- To advise on the appropriate diagnostic imaging and follow-up protocols for different tumour types
- To plan effective imaging pathways for the common cancers
- To confidently discuss the appropriate imaging strategies in oncologic imaging with clinicians within a multidisciplinary setting
- To communicate effectively with patients and professional colleagues in the interdisciplinary oncological team
- To provide clinicians with optimised images which may aid surgical management or treatment planning including the role of imaging in radiotherapy planning and treatment
- To competently work with US, CT and MRI-guided interventions and where appropriate, fluoroscopic imaging
- To undertake the following procedures under supervision: US-guided biopsy of masses and lymph nodes; CT-guided biopsy of masses (retroperitoneal, pelvic side-wall, thoracic and lymph nodes) and liver lesions; drainage of collections and local tumour treatments

COMPETENCES AND ATTITUDES

- To conduct good clinical care: To be aware of the limits of personal knowledge and to know when to seek further information or help
- To maintain good medical practice: To keep the knowledge base up to date and be able to discuss current medical practice with colleagues and patients
- To work in partnership with patients: To be aware of different levels of patient understanding and personality types, to explain diagnostic and therapeutic radiology procedures effectively, and to exhibit a flexible approach taking into account different learning styles and expectations of patients
- To demonstrate good team working skills: To understand the value of team working (multidisciplinary teams) and to demonstrate good communication with professional colleagues
- To assure and improve the quality of care: To be able to describe an effective clinical governance approach and to participate in clinical governance processes e.g. clinical audit, guidelines development
- To develop teaching competencies: To understand the principles of teaching and learning, and conduct teaching sessions in a quality assured training programme and develop competence as a clinical supervisor

B-II-12 PAEDIATRIC RADIOLOGY

KNOWLEDGE

- To have an in-depth understanding of developmental anatomy during childhood
- To describe normal variants in childhood that may mimic disease
- To have a basic understanding of embryology as applied to paediatric diseases
- To have a basic understanding of the various stages of embryonic and fetal development and their respective appearance on US and MR imaging
- To understand and describe the principles guiding the construction of a child-friendly environment
- To understand the ALARA principle and dose consideration and their application in paediatric patients
- To list and describe imaging guideline algorithms specific to children
- To have an in-depth knowledge of indications and contraindications for contrast media within the paediatric population including neonates

BRAIN AND SPINE

- To describe the imaging features and basic clinical features of the main congenital malformations of the brain (for details, see B-II-9 Neuroradiology, Congenital and developmental abnormalities)
- To describe the imaging features, causes and basic clinical features of hydrocephalus in infants, children and adolescents
- To describe the imaging features, causes and basic clinical features of subependymal and intraventricular haemorrhage in infants
- To describe the imaging features, causes and basic clinical features of periventricular leukomalacia
- To have an in-depth knowledge of the imaging features and basic clinical features of elevated intracranial pressure in infants, children and adolescents
- To have an in-depth knowledge of the imaging features and basic clinical features of brain tumours in infants, children and adolescents
- To have an in-depth knowledge of the imaging features and basic clinical features of head trauma in infants, children and adolescents
- To describe the imaging features and clinical features of non-accidental trauma in infants, children and adolescents
- To have an in-depth knowledge of the imaging features and basic clinical features of intracranial infections (including antenatal infections) in infants, children and adolescents
- To describe the imaging features, causes and basic clinical features of intracranial ischaemia / stroke in infants, children and adolescents
- To have an in-depth knowledge of the imaging features and basic clinical features of pituitary disease in infants, children and adolescents
- To describe the imaging features and basic clinical features of spinal malformations including spina bifida aperta, spina bifida occulta, meningomyelocele, dermal sinus, split cord malformations

HEAD AND NECK

- To describe the imaging features and basic clinical features of the main congenital malformations of the head and neck region including the orbit, the nose, the pharynx, the temporal bone in infants, children and adolescents (for details, see specific chapter in head and neck radiology)
- To describe the imaging features, causes and basic clinical features of inflammatory/infectious disorders of the head and neck region in infants, children and adolescents
- To have an in-depth knowledge of tumours of the head and neck region in infants, children and adolescents
- To have an in-depth knowledge of the imaging features and basic clinical features of traumatic lesions of the head and neck region in infants, children and adolescents
- To describe the imaging features of thyroid diseases in infants, children and adolescents

CHEST

- To describe the radiographic imaging features of normal thymus and its variants in infants, children and adolescents
- To describe the radiographic imaging features of congenital abnormalities of bronchus and chest (pulmonary sequestration, cystic adenomatoid malformation, lobar emphysema, bronchial atresia) in infants, children and adolescents
- To describe the radiographic imaging features of neonatal respiratory distresses in premature babies and neonates
- To describe the radiographic imaging features of foreign body aspiration in infants, children and adolescents
- To describe the radiographic imaging features of bronchiolitis in infants, children and adolescents
- To describe the radiographic imaging features of cystic fibrosis in infants, children and adolescents
- To describe the radiographic imaging features of chest consolidation, pneumonia and complications of pneumonia in infants, children and adolescents
- To describe the radiographic imaging features of pleural effusions in infants, children and adolescents
- To describe the radiographic imaging features of pneumothorax in infants, children and adolescents
- To describe the radiographic imaging features of congenital pulmonary airway malformations
- To describe the imaging features of infiltrative diseases of the lung in infants, children and adolescents
- To describe the imaging features of complications of metastatic diseases of the lung in infants, children and adolescents
- To describe the imaging features of mediastinal masses (germ-cell tumour, cystic mediastinal masses, lymphadenopathies, lymphoma, neurogenic tumours) in infants, children and adolescents
- To describe the imaging features of congenital diaphragmatic hernia, diaphragm palsy and eventration in infants, children and adolescents

CARDIOVASCULAR

- To describe the imaging features and basic clinical features of the main congenital malformations of cardiovascular system including aortic arch abnormalities in infants, children and adolescents
- To describe the imaging features, causes and basic clinical features of arterial hypertension in infants, children and adolescents
- To describe the imaging features, causes and basic clinical features of inflammatory / infectious disorders of the cardiovascular system in infants, children and adolescents
- To have an in-depth knowledge of the imaging features and basic clinical features of traumatic lesions of the cardiovascular system in infants, children and adolescents
- To have an in-depth knowledge of the imaging features and basic clinical features of vascular malformations and vascular tumours in infants, children and adolescents

DIGESTIVE TRACT

- To describe the radiographic imaging features of oesophageal atresia in neonates
- To describe the imaging features of necrotizing enterocolitis in neonates
- To describe the imaging features of pneumoperitoneum in neonates
- To describe the imaging features and basic clinical features of ano-rectal malformations in neonates
- To describe the imaging features of hypertrophic pyloric stenosis in neonates and infants
- To describe the imaging features and basic clinical features of gastrointestinal obstruction in neonates
- To describe the imaging features and basic clinical features of Hirschsprung's disease in neonates, infants, children and adolescents
- To describe the imaging features and basic clinical features of gastro-oesophageal reflux in infants, children and adolescents
- To describe the imaging features and basic clinical features of intestinal malrotations and volvulus in infants, children and adolescents
- To have an in-depth knowledge of the imaging features and clinical features of intestinal intussusception in infants, children and adolescents
- To have an in-depth knowledge of the imaging features and clinical features of appendicitis in infants, children and adolescents
- To describe the imaging features and basic clinical features of peritonitis in neonates, infants, children and adolescents
- To describe the imaging features and basic clinical features of inguinal hernia in infants, children and adolescents
- To describe the imaging features and basic clinical features of inflammatory bowel diseases and the respective complications in infants, children and adolescents
- To describe the imaging features and basic clinical features of blunt abdominal trauma in infants, children and adolescents
- To describe the imaging features and basic clinical features of digestive tract foreign bodies in infants, children and adolescents

- To describe the imaging features and basic clinical features of disorders of the hepatobiliary system (jaundice in infants, biliary atresia, choledochal cyst, benign liver tumours) in infants, children and adolescents
- To describe the evaluation of disorders of the biliary system with US and MRCP in infants, children and adolescents
- To describe the imaging features and basic clinical features of disorders of portal circulation in infants, children and adolescents
- To describe the imaging features and basic clinical features of disorders of the pancreas in infants, children and adolescents
- To describe the imaging features and basic clinical features of disorders of the spleen in infants, children and adolescents

GENITO-URINARY TRACT

- list main renal malformations, such as horseshoe kidney, ectopia, or fusion
- To describe the imaging features and basic clinical features of upper and lower urinary tract malformations in infants, children and adolescents
- To describe the imaging features and basic clinical features of urinary tract infection in infants, children and adolescents
- To describe the imaging features of the different grades of vesico-ureteral reflux and urethral anomalies on voiding cysturethrography
- To describe the imaging features and basic clinical features of uretero-hydronephrosis in infants, children and adolescents
- To describe the imaging features and basic clinical features of cystic diseases of the kidneys in infants, children and adolescents
- To describe the imaging features of urolithiasis and nephrocalcinosis in infants, children and adolescents
- To describe the imaging features and basic clinical features of oncologic disorders of the abdomen in infants, children and adolescents, including neuroblastoma, Wilms tumours, hepatoblastoma, Burkitt's lymphoma, with differential diagnosis
- To describe the imaging features and basic clinical features of common disorders of the adrenal glands in infants, children and adolescents
- To describe the imaging features and basic clinical features of sexual development disorders in neonates and infants
- To describe the imaging features and basic clinical features of pubertal development disorders in infants and adolescents
- To describe the imaging features and basic clinical features of common gynaecological disorders (malformations, ovarian cysts and tumours) in girls
- To describe the imaging features and basic clinical features of common disorders of the testis and scrotum in boys

MUSCULOSKELETAL

- To describe the imaging features and basic clinical features of fractures (accidental and non-accidental) in neonates, infants, children and adolescents
- To understand the medico-legal aspects of non-accidental injury
- To describe the imaging features and basic clinical features of complex trauma in infants, children and adolescents
- To describe the imaging features and basic clinical features of common bone dysplasia (achondroplasia, osteogenesis imperfecta, congenital metabolic disorders) in children and adolescents
- To describe the imaging features and basic clinical features of rickets
- To describe the imaging features and basic clinical features of infiltrative bone marrow diseases in infants, children and adolescents
- To describe the imaging features and basic clinical features of haemoglobinopathies including sickle cell disease and thalassaemia
- To describe the imaging features and basic clinical features of bone tumours in children and adolescents
- To describe the imaging features of joint effusions in children and adolescents
- To describe the imaging features and basic clinical features of osteomyelitis and septic arthritis in children and adolescents
- To describe the imaging features and basic clinical features of juvenile rheumatoid arthritis in children and adolescents
- To describe the imaging features and basic clinical features of congenital disorders of the spine, including scoliosis (congenital and idiopathic), and dysraphism in infants, children and adolescents
- To describe the imaging features and basic clinical features of developmental dysplasia of the hip in neonates, infants, children and adolescents
- To describe the imaging features and basic clinical features of transient synovitis in children and adolescents
- To describe the imaging features and basic clinical features of Legg-Calvé-Perthes disease in children
- To describe the imaging features and basic clinical features of slipped capital femoral epiphysis in children
- To describe the imaging features and basic clinical features of congenital disorders of the ankle and foot, including congenital tarsal coalition
- To describe the imaging features and basic clinical features of osteochondrosis, including Scheuermann's disease, in children and adolescents
- To describe the imaging features and basic clinical features of soft-tissue tumours in children and adolescents

MISCELLANEOUS

- To describe the neuro-imaging features, extracranial manifestations, diagnostic criteria and clinical features of neurofibromatosis type I
- To describe the neuro-imaging features, extracranial manifestations, diagnostic criteria and clinical features of neurofibromatosis type II
- To describe the neuro-imaging features, extracranial manifestations, diagnostic criteria and clinical features of tuberous sclerosis
- To describe the neuro-imaging features, extracranial manifestations, diagnostic criteria and clinical features of Sturge-Weber disease
- To describe the neuro-imaging features, extracranial manifestations, diagnostic criteria and clinical features of von Hippel Lindau disease
- To describe the basic imaging features of less common neurocutaneous syndromes
- To describe the imaging features and clinical features of haematological disorders in children and adolescents
- To describe the imaging features and basic clinical features of Langerhans cell histiocytosis

SKILLS

- To perform ultrasound examinations in infants, children and adolescents and to appreciate the difference between portable and departmental ultrasound machines
- To choose the most suitable contrast material and its optimal use according to the imaging technique, the clinical problem and the age in paediatric radiology
- To observe and/or perform under supervision ultrasound of brain in the infant
- To observe and/or perform under supervision Doppler sonography of the intracranial vessels in infants, children and adolescents
- To observe and/or perform under supervision ultrasound of the hip in neonates and infants
- To observe and/or perform under supervision ultrasound of the abdomen in neonates, infants, children and adolescents
- To observe and/or perform under supervision voiding cystourethrography in infants, children and adolescents
- To observe and/or perform under supervision contrast-media studies of the gastrointestinal tract in infants, children and adolescents
- To confidently perform a treatment for intussusception
- To confidently plan a CT examination in infants, children and adolescents and to tailor it to the individual situation and age, with a dose as low as reasonably achievable
- To confidently plan an MRI examination in infants, children and adolescents and to tailor it to the individual situation and age of the patient in regard to the potential use of intravenous contrast medium and spatial resolution
- To confidently perform proper post-processing tasks of examinations in paediatric radiology, including multi-planar reformations (MPR), maximum intensity projections (MIP), minimum intensity projections (MinIP), and fusion images

COMPETENCES AND ATTITUDES

- To confidently justify diagnostic imaging examinations in infants, children and adolescents
- To confidently choose the best-suited method for evaluating disorders in infants, children and adolescents
- To communicate with the patient and patients/care-takers in order to obtain informed consent prior to diagnostic imaging and interventional procedures in infants, children and adolescents
- To confidently choose optimal imaging parameters for radiographic, ultrasonographic, CT and MRI examinations in infants, children and adolescents
- To confidently apply techniques to reduce exposure doses for radiographic and CT examinations in infants, children and adolescents
- To confidently design imaging protocols and standard operating procedures for CT examinations infants, children and adolescents, including the appropriate application of intravenous contrast, positioning, spatial and temporal resolution, with a special focus on dose reduction
- To confidently design imaging protocols and standard operating procedures for MRI examinations of the brain and spine, including the appropriate application of intravenous contrast, spatial and temporal resolution, and the potential use of sedation
- To supervise and teach technical staff to ensure that appropriate images of infants, children and adolescents are obtained
- To confidently judge the quality of imaging examinations in infants, children and adolescents and to devise strategies to improve image quality
- To confidently interpret and report radiographs, ultrasonographic examinations, CT studies and MRI examinations of infants, children and adolescents
- To report oncological studies in infants, children and adolescents according to international standards (RECIST, SIOPEN, 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 infants, children and adolescents
- To confidently identify urgent and/or unexpected findings in imaging examinations of infants, children and adolescents and to communicate these timely and properly
- To empathically communicate with patients and their parents/care-takers in order to explain their imaging findings
- To perform at multi-disciplinary conferences and tumour boards for diseases of infants, children and adolescents

B-II-13 UROGENITAL RADIOLOGY

The field of urogenital radiology includes all aspects of medical imaging (diagnostic and interventional) of the kidneys, retroperitoneum, bladder, as well as male and female reproductive systems including aspects of the anatomy and pathophysiology of the respective diseases. This field of imaging includes various techniques (ultrasound, Doppler, conventional X-ray imaging, computed tomography, magnetic resonance imaging, angiography and interventional procedures).

Trainees should familiarise themselves with the field of urogenital radiology and gain knowledge, skills and competences in this field. Preferably, arrangements should be made within the training scheme for secondment to urology and/or gynaecology. Exposure to all imaging and interventional techniques used in urogenital radiology should be achieved.

KNOWLEDGE

NORMAL ANATOMY AND VARIANTS

- To describe the normal anatomy of the retroperitoneal spaces and pathways
- To describe the triple obliquity of the kidney
- To list the criteria of normality of the pyelocaliceal system on CT urography
- To describe normal variants, including junctional parenchymal defect, column of Bertin's hypertrophy, foetal lobulation, or lipomatosis of the sinus, and to accurately differentiate these variants from disease
- To describe the anatomy of the bladder wall
- To describe the segments of the male urethra and the location of the urethral glands
- To understand the physiology of micturition
- To describe the zonal anatomy of the prostate
- To describe the imaging features of prostatic zonal anatomy with ultrasound and MRI
- To describe the ultrasound anatomy of scrotal structures (testicular and extratesticular)
- To describe the Doppler anatomy of the testicular and extratesticular vessels

RENAL PHYSIOLOGY AND KINETICS OF CONTRAST AGENTS

- To describe the physiology of renal excretion of contrast agents
- To describe enhancement curves within renal compartments after intravascular injection of contrast agents
- To define the potential nephrotoxicity of contrast media and to list risk factors of contrast induced nephrotoxicity
- To list methods to reduce the risk of contrast nephrotoxicity
- To list measures to reduce the risk of contrast media nephrotoxicity
- To have an understanding of nephrogenic systemic fibrosis (NSF) including the definition of NSF, the clinical features and the risk factors
- To describe the appropriate use of Gadolinium-based contrast media in patients at risk

CONGENITAL

- To list main renal malformations, such as ectopia, duplications or fusions
- To describe congenital malformations of the bladder and urethra
- To describe congenital malformations of the prostate, seminal vesicles, vas, and the testes

ADRENAL GLANDS

- To describe the imaging and clinical features of adrenal insufficiency
- To describe the imaging features and basic clinical features of benign solid tumours of the adrenal glands
- To describe the imaging features and basic clinical features of adrenal cysts
- To describe the imaging features and basic clinical features of malignant tumours of the adrenal gland in the adult and in the paediatric population
- To describe the management and principles of differential diagnosis of incidentally discovered lesions of the adrenal glands
- To describe the imaging features and basic clinical features of adrenal trauma

KIDNEY AND URETER

- To describe the imaging features of vascular disorders of the kidney
- To describe the imaging features and basic clinical features of medical nephropathies
- To describe the imaging features and basic clinical features of infections of the kidney and/or urinary tract
- To describe the imaging features of cystic diseases of the kidney
- To describe the imaging features and basic clinical features of tumours of the kidney
- To describe the imaging features of calculi of the urinary tract
- To describe the imaging features and basic clinical features of urinary obstruction
- To describe the imaging features and basic clinical features of tumours of the ureter
- To describe the imaging features after renal transplantation
- To describe the imaging features and basic clinical features of trauma to the kidneys and/or ureters
- To describe the principles of CT urography including the main indications, choice of technique, choice of contrast agent and dose

BLADDER AND URETHRA

- To describe the imaging features and basic clinical features of inflammatory disorders of the bladder
- To describe the imaging features and basic clinical features of tumours of the bladder
- To describe the imaging features of urinary diversion
- To describe the imaging features and basic clinical features of urinary outflow obstructions
- To describe the imaging features and basic clinical features of incontinence and functional disorders of the bladder
- To describe the imaging features and basic clinical features of strictures of the urethra
- To describe the imaging features and basic clinical features of urethral diverticula
- To describe the imaging features and basic clinical features of trauma to the bladder and urethra
- To describe the principles of cystourethrography including the main indications, choice of technique, choice of contrast agent, dose, film timing and indications

MALE REPRODUCTIVE SYSTEM

- To describe the imaging features and basic clinical features of inflammatory disorders of the prostate
- To describe the imaging features and basic clinical features of benign prostatic hyperplasia
- To describe the imaging features and basic clinical features of tumoural pathology of the prostate
- To describe the imaging features and basic clinical features of inflammatory disorders of the testes
- To describe the imaging features and basic clinical features of tumoural pathology of the testes
- To describe the imaging features and basic clinical features of testicular torsion
- To describe the imaging features and basic clinical features of Peyronie's disease
- To describe the various imaging manifestations of impotence
- To describe the imaging features and basic clinical features of priapism
- To describe the imaging features and basic clinical features of tumoural pathology of the penis
- To describe the imaging features and basic clinical features of traumatic lesions of the penis

SKILLS

- To choose and/or guide the choice of the most appropriate imaging examination according in urogenital radiology related to the clinical problem and the patient's history, including any previous radiological examinations
- To choose the most suitable contrast material and its optimal dose and use according to the imaging technique, the clinical problem, and relevant patient related criteria in urogenital radiology
- To identify patients at risk of contrast nephrotoxicity
- To take measures to reduce the risk of contrast nephrotoxicity
- To take measures to reduce the risk of contrast media nephrotoxicity
- To identify patients at risk to develop NSF
- To confidently perform ultrasound examinations of the kidneys, urinary tract, and of the male reproductive system
- To perform Doppler spectrum analysis on intrarenal vessels (for resistive/pulsatility index measurement) and on the entire course of the proximal renal arteries for velocity calculation
- To confidently perform cystourethrography
- To confidently plan a CT examination in urogenital radiology and to tailor it to the individual situation with a dose as low as reasonably achievable
- To confidently perform state-of-the-art CT urography
- To confidently plan an MRI examination in urogenital radiology and to tailor it to the individual patient in regard to spatial resolution and the potential use of intravenous contrast medium
- To observe and/or perform under supervision image-guided biopsies, e.g. renal parenchymal biopsies, biopsies of kidney masses, and biopsies of retroperitoneal masses
- To observe and/or perform under supervision image-guided drainage procedures related to the urogenital tract
- To observe and/or perform under supervision percutaneous nephrostomy
- To confidently perform proper post-processing tasks of examinations in urogenital radiology, including multi-planar reformations (MPR), maximum intensity projections (MIP), minimum intensity projections (MinIP), and fusion images for diagnostic purposes and for imaging-guided interventional procedures and therapies

COMPETENCES AND ATTITUDES

- To confidently justify diagnostic imaging examinations in urogenital radiology
- To confidently choose or guide the best-suited method for evaluating disorders in urogenital radiology
- To communicate with the patient in order to obtain informed consent prior to diagnostic imaging studies and interventional procedures in urogenital radiology
- To confidently choose optimal imaging parameters for radiographic, ultrasonographic, CT and MR examinations in urogenital radiology
- To confidently apply techniques to reduce radiation exposure doses for radiographic and CT examinations in urogenital radiology
- To confidently design imaging protocols and standard operating procedures for CT examinations in urogenital radiology, including the appropriate application of intravenous contrast, positioning, spatial and temporal resolution, with a special focus on dose reduction
- To confidently design imaging protocols and standard operating procedures for MR examinations in urogenital radiology, including the appropriate application of intravenous contrast, and of spatial and temporal resolution
- To supervise and teach technical staff to ensure that appropriate images of the urogenital system are obtained, adjusted to the clinical problem
- To confidently judge the quality of imaging examinations in urogenital radiology and to provide strategies to improve image quality
- To confidently interpret and report radiographs, ultrasonographic examinations, CT studies and MRI examinations in urogenital radiology
- To report oncological studies in urogenital radiology according to international standards (RECIST, WHO) applicable to the specific situation
- To appreciate one's own limitations and to identify when it is appropriate to obtain an additional opinion (-s) in performing, interpreting and reporting images of the urogenital system
- To confidently identify urgent and/or unexpected findings in imaging examinations of the urogenital system and to communicate these findings timely and properly with the referring physician or his replacer responsible for patient care
- To empathically communicate with patients and their families in order to explain their imaging findings of the urogenital system, whenever appropriate
- To actively contribute at multi-disciplinary meetings and tumour boards for diseases of the urogenital system

B-II-14 MEDICAL IMAGING INFORMATICS

KNOWLEDGE

- To know the applications of advanced imaging (post)processing techniques (e.g. ADC measurements, diffusion tensor imaging, spectroscopy, perfusion, virtual endoscopy, angiography, volumetry...)
- To understand the principles of radiation dose registration systems
- To understand the future directions of image storage and interpretation (e.g. cloud-based archiving and processing)
- To know the modality worklist function, task creation
- To know how to create and restore a PACS archive
- To have a basic knowledge of Interoperability of medical information systems and imaging devices
- To have a basic knowledge of Computer-aided detection systems
- To have basic knowledge of emergency and disaster plans concerning the imaging informatics environment.
- To know the general principles of Imaging Biomarkers and Radiomics application
- To have knowledge of teleradiology requirements
- To know the role of tablets and mobile devices for image distribution in and out of radiology department
- To know how to handle digital printers in radiology department
- To have an understanding of image processing and analysis tools, including 2D and 3D reconstructions, 2D and 3D image analysis, quantitative imaging biomarkers, image fusion, virtual reality, augmented reality, functional analysis, and computer aided diagnosis

SKILLS

- To be able to use workstations to process quantitative images
- To be able to use the information of radiation dose registration systems to reduce radiation dose to patients while maintaining optimal image quality
- To be able to use dosimetry to optimise scanning protocols and quality management
- To participate in a shared workflow
- To be able to use voice recognition and clinical decision support systems

COMPETENCES AND ATTITUDES

- Touse IT to improve efficiency and quality of care
- To know how to use IT for proactive communications with peers, clinicians and patients