European Association of Radiology

Radiology Section of the Union of European Medical Specialists

EUROPEAN TRAINING CHARTER FOR CLINICAL RADIOLOGY

DETAILED CURRICULUM FOR THE INITIAL STRUCTURED COMMON PROGRAMME

DETAILED CURRICULUM FOR SUBSPECIALTY TRAINING

European Association of Radiology
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Preface

The European Association of Radiology (EAR) elaborated in conjunction with the Union of European Medical Specialists (UEMS) Radiology Section a revised charter for training which replaces the previous 2003 charter. This new version is a response to the rapid expansion of the role and diversity of radiology in recent years. The charter is designed to provide increased flexibility for trainees in the latter part of training to enable them to pursue a greater variety of training opportunities within the overall defined training period.

The charter reiterates that the training period for radiology is five years which recognises the vast amount of knowledge and skills required to deliver a general radiology service. This knowledge includes cell function, physiology, anatomy and physics as well as a wide understanding of all disease manifestations, natural history and treatment. Competence in undertaking and interpreting a wide range of imaging modalities and disease manifestations also takes a considerable time which cannot be condensed into shorter training periods.

The charter recognises that most radiologists work in a group providing a general service to a broad range of clinical specialists. However, the increased complexity of modern medicine and the impact of multi-disciplinary meetings requires a deeper knowledge of disease processes in many circumstances. Therefore, the charter emphasises the need for general radiologists in their final two years of training to develop a more focussed and deeper knowledge of at least two areas in order to enhance the service provided by the group of general radiologists.

Finally, the charter recognises that for more specialised services a greater degree of specialisation by radiologists is required and that training in the latter years must be focussed in order to obtain the necessary knowledge and skills. However, it is essential for this group to have a broad understanding of radiology and the wide variety of imaging modalities that they will use prior to sub-specialisation particularly as many diseases are not restricted to one organ system. Those radiologists providing therapy and particularly interventional radiologists will also require sufficient clinical time to become competent in patient management.

Two detailed curricula have also been produced which provide a in-depth check list for radiology trainers and trainees to ensure that the appropriate areas of knowledge and competence have been addressed and obtained. The first curriculum covers the initial structured training programme. The second provides guidance for those wishing to spend their career working predominantly in one organ-based subspecialty area. The subspecialty curricula also highlight the importance of the specialised scientific literature to this group. The general radiologist undertaking training in areas of special interest in the latter part of their training may also wish to use the subspecialty curricula for guidance albeit recognising that they would not be required to fulfil all aspects of them.

The detailed curricula for both the initial structured training programme and the subspecialties have been developed by the Subspecialty Societies of EAR. This has involved an immense amount of time and patience and the EAR Executive Bureau is extremely grateful to all those in the Subspecialty Societies who have contributed to the process. EAR believes that the charter and the detailed curricula will provide a valuable template for training radiologists and will enhance the quality of care for patients throughout Europe. EAR hopes that the documents will also be helpful for National Societies in their discussions with governments to ensure a high-quality, five-year training programme in every European country.

Professor N. Gourtsoyiannis
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European Training Charter for Clinical Radiology

Introduction: Radiology is a medical specialty involving all aspects of medical imaging which provide information about the anatomy, pathology, histopathology and function of disease states. It also involves interventional techniques for diagnosis and minimally invasive therapy involving image-guided systems. The duration of training is five years.

Contents:

Article 1

CORE OF KNOWLEDGE

1.1 **Basic sciences**

a. Radiation physics;
b. Radiobiology;
c. The physical basis of image formation including conventional x-ray, computed tomography, nuclear medicine, magnetic resonance imaging and ultrasound;
d. Quality control;
e. Radiation protection;
f. Anatomy, physiology, biochemistry and techniques related to radiological procedures;
g. Cell biology, DNA, RNA, and cell activity;
h. Pharmacology and the application of contrast media;
i. Basic understanding of computer science, image post processing, image archiving and image communication and teleradiology.

1.2 **Pathological sciences**

A knowledge of pathology and pathophysiology as related to diagnostic and interventional radiology.

1.3 **Current clinical practice**

A basic knowledge of current clinical practice as related to clinical radiology. Competence in producing a radiological report and in communication with clinicians and patients.

1.4 **Clinical radiology**

An expert knowledge of current clinical radiology. This knowledge should include:

a. Organ- or system-based specialties, e.g. cardiac, chest, dental, oto-rhino-laryngology, gastrointestinal, genito-urinary, mammography, musculoskeletal, neuro, obstetric and vascular radiology, including the application of conventional x-rays, angiography, computed tomography, magnetic resonance imaging, ultrasound and, where applicable, nuclear medicine.
b. Age-based specialties, i.e. paediatric radiology.
c. Common interventional procedures, e.g. guided biopsy and drainage procedures.
d. Dealing with emergency cases.

1.5 **Administration and management**

A knowledge of the principles of administration and management applied to a clinical department with multi-disciplinary staff and high-cost equipment.

1.6 **Research**

A knowledge of basic elements of scientific methods and evidence base, including statistics necessary for critical assessment and understanding of published papers and the promotion of personal research.

1.7 **Medico-legal**

An understanding of the medico-legal implications of radiological practice. An understanding of uncertainty and error in radiology together with the methodology of learning from mistakes.

Article 2

TRAINING PROGRAMMES

2.1 The specialty of radiology involves all aspects of medical imaging, which provide information about morphology, function and cell activity and those aspects of interventional radiology or minimally invasive therapy (MIT), which fall under the remit of the department of radiology.

2.2 **Clinical experience.** Radiologists are clinicians and require a good clinical background in other disciplines. This is usually achieved through clinical experience and training prior to entering radiology, but may also require additional clinical experience during radiology training which should not impact negatively on the achievement of the full radiological training curriculum. The fully trained radiologist should be capable of working independently when solving the majority of common clinical problems. In particular those undertaking interventional procedures may require sufficient clinical knowledge to accept direct referrals and to manage cases as out-patients and in-patients.

2.3 A general radiologist should be conversant with all aspects of the core of knowledge for general radiology to ensure an understanding of those radiological skills required in a general or community hospital or in a general radiological practice.

2.4 Radiological training should be based on clinical systems and not on modalities such as CT, MRI and US. Understanding of the value and use of these modalities and training in the practice of the techniques should be gained during the respective system-based module.

2.5 The duration of training in radiology is five years; the content of the first three years is a structured common programme for radiological anatomy, disease manifestations and core radiological skills. The fourth and fifth year are structured more flexibly to develop sufficient competence to function autonomously as a general radiologist and to facilitate subspecialty training. The fourth and fifth years of training for those preparing to provide a general radiology service will include gaining additional experience in all organ systems, but trainees should also develop at least two special areas of interest.

2.6 Radiologists in training should be available on a full-time basis for the five years of training. Arrangements may vary for those undertaking flexible training, but the total time of training will be equivalent to a full-time trainee. It is recognised that the starting date for radiological training programmes will vary throughout Europe.

2.7 The precise structure of the system-based modules may vary a little from country to country and from department to department, but the time balance should reflect the importance of the system to the core of radiological practice.

2.8 **The training programme in years one to three**

2.8.1 Early in this three-year period, trainees should acquire the necessary knowledge of the basic sciences, i.e. the physical basis of image formation in all imaging modalities, picture archiving computer systems (PACS), radiology and hospital information systems, quality control, radiation protection, radiation physics, radiation biology, anatomy, physiology, cell biology and molecular structure, biochemistry and techniques related to radiological procedures, the pharmacology and application of contrast media and a basic understanding of computer science as outlined in the core of knowledge for general radiology.

2.8.2 The radiology training should ensure the understanding and implementation of the process of justification and optimisation as laid down in Euratom directive 97 / 43.

2.8.3 A detailed knowledge of normal imaging anatomy should be gained in the early stages of training.

2.8.4 Modular rotations in clinical areas of radiology should be system-based involving the use of all relevant modalities within the module and formulated into an integrated programme to cover all aspects of radiology. The distribution of time will reflect the complexity and relevance to general clinical practice, but as a guideline the musculoskeletal system, thorax and cardio-vascular systems, gastrointestinal system including parenchymal organs, central nervous systems including head and neck and paediatrics are likely to require similar time balance. The remaining areas being balanced as required.

2.8.5 Trainees should participate in clinical radiology examinations and activities and the extent and complexity should gradually increase during the first year in line with experience. It is important that trainees participate in all sections of the department of radiology to gain experience in all techniques so that they understand the function and role and learn how to use the technology in practice of the following imaging methods:

- Conventional radiology including film processing and archiving,

- Fluoroscopy,
- Ultrasound,
- Computed tomography,
- Magnetic resonance imaging,
- Radionuclide imaging where possible. All radiology trainees should have a knowledge of techniques available and diagnostic features of the studies.

2.8.6 The first three years of the five-year training programme should include the following elements:

- Chest diseases
- Central nervous system
- Musculoskeletal system
- Gastrointestinal system including the hepatobiliary system
- Urogenital system
- Paediatrics
- Cardiac diseases
- Head and neck, maxillo-facial and dental radiology
- Obstetrics and gynaecology
- Breast diseases
- Endocrine system
- Vascular and lymphatic system
- Oncology
- Emergency department radiology
- Basic interventional techniques

2.8.6 The trainee should be involved in the radiological examination and diagnosis of patients presenting in the emergency department and be able to appropriately evaluate patients who are severely or critically ill. It is not anticipated that a trainee would enter into an emergency on-call rotation entailing clinical responsibility until the end of the first year of training.

2.8.7 Trainee radiologists at the end of three years should be fully conversant with the basic aspects of the common trunk for general radiology. This will be achieved by a mixture of didactic and practical training.

2.8.8 In the common trunk, the trainees in radiology should develop a knowledge of the radiological signs and techniques in line with the following outline targets. All trainees should undertake basic interventional procedures during this period. The trainees should be closely supervised by a fully qualified radiologist. Some detailed curricula for the use of trainers and trainees are presented on pages 11-44.

Musculoskeletal

Core knowledge

- Musculoskeletal anatomy, normal skeletal variants which mimic disease and common congenital dysplasias.
- Clinical knowledge of medical, surgical and pathology related to musculoskeletal system.
- Trauma involving skeleton and soft tissue and the value of different imaging modalities.
- Degenerative disorders and their clinical relevance.
- Manifestations of musculoskeletal infection, inflammation and metabolic diseases including osteoporosis and bone densitometry.
- Recognition and management of tumours.

Core skills

- Reporting plain radiographs, radionuclide investigations, CT and MR of common musculoskeletal disorders.
- Performing and reporting Ultrasound examinations of muscle, tendons and ligaments where appropriate.
- Managing and reporting radiographs, CT and MR of musculoskeletal trauma.
- Observing image guided biopsies and drainages in the musculoskeletal system.
- Observing minimally invasive therapeutic procedures of the musculoskeletal system.

Thorax

Core knowledge

- Anatomy of the respiratory system, heart and vessels, mediastinum and chest wall on radiographs, CT and MR.
- Recognise and state significance of generic signs on chest radiographs.
- Features on radiographs and CT and differential diagnosis of atelectasis, diffuse infiltrative and alveolar lung disease, airways and obstructive lung disease.
- Recognise solitary and multiple pulmonary nodules, benign and malignant neoplasms, hyperlucencies and their potential aetiology.
- Thoracic diseases in immuno-compromised patients and congenital lung disease.
- Disorders of the pulmonary vascular system and great vessels including the diagnostic role of radiographs, radionuclides, CT and MR in diagnosis.

- Abnormalities of the chest wall mediastinum and pleura and including the post operative chest and trauma.

Core skills
- Managing and reporting radiographs, chest radiographs, V/Q scans, high- resolution CT including CT pulmonary angiography.
- Drainage of pleural space collections under image guidance and observation of image guided biopsies of lesions within the thorax.

Gastrointestinal

Core knowledge
- Anatomy of the abdomen including internal viscera, abdominal organs, omentum, mesentery and peritoneum on radiographs, barium and other contrast studies, CT, US and MR.
- Recognise features of abdominal trauma and acute conditions including perforation, haemorrhage, inflammation, infection, obstruction, ischaemia and infarction on radiographs, ultrasound and CT .
- Imaging features and differential diagnosis of primary and secondary tumours of the solid organs, oesophagus, stomach, small bowel, colon and rectum. Imaging features of the stage and extent of tumours including features which indicate un-resectability and knowledge of the role of endoscopy and endoscopic US.
- Radiological manifestations of inflammatory bowel diseases, malabsorption syndromes and infection.
- Recognition of motility disorders, hernias and diverticula.
- Radiological manifestation of vascular lesions including varices, ischaemia, infarction, haemorrhage and vascular malformations.
- Understanding of the applications of angiography, vascular interventional techniques, stenting and porto-systemic decompression procedures.

Core skills
- Performance of plain film reporting.
- Performing and reporting contrast examinations of the pharynx, oesophagus, stomach, small and large bowel.
  Performing and reporting trans-abdominal ultrasound of the gastrointestinal system, abdominal viscera and their vessels.
- Managing and reporting CT of the abdomen.
- Understanding and where possible and appropriate observation and experience of transrectal, transvaginal and endoscopic ultrasound.
- Performing US and CT guided drainage and biopsy.
- Experience of the manifestations of abdominal disease on MRI.
- Understanding and, where appropriate, experience of radionuclide investigations of the GI tract and abdominal organs.
- Observation of angiography and vascular interventional techniques.

Neuroradiology

Core knowledge
- Knowledge of the normal anatomy and normal variants of the brain, spinal cord and nerve roots.
- Understanding the rationale for selecting certain imaging modalities, and the use of contrast enhancement, in diagnosing diseases of the central nervous system.
- Imaging features on CT and MR and differential diagnosis of stroke, haemorrhage, and other vascular lesions of the brain and spinal cord and of the application of CT and MR angiography.
- Diagnosis of skull and spinal trauma and its neurological sequelae.
- Imaging features and differential diagnosis of white matter disease, inflammation and degeneration.
- Diagnosis of benign and malignant tumours of the brain, spinal cord and cranial nerves.
- Understanding the role of nuclear medicine including PET in neurological disorders.

Core skills
- Reporting radiographs of the skull and spine.
- Managing and reporting cranial and spinal CT and MR.
- Observation of cerebral angiography.
- Observation of carotid ultrasound including Doppler.
- Observation of interventional procedures.

Urogenital

Core knowledge (See also obstetrics and gynaecology.)
- Knowledge of the normal anatomy of the kidneys, ureters, bladder and urethra including normal variants.
- Knowledge of the normal anatomy of the retroperitoneum, female pelvis and male genital tract.
- Understanding of renal function, the diagnosis of renal parenchymal diseases including infection and renovascular disease including management of renal failure.
- Imaging features and appropriate investigation of calculus disease.
- Investigation and features of urinary tract obstruction and reflux including radionuclide studies.
- Imaging features and differential diagnosis of tumours of the kidney and urinary tract.
- Imaging features and investigation of renal transplants.
- Imaging features and differential diagnosis of the retroperitoneum, prostate and testis.

Core Skills
- Reporting radiographs of the urinary tract.
- Performing and reporting intravenous urograms, retrograde pyelo-ureterography, loopogram, nephrostograms, ascending urethrograms and micturating cysto-urethrograms.
- Performing and reporting transabdominal ultrasound imaging of the urinary tract and testis.
- Managing and reporting computed tomography and MR imaging of the retroperitoneum, urinary tract and pelvis.
- Observing nephrostomies, image guided renal biopsies and angiography as applied to the urinary tract.

Cardiac, vascular and lymphatics

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

Core skills
- Reporting radiographs relevant to cardio-vascular disease.
- Femoral artery and venous puncture techniques, and the introduction of guidewires and catheters into the arterial and venous system.
- Performing and reporting aortography and lower limb angiography.
- Performing ultrasound of arteries and veins
- Managing and reporting CT and MR of the vascular system including image manipulation.

Paediatric

Core knowledge
- Normal paediatric anatomy and normal variants with particular relevance to normal maturation and growth.
- Disease entities specific to the paediatric age group and their clinical and radiological manifestations using all modalities.
- The value and indications for ultrasound, CT and MR in children.
- Disorders and imaging features of the neonate.
- Understanding the role of radionuclide imaging in paediatrics.

Core skills
- Reporting conventional radiographs in the investigation of paediatric disorders.
- Performing and reporting ultrasound of the abdomen, head and musculoskeletal system in the paediatric age group.
- Performing and reporting routine fluoroscopic contrast studies of the gastrointestinal system and urinary tract.
- Managing and reporting CT and MR examinations.

Head and neck

Core knowledge
- Normal anatomy and congenital lesions of the head and neck including paranasal sinuses oral cavity, pharynx and larynx inner ear, orbit, teeth and temporo-mandibular joint.
- Manifestations of diseases and the investigation of the eye and orbit including trauma, foreign bodies inflammation and tumours.
- Diagnosis of faciomaxillary trauma and tumours and disorders of the teeth.
- Diagnosis of lesions and abnormal function of the temporomandibular joint.
- Diagnosis of disorders of the thyroid, parathyroid and salivary glands including hypo and hyperactivity and tumours and awareness of the role of radionuclide imaging.
- Imaging features of trauma, inflammation, infection and tumours of the paranasal sinuses, oral cavity, larynx and pharynx.
- Understanding the role of US and CT guided punctures of salivary glands, lymph nodes and thyroid.

Core skills
- Reporting radiographs performed to show ENT/dental disease.
- Performing and reporting fluoroscopic examinations including barium swallows, sialography and dacrocystography.
- Performing and reporting ultrasound evaluation of the neck including thyroid parathyroid and salivary glands.
- Managing and reporting CT and MR of neck, ear, nose, throat and skull base disorders.

Breast

Core knowledge
- Normal anatomy and pathology of the breast relevant to clinical radiology.
- Understanding of the radiographic and ultrasound techniques employed in screening and diagnostic mammography.
- Diagnosis of both benign and malignant abnormalities in the breast.
- Understanding current practice in breast imaging, breast interventions and screening for breast cancer.
- Awareness of the role of other techniques for breast imaging.

Core skills
- Mammography and ultrasound reporting of common breast diseases.
- Observation of interventions especially for biopsies and localisations.

Gynaecology and obstetrics

Core knowledge
- Normal anatomy of the female reproductive organs and physiological changes affecting imaging.
- Changes in foetal anatomy during gestation and the imaging appearances of foetal abnormalities.
- Imaging features of disorders of the ovaries, uterus and vagina as demonstrated on ultrasound, CT and MR.
- Awareness of the applications of angiography and vascular interventional techniques.

Core skills
- Reporting radiographs performed for gynaecological disorders.
- Performing and reporting trans-abdominal and, where possible, endo-vaginal ultrasound examinations in gynaecological disorders.
- Observing and, where possible, performing obstetric ultrasound.
- Managing and reporting CT and MR in gynaecological disorders.

Oncology

Core knowledge
- Familiarity with tumour staging nomenclature.
- Application of all imaging and interventional techniques in staging and monitoring the response of tumours to therapy.
- Radiological manifestations of complications in tumour management.

Core skills
- Reporting radiographs performed to assess tumours.
- Performing and reporting ultrasound, CT, MR and, where possible, radionuclide examinations for staging and monitoring tumours.

2.8.9 Trainees should become familiar with clinical problems presenting in the emergency department and be able to manage the appropriate im-

aging of cases in acutely ill or traumatised patients.

2.8.10 An assessment process should be instituted during the clinical radiological training programme. This should be a structured process with written assessments of the trainees by the trainers at the end of each rotation. The extent of assessment and appraisal will vary from country to country, but a regular dialogue between trainer and trainee is desirable to monitor progress and to rectify any weaknesses that may be manifested. Formal written / oral examination and / or a scientific thesis may be required in some countries during or at the end of this period of training. It is recommended that a log-book (carnet de stage) of clinical radiological activities and periods of rotation should be maintained during the training period. Such a log-book might include the number of clinical examinations performed.

It is recommended that personal guidance and continuous assessment should be provided by a nominated tutor.

2.9 **Fourth and fifth year of training**

2.9.1 In the fourth and fifth year the rotations of the radiologist in training should be organised to serve the individual's needs, dependent on the availability within the training programme, which may be in general radiology or in a subspeciality.

2.9.2 **General Radiology:** General radiology training in the fourth and fifth year is designed to enable the trainee to acquire further experience, knowledge and skills in disorders present in general hospitals and private practice in order to reach a level required to undertake autonomous practice. This period of training should include an extended period of time in at least two areas of special interest to acquire more detailed knowledge and skills. This will enable the general radiologist to have areas where they may contribute to specific multidisciplinary meetings and consultations as part of a radiologists' team within his / her future general radiology practice.

2.9.3 **Radiological Subspecialty:** For those entering a subspecialty, the total period of subspecialist training will vary according to the subspecialty, but would normally be expected to be completed during the fourth and fifth year. For those subspecialties with a single year of subspecialty training continued training in general radiology during the balance of time will be undertaken.

2.9.4 A period of training in approved hospitals other than those in which the trainee is based in either the same country or abroad may be required for a variable period according to the national regulations.

2.9.5 Some subspecialty training may extend beyond the fifth year depending on national training arrangements relevant to their specialist programme.

2.10 **Course participation**

Attendance at outside-courses will depend on the stage of training and the relevance of the courses to the trainees' stage of training.

At least two congress or course attendances should be mandatory over the period of the fourth and fifth year of training.

2.11 **Research**

A dedicated period of research should be permissible as part of the overall training programme. This may be up to one year and may require approval by a national regulatory or European body, especially if any additional time is involved. Trainees should be encouraged to undertake a research project during their training, even if they do not have a dedicated period of research. This is particularly valid for those undertaking subspecialty training.

Article 3

TRAINING FACILITIES

3.1 Aims of training: Each training programme should outline the educational goals and objectives of the programme with respect to knowledge, skills and other attributes of residents at each level of training and for each major training assignment.

3.1.1 Training should aim at providing sufficient knowledge to enable the trainee on completion of the training period to be able to work independently as a qualified radiologist at radiological departments in hospitals, out-patient departments and private practice.

3.1.2 As previously indicated formal trainee appraisal and assessment during the period of specialist training should be performed in order to verify that the appropriate training has been undertaken and that the required standard has been achieved towards the award of the certificate of completion of specialist training (CCST) or other national equivalent.

Assessments must include:
- Clinical competences
- echnical competences
- Attitude and character

3.1.3 Health-care systems in individual European countries differ for a variety of reasons, which include administration, management, equipment, budgeting and tradition. In spite of these differences, recommendations for training facilities for specialisation in general radiology can be defined. The practical implementation of these recommendations must be left to the respective countries.

3.2 Requirements for fully accredited training departments

3.2.1 The status of a training department can be specified in the following ways:
a. Quantity and distribution of radiological examinations,
b. Standards of equipment,
c. Availability of modalities,
d. Staffing,
e. Teaching programme of the radiological department,
f. Teaching materials,
g. Research activity.

3.3 Quantity and distribution of radiological examinations

3.3.1 Patient material should be varied enough to enable the trainee to gain experience in all fields of clinical radiology. This requires a radiological department situated in a large polyvalent hospital. However, some attachments may be in small or specialist hospitals providing expert teaching in specific parts of the curriculum. All training departments should have access to expert pathology services.

3.3.2 The number of radiological examinations per year should be sufficient to enable a comprehensive experience of general radiology.

3.4 Standard of equipment

3.4.1 Only departments with adequate imaging equipment and services should be approved.

3.4.2 The equipment should fulfil radiological safety standards and be in good technical condition. Technical efficiency, security, electric control, radiation safety and control should be of adequate standard and fulfil agreed quality control criteria.

3.4.3 Radioprotection should be organised and radiation monitored according to European standards.

3.4.4 Down-time of the equipment for repairs should be minimal and not interfere with training.

3.5 Availability of modalities

3.5.1 The modalities for adequate radiological training will depend on local availability.

3.5.2 The following are mandatory:
a. Conventional radiography,
b. Angiography,
c. Ultrasonography,
d. Computed tomography,
e. Interventional radiology,
f. Magnetic resonance imaging (cooperation with other radiological training departments may be necessary).

3.5.3 Access to nuclear medicine is desirable.

3.6 Staffing structure

3.6.1 The number of qualified radiologists with teaching functions in the department should be sufficient to cover the needs of teaching, even at time of leave or in the event of other staff shortages.

3.6.2 The expertise of the teaching staff should be diversified and cover the main areas of activity.

3.6.3 Teaching staff should have training in teaching methods.

3.7 **Teaching programme**

3.7.1 There must be an approved and structured continuing teaching programme for general radiology as well as the main subspecialty areas.

3.7.2 The teaching programme should also include regular clinico-radiological meetings and other consultations with clinical departments at least on a weekly basis. Participation in meetings to review radiological errors should be undertaken.

3.7.3 Radiological and clinico-radiological conferences, seminars and training courses outside the hospital are recommended.

3.8 **Teaching facilities**

Appropriate demonstration equipment and rooms should be available in the department of radiology, sufficient to enable the teaching programme to be implemented.

3.9 **Teaching material**

3.9.1 There should be a selection of good and modern text books as well as other audio-visual material in a general radiology department, completed by text books in sub-specialties and modalities (e.g. neuroradiology, paediatric radiology, ultrasonography, computed tomography, magnetic resonance imaging, mammography). Adequate textbooks in imaging physics and pertinent material concerning radiation protection should be available.

3.9.2 A selection of high-standard radiological journals should be available on a continuing basis.

3.9.3 There should be an active teaching film-video library.

3.9.4 Computer technology for teaching, research purposes, image processing and communication is highly desirable.

3.10 **Research and Audit**

3.10.1 The importance of radiological research and audit for the training of radiologists should be emphasized.

3.10.2 There should be an active and ongoing research and audit programme at the training department and trainees should be encouraged to participate.

3.11 **Partition of radiological training in university, teaching and non-university hospitals**

3.11.1 Part of the training may be at acknowledged and accredited non-university hospitals, or private practices that have been appropriately accredited, but some should be carried out at university departments. The non-university component should provide training at least in general radiology, and may provide some sub-specialty training which would supplement that provided in the university departments. The composition of the patient material needs to be taken into account in selecting all hospitals concerned with teaching.

3.11.2 All the university departments and training hospitals should be part of a coordinated national or federal training scheme.

3.11.3 It is of great importance that cooperation exists between central authorities (e.g. Ministry of Health, Ministry of Education, National Professional Organizations, National Radiological Societies, National Health Insurance Funds etc.) and regional and local authorities, teaching centres and local hospital administrations etc.

Detailed Curriculum for the Initial Structured Common Programme

This document details the knowledge-based curriculum for resident training in radiology. It defines the required standards in terms of the core of knowledge that might be reasonably achieved within the first three years of the training programme. The document is presented in organ-based sections plus one section dedicated to paediatric radiology and one to interventional radiology.

The specialty of clinical radiology involves all aspects of medical imaging, which provide information about morphology, function and cell activity and those aspects of interventional radiology or minimally invasive therapy (MIT), which fall under the remit of the department of radiology. A general radiologist should be conversant with all aspects of the core of knowledge for general radiology to ensure an understanding of those radiological skills required in a general or community hospital or in a general radiological practice.

It is important to remind the duration of training in radiology is 5 years; the content of the first 3 years is a structured common programme for radiological anatomy, disease manifestations and core radiological skills. The fourth and fifth years are structured more flexibly to develop sufficient competence to function autonomously as a general radiologist and to facilitate subspecialty training. General radiology training in the fourth and fifth years is designed to enable the trainee to acquire further experience, knowledge and skills in disorders present in general hospitals and private practice in order to reach a level required to undertake autonomous practice. The fully trained radiologist should be capable of working independently when solving the majority of common clinical problems.

Breast Radiology

1 - INTRODUCTION

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

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

2 - CORE OF KNOWLEDGE

2.1. Breast anatomy and associated structures and how they change with age.

2.2. Breast pathology and clinical practice relevant to breast imaging.

2.3. Knowledge and understanding of the physics of image production, particularly how they affect image quality.

2.4 Knowledge and understanding of the risk/benefit analysis associated with breast screening using ionising radiation as compared with other techniques.

2.5. Understanding of the radiographic techniques employed in diagnostic mammography.

2.6. Understanding of the principles of current practice in breast imaging and breast cancer screening.

2.7. Awareness of the proper application of other imaging techniques in this specific field, such as US, MRI, or radionuclide imaging.

2.8. Knowledge of the indications and contraindications of FNA and core biopsy and their relative advantages and disadvantages.

2.9. Appearances of cancer and common benign disease on
- Mammography
- Ultrasound
- Magnetic Resonance Imaging.

2.10. Knowledge and understanding of the principles of communication specifically related to the breaking of bad news and consent.

3 - TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

3.1. Supervise technical staff to ensure appropriate images are obtained.

3.2. Understand when to utilise ultrasound and other imaging techniques.
Produce a report on mammographic and ultrasound breast imaging with respect to
common breast disease.

3.3. Understand when it is appropriate to obtain assistance in interpreting and reporting breast images.

3.4. To be able to perform interventional breast procedures under ultrasound and X-ray control under supervision.

3.5. To be able to communicate with patients Explaining the nature of benign breast disease Giving and observing 'breaking bad news'.

4 - CONFERENCES

As part of the curriculum in breast imaging, the trainee should attend in-house teaching sessions for radiologists as well as multidisciplinary conferences with the rest of the breast team where patient management is discussed. The MDT conference should be included to facilitate the radiology residents' understanding of the use of imaging and its role in the management of breast disease and to allow direct radiological-pathological correlation.

Cardiac Radiology

1 - INTRODUCTION

Cardiac radiology is an important and rapidly developing field in radiology. The use of cardiac imaging has progressed over the last decade to involve all modalities in diagnostic radiology. Interventional techniques in the heart have also progressed, and whether or not a radiologist is involved in cardiac intervention it is important that there is an understanding of the clinical and diagnostic implications of these techniques. The heart is not an isolated organ, and it is equally important that the relationship between the heart and the cardiovascular and cardiopulmonary systems are understood.

2 - CORE OF KNOWLEDGE

2.1. **Basic knowledge**

The principle is to acquire:

2.1.1. Basic clinical, pathological, and pathophysiological knowledge in cardiovascular disease.

2.1.2. An understanding of the principles and practice of screening techniques and risk factors in cardiac disease.

2.1.3. Knowledge of:
- The indications, contraindications and potential hazards (especially radiation hazards) of procedures and techniques relevant to cardiovascular disease.
- Cardiovascular anatomy in clinical practice relevant to clinical radiology.
- Normal variants, which may mimic disease.
- Manifestations of cardiovascular disease including trauma as demonstrated by conventional radiography, CT, MRI, angiography, radionuclide investigations and ultrasound.
- Differential diagnosis relevant to clinical presentation and imaging appearance of cardiovascular disease.
- Calcium scoring.
- Relevant embryological, anatomical, pathophysiological, biochemical and clinical aspects of cardiac disease.

2.1.4. Knowledge and management of procedural complications in cardiac treatment and diagnosis.

2.1.5. An understanding of the various treatment modalities for cardiac disease and their relationship to cardiac imaging.

2.2. **Knowledge in clinical cardiac radiology**

The following manifestations of cardiovascular disease, including trauma, have to be covered during the general radiological training. This should include formal teaching and exposure to clinical case material.

2.2.1. Coronary artery disease including acute coronary syndromes
- Myocardial ischaemia
- Myocardial infarction
- Post myocardial infarction syndrome
- Ventricular aneurysm
- Coronary calcium
- Coronary disease in women and specific coronary disease patterns in different communities
- Heart disease in the elderly

2.2.2. Valve disease
- Stenosis and incompetence of cardiac valves
- Endocarditis
- Sub and supra-valvar disease
- Subvalvar apparatus disease

2.2.3. The pericardium
- Tamponade and restrictive disease
- Acute pericarditis
- Tuberculous disease
- Malignant pericardial disease

2.2.4. Cardiac tumors
- Intracardiac tumors, i.e. myxomas, haemangiomas, and sarcomas
- Secondary tumors
- Tumours invading the heart

2.2.5. Cardiomyopathy
- Acute myocarditis
- Dilated cardiomyopathy
- Restrictive and obstructive cardiomyopathy
- Cardiomyopathy related to systemic disease
- Infiltrative heart disease
- Diabetic and renal cardiac disease
- Athlete's heart

2.2.6. Congenital heart disease
- Neonatal heart disease
- Congenital disease in childhood
- Grown-up congenital heart disease

2.2.7. Major vessel disease
- Thoracic aneurysm,
- Marfan's syndrome
- Takayasu's disease
- Relationship between peripheral and cerebro-vascular disease and cardiac disease

2.2.8. Right heart Disease
- Pulmonary embolism
- Right heart disease related to pulmonary disease

2.2.9. Acute cardiac and thoracic vascular trauma
- Aortic dissection
- Aortic rupture and fracture
- Blunt trauma

2.2.10. Arrhythmias
- Diagnosis of disease causing or predisposing to arrhythmias
- Cardiac disease in endocrine conditions
- Cardiac psychological related illness, i.e. manifestations of anxiety
- Pacemakers
- Defibrillators
- Ablation

2.2.11. Hypertension
- Hypertensive heart disease
- Diseases causing hypertension

2.2.12. Medical and invasive treatment
- Abnormalities arising from cardiac therapy, i.e. amioderone treatment
- Complications of cardiac catheterisation and coronary angioplasty
- Appearance of stents and stent grafts

2.2.13. Post-operative cardiac disease and findings
- By-pass grafts
- Valve replacement
- Aortic replacement
- Ventricular surgery
- Pericardectomy

3 - TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

At the end of his/her training, the resident should be able to discuss the appropriate imaging modality for the clinical problem with the referring clinician. He/She should be able to understand management and communications issues in cardiac disease.

3.1. Modality-based skills

3.1.1. Plain film interpretation
- Limitations, advantages and principles of chest X-ray diagnosis of adult and congenital cardiac disease
- Ability to recognise cardiac conditions on PA, AP, and lateral radiographs
- Ability to recognise cardiac post-operative findings on plain radiographs.

3.1.2. CT interpretation and patient management
- CT anatomy of the heart pulmonary arteries and great vessels
- Principles of multislice and ultrafast CT of the heart including prospective and retrospective gating
- Interpretation of cardiac and pulmonary pathology
- Contrast administration
- Decision-making on the basis of patients´ symptoms and CT diagnosis.

3.1.3. MRI interpretation and patient management
- MRI anatomy of the heart, great vessels, pulmonary and peripheral vascular system
- Principles of image sequencing and specialised gating
- Interpretation of cardiovascular and pulmonary pathology
- Understanding of cardiac physiology related to MRI, including flow sequencing and specialised tagging techniques
- Use of MRI contrast
- Uses limitations and hazards of MRI cardiac imaging

3.1.4. Cardiac imaging by other modalities
- Principles´ uses and limitations of cardiac angiography catheterisation and pressure measurement
- Principles´ uses and interpretation of stress and non-stress echocardiography, including trans-oesophageal echocardiography
- Principles´ uses and limitations of nuclear cardiac imaging
- Principles of intravascular imaging

3.2. Stress testing
- Principles of exercise stress testing, uses and limitation
- Methods of stress testing as applied to cardiac imaging
- Patient management of stress testing for cardiac imaging

3.3. Communication and management skills
- To be able to supervise technical staff to ensure appropriate images are obtained.
- To discuss significant or unexpected radiological findings with refering clinicians and know when to contact a clinician.
- To be able to recommend the most appropriate imaging modality, appropriate to patients´ symptoms or pathology or request from the refering clinician.
- To develop skills in forming protocols, monitoring and interpreting cardiac studies, appropriate to the patient history and other clinical information.
- To demonstrate the ability to effectively present cardiac imaging in a conference setting.
- To demonstrate the ability to provide a coherent report.

Chest Radiology

1 – INTRODUCTION

Physics, radiography and contrast media are generally covered in separate courses and are therefore not included in this document, but physics and radiography topics specific to thoracic imaging should be covered either in the thoracic rotation or included in the physics/radiography courses, particularly:

- Positioning/views of chest radiographs for adults, newborns, infants and children
- Mean exposure doses at skin entrance, kVp, antiscatter techniques
- Principles of digital imaging and image processing pertinent to chest radiology.

2 – CORE OF KNOWLEDGE

2.1. **Normal anatomy**

2-1.1 Be able to:
- List the lobar and segmental bronchi
- Describe the relationships of the hilar vessels and bronchi
- Define a secondary pulmonary lobule and its component parts
- Use the correct terminology for describing the site of mediastinal and hilar lymph nodes.

2.1.2. Identify the following structures on posteroanterior (PA) and lateral chest radiographs:
- Right upper, middle and lower lobes; left upper and lower lobes; and lingula
- Fissures – major, minor, superior accessory, inferior accessory, and azygos
- Airway – trachea, carina, main bronchi, posterior wall of intermediate bronchus, and lobar bronchi
- Heart – position of the two atria, two ventricles, left atrial appendage, and the location of the four cardiac valves
- Pulmonary arteries – main, right, left, and interlobar
- Aorta – ascending, arch and descending aorta
- Arteries – brachiocephalic (innominate), carotid, and subclavian arteries
- Veins – superior and inferior vena cava, azygos, left superior intercostal ("aortic nipple"), and left brachiocephalic (innominate) veins
- The components of the thoracic skeleton
- Mediastinal stripes and interfaces
- Aortopulmonary window
- Both hemidiaphragms.

2.1.3. Identify the following structures on chest CT and/or chest MRI:
- All pulmonary lobes and segments
- A secondary pulmonary lobule
- 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 ventricle, right ventricle, left atrium, left atrial appendage, right atrium, right atrial appendage
- 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, hemiazygos, left superior intercostal, internal mammary
- Esophagus
- Thymus
- Normal mediastinal and hilar lymph nodes
- Azygoesophageal recess
- Inferior pulmonary ligaments.

2.2. **Generic signs on chest radiographs**

To be able to recognise and state the significance of the following chest radiographic signs:

2.2.1 Silhouette sign - loss of the contour of the heart or diaphragm indicating adjacent pathology (e.g. atelectasis of the right middle lobe obscures the right heart border).

2.2.2. Air bronchogram - indicates airless alveoli and, therefore, a parenchymal process as distinguished from a pleural or mediastinal process.

2.2.3. Air crescent sign - indicates solid material in a lung cavity, often due to a fungus ball, or crescentic cavitation in invasive fungal infection.

2.2.4. Cervicothoracic sign - a mediastinal opacity that projects above the clavicles, situated posterior to the plane of the trachea, while an opacity

projecting at or below the clavicles is situated anteriorly.

2.2.5. Tapered margins - a lesion in the chest wall, mediastinum or pleura may have smooth tapered borders and obtuse angles with the chest wall or mediastinum, while parenchymal lesions usually form acute angles.

2.2.6. Gloved finger sign - indicates bronchial impaction, e.g. in allergic broncho- pulmonary aspergillosis, or other chronic obstructive processes.

2.2.7. Golden S sign - indicates lobar collapse with a central mass, suggesting an obstructing bronchogenic carcinoma in an adult.

2.2.8. Deep sulcus sign on a supine radiograph - indicates pneumothorax.

2.3. Features of diffuse infiltrative lung disease on chest radiographs and chest CT

2.3.1. To recognise the effects of various pathological processes on the component parts of the secondary pulmonary lobule as seen on HRCT.

2.3.2. To list and be able to identify the following patterns: air space shadowing, ground glass opacity (and understand its pathophysiology), reticular pattern, honeycombing, nodular pattern, bronchiolar opacities ("tree-in- bud"), air trapping, cysts and mosaic attenuation pattern.

2.3.3. To identify septal lines (thickened interlobular septa) and explain the possible causes.

2.3.4. To make a specific diagnosis of interstitial lung disease (ILD) when HRCT appearances are characteristic or findings are present (e.g. dilated esophagus and ILD in scleroderma, enlarged heart and a pacemaker or defibrillator in a patient with prior sternotomy and ILD suggesting amiodarone drug toxicity).

2.3.5. To recognise the spectrum of changes of heart failure on chest radiographs, notably: pleural effusions, vascular redistribution on erect chest radiographs, and the features of interstitial and alveolar edema, including septal lines and thickening of fissures.

2.3.6. To define the terms "asbestos-related pleural disease" and "asbestosis"; identify the imaging findings.

2.3.7. To recognise progressive massive fibrosis/conglomerate masses secondary to silicosis or coal worker's pneumoconiosis on radiography and chest CT.

2.4. Differential diagnosis of diffuse infiltrative lung disease

To be able to develop a differential diagnostic list for the following patterns taking account of the anatomical and imaging distribution of the signs and the clinical information:

2.4.1. On chest radiographs (according to whether the pattern is upper, mid or lower zone predominant; or shows central or peripheral predominance):
- Air space shadowing
- Ground glass opacity
- Nodular pattern
- Reticular pattern
- Cystic pattern
- Widespread septal lines

2.4.2. On HRCT (according to whether the pattern is upper, mid or lower zone predominant; or shows perihilar or subpleural predominance; or shows centrilobular, bronchocentric, lymphatic or perilymphatic, or random distributions)
- Septal thickening/nodularity
- Ground glass opacity
- Reticular pattern
- Honeycombing
- Nodular pattern
- Air space consolidation
- Tree-in-bud pattern
- Mosaic attenuation pattern
- Cyst and cyst-like pattern

2.5. Alveolar lung diseases and atelectasis

- To recognise segmental and lobar consolidation.
- To list four common causes of segmental consolidation.
- To recognise partial or complete atelectasis of single or combined lobes on chest radiographs and list the likely causes.
- To recognise complete collapse of the right or left lung on a chest radiograph and list appropriate causes for the collapse.
- To distinguish lung collapse from massive pleural effusion on a frontal chest radiograph.
- To list five of the most common causes of adult (acute) respiratory distress syndrome.
- To name four predisposing causes of or associations with organising pneumonia.
- To recognise the halo sign and suggest a di-

agnosis of invasive aspergillosis in an immunosuppressed patient.

2.6. Airways and obstructive lung disease

- To recognise the signs of bronchiectasis on chest radiographs and chest CT.
- To name four common causes of bronchiectasis.
- To recognise the HRCT signs of obliterative and exudative small airways disease (tree-in-bud, air trapping, mosaic pattern, and associated bronchiectasis).
- To recognise the typical appearance of cystic fibrosis on chest radiographs and chest CT.
- To list the causes of wheeze that may be detected on chest radiographs.
- To recognise tracheal and bronchial stenosis on chest CT and name the most common causes.
- To define centrilobular, paraseptal and panacinar emphysema.
- To recognise the signs of panacinar emphysema on chest radiographs and CT.
- To recognise the signs of centrilobular emphysema on HRCT.
- To state the imaging findings used to identify surgical candidates for giant bullectomy or lung volume reduction surgery.

2.7. Unilateral hyperlucent lung /Hemithorax

- To recognise a unilateral hyperlucent lung on chest radiographs or chest CT.
- To give an appropriate differential diagnosis when a hyperlucent lung/hemithorax is seen on a chest radiograph, and indicate the signs that allow a specific diagnosis.

2.8. Solitary and multiple pulmonary nodules

- To state the definition of a solitary pulmonary nodule and a pulmonary mass.
- To name the four most common causes of a solitary pulmonary nodule, cavitary pulmonary nodules and multiple pulmonary nodules.
- To provide strategy for managing an incidental or screening-detected solitary pulmonary nodule.
- To state the role of contrast-enhanced CT and positron emission tomography (PET) in the evaluation of a solitary pulmonary nodule.
- To describe the features that indicate benignity of a solitary pulmonary nodule and their limitations.
- To state the complications of percutaneous lung biopsy and their frequency.
- To state the indications for chest tube placement as a treatment for pneumothorax related to percutaneous lung biopsy.

2.9. Benign and malignant neoplasms of the lung

- To name the four major histologic types of bronchogenic carcinoma, and state 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 (I, II, III, IV, and substages) and the definition of each component (T1-4, N0-3, M0-1).
- To state up to which stage a non-small cell lung cancer is generally regarded as surgically resectable for cure.
- To state the staging of small cell lung cancer.
- To name the four most common extrathoracic metastatic sites for non-small cell lung cancer and for small cell lung cancer.
- To recognise abnormal contralateral mediastinal shift on a post-pneumonectomy chest radiograph and state 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 the temporal relationship to radiation therapy.
- To state the roles of CT and MR in lung cancer staging. To state the role of positron emission tomography (PET) in lung cancer staging.
- To name the most common location and appearance of adenoid cystic and carcinoid tumors.
- To describe the appearances of hamartoma of the lung on chest radiographs and CT.
- To state the manifestations and the role of imaging in thoracic lymphoma.
  To describe the typical chest radiograph and chest CT appearances of Kaposi sarcoma.

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

- To name and recognise the radiographic manifestations of pulmonary tuberculosis on a radiograph and CT.
- To describe the types of pulmonary Aspergillus disease, understand that they form part of a continuum, and recognise these entities on chest radiographs and CT.
- To name the major categories of disease-causing chest radiographic or chest CT abnormalities in the immunocompromised patient.
- To name two common infections and two common neoplasms in patients with AIDS and chest radiographic or chest CT abnormalities.
- To describe the chest radiographic and chest CT appearances of pneumocystis now called "jiroveci" pneumonia.
- To name the three most important aetiologies of hilar and mediastinal adenopathy in patients with AIDS.
- To list the differential diagnoses for widespread consolidation in an immunocompromised host.
- To describe the chest radiographic and CT findings of post-transplant lymphoproliferative disorders.
- To describe the chest radiographic and CT findings of graft-versus-host-disease.

2.11. **Congenital lung disease**

- To name and recognise the components of the pulmonary venolobar syndrome (scimitar syndrome) on a frontal chest radiograph, chest CT and chest MRI.
- To list the signs of intralobar pulmonary sequestration and cystic adenomatoid malformation on chest radiographs and chest CT.
- To explain the differences between intralobar and extralobar pulmonary sequestration.
- To recognise bronchial atresia on a radiograph and chest CT, and state the most common lobes of the lungs in which it occurs.

2.12. **Pulmonary vascular disease**

- To recognise enlarged pulmonary arteries on a chest radiograph and distinguish them from enlarged hilar lymph nodes.
- To name five of the most common causes of pulmonary artery hypertension.
- To recognise lobar and segmental pulmonary emboli on CT angiography and chest MRI (including MR angiography).
- To define the role of ventilation-perfusion scintigraphy, 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 modality depending on patient presentation.
- To recognise the vascular redistribution seen in raised pulmonary venous pressure.

2.13. **Pleura and diaphragm**

- To recognise the typical chest radiographic appearances of pleural effusion in erect, supine and lateral decubitus chest radiographs and name four causes of a large unilateral pleural effusion.
- To recognise a pneumothorax on an upright and supine chest radiograph.
- To recognise a pleural-based mass with bone destruction or infiltration of the chest wall on a radiograph or chest CT, and name four likely causes.
- To recognise the various forms of pleural calcification on a radiograph or chest CT and suggest the diagnosis of asbestos exposure (bilateral involvement) or old TB, old empyema, or old haemothorax (unilateral involvement).
- To recognise unilateral elevation of one hemidiaphragm on chest radiographs and list five causes (e.g. subdiaphragmatic abscess, diaphragm rupture, and phrenic nerve involvement with lung cancer, postcardiac surgery, eventration).
- To recognise tension pneumothorax.
- To recognise diffuse pleural thickening and list four causes.
- To recognise the split pleura sign in empyema.
- To state and recognise the chest radiographic and CT findings of malignant mesothelioma.

2.14. Mediastinal and hilar disease

- To name the four most common causes of an anterior mediastinal mass and localise a mass to the anterior mediastinum on chest radiographs, chest CT and chest MRI.
- To name the three most common causes of a middle mediastinal mass and localise a mass in the middle mediastinum on chest radiographs, chest CT and chest MRI.
- To name the most common cause of a posterior mediastinal mass and localise a mass in the posterior mediastinum on chest radiographs, chest CT and chest MRI.
- To name two causes of a mass that straddles the thoracic inlet and localise a mass to the thoracic inlet on chest radiographs, chest CT and chest MRI.
- To identify normal vessels or vascular abnormality on chest CT and chest MRI that may mimic a solid mass.
- To recognise mediastinal and hilar lymphadenopathy on chest radiographs, CT and MRI.
- To name four aetiologies of bilateral hilar lymph node enlargement.
- To list the four most common aetiologies of "egg-shell" calcified lymph nodes in the chest.
- To name four causes of a mass arising in the thymus.
- To list the imaging features and common associations of thymoma.
- To list three types of malignant germ cell tumor of the mediastinum.
- To recognise the imaging signs of benign cystic teratoma.
- To list five signs of intrathoracic thyroid masses.
- To recognise a cystic mass in the mediastinum and suggest the possible diagnosis of a bronchogenic, pericardial, thymic or oesophageal duplication cyst.
- To state the mechanisms and list the signs of pneumomediastinum.

2.15. Thoracic aorta and great vessels

- To state the normal dimensions of the thoracic aorta.
- To describe the Stanford A and B classification of aortic dissection and the implications of the classification for medical versus surgical management.
- To state and recognise the findings of, and distinguish between each of the following on chest CT and MR:
  - aortic aneurysm
  - aortic dissection
  - aortic intramural hematoma
  - penetrating atherosclerotic ulcer
  - ulcerated plaque
  - ruptured aortic aneurysm
  - sinus of Valsalva aneurysm
  - subclavian or brachiocephalic artery aneurysm
  - aortic coarctation
  - aortic pseudocoarctation
  - cervical aortic arch
- To state the significance of a right aortic arch with mirror image branching versus an aberrant subclavian artery.
- To recognise the two standard types of right aortic arch and a double aortic arch on chest radiographs, chest CT and chest MR.
- To recognise an aberrant subclavian artery on chest CT.
- To recognise normal variants of aortic arch branching, including the common origin of brachiocephalic and left common carotid arteries ("bovine arch"), and separate origin of vertebral artery from arch.
  To define the terms aneurysm and pseudoaneurysm.
- To state and identify the findings seen in arteritis of the aorta on chest CT and chest MR.
- To state the advantages and disadvantages of CT, MRI/MRA and transoesophageal echocardiography in the evaluation of the thoracic aorta.

2.16. Chest Trauma

- To identify a widened mediastinum on chest radiographs taken for trauma and state the possible causes (including aortic/arterial injury, venous injury, fracture of sternum or spine).
- To identify the indirect and direct signs of aortic injury on contrast-enhanced chest CT scan.
- To identify and state the significance of chronic traumatic pseudoaneurysm on chest radiographs, CT or MRI.
- To identify fractured ribs, clavicle, spine and scapula on chest radiographs or chest CT.

- To name three common causes of abnormal lung opacity following trauma on chest radiographs or CT.
- To identify an abnormally positioned diaphragm or loss of definition of a diaphragm on chest radiographs following trauma and be able to suggest the diagnosis of a ruptured diaphragm.
- To identify a pneumothorax and pneumomediastinum following trauma on chest radiographs.
- To identify a cavitary lesion following trauma on chest radiographs or chest CT and suggest the diagnosis of laceration with pneumatocele formation, hematoma or abscess secondary to aspiration.
- To name the three most common causes of pneumomediastinum following trauma.
- To recognise and distinguish between pulmonary contusion, laceration and aspiration.

2-17. **Monitoring and support devices – "Tubes and lines"**

To be able to identify and state the preferred placement of the following devices and lines. To be able to list the complications associated with malposition of each of the following:

- endotracheal tube
- central venous catheter
- Swan-Ganz catheter
- nasogastric tube
- chest tube/drain
- intra-aortic balloon pump
- pacemaker and pacemaker leads
- implantable cardiac defibrillator
- left ventricular assistant device
- atrial septal defect closure device ("clamshell device")
- pericardial drain
- extracorporeal life support cannulae
- intraoesophageal manometer, temperature probe or pH probe
- tracheal or bronchial stent.

2.18. **Postoperative Chest**

To identify normal post-operative findings and complications of the following procedures on chest radiographs, CT and MRI:

- wedge resection, lobectomy, pneumonectomy
- coronary artery bypass graft surgery
- cardiac valve replacement
- aortic graft
- aortic stent
- transhiatal oesophagectomy
- lung transplant
- heart transplant
- lung volume reduction surgery.

3 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

At the end of his/her training, the resident should be able to demonstrate the following:

3.1. Dictate intelligible and useful reports on chest radiographs, CT and MR imaging. These reports should contain a brief description of the imaging findings and their significance along with a short summary where necessary.

3.2. Supervise technical staff to ensure appropriate images are obtained.

3.3. Discuss significant or unexpected radiologic findings with refering clinicians and know when to contact a clinician.

3.4. Describe patient positioning and indications for a PA, lateral, decubitus, and lordotic chest radiograph.

3.5. Decide when it is appropriate to obtain help from supervisory faculty in interpreting radiographs.

3.6. Understand the clinical indications for obtaining chest radiographs and when further views or a chest CT or MR may be necessary.

3.7. Develop skills in protocolling, monitoring, and interpreting chest CT scans, including HRCT, appropriate to patient history and other clinical information.

3.8. Describe a chest CT protocol optimised for evaluating each of the following:

- thoracic aorta and great vessels
- superior vena cava and brachiocephalic vein stenosis or obstruction
- suspected pulmonary embolism
- tracheobronchial tree
- suspected bronchiectasis
- suspected small airway disease

- lung cancer staging
- oesophageal cancer staging
- superior sulcus tumour
- suspected pulmonary metastases
- suspected pulmonary nodule on a radiograph
- shortness of breath
- haemoptysis.

3.9. Develop skills in protocoling, monitoring, and interpreting chest MR studies.

3.10. Demonstrate the ability to effectively present chest imaging in a conference setting.

3.11. Recommend the appropriate use of imaging studies to referring clinicians.

3.12. Be able to perform the following imaging-guided transthoracic interventions under appropriate supervision, and know the indications, contraindications, and management of complications:
- paracentesis and drainage of pleural effusions
- percutaneous lung biopsy
- paracentesis of mediastinal and pericardial fluid collections
- drainage of refractory lung abscess
- arteriography of thoracic aorta and great vessels
- venography of major intrathoracic systemic veins of bronchial arteries, anatomy, and important collaterals
- pulmonary arteriography
- principles of bronchial artery embolization: indications, technique and complications
- principles of intrathoracic vein recanalisation and stenting: indications, technique
- principles of interventional procedures in the pulmonary circulation:
  - local thrombolysis
  - AVM embolization.

3.13. Correlate pathologic and clinical data with radiographic and chest CT and MRI findings.

4 – CONFERENCES

The following list gives examples of the types of conferences that should be considered part of the chest curriculum. Some of these conferences may be run by the Radiology Department, others may be run by other departments or multidisciplinary programmes. It is recommended that this latter type of conference be included to facilitate the radiology residents' understanding of the use of imaging and clinical circumstances, in which imaging is requested.

- Radiology resident-specific chest radiology teaching conference
- An appropriate proportion of radiology grand rounds devoted to chest radiology
- Pulmonary medicine conference
- Intensive care unit conference
- Thoracic oncology conference
- Thoracic surgery conference.

5 – TEACHING MATERIAL AND SUGGESTIONS FOR READING

Recommended study materials and mandatory conference attendance are an important component of training, but since they vary between individual departments, a detailed listing is not provided in this document. The following short list of textbooks covering a wide range of topics should be available in departmental libraries:

Webb WR, Müller NL, Naidich DP: High-resolution CT of the Lung, published by Lippincott Williams & Wilkins.
Hansell DM, Armstrong P, Lynch DA, McAdams HP: Imaging of Diseases of the Chest, published by Elsevier.
Fraser RS, Müller NL, Colman N, Paré PD: Fraser & Paré's Diagnosis of Diseases of the Chest, published by Saunders.
Colby TV, Lombard C, Yousem SA, Kitaichi M: Atlas of Pulmonary Surgical Pathology, published by Saunders.
McCloud TC: Thoracic Radiology: the Requisites, published by Mosby.

Gastrointestinal and Abdominal Radiology

1 – INTRODUCTION

Gastrointestinal and abdominal radiology include all aspects of medical imaging (diagnostic and interventional), thus covering information relative to the anatomy, pathophysiology and the various diseases that may affect the abdomen. Gastrointestinal and abdominal radiology includes various techniques (ultrasonography, duplex Doppler, conventional X-ray imaging, computed tomography, magnetic resonance imaging, angiography and other interventional procedures) and various organs (pharynx, oesophagus, stomach, duodenum, small bowel, colon, rectum, anus, pancreas, liver, biliary tract, spleen, peritoneum, abdominal wall and pelvic floor). The aim of this document is to describe a curriculum for training in gastrointestinal and abdominal radiology.

2 – CORE OF KNOWLEDGE

2.1. Anatomy and physiology

- To know the principal aspects of embryology of the oesophagus, stomach, duodenum, small bowel, appendix, colon, rectum, anus, pancreas, liver, biliary tract, and spleen.
- To know the anatomy of the pharynx, oesophagus, stomach, duodenum, small bowel, appendix, colon, rectum, anus, pancreas, liver, biliary tract, spleen, mesentery, and peritoneum.
- To know the anatomy of the pelvic floor and abdominal wall.
- To know the arterial supply and venous drainage, including important variants, of the various portions of the gastrointestinal tract. To know the possible variations of flow in the superior mesenteric artery and vein and the portal and hepatic veins.
- To know the lymphatic drainage of the relevant organs.

2.2. Oesophagus

- To be able to identify the abnormalities demonstrable on a video-fluoroscopy study of the swallowing mechanism and their implications in conjunction with swallowing therapists. To recognise pharyngeal pouch, webs and post-cricoid tumours.
- To be able to identify oesophageal perforation on plain films and contrast studies.
- To be able to identify oesophageal cancer, diverticulum, extrinsic compression, sub-mucosal masses, fistulae, sliding and para-oesophageal hiatus hernia, benign strictures, benign tumours, varices, different forms of oesophagitis on a contrast examination of the oesophagus.
- To understand the significance of Barrett's oesophagus and the manifestations of this disease.
- To be able to perform a motility assessment barium study and understand the appearance of common motility disorders.
- To understand the use and be experienced in the technique of bolus studies, such as bread or marshmallow, in the identification of causes of dysphagia.
- To know the basic surgical techniques in oesophageal surgery and to be able to identify post-surgical appearances on imaging examinations.
- To be able to identify a mega oesophagus, oesophageal diverticulum, hiatus hernia, oesophageal varices, pneumo-mediastinum, and oesophageal perforation on CT scan.
- To be able to identify an oesophageal cancer on CT scan and to analyse 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.

2.3. Stomach and duodenum

- To be able to determine the most appropriate imaging examination and contrast use in suspected perforation of the stomach and post-operative follow-up. To know the limitations of each examination for these specific conditions.
- To understand the imaging features (on barium and CT) of a variety of conditions such as benign and malignant tumours, infiltrative disorders, e.g. linitis plastica, gastric ulcers and positional abnormalities including gastric volvulus.
- To be able to perform a CT examination of the stomach, using the most appropriate protocol according to the clinical problem.

- To be able to stage gastric carcinoma and lymphoma on CT and MRI.
- To be able to identify duplication cysts of the upper gastrointestinal tract on CT scan.
- To understand the appearance of gastro-duodenal disease on ultrasound.
- To understand rotational abnormalities of the duodenum on barium studies and also the appearance of annular pancreas, sub-mucosal tumours, papillary tumours, inflammatory disease including ulceration, as well as lymphoid hyperplasia and gastric metaplasia.

2.4. Small bowel

- To be able to determine the most appropriate imaging examination in the following cases: small bowel obstruction, inflammatory disease, infiltrative disease, small bowel perforation and ischaemia, cancer, lymphoma, carcinoid tumour, and post-operative follow-up. To know the limitations of each examination for these specific cases.
- To be able to identify lymphoid hyperplasia of the terminal ileum on small bowel series. To be able to identify the most common mid gut abnormalities (malrotation, internal hernia).
- To know the features of small bowel diseases on small bowel series, including stenosis, fold abnormalities, nodules, ulcerations, thickening, marked angulation, extrinsic compression, and fistula.
- To be able to identify on a small bowel series the following diseases: adenocarcinoma, polyposis, stromal tumor, lymphoma, carcinoid tumor, Crohn's disease, mesenteric ischaemia, haematoma, Whipple's disease, amyloidosis, radiation-induced injury, malrotation, Meckel's diverticulum, coeliac disease, diverticulosis, systemic sclerosis, chronic pseudo-obstruction.
- To be able to perform a CT examination of the small bowel and to know the main principles of interpretation. To know the findings in the various diseases of the small bowel, and especially to describe a halo sign and a target sign. To be able to identify a transitional zone in case of small bowel obstruction. To be able to identify a small bowel tumor (adenocarcinoma, lymphoma, carcinoid tumor, stromal tumor). To be able to identify mural pneumatosis, vascular engorgement, increased density of the mesenteric fat, peritoneal abnormality and malrotation.
- To be able to determine the cause of small bowel obstruction on CT scan (adhesion, band, strangulation, intussusception, volvulus, internal and external hernias) and their complications. To be able to identify criteria for emergency surgery.
- To know the basic principles of MR imaging of the small bowel.

2.5. Colon and rectum

- To be able to determine the optimal imaging examination to study the colon according to the suspected disease (obstruction, volvulus, diverticulitis, benign tumor, inflammatory disease, cancer, lymphoma, carcinoid tumor, stromal tumor, perforation, postoperative evaluation) and to know the limitations of each technique.
- To be able to identify rotational abnormalities of the colon on contrast studies and CT.
- To be able to identify the normal appendix on a CT scan and a sonographic examination. To know the various features of appendicitis on CT scan and sonographic examination.
- To know the different features of colon tumors, diverticulitis, inflammatory diseases, colon ischaemia, radiation-induced colitis.
- To be able to identify a megacolon, colonic diverticulosis, specific and non-specific colitis, colonic fistula, carcinoma, polyps and postoperative stenosis on an enema.
- To be able to identify a colonic diverticulosis, diverticulitis, tumor stenosis, ileocolic intussusception, colonic fistula, paracolic abscess, epiploic appendicitis, intra-peritoneal fluid collection, colonic pneumatosis, and pneumoperitoneum on a CT scan.
- To know the CT features of colon cancer on a CT scan. To be able to identify criteria for local extent (enlarged lymph nodes, peritoneal carcinomatosis, hepatic metastases, and obstruction).
- To know the TNM classification of colon cancer and its prognostic value. To understand the technique and value of both MRI and endosonography in the staging of rectal cancer.
- To know the basic technique of interventional radiology in colon cancer, especially of colonic stent placement in case of colonic ob-

struction. To know the indications and contraindications of this technique.
- To know the various diseases of the rectum and the anus and the most frequent operative techniques that may be used to treat them.
- To know the anatomy of the rectum, peri-rectal tissues and of the anal sphincters.
- To know the main functional diseases of the pelvic floor and their features on a defeacography examination. To know the potential role of sonography and MR imaging in the evaluation of functional diseases of the pelvic floor.
- To be able to identify a rectal cancer, tumour recurrence after surgery and a pelvic fistula on a CT scan and on a MR examination. To know the value of CT/PET. To know the criteria that may help in differentiating between postoperative fibrosis and tumor recurrence. To be able to select patients who may benefit from percutaneous biopsy in case of suspected tumor recurrence.
- To know the basic MR imaging technique that is used to search for a pelvic/perianal fistula. To be able to identify fistulae on MR imaging.
- To know the basic MR imaging technique that has to be used for MRI of rectal cancer.
- To know the TNM classification of rectal cancer and its effect on treatment options.
- To be able to identify a rectal cancer and its relation to relevant surrounding structures.

2.6. Peritoneum and abdominal wall

- To be able to identify the various types of abdominal wall hernias (inguinal, umbilical, parastomal, postoperative) on a CT scan. To be able to identify an abdominal wall hernia on a sonographic examination. To be able to identify a hernial strangulation on a CT scan and on a sonographic examination.
- To be able to identify a mesenteric tumour and to determine its location on a CT scan.
- To know the features of a mesenteric cyst on a CT scan.
- To know the normal features of the peritoneum on a sonographic and a CT scan examination. To know the various findings that can be seen in cases of peritoneal disease (nodules, thickening, fluid collection).
- To be able to identify an ascites on a sonographic and a CT scan examination. To know the features of loculated ascites.
- To be able to identify the following peritoneal diseases on CT: peritonitis, peritoneal carcinomatosis, peritoneal tuberculosis, mesenteric lymphoma, mesenteric and greater omental infarction.

2.7. Vessels

- To know the basic principles of duplex Doppler sonography and to be able to identify superior mesenteric artery stenosis or occlusion on duplex Doppler sonography. To be able to use Doppler to assess the patency of and the direction of flow in the portal and hepatic veins.
- To be able to identify small bowel infarct on a CT scan.
- To be able to interpret an angiographic study of the mesenteric vessels and to identify occlusion and stenosis of the superior mesenteric artery.
- To know the basic principles of balloon angioplasty and stenting of the superior mesenteric artery for the treatment of stenosis of the superior mesenteric artery.

2.8. Liver

- To be able to localise a focal liver lesion according to liver segmentation and major vessels anatomy (hepatic and portal vein, IVC)
- To describe the appearance of typical biliary cyst on US, CT and MRI
- To describe the appearance of Hyatid cysts and to be able to classify into the five categories.
- To list the differences between amoebic abscess and pyogenic abscess of the liver (appearance, evolution, treatment, indication for drainage).
- To be able to describe the most common surgical procedures for hepatectomy.
- To know the appearance of liver haemangioma on US, CT and MRI including typical cases and giant haemangioma. To be able to discuss the indications for CT or MRI as an adjunct to US.
- To describe the usual appearance of Focal Nodular Hyperplasia and Liver Cell Adenoma on US including Doppler US, CT and MRI. To be able to discuss the indications for CT or MRI as an adjunct to US, as well as cases when biopsy is necessary.

- To know the appearance of fatty liver, homogenous and heterogeneous, on US, CT, and MRI (including in-/out-of-phase imaging).
- To describe the natural history of hepatocellular carcinoma (HCC), major techniques and indications for treatment (surgical resection, chemotherapy, chemoembolisation, percutaneous ablation, liver transplantation).
- To describe the appearance of HCC on US (including Doppler), CT, and MRI. To be able to stage the lesion in order to discuss indications for treatment.
- To describe the usual appearance of liver metastases on US (including Doppler), CT, and MRI, sensitivity and specificity for each. Be able to discuss the indications for percutaneous biopsy.
- To be able to discuss the indications for advanced methods (CTAP, MRI with liver specific contrast) in liver metastases staging.
- To describe the most common morphologic changes associated with liver cirrhosis: lobar atrophy or hypertrophy, regeneration nodules, fibrosis. To list the main causes for liver cirrhosis.
- To be able to list rare tumors of the liver and to find their radiological appearance using literature sources.
- To be able to describe the technique for percutaneous guided liver biopsy and its most common indications. To list the complication with a precise evaluation of the occurrence of morbidity and mortality.

2.9. Biliary tract

- To know sensitivity and specificity of imaging methods for the detection of gall bladder and common bile duct stones.
- To describe the common appearance of acute cholecystitis on US (including Doppler), CT, and MRI. To know the unusual features like gangrenous, emphysematous, and acalculous cholecystis.
- To list the main causes for gallbladder wall thickening on US.
- To describe the appearance of gallbladder cancer on US, CT, and MRI. To be able to differentiate cancer from subacute cholecystitis on US and CT.
- To describe the appearance of cholangiocarcinoma of the liver hilum (Klatskin tumour) and to be able to perform tumor staging, with regard to treatment options (resectability, indication for palliation).
- To describe the appearance of ampullar carcinoma on US, CT, MRI, and endoscopic US.
- To be able to describe the common appearance of sclerosing cholangitis on US, CT, and MRI, including MRCP. To know the natural history and possibility for associated cholangiocarcinoma and indications for treatment. To be able to discuss indications for biliary tract opacification.
- To describe the main techniques for surgery of the bile duct and its common complications.
- To list the methods for interventional radiology of the biliary tract and discuss the indications and complications. To attest participation in five procedures.

2.10. Pancreas

- To know the natural history of chronic pancreatitis. To list the common causes.
- To identify pancreatic calcifications on plain films, US, and CT.
- To know the clinico-biological pancreatitis (Ranson score, APACHE II) and CT (Balthazar's CT severity score) methods for the grading of acute pancreatitis.
- To describe the common appearance of extra-pancreatic fluid collection and phlegmons in case of acute pancreatitis.
- To be able to detect a pancreatic pseudocyst and discuss advantages and limitations of different treatments (follow-up, interventional procedure, percutaneous or endoscopic, surgery) according to practical cases.
- To describe the most common appearance (nodular, infiltrating) on US, CT, MRI, and endoscopic US of pancreatic adenocarcinoma and be able to perform staging in order to choose a treatment.
- To be able to describe the usual appearance of cystic tumours of the pancreas, mainly serious and mucinous cystadenoma, intraductal mucinous tumor, and rare cystic tumors. To be able to give initial indication for tumor characterisation.
- To be able to describe the main techniques for pancreatic surgery and their usual complications.

3 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

3.1. Patient information and examination conduct

- To be able to tailor the examination protocol to the clinical question.
- To be able to justify and explain the indication and the examination conduct to the patient.
- To be able to obtain fully informed consent.
- To be able to inform the patient of the results of the examination and to be able to evaluate the patient's understanding.

3.2. Reporting

- To be able to make a precise and concise description of the imaging signs present.
- To be able to answer the clinical problem and make a conclusion accordingly.
- To be able to suggest additional imaging examinations when needed, using appropriate justification.
- To be able to maintain good working relationships with refering clinicians.
- To be able to code the findings of examinations.

3.3. Imaging techniques - General requirements

- To know the indications and contra-indications of the various imaging examinations in abdominal imaging.
- To be able to indicate to the refering physician the most appropriate imaging examination according to the clinical problem.
- To be able to determine the best contrast material and its optimal use according to the imaging technique and the clinical problem.
- To be able to evaluate the quality of the imaging examinations in abdominal imaging.
- To know the relative cost of the various imaging examinations in abdominal imaging.
- To understand the radiation burden and risks of different investigations.

3.4. Imaging techniques - Specific requirements

3.4.1. Plain abdominal film

- To know the three basic indications for plain abdominal film.
- To be able to diagnose pneumoperitoneum, mechanical obstruction and pseudo obstruction, toxic dilatation of the colon, gas in small and large bowel wall indicating ischaemia and necrosis, pancreatic and biliary calcifications, and aerobilia on plain abdominal films.

3.4.2. X-ray examination of the upper gastrointestinal tract

- To know how to perform an X-ray examination of the upper gastrointestinal tract and to determine the most appropriate contrast material.
- To know how to perform both single and double contrast studies as well as motility assessments. To understand the principles and limitations of these studies and their advantages and disadvantages compared to endoscopy.
- To understand the technique and indications of video-fluoroscopy of the swallowing mechanism in conjunction with speech therapy and ENT.
- To know how to perform small bowel follow through and enteroclysis, including catheter placement beyond the ligament of Treitz. To appreciate the importance and degree of filling and distension of small bowel loops.
- To be able to interpret a small bowel series, to recognise normal findings and to be able to recognise the various segments of the small bowel.

3.4.3. X-ray examination of the lower gastrointestinal tract

- To be able to perform a double contrast barium enema.
- To be able to perform a single contrast enema.
- To know how to catheterise a stoma for colon opacification and how to perform pouchograms and loopograms.
- To understand the indication and technique to be used in an instant enema.
- To know the indications and contraindications for enema techniques and to be able to determine the optimal contrast material and technique to be used in each clinical situation.
- To be able to interpret an enema, to know the normal findings and recognise the anatomical components of the rectum and colon.

3.4.4. Sonography

- To be able to perform an ultrasound examination of the liver, gall bladder biliary tree, pancreas, and spleen.
- To be able to perform a duplex Doppler study of the abdominal vessels. To know the normal findings of the duplex Doppler study of the hepatic artery, superior mesenteric artery, portal vein, and hepatic veins.
- To be able to perform a sonographic study of the gastrointestinal tract and to identify the various portions (stomach, duodenum, small bowel, appendix, and colon).
- To recognise the retroperitoneal structures and understand the application and limitations of sonography in this area.
- To understand the strengths and limitations of endosonography, particularly in the oesophagus, pancreas, rectum and anal canal.

3.4.5. Computed tomography

- To be able to perform a CT examination of the abdomen and to tailor the protocol to the specific organ or clinical situation to be studied. To be able to determine if intravenous administration of a contrast material is needed. To determine the optimal protocol for the injection of contrast (rate of injection, dose, delay). To know the various phases (plain, arterial-dominant, portal-dominant, late phase) and their respective values according to the clinical problem.
- To be able to determine the best contrast material for imaging a specific gastrointestinal segment according to the clinical problem (water, air, fat, iodine or barium containing contrast materials).
- To know the techniques for CT Colonography. To be aware of the potential of CT enteroclysis.
- To understand the technique and limited indication for CT Cholangiography.
- To have experience of the use of workstations for multiplanar reconstructions (MPR) and 3D reconstruction based around volume data sets.

3.4.6. Magnetic resonance imaging

- To be able to perform an MR examination of the liver, the biliary tract and the pancreas. To be able to tailor the protocol to the specific organ to be studied. To be able to determine if intravenous administration of a contrast material is needed. To determine the optimal protocol for the injection (rate of injection, dose, delay). To know the various phases (plain, arterial-dominant, portal-dominant, late phase) and their respective values according to the clinical problem.
- To know the various contrast materials that can be used for MR examination of the liver and their individual uses.
- To be able to perform an MR examination of the biliary tree and the pancreatic duct. To know the single shot fast spin echo technique (SSFSE) and to be able to place the various planes on the axial image.
- To be able to perform an MR examination of the gastrointestinal tract. To be aware of a potential of MR enteroclysis. To know the basic protocol for MR examination of the anorectum.

3.4.7. Interventional imaging

- To know the basic techniques for percutaneous drainage of abdominal collections using CT and ultrasonography.
- To know the basic rules of percutaneous biopsy of the liver (indications, contraindications) and other organs under sonographic and CT guidance.
- To know the basic principles for angiography of the abdominal arteries (including indications, contraindications). To be able to identify the hepatic artery and its main anatomical variants, the superior and inferior mesenteric artery, and the portal vein.
- To know the basic principles for selective embolisation of the abdominal arteries (including indications, contra-indications).
- To know the technique of percutaneous gastrostomy under image guidance.
- To know the techniques for percutaneous biliary intervention.
- To understand the technique for radiological guided stenting of the biliary system and gastrointestinal system, using PTFE and expandable metal stents.

3.4.8. Miscellaneous

- To know the indications, strengths and limitations of the other imaging techniques (including endoscopy, endosonography, nuclear medicine (including PET) in abdominal imaging).

4 – CONFERENCES

As part of the curriculum in abdominal radiology, the trainee should attend in-house teaching sessions for radiologists as well as clinical conferences with colleagues from other specialties. The latter type of conference should be included to facilitate the radiology residents' understanding of the use of imaging and clinical circumstances, in which imaging is requested.

The following list gives examples of the types of conferences that should be considered part of the curriculum:

1. Abdominal radiology resident-specific teaching conference
2. Internal medicine/gastroenterology conferences
3. Surgery/abdominal surgery conferences
4. Oncology conferences
5. Pathology conferences

5 – TEACHING MATERIAL AND SUGGESTIONS FOR READING

The following English textbooks are recommended to answer all questions and address all objectives defined in the curriculum of abdominal radiology. One of these books (title) serves as "bench book", i.e. it is valid for all training programmes across Europe and aims at unification and standardisation of Radiology training in Europe. It is very important that "bench books" be available in the radiology department and the library of each institution.

- Gore RM, Levine MS. Textbook of Gastrointestinal Radiology (2nd Edition). WB Saunders, Philadelphia, 2000.
- Eisenberg RL. Gastrointestinal Radiology – A Pattern Approach (4th Edition). Lippincott, Philadelphia, 2003
- Abdominal radiology book(s) in local language.

Head and Neck Radiology

(Including Maxillo-Facial and Dental Radiology)

1 – INTRODUCTION

The head and neck imaging curriculum describes:

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

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

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

2 – CORE OF KNOWLEDGE

2.1. Normal anatomy

- Temporal bone
- Facial skeleton, skull base and cranial nerves
- Orbit and visual pathways
- Sinuses
- Pharynx
- Oral cavity
- Larynx
- Neck
- Mandible, teeth and temporomandibular joints
- Salivary glands
- Deep spaces of the face and neck
- Thoracic inlet and brachial plexus
- Thyroid gland and parathyroid glands

2.2. Temporal bone

- To know pathologic conditions defining deafness
- To know and recognise on CT and MRI
  - Temporal bone inflammatory disease
  - Temporal bone fractures
  - Tumors of the temporal bone and cerebello-pontine angle
- To know vascular tinnitus

2.3. The facial skeleton, skull base and cranial nerves

- To know and be able to recognise on CT and MRI
  - Inflammatory conditions
  - Tumors and tumor-like conditions
  - Trauma and resulting complications
  - Major pathologic conditions involving the cranial nerves

2.4. Orbit and visual pathways

- To know
  - Orbital pathology
  - Pathology of the visual apparatus

2.5. The sinuses

- To know and be able to recognise on CT anatomical variations and congenital anomalies of the paranasal sinuses
- To know and be able to recognise on CT and MRI inflammatory conditions, tumors and tumor-like conditions
- To be familiar with common (Functional Endoscopic Sinus Surgery) techniques
- To know how to evaluate the paranasal sinuses after surgery

2.6. The pharynx

- To know and be able to recognise on US, CT and MRI the pathologic conditions of:
  - nasopharynx
  - oropharynx
  - hypopharynx

2.7. The oral cavity

- To know and be able to recognise on US, CT, MRI and videofluoroscopy the pathologic conditions of the oral cavity.

2.8. The larynx

- To know and be able to recognise on CT and MRI the pathologic conditions of the larynx.

2.9. The neck

- To know and be able to recognise on US, CT and MRI
  - Embryology and congenital cystic lesions
  - The clinical significance of lymph nodes, metastatic, inflammatory, and infectious disease
  - Non-nodal masses of the neck.
- To know and be able to recognise on US, CT, CT-angiography, MRI, MRI-angiography and conventional angiography vascular diseases.

2.10. The mandible, teeth, and temporomandibular joints

- To know and be able to recognise on orthopantomography, CT, MRI, and dental radiographs pathologic conditions of the mandible.
- To get familiarity with dental implants and dental CT programmes.
- To know pathologic conditions of the temporo-mandibular joint.

2.11. The salivary glands

- To know and be able to recognise on US, CT, MRI and MR-sialography inflammatory disorders and tumors.
- To know and be able to recognise on US, Doppler US, CT and MRI vascular malformations.
- To know and be able to recognise on US, CT and MRI periglandular lesions and recognising these on US, CT, MRI.

2.12. The deep spaces of the face and neck

- To know the anatomy of the deep cervical fascia and of the most common pathologic conditions involving the different spaces of the supra- and infrahyoid neck.

2.13. The thoracic inlet and the brachial plexus

- To know and be able to recognise on CT and MRI the most common pathologic conditions of the thoracic inlet and brachial plexus.

2.14. The thyroid gland and the parathyroid glands

- To know and be able to recognise on US, Doppler US, CT and MRI
  - Congenital lesions
  - Inflammatory lesions
  - Benign thyroid masses
  - Malignancies of the thyroid gland
  - Pathologic conditions of the parathyroid glands.
- To be familiar with the most important findings of Tc-99m-scintigraphy in specific disease of the thyroid gland.
- To be able to perform fine needle aspiration biopsy in easy cases.

3 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

Diagnostic procedures:
Skull radiography + special views: 50
Sinus radiography: 50
Head and neck CT (including Dental CT): 100
Head and neck MRI: 50
Ultrasound of head and neck: 50

3.1. **At the end of the 4th year** the resident should be able to carry out or supervise the following techniques to a level appropriate to practice in a general hospital. This competence should include the ability to evaluate and justify referrals for the purpose of protection of the patient.

- Radiography of the skull, sinus, skull base, and facial bones including special views
- Imaging of swallowing including dynamic functional studies
- Orthopantomography (OPG)
- Ultrasound of the neck, tongue, and salivary glands
- Percutaneous biopsy, guided by ultrasound, CT and/or MRI in straightforward/ technically easy cases
- Doppler ultrasound
- CT of the face, skull base and neck
- MRI of the face and neck
- Angiography, including digital subtraction or CT angiography
- Dental radiology, including the use of CT.

3.2. The trainee should also have knowledge of orthopantomography and experience of lymph node aspiration biopsies.

3.3. At the end of his/her training the resident should be able to:

3.3.1. Dictate intelligible and useful reports. The reports should contain a brief description of the imaging findings and their significance along with a short summary where necessary.

3.3.2. Recommend the appropriate use of imaging studies to refering clinicians.

33.3. Demonstrate the ability to present head and neck examinations effectively in a conference setting.

3.3.4. Significant and radiologic findings with refering clinicians and know when to contact a clinician.

Interventional Radiology

1 – INTRODUCTION

Interventional Radiology is a vibrant and dynamic specialty in which, unfortunately, trainees have variable exposure to radiology during training. It is important that radiology trainees develop the basic skills in interventional radiology, irrespective of whether they specialise in interventional radiology. Basic skills and a core programme of knowledge will allow the trainees to perform routine procedures using image guidance throughout their careers. This can only serve to strengthen the specialty of radiology as a whole.

The following is an attempt to develop a core programme of knowledge for trainees in interventional radiology. It is clear that there is some overlap with some other sections in the diagnostic radiology syllabus, but it is nevertheless important to define a core programme for interventional radiology.

Lengh of training
In order for the trainee to achieve basic skills and core knowledge in interventional radiology, four to six months of dedicated time in interventional radiology will be required during basic training.

2 – CORE OF KNOWLEDGE

It is expected that, at the end of residency, the trainee will have a thorough knowledge of the performance and interpretation of diagnostic vascular techniques and a basic understanding of common interventional procedures.

2.1. Non-Invasive Vascular Imaging

2.1.1. Doppler Ultrasound

The trainee should demonstrate a thorough understanding and be able to interpret the following:
- Duplex ultrasound, including both arterial and venous examinations
- Normal and abnormal Doppler waveforms
- Common Doppler examinations, such as carotid Doppler, hepatic and renal Doppler studies and lower extremity venous duplex examinations.

2.1.2. CT Angiography

The trainee should have a thorough understanding of:
- The basic physics of single slice helical CT and multi-detector CT
- CTA protocols including contrast materials used and reconstruction techniques
- Radiation doses for CTA and methods to reduce these
- Advantages and disadvantages of CTA versus other techniques.

2.1.3. MR Angiography (MRA)

The trainee should be familiar with:
- MR physics and MRA techniques
- Advantages and disadvantages of different contrast materials used for MRA
- Differences between time of flight, phase contrast, and contrast-enhanced techniques pertaining to MRA
- Advantages and disadvantages of MRA compared to other techniques.

2.2. Diagnostic Angiography/Venography

2.2.1. General

The trainee should be familiar with:
- The basic chemistry of the different iodinated contrast materials used, and the advantages/disadvantages of each for angiography
- Mechanisms to minimise nephrotoxicity in risk patients, such as patients with diabetes or renal impairment
- Cortico-steroid prophylaxis
- Treatment of both minor and major allergic reactions to iodinated contrast materials.

2.2.2. Arterial Puncture Technique

The Trainee should have a thorough knowledge of:
- Standard groin anatomy, including the position of the inguinal ligament and the femoral nerve, artery and vein
- The Seldinger technique of arterial and venous puncture
- Mechanisms for guidewire, sheath and catheter insertions into the groin
- Mechanisms of puncture site haemostasis including manual compression and common closure devices
- Alternative sites of arterial puncture, such as brachial, axillary and translumbar.

2.2.3. Diagnostic Angiography

The trainee should be familiar with:
- Guidewires, sheaths and catheters used for common diagnostic angiographic procedures
- Digital subtraction angiographic techniques,

bolus chase techniques, road mapping, and pixel shift techniques
- Standard arterial and venous anatomy and variations in anatomy throughout the body
- Peripheral vascular angiography
- Mesenteric and renal angiography
- Abdominal aortography
- Thoracic aortography
- Carotid, vertebral and subclavian angiography
- Diagnosis of atherosclerotic disease, vasculitis, aneurysmal disease, thrombosis, embolism and other vascular pathology
- The complication rates for common diagnostic procedures
- Post-procedural care regimens for standard diagnostic vascular procedures.

2.3. Vascular Intervention

The trainee should be familiar with common vascular interventional procedures, such as:

2.3.1. Angioplasty

- Angioplasty balloon dynamics, mechanism of action of angioplasty
- Indications for angioplasty
- Complications and results in different anatomic areas
- Drugs used during angioplasty
- Intra-arterial pressure studies
- Common angioplasty procedures, such as renal, iliac and femoral angioplasties
- Groin closure techniques and post-procedural care.

2.3.2. Arterial/Venous Stenting

- Basic mechanisms for stent deployment and materials used for stent construction
- Indications for stent placement versus angioplasty
- Complications and results
- Post-procedural care.

2.4. Venous Intervention

2.4.1. Venous Access

The trainee should be familiar with the various forms of venous access including:
- PICC lines, Hickman catheters, dialysis catheters and ports
- Indications for use of the above venous access catheters
- The technique of venous access in jugular and subclavian veins
- Results and complications.

2.4.2. Venoplasty and Stenting.

The trainee should be familiar with:
- Techniques of venoplasty and stenting
- Success rates and complications
- Post-procedural care.

2.4.3. Caval Interruption

The trainee should be familiar with:
- Indications for caval filter placement
- Different filter types available, including retrievable filters
- Success rates and complications
- Post-procedural care.

2.5. Non-Vascular Intervention

Trainees should have performed and have a thorough understanding of basic non-vascular interventional techniques, such as biopsy, abscess drainage, transhepaticholangiography and nephrostomy techniques.

2.5.1. Biopsy

The trainee should be familiar with:
- Consent procedures
- Pre-procedure coagulation tests and correction of abnormalities
- Differences in image modalities used for guiding biopsy, including CT and ultrasound
- Needles used for biopsy procedures including fine gauge needles, large gauge needles and trucut biopsy
- Planning a safe access route to the lesion to be biopsied
- Complication rates associated with individual organ biopsy
- Indications for fine needle biopsy versus large gauge or core biopsy
- Post-procedural care for chest and abdominal biopsy
- Algorithms for treatment of common complications, such as pneumothorax and hemorrhage.

2.5.2. Fluid Aspiration and Abscess Drainage.

The trainee should be familiar with:
- Commonly used chest tubes and abscess drainage catheters

- Indications for chest drainage, fluid aspiration, and abscess drainage
- Imaging modalities used for guidance
- Interpretation of gram stain results
- Methods of chest tube placement
- Underwater seal drainage systems
- Fibrinolytic agents used in patients with loculated or complex empyemas
- Planning a safe access route for abscess drainage
- Antibiotic regimens used before abscess drainage
- Trocar and Seldinger techniques for catheter placement
- Situations where more than one catheter or larger catheters are required
- Various approaches to pelvic abscess drainage
- Post-procedural care including catheter care, ward rounds and when to remove catheters.

2.5.3. Hepatobiliary Intervention

The trainees should have knowledge of, and be able to perform basic hepatobiliary intervention, such as, transhepaticholangiography and basic percutaneous biliary drainage (PBD).

The trainee should be familiar with:

- Pre-procedure workup, including antibiotic regimens, coagulation screening and intravenous fluid replacement
- Performance of transhepaticholangiography
- One-stick needle systems for biliary drainage
- Catheters used for biliary decompression
- Complications of biliary procedures
- Aftercare, including knowledge of complications, catheter care, and ward rounds.

2.5.4. Genitourinary Intervention

The trainee should be familiar with:

- Indications for percutaneous nephrostomy
- Integration of ultrasound, CT and urographic studies to plan an appropriate nephrostomy
- Pre-procedural work-up including coagulation screens and antibiotic regimens
- Ultrasound/fluoroscopic guidance mechanism for percutaneous nephrostomy
- Catheters used for percutaneous nephrostomy
- Placement of percutaneous nephrostomy tubes
- Complications of percutaneous nephrostomy
- Aftercare, including catheter care and removal.

3 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

The goals of basic training in interventional radiology are as follows:

- The trainee should be able to interpret non-invasive imaging studies to determine that the requested procedure is appropriate.
- To determine the appropriateness of patient selection for a requested interventional procedure through a review of available history, imaging, laboratory values, and proposed or expected outcomes of the procedure.
- To demonstrate an understanding of the history or physical findings that would require pre-procedure assistance from other specialty disciplines, such as Cardiology, Anaesthesia, Surgery or Internal Medicine.
- To obtain informed consent after discussion of the procedure with the patient, including a discussion of risks, benefits, and alternative therapeutic options.
- To be familiar with monitoring equipment used during interventional radiology procedures and be able to recognise abnormalities and physical signs or symptoms that need immediate attention during the procedure.
- To demonstrate an understanding of and be able to identify risk factors from the patient's history, physical or laboratory examinations that indicate potential risk for bleeding, nephrotoxicity, cardiovascular problems, breathing abnormalities, or adverse drug interactions during or after the procedure.
- Knowledge of agents used for conscious sedation and analgesia during interventional procedures, with ability to identify risk factors that may indicate potential risks for conscious sedation.
- Knowledge of radiation safety in the interventional radiology suite.
- Knowledge of methods used to reduce accidental exposure to blood and body fluids in the Interventional Radiology Suite.

Musculoskeletal Radiology

1 – INTRODUCTION

Musculoskeletal imaging involves all aspects of medical imaging which provide information about the anatomy, function, disease states and those aspects of interventional radiology or minimally invasive therapy appertaining to the musculoskeletal system. This will include imaging in orthopaedics, trauma, rheumatology, metabolic and endocrin disease as well as aspects of paediatrics and oncology. Imaging of the spine is included within both the musculoskeletal and neuroradiological fields. It should be noted that elements of musculoskeletal imaging are part of paediatric and emergency radiology and to a lesser extent of oncological imaging.

2 – CORE OF KNOWLEDGE

- Basic clinical knowledge, that is medical, surgical and pathology as well as pathophysiology related to the musculoskeletal system
- Knowledge of current good clinical practice
- Knowledge of the indications, contraindications and potential hazards (especially radiation hazards) of procedures and techniques relevant to musculoskeletal disease and trauma
- Knowledge and management of procedural complications
- Knowledge of musculoskeletal anatomy in clinical practice relevant to clinical radiology
- Knowledge of normal skeletal variants, which may mimic disease
- Knowledge of the manifestations of musculoskeletal disease and trauma (see list below), as demonstrated by conventional radiography, CT, MRI, arthrography, radionuclide investigations, and ultrasound
- Knowledge of differential diagnosis relevant to clinical presentation and imaging appearance of musculoskeletal disease and trauma as listed below.

The following manifestations of musculoskeletal disease and trauma have to be covered during the general radiological training. This should include formal teaching and exposure to clinical case material.

2.1. Trauma (acute & chronic)

2.1.1. Fractures & Dislocations

- types and general classifications
- features in the adult skeleton
- features in the immature skeleton* (including normal development)
- articular (chondral & osteochondral)(including osteochondritis dissecans)
- healing & complications
  - delayed union/non-union
  - avascular necrosis
  - reflex sympathetic dystrophy
  - myositis ossificans
- stress (fatigue & insufficiency)
- avulsion
- pathological
- non-accidental injury*

2.1.2. Specific Bony/Joint Injuries

- skull & facial bone fractures
- spinal fractures (including spondylolysis)
- shoulder girdle
  - sternoclavicular & acromioclavicular dislocations
  - clavicular fractures
  - scapular fractures
  - shoulder dislocation/instability
- upper limb
  - humeral fractures
  - elbow fractures/dislocations
  - proximal & distal forearm fractures/dislocations
  - wrist joint fractures/dislocations
  - hand fractures/dislocations
- pelvic fractures/dislocations (including associated soft tissue injuries)
- lower limb
  - hip fractures/dislocations
  - femoral fractures
  - tibial & fibular fractures (including ankle joint)
  - hindfoot fractures
  - tarso-metatarsal fractures/dislocations
  - forefoot fractures/dislocations

2.1.3. Soft Tissues

- shoulder
  - rotator cuff, glenoid labrum, biceps tendon
- wrist
  - triangular fibrocartilage complex
- knee
  - menisci, cruciate ligaments, collateral ligaments
- ankle
  - principal tendons & ligaments

2.2. **Infections**
- acute, subacute & chronic osteomyelitis
  - spine
  - appendicular skeleton
- post-traumatic osteomyelitis
- tuberculosis
- spine
- appendicular skeleton
- rarer infections (eg. leprosy, brucellosis – main manifestations only)
- commoner parasites worldwide (e.g. echinococcus)
- soft tissue infections
- HIV-associated infections

2.3. **Tumors & tumor-like lesions**

2.3.1. Bone
- principles of tumor characterisation and staging
- bone-forming
  - osteoma & bone islands
  - osteoid osteoma & osteoblastoma
  - osteosarcoma (conventional and commoner variants)
- cartilage-forming
  - osteochondroma
  - enchondroma
  - chondroblastoma
  - chondromyxoid fibroma
  - chondrosarcoma (central & peripheral)
- fibrous origin
  - fibrous cortical defect/non-ossifying fibroma
  - fibrous dysplasia
  - fibrosarcoma/malignant fibrous histiocytoma
- haematopoietic and reticuloentholelial
  - giant cell tumor
  - Langerhans cell histiocytosis
  - malignant round cell (Ewing's sarcoma, lymphoma & leukaemia)
  - myeloma & plasmacytoma
- tumor-like
  - simple bone cyst
  - aneurismal bone cyst
- metastases
- others
  - chordoma
  - adamantinoma

2.3.2. Soft Tissue
- fat origin
  - lipoma
  - liposarcoma
- neural origin
  - neurofibroma
  - schwannoma
- vascular origin
  - haemangioma
- soft tissue sarcomas

2.4. **Haematological disorders**
- haemoglibinopathies
  - sickle cell disease
  - thalassaemia
- myelofibrosis

2.5. **Metabolic, endocrine & toxic disorders**
- rickets* & osteomalacia
- primary & secondary hyperparathyroidism (including chronic renal failure)
- osteoporosis (including basic concepts of bone mineral density measurements)
- fluorosis

2.6. **Joints**
- degenerative joint disease
  - spine (including intervertebral disc & facet joints)
  - peripheral joints
- inflammatory joint disease
  - rheumatoid arthritis
  - juvenile rheumatoid arthritis*
  - ankylosing spondylitis
  - psoriatic arthritis
  - enteropathic arthropathies
  - infective (pyogenic & tuberculous)
- crystal arthropathies
  - pyrophosphate arthropathy
  - hydroxyapatite deposition disease
  - gout
- masses
  - ganglion
  - synovial chondromatosis
  - pigmented villonodular synovitis
- neuroarthropathy
  - diabetic foot
  - charcot joints
  - pseudo-Charcot (steroid induced)
- complications of prosthetic joint replacement (hip & knee)

2.7. **Congenital, developmental & paediatric***
- spine
  - scoliosis (congenital & idiopathic)
  - dysraphism

- shoulder
  - Sprengel's deformity
- hand & wrist
  - Madelung deformity (idiopathic & other causes)
- hip
  - developmental dysplasia
  - irritable hip
  - Perthes disease
  - slipped upper femoral epiphysis
- bone dysplasias
  - multiple epiphyseal dysplasia
  - achondroplasia
  - osteogenesis imperfecta
  - sclerosing (osteopetrosis, melorheostosis & osteopoikilosis)
  - tumor-like (diaphyseal aclasis & Ollier's disease)
  - neurofibromatosis

2.8. **Miscellaneous**

- Paget's disease
- sarcoidosis
- hypertrophic osteoarthropathy
- transient or regional migratory osteoporosis
- osteonecrosis
- characterisation of soft tissue calcification/ossification

* These topics may or may not be covered in the paediatric component of the radiologists´ training. It is the responsibility of the director of each training scheme to ensure that the topics are adequately covered in either the paediatric or musculoskeletal components.

3 – TECHNIQUE, COMMUNICATION AND DECISION-MAKING SKILLS

3.1. **Core of skills**

- supervising and reporting plain radiographic examinations relevant to the diagnosis of disorders of the musculoskeletal system including musculoskeletal trauma
- supervising and reporting CT of the musculoskeletal system including trauma
- supervising and reporting MRI of the musculoskeletal system including trauma
- performing and reporting ultrasound of the musculoskeletal system including trauma
- supervising and reporting CT and MRI examinations of trauma patients, including the provision of on-call service
- communicating with patients and taking history relevant to the clinical problem
- using all available data (clinical, laboratory, imaging) to find a concise diagnosis or differential diagnosis.

3.2. **Core of experience**

- experience of the relevant contrast medium examinations (e.g. arthrography)

Optional experience includes:

- reporting radionuclide investigations of the musculoskeletal system, particularly skeletal scintigrams
- awareness of the role and, where practicable, the observation of discography, facet joint injections, and vertebroplasty
- observation of image-guided bone biopsy and drainage of the musculoskeletal system
- interpretation of bone densitometry examinations
- familiarity with the application of angiography in the musculoskeletal system

Neuroradiology

1 – INTRODUCTION

The aim of this core training is for the trainees to familiarise themselves and gain core competence in the basics of neuroradiology as well as to develop enough understanding of neuroradiology so as to be able to recognise that there is an abnormality and to know where and when to seek help. It should be undertaken under the supervision of a neuroradiologist. Arrangements should be made within the training scheme for secondment to another department if necessary. Exposure to all imaging techniques used in neuroradiology should be achieved.

2 - CORE OF KNOWLEDGE

2.1. To know:
- Neuroanatomy and clinical practice relevant to neuroradiology
- The manifestations of CNS disease as demonstrated on conventional radiography, CT, MRI, and angiography.

2.2. To understand the indications for a neuroradiological examination.

2.3. To recognise normal results on x-ray, ultrasound, CT, and MR.

2.4. To be aware of the applications, contraindications and complications of invasive neuroradiological procedures.

2.5. To get familiarity with the application of:
- Radionuclide investigations in neuroradiology
- CT and MR angiography in neuroradiology

2.6. To get basic competence in the following:

2.6.1. Trauma
- Skull and facial injury
- Intracranial injury, including child abuse and the complications
- Spinal cord injury

2.6.2. Developmental anomalies
- Brain anomalies
- Spinal cord malformations

2.6.3. Tumors of the brain, orbits and spinal cord

2.6.4. Vascular disease including congenital and acquired malformations

2.6.5. Degenerative diseases of the brain

2.6.6. Hydrocephalus

3 - TECHNIQUE, COMMUNICATION AND DECISION-MAKING SKILLS

3.1. At the end of his/her training, the resident should be able to:
- Report plain radiographs in the investigation of neurological disorders
- Supervise and report cranial and spinal CT scans
- Supervise and report cranial and spinal MR scans.

3.2. During his/her training, the resident should also observe:
- Cerebral angiograms and their reporting
- Carotid ultrasound examination including Doppler.

3.3. The resident should get experience in MR and CT angiography and venography to image the cerebral vascular system

3.4. Optional experience includes the following:
- To perform and report cerebral angiograms, myelograms and carotid ultrasound, including Doppler and transcranial ultrasound
- To observe interventional neuroradiological procedures, including magnetic resonance spectroscopy
- To get experience on functional brain imaging techniques (radionuclide and MRI).

Paediatric Radiology

1 – INTRODUCTION

The aim of this core training is for the trainee to gain basic understanding of children's diseases and basic competence of paediatric diagnostic imaging in order to be able to recognise whether there is an abnormality and to know where to seek help. It should be undertaken under the supervision of a paediatric radiologist. Arrangements should be made within the training scheme for secondment to another department if necessary. Exposure to all imaging techniques, including nuclear medicine, should be achieved.

Paediatric Radiology covers all the organ disciplines as described in the other curricula but is age-related. A child is defined as a person under 16 years of age. As the child approaches adulthood, disease patterns become more similar to those in adult life. Paediatric Radiology encompasses diagnostic imaging of the fetus, the newborn, the infant, the child, and the adolescent.

2 – CORE OF KNOWLEDGE

In the twelve-week course, in addition to acquiring knowledge of the paediatric organ system, the trainee is expected to also acquire a basic understanding of the following:

- Principles of integrated imaging in relation to paediatric problems
- Choice of useful imaging technique(s) for common clinical questions
- Correct sequence of imaging in relation to the clinical problem
- Adaptation of imaging techniques for children, i.e. minimising radiation, especially in relation to CT and fluoroscopy; indications for and choice of contrast media
- Special requirements for children, e.g. environment, sedation and anaesthesia, physiology of the young infant, and psychology of managing children
- Communication with the children and their parents, as well as medical colleagues; Importance of clinico-radiological conferences, both formal and informal
- Guidelines for investigation of common clinical problems and understanding of risk/benefit analysis related to children
- Radiation protection, equipment, and regulation.

2.1. Imaging techniques

The emphasis throughout the attachment is to appreciate the differences between children and adults. All work should be closely supervised and, ideally, a log book kept.

2.1.1. *Ultrasound:* This should include duplex, colour and Doppler techniques and the full age range, including premature infants. The trainee should perform the ultrasound examinations under supervision. The experience should include exposure to the following areas:

- Neonatal head
- Abdomen: kidneys and urinary tract; liver and spleen; gynaecology
- Chest: pleurae
- Soft tissues: neck, scrotum, musculoskeletal system
- Doppler studies: neck and abdomen, testes

2.1.2. *Radiographs:* Supervised reporting of children's radiographs, especially in relation to A. & E. presentation, musculoskeletal system, chest, and abdomen.

2.1.3. *Fluoroscopy:* Discussion of indications for gastrointestinal fluoroscopy versus specialist paediatric endoscopy with supervisor before initiating studies. Performing studies under direct supervision.

- Technique of bladder catheterisation and performance of micturition cystourethrography (MCU)
- Observation and conduct of upper and lower G.I. contrast studies in neonates
- Tailored upper and lower gastrointestinal contrast studies in children for investigation of gastro-oesophageal reflux, aspiration and constipation in neurologically normal and impaired children
- Observation of intussusception reduction
- Observation of videophonetics if locally performed.

2.1.4. *Small and large Bowel Studies*

2.1.5. *Urography:* To understand the indications for intravenous (iv) and MR urography; to know how to conduct the iv urography in children.

2.1.6. *CT:* To understand the technique in a paediatric trauma patient and the special low dose imaging protocols in general use. Experience of CT of the head and neck, abdomen, chest and musculoskeletal system, especially in a trauma patient, should be gained as far as possible.

2.1.7. *MR:* The experience in MR by observation should include neuroimaging (brain and spinal cord), abdominal and musculoskeletal imaging.

2.1.8. *Nuclear Medicine:* To gain experience in renal imaging – both DMSA scintigraphy and renography, possibly MAG3, and skeletal imaging.

2.1.9. *Angiography and Interventional Radiology:* Understanding of indications and observation of techniques according to local possibilities.

2.1.10. *Fetal Imaging:* If the opportunity arises for exposure to fetal MR and antenatal ultrasound that familiarises the trainee with the indications for these techniques, this should be included. The trainee thus exposed should also gain an understanding of the multidisciplinary approach to the specific problems of fetal imaging.

2.2. Pathology

All the following sections should be cross-referenced to the core curricula for the other organ specialties, as in this section those diseases are emphasised that are specific to children. Many of the following pathological conditions are characteristic of childhood and should be included in differential diagnostic case discussion during the 12-week- training period.

2.2.1. *Chest:* Diseases of the tracheobronchial tree, lungs and pleura:

- Recognise the radiology of lobar, viral and specific organism infection and pulmonary abscess
- Recognise infiltrative lung disease
- Recognise the possibility of tuberculosis
- Be aware of opportunistic infection in immunocompromised children
- Recognise cystic fibrosis changes
- Recognise bronchiectasis
- Recognise a pleural effusion and empyema
- Recognise a pneumothorax
- Recognise complications of asthma
- Recognise premature lung disease and its complications
- Recognise and know how to investigate suspected inhaled foreign bodies
- Recognise mass lesions and know how to further investigate them, including congenital bronchopulmonary foregut malformation
- Recognise metastatic lung disease
- Know about specific clinical problems, such as stridor and recurrent infection
- Recognise and know how to assess chest trauma.

2.2.2. *Mediastinum*

- Recognise and know how to investigate a mediastinal mass in children.

2.2.3. *Diaphragm*

- Recognise diaphragmatic paralysis, eventration, and possible paralysis.

2.2.4. *Cardiovascular System*

- Recognise abnormal cardiac size and contours
- Recognise cardiac failure (left vs. right heart failure)
- According to local possibilities, get an understanding of the role of ultrasound, MR and angio-CT in the investigation of cardiac disease in children.

2.2.5. *Gastrointestinal Tract:*

- The investigation and imaging of congenital gastrointestinal malformations in the neonatal period and later. These include:
  - Oesophageal atresia
  - Tracheooesophageal fistula
  - Malrotation and situs anomalies
  - Duodenal obstruction (e.g. atresia and stenosis)
  - Hirschsprung's Disease
  - Duplication anomalies
- The investigation of neonatal bowel obstruction, e.g.
  - Hirschprung's Disease
  - Meconium ileus
  - Meconium plug syndrome
- The ultrasound appearance of pyloric stenosis

- Intussusception
- Inflammatory bowel disease in children
- Appendicitis
- Gastroenteritis
- Investigation of the following clinical problems:
  - Abdominal pain
  - Constipation
  - Malabsorption
  - Suspected bowel obstruction and ileus
  - The vomiting neonate
  - Abdominal trauma
- The investigation of an abdominal mass
- The management of ingested foreign bodies

2.2.6. *Hepatobiliary Disease*
- Approach to the investigation of neonatal jaundice
- Cause and investigation of jaundice in the older child
- Choledocholithiasis in children
- Congenital malformations of the biliary tree
- Trauma
- Hepatobiliary tumours

2.2.7. *Spleen*
- Trauma
- Haematological diseases
- Congenital syndromes associated with asplenia, polysplenia, etc.

2.2.8. *Pancreas*
- Trauma
- Pancreatitis
- Tumor involvement

2.2.9. *Endocrine Disease*

Understand the approach to the investigation of:
- Thyroid disorders in children
- Adrenal disorders in children including neuroblastoma
- Growth abnormalities and suspected growth hormone deficiency

2.2.10. *Genitourinary tract*
- Recognise the normal appearance of the organs in any imaging modality
- Understand the urethral anatomy of the boy
- Understand the clinical and biological criteria of UTI
- Be able to perform ultrasound of the urinary tract on infants including the use of Doppler
- Know when and how to perform a MCU and how to read it
- Detect and evaluate VUR
- Recognise renal abscess and pyonephrosis
- Recognise congenital urinary tract anomalies on ultrasound and understand their further evaluation
- Recognise hydronephrosis/hydroureteronephrosis on ultrasound and understand their further evaluation
- Recognise the urinary tract features and complications of spinal dysraphism and other neuropathies
- Recognise bladder exstrophy radiologically
- Know about indications for urodynamic studies
- Recognise Wilms' tumor and understand its further investigation
- Recognise pelvic and bladder tumors and their further investigations
- Recognise polycystic kidney disease; know about various forms
- Recognise urinary tract lithiasis and understand its investigation
- Understand the investigation of hematuria
- Be aware of renal manifestations of systemic disease
- Recognise the imaging features of nephrotic syndrome and glomerulonephritis.

2.2.11. *Gynecology*
- Recognise ovarian cysts, possible torsion and tumors in the child and adolescent
- Recognise neonatal presentation of ovarian cysts and hydro(metro)colpos
- Recognise genital and extragenital tumors and understand their investigation
- Be aware of cloacal and urogenital sinus anomalies
- Be aware of intersex anomalies arising in the neonate and at adolescence
- Recognise congenital uterine malformation
- Know how to investigate precocious and delayed puberty

2.2.12. *Breast Disease*
- Recognise the ultrasonic and MR appearances of breast cysts

2.2.13. *Testes*
- Recognise scrotal trauma
- Recognise and know how to evaluate testicular torsion
- To recognise epidydymo-orchitis

- Recognise testicular tumours
- Understand the investigation of undescended testes.

2.2.14. *The Musculoskeletal System*

Trauma

- Recognise normal variants that may be misinterpreted as pathology
- Recognise fractures of the limbs, pelvis, and spine
- Understand the Salter-Harris classification of fractures and recognise the therapeutic implications
- Recognise the bony lesions of child abuse
- Recognise sports injuries, such as avulsion fracture and enthesopathy
- Recognise soft tissue injury on X-ray, ultrasound, and MR
- Recognise a slipped upper femoral epiphysis
- Recognise Legg-Calvé-Perthes Disease.

Infection

- Recognise the imaging features of bone, joint, and soft tissue, including spinal infection
- Recognise juvenile discitis
- Recognise conditions that may mimic infection, such as SAPHO syndrome
- Recognise the complications of foreign body penetration
- Be familiar with tropical infection.

Congenital Disease

- Recognise congenital hip dysplasia on ultrasound and X-ray
- Gain an approach to the radiology of skeletal dysplasia and isolated congenital malformations
- Be aware of need for investigation of congenital and acquired scoliosis and muscular dystrophy.

2.2.15 *Rheumatology*

- Recognise the imaging features of juvenile arthritis and its differential diagnosis.

2.2.16. *Neurological Disease*

- Understand the indications for examination
- Recognise normal results on X-ray, ultrasound, CT, and MR
- Recognise trauma: skull and facial injury
- Understand intracranial injury, including child abuse and the complications
- Understand the indications for the investigation of headache, diplopia, and epilepsy
- Infection of the brain, meninges, orbits and sinuses, and the complications
- Hydrocephalus
- Tumors of the brain, orbits and spinal cord
- Premature brain disease on both ultrasound and MR
- Congenital malformation of brain and spinal cord
- Spinal cord injury
- Spinal cord malformations and imaging for clinical presentations, e.g. back pain, claw foot, or dermal sinus
- Be aware of developmental anomalies: migrational disorders
- Craniofacial malformations including craniostenosis
- Congenital ear disease
- Dental radiology.

2.2.17. *Miscellaneous*

These conditions are often multiorgan in presentation and are mentioned separately so that the trainee is aware of their protean manifestation.

- Non-accidental injury (NAI)
- AIDS in children
- Lymphoma in children
- Vascular malformations including lymphoedema
- Collagen vascular disease including myofibromatosis
- Endocrine disease
- Investigation of small stature and growth disorders
- Phakomatoses (tuberous sclerosis, neurofibromatosis, etc.)
- Langerhans Cell Histiocytosis

Urogenital Radiology

1 – INTRODUCTION

The aim of establishing a curriculum for training in urogenital imaging is to ensure trainees have acquired:

- Knowledge of the relevant embryological, anatomical, pathophysiological and clinical aspects of uronephrology and gynaecology
- Understanding of the major imaging techniques relevant to uronephrological and gynaecological diseases and problems
- Understand the role of radiology in the management of these specialist areas
- Knowledge of the indications, contra-indications, complications and limitations of procedures.

2 – CORE OF KNOWLEDGE

2.1. Urinary & male genital tract – Specific objectives

2.1.1. Renal physiology and kinetics of contrast agents

- To understand the physiology of renal excretion of contrast medium
- To understand the enhancement curves within renal compartments after injection of contrast agents
- To know the concentrations and doses of contrast agents used intravenously.

2.1.2. Normal anatomy and variants

- *Retroperitoneum:*
  - To recognise retroperitoneal spaces and pathways
- *Kidney:*
  - To understand the triple obliquity of the kidney
  - To know the criteria of normality of the pyelocaliceal system on IVU
  - To recognise normal variants, such as junctional parenchymal defect, column of Bertin hypertrophy, fœtal lobulation, or lipomatosis of the sinus
  - To identify the main renal malformations, such as horseshoe kidney, duplications, ectopia, or fusions.
- *Bladder and urethra:*
  - To know the anatomy of the bladder wall and physiology of micturion
  - To identify the segments of male urethra and location of urethral glands.
- *Prostate:*
  - To recognise zonal anatomy of the prostate
  - To identify prostatic zones with US and MRI.
- *Scrotum:*
  - To know the US anatomy of intra-scrotal structures (testicular and extratesticular)
  - To know the Doppler anatomy of testicular and extratesticular vasculature.

2.1.3. Imaging techniques

- Sonography of urinary tract
  - To choose the appropriate transducer according to the organ imaged
  - To optimise scanning parameters
  - To recognise criteria for a good sonographic image
  - To recognise and explain the main artifacts visible in urinary organs
  - To be able to get a Doppler spectrum on intrarenal vessels (for resistive index measurement) and on proximal renal arteries for velocity calculation.
- IVU
  - To list the remaining indications of IVU
  - To know the main technical aspects:
    . choice of the contrast agent
    . doses
    . film timing and sequences
    . indication for ureteral compression
    . indication of Frusemide.
- Cysto-urethrography
  - To list the main indications of cysto-urethrography
  - To know the main technical aspects:
  - Choice of technique: trans-urethral, trans-abdominal
  - Choice of the contrast agent
  - Film timing and sequences
  - To remember aseptic technique
- CT of the urinary tract
  - To define the normal level of density (in HU) of urinary organs and components
  - To know the protocol for a renal and adrenal tumor
  - To know the protocol for urinary obstruction (including stones)
  - To know the protocol for a bladder tumor
- MR of the urinary tract
  - To know the appearances of urinary organs on T1 and T2w images
  - To know the protocol for a renal and adrenal tumor

- To know the protocol for urinary obstruction
- To know the protocol for a bladder tumor
- To know the protocol for a prostatic tumor

2.1.4. Pathology

- Kidney and ureter
  - Congenital – covered under 2.1.2.
  - Obstruction
  - Calculus
  - Infection
  - Tumors
  - Cystic diseases
  - Medical nephropathies
  - Vascular
  - Renal transplantation
  - Trauma
- Bladder
  - Congenital – covered under 2.1.2.
  - Obstruction
  - Inflammatory
  - Tumors
  - Trauma
  - Incontinence & functional disorders
  - Urinary diversion
- Urethra
  - Congenital
  - Strictures
  - Diverticula
  - Trauma
- Prostate & Seminal Vesicles
  - Congenital
  - Benign prostatic hypertrophy
  - Inflammatory
  - Tumors
- Testis & scrotum
  - Congenital
  - Inflammatory
  - Torsion
  - Tumors
- Penis
  - Impotence
- Adrenal
  - Masses

2.1.5. Interventional

- In general
  - To verify indications, satisfactory blood count, and coagulation status
  - To explain the procedure and follow-up to the patient
  - To know what equipment is required
  - To know what aftercare is required.
- US-guided biopsies/cystic drainage, e.g. kidney mass, prostate
- CT-guided biopsies
- Percutaneous nephrostomy

2.2. Gynecological Imaging

2.2.1. Techniques

- US examination
  - To be able to explain the value of a US examination
  - To be able to explain the advantages and limits of abdominal vs. transvaginal approach
  - To know indications and contra-indications of hysterosonography.
- Hysterosalpingography
  - To be able to describe the procedure
  - To know the possible complications of hysterosalpingography
  - To know the contra-indications of hysterosalpingography
  - To explain the choice of contrast agent
  - To know the different phases of the examination.
- CT scan
  - To be able to explain the technique of a pelvic CT
  - To know the possible complications of CT
  - To know the contra-indications of CT
  - . To know the irradiation delivered by a pelvic CT
  - To know the required preparation of the patient and the choice of technical parameters (slice thickness, Kv, mA, number of acquisitions, etc.) depending on indications.
- MRI
  - To be able to explain the technique of a pelvic MRI
  - To know the contra-indications of MRI
  - To know the required preparation of the patient and the choice of technical parameters (slice thickness, orientation, weighting, etc.) depending on indications.
- Angiography
  - To know the main indications of pelvic angiography in women
  - To know how to perform a pelvic angiography

2.2.2. Anatomy

- To know main normal dimensions of uterus and ovaries with US
- To describe variations of uterus and ovaries during genital life
- To describe variations of uterus and ovaries during the menstrual cycle
- To describe normal pelvic compartments
- To identify normal pelvic organs and boundaries on CT and MRI
- To explain the role of levator ani in the physiology of pelvic floor
- To know what imaging modalities can be used to visualise the pelvic floor
- To know the factors responsible for urinary incontinence.

2.2.3. Pathology

- Uterus
  - Congenital anomalies
  - Tumors (benign and malignant)
    - myometrium
    - endometrium
    - cervix
  - Inflammation
  - Adenomyosis
  - Functional disorders
- Ovaries/Tubes
  - Ovary
    - Cysts
    - Tumours
    - Functional disorders, e.g. precocious puberty, polycystic ovaries
    - Endometriosis
  - Tubes
    - Inflammatory disorders
    - Tumors
- Pelvis
  - Prolapse
- Infertility

3 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

3.1. Before the examination

- To check the clinical information and risk factors (diabetes, allergy, renal failure, etc.)
- To validate the request and the choice of examination
- To know the specific preparation and protocols, if necessary
- To explain the examination to the patient and inform him/her about risks.

3.2. To validate the request based on

- Risk factors
- Irradiation involved
- Possible alternatives.

3.3. To perform the examination

- To know the clinical history and the clinical questions to be answered
- To know the protocol of examination
- To assess the anxiety of the patient before, during and after the examination, and provide appropriate reassurance.

3.4. Communication with the patient and the colleagues and recommendations for follow-up

- To explain clearly the results to the patient
- To assess the level of understanding of the patient
- To explain the type of follow-up
- To assess the degree of emergency
- To produce a clear report of the examination
- To discuss strategies for further investigation if necessary

Detailed Curriculum for Subspecialty Training

In the fourth and fifth years, the rotations of the radiologists in training should be organised to serve the individual's needs depending on the availability in the training programme, which may be in general radiology or in a subspecialty.

General radiology training in the fourth and fifth years is designed to enable the trainee to gain further experience, knowledge and skills in disorders that are present in general hospitals and private practice in order to reach a level required to undertake autonomous practice.

This period of training should include an extended period of time in a minimum of two areas of special interest so as to acquire more detailed knowledge and skills. General radiologists being in training in areas of special interest may wish to use the subspecialty curricula for guidance albeit recognising that they would not be required to fulfill all aspects of them.

For trainees entering a subspecialty, the total period of subspecialist training will vary according to the subspecialty but would normally be expected to be completed during the fourth and fifth years. For those subspecialties with a single year of subspecialty training, continued training in general radiology during the balance of time will be undertaken. Some subspecialty training may extend beyond the 5th year depending on national training arrangements relevant to their specialty programme.

Subspecialty training may be undertaken in a modular fashion during the fifth and/or fourth year(s) of training. Subspecialty training contains elements of choice to reflect the requirements of the trainee. It is also appreciated that training in the individual subspecialties may vary from center to center. It is recommended for subspecialty rotation that there be a minimum commitment of six sessions per week to subspecialty training. It will sometimes be appropriate to link system-based expertise with technique-based expertise.

Even within a subspecialty, there will be those individuals wishing to train in or have aptitude for certain areas at the relative expense of others. Thus, training in some centers and certain subspecialties may be delivered in a more modular fashion.

Formal teaching is organised on the basis of lectures, tutorials, and workshops. Whatever the chosen subspecialty will be, the trainees should maintain one or two sessions of relevant general radiology during the week in order to maintain basic skills and participate in and gain experience in emergency on-call work.

The curricula for selected subspecialties are included in this document. In general terms, trainees are expected to acquire the elements identified below.

- Detailed knowledge of current theoretical and practical developments in their chosen subspecialty (or subspecialties).
- Development of clinical knowledge relevant to their chosen subspecialty (or subspecialties).
- Extensive directly observed, or non-observed but supervised practical experience in their chosen subspecialty (or subspecialties).

In order to make the curriculum intelligible for each individual subspecialty as a stand-alone document, there is repetition of some of the generic points. These subspecialty curricula have been prepared by different European societies of specialty in radiology, for which the EAR (ESR) is very grateful. Inevitably certain compromise decisions have had to be taken, especially in the face of conflicting advice. Furthermore, each curriculum has had to conform to a uniform style.

Breast Radiology

1 – INTRODUCTION

The aim of subspecialised training in breast imaging is to prepare a radiologist for a career in which a significant portion of his/her time will be devoted to breast imaging and/or breast cancer screening with mammography. Such individuals will be expected to provide and promote breast imaging and interventional methods, as well as new imaging breast cancer screening procedures.

The aims of establishing a curriculum for subspecialty training in breast radiology is to ensure:

- An in-depth understanding of breast disease with particular knowledge of the nature of breast cancer in all its guises.
- A clear understanding of the role of imaging in the early diagnosis of breast cancer.
- Development of the necessary clinical and management skills to enable radiologists to become an integral part of a multidisciplinary breast team in symptomatic and/or population screening settings.

2 – EXPERTISE AND FACILITIES

- Training must be undertaken in a team with access to full clinical service in radiology, general surgery/gynecology and pathology. If possible, oncology, radiotherapy, plastic surgery, social and preventive medicine should also be offered.
- Training should be supervised by a radiologist with extensive experience in breast imaging and breast cancer screening methods (e.g. reporting 5,000 mammograms per year). The training department(s) should fulfill EU guidelines, must have mammography, ultrasonography and interventional equipment including stereotaxic and ultrasonically guided biopsy systems.
- Trainees should also have access to breast MRI, nuclear medicine and acquire knowledge of breast cancer screening.
- Trainees must also have access to a radiological library containing senology and radiology textbooks along with journals and must have access to a film library.

3 – OVERVIEW

- Trainees will have obtained a basic knowledge of breast diagnosis in their initial training. The training outlined below will extend this to the practical role.
- Those clinical radiologists who wish to devote essentially all their time as specialists/consultants in breast imaging should undertake 12 months or its equivalent of subspecialty training. Those who wish to practice breast imaging, as one out of a variety of activities would normally expect to undertake 6 months.
- Trainees will acquire an extensive knowledge of the pathology and epidemiology of breast diseases, both female and male and both primary, of local recurrence, as well as distant disease. They should have at least a basic knowledge of the treatment of breast disease by surgery, radiotherapy and chemotherapy and be aware of the diagnostic needs of their surgical, radiotherapy and oncology colleagues. It would therefore be helpful for trainees to spend time in breast clinics, operating theatres, as well as radiotherapy and oncology departments.
- Trainees also must develop skills in the use and interpretation of imaging modalities used in the diagnosis and treatment of the distant spread of a disease, e.g. plain radiographs, ultrasound, CT, MR, and nuclear medicine. They will receive training in communication with patients and colleagues and "breaking bad news".
- They must obtain extensive experience in all diagnostic procedures listed in the syllabus and will be expected to be familiar with the current breast imaging literature, both from standard textbooks and original articles.
- As audit is an integral part of the process of breast imaging, particularly screening, the trainee will have ready access to data to analyse the proficiency of his or her activities. Additionally, the trainee will be expected to complete a focused audit and develop an understanding of the process of interval cancer review.
- They should participate in research and be encouraged to pursue a project up to and including publication. An understanding of the principles and techniques used in research, including the value of clinical trials and basic biostatistics, should be acquired.
- They must attend regular multi-disciplinary conferences.

4 – THEORETICAL KNOWLEDGE

Trainees should attend 40 hours of theoretical training in the form of locally delivered tutorials, specialist breast imaging courses as well as national and international breast imaging and breast screening conferences such as those of EUSOBI and ECR.

- Clinical training
  - Knowledge of the clinical findings associated with normal, benign and malignant tissue.
  - Knowledge of the risks of breast disease associated with family history, hormone replacement therapy, etc.
  - Knowledge of breast surgery, treatment and reconstruction and how these might influence imaging appearances.
- Radiation protection
  - Knowledge and understanding of the current legislation governing the use of ionising radiation and of the responsibilities as defined in national and European legislation.
  - Knowledge and understanding of the need to minimise the radiation dose received by the patient/client.
  - Knowledge and understanding of the risk/benefit analysis associated with breast screening using ionising radiation as compared with other techniques, e.g. ultrasound, MR.
- Physics

  For all imaging modalities
  - Knowledge and understanding of the physics of image production and how alteration of machine parameters affect the image.
  - Knowledge and understanding of image recording and display systems and how alterations in machine parameters affect the image.
  - Knowledge and understanding of Quality Assurance Programmes and the impact that image quality has on clinical performance.
  - Knowledge of artefacts, limitations of resolution, and contrast.
- Anatomy and Pathology
  - Knowledge and understanding of normal embryology, physiology and anatomy of the breast and associated structures in particular changes due to age, lactation, hormonal status, surgery, radiotherapy, etc.
  - Knowledge and understanding of normal physiology, pathology and pathophysiology of breasts and associated structures including synchronous and metachronous disease.
  - Knowledge and understanding of benign and malignant diseases of the breast and associated structures and how these processes manifest both clinically and on imaging.
  - Knowledge of the spread of breast carcinoma and the pathology in other organs.
- Imaging techniques

  Trainees should understand the principles of all imaging methods including:
  - Relative indications and contraindications
  - Complications
  - Recognition of artefacts
  - Normal appearances, normal variations, benign and malignant processes (both primary), local recurrence and distant spread
  - Limitations of individual techniques, examinations, sequences/views and the complementary nature of other techniques and the role of each technique in the investigation of breast disease
  - Knowledge and understanding of how imaging findings influence decisions by others, e.g. surgeons, pathologists, oncologists, etc.:
    - Mammography including additional and special views
    - Ultrasound
    - MRI
    - Nuclear medicine
- Screening
  - Knowledge and understanding of the aims, objectives and principles of population breast screening.
  - Knowledge and understanding of the risks and benefits of screening by the population and the individual, including those related to age factors, family history, and hormone replacement therapy.
  - Knowledge and understanding of the objectives and principles of Quality Assurance.
  - Understanding of the principles and techniques used in audit and research, including the value of clinical trials and basic biostatistics.
  - Knowledge and understanding of legal liability and processes.

5 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

- Clinical training
  - Ability to undertake physical examination of the breast and associated structures.
- Interventional techniques
  - Trainees should understand the principles of all interventional methods including:
    - Relative indications and contraindications
    - Complications
    - Advantages and disadvantages
    - Limitations of individual examinations and complementary nature of other techniques and the role of each technique in the investigation of breast disease
    - Knowledge and understanding of how biopsy and interventional techniques influence decisions and treatment planning by others, e.g. surgeons, pathologists, oncologists, etc.
  - The applicable procedures are:
    - Cyst aspiration
    - Fine needle aspiration cytology (free hand- and/or image-guided)
    - Mechanical and vacuum-assisted core biopsy (free hand- and/or image-guided)
    - Image-guided localisation
    - Abscess management
    - MR-guided focused ultrasound and any other new techniques.
- Communication
  - Knowledge and understanding of the importance of effective communication with both the patient and the members of the multidisciplinary team.
  - Knowledge and understanding of the principles of breaking bad news and the psychosocial consequences of doing this badly.
- Teamworking
  - Knowledge of roles and responsibilities of other members of the breast imaging team, e.g. clerical officers, radiographers, nurses, support staff, secretaries, etc.
  - Knowledge of roles and responsibilities of other members of the Multi-Disciplinary Team.
  - Knowledge and understanding of how imaging findings influence decisions by others, e.g. surgeons, pathologists, oncologists, etc.
- Practical experience

The trainee must obtain a substantial experience in all clinical, imaging and interventional techniques that are listed above.

Minimum experience per month of training:

- Interpretation of screening mammograms
  300 cases
- Interpretation of symptomatic cases including ultrasound
  80 cases
- Experience of image-guided procedures
  20 cases

Cardiac Radiology

1 – INTRODUCTION

This curriculum outlines the training requirements to prepare a radiologist for a career in which a significant proportion of his/her time will be devoted to cardiac radiology.

Trainees in radiology should have undergone training and education in cardiovascular/cardiac radiology prior to subspecialty training and will therefore have already obtained basic skills.

It is expected that some trainees will wish to devote the entire subspecialty training period to cardiac radiology with a view to devoting a large portion of their future career to this area. Other trainees may be more inclined to combine elements of this training programme with another specialist area, such as vascular or thoracic radiology over a two-year-period. This document outlines a framework for both full-time and modular approaches to training in cardiac radiology.

The aim of establishing a curriculum for subspecialty training in cardiac radiology is to ensure:

- A detailed knowledge of current theoretical and practical developments in the specialty
- Extensive hands-on experience with graded supervision
- Clinical knowledge relevant to cardiology so that the trainee may confidently discuss the appropriate imaging modality for the clinical problem with the refering clinician
- A knowledge of the relevant embryological, anatomical, pathophysiological, biochemical and clinical aspects of cardiac disease
- An in-depth understanding of the major imaging modalities relevant to cardiac disease
- Director practical exposure – with appropriate graded supervision – in all forms of cardiac imaging

2 – EXPERTISE AND FACILITIES

- UEMS-Training charter in diagnostic radiology identifies the core of knowledge required during the common trunk of radiology training. Basic skills in the cardiovascular system will therefore have been acquired prior to sub-specialist training.
- Clinical knowledge will be obtained by a variety of means, including close liaison with the appropriate surgical and medical teams, e.g. by exposure to combined clinico-radiological conferences. The following clinical interrelationships should be explored:
  - Cardiology (adult and paediatric)
  - Cardiac surgery (adult and paediatric)
  - Cardiac pathology
  - Cardiac anaesthesia/critical care and emergency medicine
- In some instances, it may be appropriate for the trainee to have a regular attachment to cardiac out-patient clinics/ward rounds/CCUs in order to acquire further clinical knowledge relevant to the subspecialty.
- Experience will be documented in logbooks. If adequate experience cannot be offered in one training scheme, it will be necessary for the trainee to have a period of secondment at other training schemes with a large active practice in another center.
- The trainee should participate in clinical audit relevant to the subspecialty.
- The trainee should be encouraged and given the opportunity to attend appropriate meetings and courses.
- The trainee should be involved in research and have the opportunity to present in suitable national and international meetings. The progression of research projects to formal peer-reviewed publication should be supported and encouraged by the supervising consultant(s).
- The trainee should be encouraged to participate in an on-call rota along with an appropriate back-up.
- The posts should be approved and recognised for training by the ESCR.

3 – GENERAL OVERVIEW

- The period spent in training will vary according to whether the trainee wishes to combine subspecialty training in cardiac radiology with another specialist area (such as thoracic radiology), or whether the trainee wishes to make cardiac radiology alone the prime focus.

- For trainees wishing to specialise primarily in cardiac radiology, a period of 12 months substantially devoted (minimum of 8 sessions per week) to the subject is recommended.

- For trainees wishing to specialise in cardiac radiology together with another area of interest, the training can be provided in a modular training programme over two years.

- The exact structure of the training programme needs to be flexibly interpreted to allow for local facilities and expertise. Rather than adopt a "number of investigations required" approach, it is suggested that centres wishing to offer training in cardiac radiology as either a major or minor subspecialty option make available a fixed number of sessions offering the requisite experience. An example schedule is given below (per week):
  - CXR film interpretation (1 session)
  - Echocardiography (1 session)
  - Cardiac CT and MRI (2 sessions)
  - Coronary angiography/left and right heart catheterisations (1 session)
  - Nuclear cardiology (1 session)
  - Research (2 sessions).

  The remaining 2 sessions per week would be used to maintain experience in general radiology according to local departmental service requirements.

  It is stressed that the schedule above is intended **as an example only.** Clearly the exact ratio of training in the different modalities of cardiac imaging *will need to reflect the individual interests of the trainee, as well as the experience that can be offered locally*.
- In a situation where the interests of a trainee cannot be met entirely locally, it may be appropriate to negotiate a period of "external" training either as a block elective period or as an ongoing regular day release.
- Regardless of the imaging modality concerned, the trainer or training committee must be satisfied with the trainee being able to consistently interpret the results of such investigations accurately and reliably. All studies should be reviewed in a formal reporting session. It is recognised that for some modalities (such as cardiac ultrasound) supervision may be provided by non-consultant personnel, provided they are of sufficient seniority and experience.
- The modalities listed and the time devoted to each will be reviewed at intervals. It is recognised that some studies will become obsolete and new imaging techniques will be developed.
- The trainee should become familiar with providing analgesia and/or sedation where required as well as the necessary continuous monitoring required to perform this safely.
- In view of the use of potentially hazardous techniques (e.g. angiography) and substances (e.g. adenosine, dobutamine, iodinated contrast media), the trainee should be fully competent in basic and advanced life-support. Regular "refresher" course training should be undertaken at least on a yearly basis and formal ALS certification should be considered.
- The trainee should become aware of the local and national guidelines in obtaining informed patient consent where appropriate.

4 – THEORETICAL KNOWLEDGE

- Basic Sciences
  - Basic cardiac and cardiovascular physiology
  - Cardiac and cardiovascular anatomy including the heart great vessels, peripheral arterial tree and the pulmonary arteries
  - Basic biochemistry related to cardiac diagnosis and treatment
  - Radiation physics and radiation protection as applied to cardiac diagnosis
  - Principles of radio-isotope imaging
  - Principles of cardiac gating and cardiac triggering
- Applied Sciences
  - Basic cardiovascular pharmacology use and limitations of commonly prescribed cardiac drugs including cardiac stress agents.
  - Applied pharmacology of contrast agents and radionuclide imaging agents
  - Applied physiology of cardiac stress testing
  - Knowledge of normal cardiac parameters, including the cardiac cycle, blood flow cardiac output, pressures, and flow-dynamics
- Clinical Sciences
  - Knowledge of ECG interpretation
  - Common cardiac pathology
  - Common cardiac disease presentations
  - Basic epidemiology of cardiovascular disease
- Current Clinical Practice
  - Knowledge of modern therapy rationale including risk assessment
  - Basic knowledge of cardiac disease presentation and non-imaging diagnostics
  - Age-based presentations of cardiac disease
  - Treatment of common cardiac conditions
- Cardiac Radiology Practice
  - Understanding of principles of each cardiac imaging modality
  - Selection of appropriate imaging modality for the patient´s condition, including risks and benefits
  - Limitations and advantages of each method of cardiac imaging

- Management
  - Principles of managing a cardiac imaging service
  - Purchase and selection of equipment
- Research
  - Methodology of research in cardiac imaging and cardiology
  - Evidence base in cardiac imaging
  - Knowledge of statistical methods
  - Methodology of scientific writing and presentation
- Medico-legal
  - Understanding of medico-legal issues relating to cardiac radiology
  - Understanding of uncertainty and error in cardiac imaging practice

5 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

- Plain Film Interpretation
  - Limitations, advantages and principles of chest X-ray diagnosis of adult and congenital cardiac disease
- CT Interpretation and patient management
  - CT anatomy of the heart pulmonary arteries and great vessels
  - Principles of spiral and ultrafast CT of the heart including prospective and retrospective gating
  - Interpretation of cardiac and pulmonary pathology
  - Contrast administration
  - Decision-making on the basis of patients´ symptoms and CT diagnosis
- MRI Interpretation and patient management
  - MRI anatomy of the heart, great vessels, pulmonary, and peripheral vascular system
  - Principles of image sequencing and specialised gating
  - Interpretation of cardiovascular and pulmonary pathology
  - Understanding of cardiac physiology related to MRI, including flow sequencing and specialised tagging techniques
  - Uses, limitations and hazards of MRI cardiac imaging
- Cardiac imaging by other modalities
  - Principles, uses and limitations of cardiac angiography catheterisation and pressure measurement
  - Principles, uses and interpretation of stress and non-stress echocardiography, including transoesophageal echocardiography
  - Principles, uses and limitations of nuclear cardiac imaging
  - Principles of intravascular imaging
- Stress testing
  - Principles, uses and limitation of exercise stress testing
  - Methods of stress testing as applied to cardiac imaging
  - Patient management of stress testing for cardiac imaging

6 – APPRAISAL AND ASSESSMENT

At the end of the programme, the trainee should:

- Be able to supervise technical staff to ensure appropriate images are obtained;
- Discuss significant or unexpected radiological findings with refering clinicians and know when to contact a clinician;
- Be able to recommend the most appropriate imaging modality, appropriate to the patients´ symptoms or pathology or request from the referring clinician;
- Develop skills in forming protocols, monitoring and interpreting cardiac studies, appropriate to patient history and other clinical information;
- Demonstrate the ability to effectively present cardiac imaging in a conference setting.

Chest Radiology

1 – INTRODUCTION

This curriculum outlines the subspecialty training requirements for specialist training in thoracic radiology. This involves those aspects of radiology which provide information about anatomy, function, disease states and those aspects of interventional radiology or minimally invasive therapy appertaining to the thorax.

The aim of subspecialised training in thoracic radiology is to enable the trainee to become clinically competent and to consistently interpret the results of thoracic investigations accurately and reliably. Where appropriate, trainees also need to be capable of providing a comprehensive and safe interventional diagnostic and therapeutic service.

The aim of establishing a curriculum for subspecialty training in thoracic radiology is to ensure the trainee acquires:

- Knowledge of the relevant embryological, anatomical, pathophysiological and clinical aspects of thoracic disease;
- An in-depth understanding of the major imaging techniques relevant to thoracic disease;
- An in-depth understanding of the indications, contraindications and complications of surgical, medical and radiological interventions and procedures including radiation exposure issues and contrast media;
- Clinical knowledge relevant to thoracic medicine and surgery such that the trainee may confidently discuss the appropriate imaging strategy for the clinical problem with the refering clinician;
- Detailed knowledge of current technological and clinical developments in the specialty;
- Direct practical exposure with appropriate graded supervision of all forms of thoracic imaging and intervention;
- Competence in basic and advanced life-support.

The anticipated outcome at the end of subspecialty training in thoracic radiology will be that the trainee can select the suitable imaging modality for thoracic problems, supervise (and perform where appropriate) the examination and accurately report on the examination findings. The trainee should be competent in all aspects of thoracic imaging and intervention.

2 – EXPERTISE AND FACILITIES

The trainee undergoing subspecialty training should be actively involved in thoracic imaging within an educational environment with graduated supervision.

Training must be undertaken in a team with access to appropriate CT, MR, ultrasound, fluoroscopy, and radionuclide imaging facilities.

The trainee should be exposed to a clinical service involving thoracic medicine, thoracic surgery, respiratory pathology, and a pulmonary function laboratory.
An up-to-date database of "interesting cases" or "teaching files" should be present in the training department.

Additionally, the training department should have access to interesting educational sites on the internet.

Trainees must also have access to a radiological library containing textbooks on thoracic radiology, thoracic medicine, thoracic surgery, pathology, and pulmonary physiology.

3 – THEORETICAL KNOWLEDGE

The trainee should acquire:

- A comprehensive knowledge of normal respiratory function and thoracic diseases, including:
  - The embryology, anatomy, normal variants and pathophysiology relevant to cardiorespiratory function;
  - The pathology of benign and malignant conditions involving the thorax;
  - The epidemiology of lung diseases;
  - The principles of population screening for lung cancer and other lung diseases;
  - The techniques used in thoracic surgery;
  - The techniques involved in all imaging and interventional procedures used in evaluating and treating thoracic diseases, including managing the complications of these procedures;
  - Local, national and, where appropriate, international imaging guidelines relevant to thoracic radiology.

- Knowledge of the full range of radiological diagnostic techniques available, in particular:
  - The indications, contraindications and complications of each imaging method;
  - The factors affecting the choice of contrast media and radiopharmaceuticals;
  - The effects and side effects of these agents;

- Radiation dose reduction strategies, particularly for paediatric patients.

- Particular emphasis should be placed on the strengths and weaknesses of the different imaging methods in various conditions. The appropriate choice of imaging techniques and/or the appropriate sequence of imaging techniques in the investigation of specific clinical problems should be emphasised.

4 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

- Specific skills to enable:
  - The conduct, supervision and accurate interpretation of all imaging techniques used in the investigation of thoracic diseases to a consistent and high standard;
  - The accurate localisation and, where appropriate, biopsy of pulmonary, mediastinal, pleural and chest wall masses and lymph nodes;
  - Where appropriate, the safe and effective practice of interventional techniques;
  - Good communication with patients and professional colleagues;
  - Accurate informed consent to be obtained from patients;
  - Continuing accreditation and maintenance of life-support skills.

- A clear understanding of the purpose of multidisciplinary meetings, including their role in:
  - Planning of investigations, including the selection of appropriate tests and imaging techniques for the diagnosis of benign and malignant disease;
  - Staging of malignant disease;
  - Planning and outcomes of treatment;
  - The detection of errors in diagnosis and complications of treatment.

- During the training period it is recommended that the trainee obtain experience in the following:
  - Plain radiography including:
    - Primary care examinations
    - Post-operative (cardiac and thoracic surgery) examinations
    - Intensive care and high-dependency unit examinations
    - Thoracic trauma
    - Paediatric examinations
    - Respiratory medicine out-patients examinations
  - CT of the thorax including:
    - The staging of bronchial carcinoma
    - The investigation of
      - Pleural lesions
      - Thoracic wall lesions
      - Pulmonary lesions
      - Mediastinal lesions
    - Identification and categorisation of diffuse interstitial lung disease
    - Identification of large and small airways disease
    - CT pulmonary angiography.
  - MRI in thoracic imaging where applicable
  - Radionuclide radiology including:
    - Ventilation/perfusion lung scintigraphy (only)
    - PET and its application to lung cancer staging
  - Interventional techniques.
    Trainees should acquire experience in the following procedures:
    - Biopsy of thoracic wall, pleural, pulmonary and mediastinal lesions including:
      - CT-guided
      - Ultrasound-guided
    - Other interventional procedures including:
      - Ultrasound-guided thoracocentesis
      - Chest drain insertion
  - Optional interventional procedures:
    - Bronchoscopy
    - Airway stenting
    - Vascular (e.g. SVC) stenting
    - Thoracoscopy

- Clinical knowledge will be acquired by a variety of means, including close liaison with appropriate medical, surgical and oncological teams and combined clinical and radiological meetings. Multidisciplinary cancer meetings should be an important component. Inter-relationships with the following disciplines are also important:
  - Thoracic medicine
  - Thoracic surgery
  - Respiratory pathology
  - Pulmonary physiology

- It may be useful for the trainee to have a regular attachment to thoracic out patient clinics, ward rounds and bronchoscopy/theatre sessions in order to further clinical knowledge relevant to the subspecialty.

- The trainee should be encouraged and given the opportunity to attend and lead appropriate clinico-radiological and multidisciplinary meetings. The trainee should be encouraged to attend appropriate educational meetings and courses.

- The trainee should participate in relevant clinical audit, management and clinical governance and have a good working knowledge of local and national guidelines in relation to radiological practice.

- Trainees will be expected to be familiar with current thoracic radiology literature. The trainee should be encouraged to participate in research and to pursue one or more project(s) up to and including publication. An understanding of the principles and techniques used in research, including the value of clinical trials and basic biostatistics, should be acquired. Presentation of research and audit results at national and international meetings should be encouraged.

5 – APPRAISAL AND ASSESSMENT

- Regular appraisal of the trainee is mandatory and the consultant trainer must be satisfied that the trainee is clinically competent, as determined by an in-training performance assessment, and can consistently interpret the results of investigations accurately and reliably.

- Methods of trainee assessment include:
  - Regular direct observation of clinical techniques (including communication skills, ability to obtain informed consent and sedation skills) by the trainer and/or external observer;
  - Regular formal review of the trainee's skills in the accurate interpretation of investigations for thoracic diseases;
  - A final assessment of overall professional competence.

Gastrointestinal and Abdominal Radiology

1 – INTRODUCTION

The subspecialty training programme in gastrointestinal and abdominal imaging further extends the knowledge acquired during the common trunk and is dedicated to train radiologists with strong devotion to spend major parts of their professional activity in close cooperation with clinicians practicing gastroenterology and abdominal surgery. The ideal framework is supposed to be a large clinical centre with wide experience in gastroenterology, abdominal surgery, oncology, diagnostic and interventional radiology, possessing imaging modalities necessary to perform state-of-the-art gastrointestinal and abdominal radiology. The principles of evaluation of a resident's knowledge, skills and overall performance, including the development of professional attitudes, are tailored to fit the general evaluation system and standards of other subspecialties.

2 – THEORETICAL KNOWLEDGE

During the training in the subspecialty of gastrointestinal and abdominal radiology, the resident should have achieved the following knowledge-based objectives:

- Anatomy and Physiology
  - Detailed anatomic knowledge of the sections of the gastrointestinal tract, the diaphragm, the abdominal wall, the pelvic floor, the peritoneal cavity, the liver, spleen, biliary tract and pancreas using plain films, fluoroscopy, barium/gastrografin studies, sonography, CT, and MRI.
  - To know the arterial supply and venous drainage of the various portions of the gastrointestinal tract. To explain the possible variations of flow in the superior mesenteric artery and vein and the portal and hepatic veins.
  - To know the lymphatic drainage of the relevant organs.
  - To know the important variants of anatomy.
  - To have a basic understanding of physiology of the gastrointestinal tract and the abdominal organs.

- Oesophagus
  - To identify oesophageal perforation on plain films, contrast studies, and CT.
  - To identify mega-oesophagus, diverticulum,

extrinsic compression, fistulae, sliding and para-oesophageal hiatus hernia, benign strictures, varices, oesophagitis and oesophageal cancer on a contrast examination and/or CT. To analyse the criteria for non-resectability and lymph node involvement in oesophageal cancer on CT. To know the TNM staging of oesophageal cancer and the potential role of PET-CT in this setting.
- To understand the basic surgical techniques in oesophageal surgery/radiation therapy and identify post-surgical/post-radiation therapy appearances on imaging examinations.

- Stomach and Duodenum
  - To define the most appropriate imaging examination and contrast use in suspected perforation of the stomach and postoperative follow-up. To name the limitations of each examination for these specific conditions.
  - To understand the imaging features (on barium studies and CT) of a variety of conditions, such as benign and malignant tumors, including GIST, infiltrative disorders (e.g. linitis plastica), gastric ulcers, duodenal diverticulum, and positional abnormalities including gastric volvulus.
  - To perform a CT examination of the stomach/duodenum, using the most appropriate protocol according to the clinical problem, and stage carcinoma and lymphoma on CT. To know the potential role of PET-CT in nodal staging.

- Small Bowel
  - To determine the most appropriate imaging examination in the following cases: small bowel obstruction, inflammatory disease, small bowel perforation and ischaemia, cancer, lymphoma, carcinoid tumor and post-operative follow-up. To name the limitations of each examination for these specific cases.
  - To know the features of small bowel diseases on small bowel series, including stenosis, fold thickening, nodules, ulcerations, marked angulation, extrinsic compression, diverticula, and fistula.
  - To identify on a small bowel series the following diseases: adenocarcinoma, polyposis, lymphoma, carcinoid tumor, GIST, Crohn's disease, radiation-induced injury, malrotation, Meckel's diverticulum, diverticulosis, lymphoid hyperplasia of the terminal ileum, and the most common mid gut abnormalities (malrotation, internal hernia).
  - To perform a CT examination of the small bowel, including CT enteroclysis. Identify a transitional zone in case of small bowel obstruction. To identify a small bowel tumor (adenocarcinoma, lymphoma, carcinoid tumor, stromal tumor). To identify mural pneumatosis, vascular engorgement, increased density of the mesenteric fat, duplication cysts and malrotation. To know the potential role of MRI in examining the small bowel.
  - To determine the cause of small bowel obstruction on CT (adhesion, band, strangulation, intussusception, volvulus, internal and external hernias) and their complications. To identify criteria for emergency surgery.

- Colon and Rectum
  - To determine the optimal imaging examination to study the colon according to the suspected disease (obstruction, volvulus, diverticulitis, tumor (including lymphoma and carcinoid), inflammatory disease, perforation, postoperative evaluation) and know the limitations of each technique.
  - To know the indications of virtual CT/MRI colonoscopy.
  - To identify rotational abnormalities of the colon on contrast studies and CT.
  - To identify the normal appendix on CT and sonography. To know the various features of appendicitis on CT and sonography.
  - To know the different features of colon tumors, including GIST, diverticulitis, inflammatory diseases, colon ischaemia, and radiation-induced colitis.
  - To identify a megacolon, colonic diverticulosis and diverticulitis, colitis, colonic fistula, carcinoma, polyps, and postoperative stenosis on an enema.
  - To identify colonic diverticulosis, diverticulitis, tumor stenosis, ileocolic intussusception, colonic fistula, paracolic abscess, intra-peritoneal fluid collection, colonic pneumatosis, and pneumo-peritoneum on CT.
  - To know the CT features of colo-rectal cancer and identify criteria for local extent (enlarged lymph nodes, peritoneal carcinomatosis, hepatic metastases, and obstruction). To know the TNM classification of colo-rectal cancer and the potential role of PET-CT. To understand the most frequent operative techniques

that may be used to treat colo-rectal cancer.
- To identify tumor recurrence after surgery. To know the criteria that may help in differentiating between postoperative fibrosis and tumor recurrence. To know the potential role of PET-CT.
- To know the MRI appearance of pelvic/perianal fistula and abscesses as well as the increased risk of anal carcinoma in Crohn's disease with long standing perianal complications.

- Peritoneum and abdominal wall
  - To identify the various types of abdominal wall hernias (inguinal, umbilical, parastomal, postoperative) on a CT scan.
  - To identify a mesenteric tumor and to determine its location on CT.
  - To know the features of a mesenteric cyst on CT.
  - To recognise the features of mesenteric panniculitis and sclerosing mesenteritis.
  - To know the normal features of the peritoneum on sonography and CT. To identify the following peritoneal diseases on CT: peritoneal carcinomatosis, peritoneal tuberculosis and mesenteric lymphoma.
  - To identify ascites on sonography and CT. To know the features of loculated ascites.

- Vessels
  - To identify small bowel infarct on CT.
  - To perform and interpret an angiographic study of the mesenteric vessels and identify occlusion and stenosis of the superior mesenteric artery.

- Liver
  - To localise a focal liver lesion according to liver segmentation and major vessels anatomy (hepatic and portal vein, IVC).
  - To describe the appearance of typical biliary cyst on sonography, CT, and MRI.
  - To describe the appearance of Hydatid cysts.
  - To list the differences between amoebic abscess and pyogenic abscess of the liver (appearance, evolution, treatment, indication for drainage).
  - To describe the most common surgical procedures for hepatectomy.
  - To know the appearance of liver haemangioma on US, CT, and MRI, including typical cases and giant haemangioma. Discuss the indications for CT or MRI as an adjunct to US.
  - To describe the usual appearance of focal nodular hyperplasia and liver cell adenoma on sonography, including Doppler US, contrast sonography, CT, and MRI.
  - To know the appearance of fatty liver, both homogenous and heterogeneous, on sonography, CT, and MRI (including in-/out-of-phase imaging and fat suppression images).
  - To describe the appearance of iron overload, causes and quantitation with MRI.
  - To describe the natural history of hepatocellular carcinoma (HCC), major techniques and indications for treatment (surgical resection, chemotherapy, chemoembolisation, percutaneous ablation, liver transplantation).
  - To describe the appearance of HCC on sonography (including Doppler and contrast enhanced sonography) CT and MRI.
  - To describe the usual appearance of liver metastases on sonography (including Doppler) CT and MRI.
  - To describe the most common morphologic changes associated with liver cirrhosis: lobar atrophy or hypertrophy, regeneration nodules, fibrosis. To know the main causes for liver cirrhosis.

- Biliary Tract
  - To know the imaging methods for the detection of gall bladder and common bile duct stones.
  - To know the common appearance of acute cholecystitis (including emphysematous cholecystitis) on sonography, including Doppler, CT, and MRI.
  - To list the main causes for gallbladder wall thickening.
  - To describe the appearance of gallbladder cancer on sonography, CT, and MRI.
  - To know the appearance of cholangiocarcinoma of the liver hilum (Klatskin tumour) and know how to stage it.
  - To know the appearance of ampullar carcinoma on sonography, CT, and MRI, and list differential diagnoses.
  - To describe the common appearance of sclerosing cholangitis on sonography, CT, and MRI, including MRCP. To know the natural history of associated cholangiocarcinoma.
  - To know the main congenital disorders of the bile ducts: Caroli disease, choledochal cyst (and the risk of cholangiocarcinoma).

- To describe the main techniques for surgery of the bile duct and common complications.

- Pancreas
  - To know the natural history of acute and chronic pancreatitis.
  - To identify pancreatic calcifications on plain films, sonography, and CT.
  - To know the common appearance of extra-pancreatic fluid collection and phlegmons in case of acute pancreatitis.
  - To know the ductal changes in chronic pancreatitis with MRI and secretine.
  - To detect a pancreatic pseudocyst.
  - To know the most common appearance (nodular, infiltrating) of pancreatic adenocarcinoma on sonography, CT, and MRI, and perform staging in order to choose a treatment.
  - To know the features of endocrine tumors.
  - To describe the usual appearance of cystic tumors of the pancreas, mainly serous and mucinous cystadenoma, intraductal mucinous tumor and rare cystic tumors.
  - To describe the main techniques for pancreatic surgery and potential complications.

- Spleen
  - To know the appearance of accessory spleen and splenosis on sonography, CT, and MRI.
  - To name common causes of splenomegaly (e.g. lymphoma, portal hypertension, or haematological disorders).
  - To identify splenic infarction on sonography, CT, and MRI.
  - To know common causes of focal splenic lesions (cyst, hydatid cyst, metastasis, lymphoma, abscess, haemangioma).

- Trauma
  - To know the CT technique for trauma patients.
  - To identify abdominal hematoma, active bleeding, parenchymal laceration, and traumatic lesions of the gastrointestinal tract. To know the limitations of CT to identify gastrointestinal tract lesions.
  - To know which conditions require immediate embolisation or surgery.

(Links for reference cases to be sampled in EURORAD will be provided later.)

3 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

By the end of the fifth year, the resident should have acquired the following skills:

- General Requirements
  - To know the indications and contra-indications of the various imaging examinations in abdominal imaging.
  - To indicate to the refering physician the most appropriate imaging examination according to the clinical problem.
  - To determine the best contrast material and its optimal use according to the imaging technique and the clinical problem.
  - To tailor the examination protocol to the clinical question.
  - To supervise technical staff to ensure appropriate images are obtained.
  - To evaluate the quality of the imaging examinations in abdominal imaging.
  - To know the relative cost of the various imaging examinations in abdominal imaging.
  - To understand the radiation exposure and risks of different investigations.

- Specific Requirements

  Plain Abdominal Film
  - To describe patient positioning and know the three basic indications for a plain radiograph.
  - To understand the clinical indications for obtaining plain radiographs and when further views or a CT or MRI may be necessary.
  - To diagnose pneumoperitoneum, mechanical obstruction and pseudo obstruction, toxic dilatation of the colon, gas in small and large bowel wall indicating ischaemia and necrosis, pancreatic and biliary calcifications and aerobilia.

  Upper Gastrointestinal Tract X-ray Examination
  - To perform and interpret both single and double contrast X-ray examination of the upper gastrointestinal tract and to determine the most appropriate contrast material. To understand the principles and limitations of these studies, their advantages, and disadvantages compared to endoscopy.
  - To perform and interpret small bowel follow-through and enteroclysis, including catheter placement beyond the ligament of Treitz. To appreciate the importance and degree of filling and distension of small bowel loops.

Lower Gastrointestinal Tract X-ray Examination
- To perform and interpret a double contrast barium enema and a single contrast enema.
- To know how to catheterise a stoma for colon opacification and how to perform pouchograms and loopograms.
- To know the indications and contraindications for enema techniques and determine the optimal contrast material and technique to be used in each clinical situation.
- To perform and interpret defecography (with X-ray and MRI).

Sonography
- To perform an ultrasound examination of the liver, gall bladder, biliary tree, pancreas, spleen, and the gastrointestinal tract.
- To recognise the retroperitoneal structures and understand the application and limitations of sonography in this area.
- To know the indications and contraindications of contrast agents.

Computed Tomography
- To perform a CT examination of the abdomen and to tailor the protocol to the specific organ or clinical situation to be studied. To determine whether intravenous administration of a contrast material is needed. To determine the optimal protocol for the injection of contrast (rate of injection, dose, delay). To know the various phases (plain, arterial-dominant, portal-dominant, late phase) and their respective values according to the clinical problem.
- To determine the best contrast material for imaging a specific gastrointestinal segment according to the clinical problem (water, air, fat, iodine or barium containing contrast materials).
- To have experience in the use of workstations for multiplanar reconstructions (MPR) and 3D reconstruction based around volume data sets.
- To perform and be able to interpret CT colonoscopy.

Magnetic Resonance Imaging
- To perform MRI of the liver, the biliary tract (including MRCP), pancreas, and the spleen.
- To know the various contrast materials that can be used for MRI of the liver and their individual uses.
- To perform MRI of the gastrointestinal tract.
- To have experience in the use of workstations for multiplanar reconstructions (MPR) and 3D reconstruction based around volume data sets.

Interventional Imaging
- To perform percutaneous drainage of abdominal collections using CT and sonography.
- To perform percutaneous biopsy of the liver and other organs under sonographic and CT guidance.
- To perform angiography of the abdominal arteries.
- To perform selective embolisation of the abdominal arteries in hemorrhage and treatment of tumors.
- To perform percutaneous gastrostomy under image guidance.
- To perform percutaneous biliary intervention.
- To perform radiologically guided stenting of the biliary system and gastrointestinal system, using PTFE and expandable metal stents.
- To know indications and contraindications of common interventions in gastrointestinal and abdominal radiology.

Endoscopy and endoscopic ultrasound (optional)
- To perform endoscopic evaluation of gastrointestinal tract.
- To perform and interpret endoscopic ultrasound examination of the oesophagus, pancreas, biliary tract, and rectum.

- Communication and Decision-Making Skills
- To justify and explain the indication and the examination conduct to the patient.
- To obtain fully informed consent.
- To inform the patient of the results of the examination and evaluate the patient's understanding.
- To make a precise and concise description of the imaging signs present. To answer the clinical problem and make a conclusion accordingly. To suggest additional imaging examinations when needed, using appropriate justification. To decide when it is appropriate to obtain help from supervisory faculty in interpreting imaging findings. To code the findings of examinations.
- To maintain good working relationships with refering clinicians. To discuss significant or unexpected radiologic findings with refering

clinicians and know when to contact a clinician. To effectively present imaging findings in a conference setting.
- To correlate pathologic and clinical data with imaging findings.

- Conferences

As part of the curriculum in abdominal radiology, the trainee should attend in-house teaching sessions for radiologists as well as clinical conferences with colleagues from other specialties. The latter type of conference should be included to facilitate the radiology residents' understanding of the use of imaging and clinical circumstances in which imaging is requested.

The following list gives examples of the types of conferences that should be considered part of the curriculum:
- Abdominal radiology resident-specific teaching conference
- Internal medicine/gastroenterology conferences
- Surgery/abdominal surgery conferences
- Oncology conferences
- Pathology conferences

- Teaching material and suggestions for reading

The following English textbooks are recommended to answer all questions and address all objectives defined in the curriculum of abdominal radiology. One of these books (titles) serves as "bench book", i.e. it is valid for all training programmes across Europe and aims at unification and standardisation of radiology training in Europe. It is very important that "bench books" be available in the radiology department and the library of each institution.

1. Gore RM, Levine MS. Textbook of Gastrointestinal Radiology (2nd Edition). WB Saunders, Philadelphia, 2000.
2. Eisenberg RL. Gastrointestinal Radiology – A Pattern Approach (4th Edition). Lippincott, Philadelphia, 2003.
3. Abdominal radiology book(s) in local language.

- Eurorad (www.eurorad.org)

In the sections "Gastrointestinal Imaging" and "Liver, Biliary System, Pancreas Spleen", edited by O. Ekberg and B. Marincek, a subsection will be devoted to curricular cases. These model cases correspond to the knowledge-based objectives and allow a resident to see and study abnormalities, even if they are not seen in a resident's immediate training environment.

4 – APPRAISAL AND ASSESSMENT

In gastrointestinal and abdominal radiology, as in all other parts of radiology training, each trainee should be individually appraised on an annual basis. The purpose of appraisal is to assess the progress of the resident over the past year and to anticipate and correct any deficiencies in training at an early stage. In addition, for those residents rotating through a specialised abdominal radiology section/department, the attachment should commence and finish with a meeting with the senior trainer in that section/department. The purpose of the first meeting is to establish goals for the attachment and the second meeting to see whether the goals have been achieved. Logbooks can be used for documenting the skills and experience obtained. Logbooks are mandatory for all interventional procedures, irrespective of subspecialty.

Head and Neck Radiology

1– INTRODUCTION

Head and neck radiology is a subspecialty of Radiology. Because of the complex anatomy and the very diverse pathology, specialty training in head and neck radiology may be considered to be complex and demanding.

Head and neck radiology comprises diagnostic imaging by all techniques of conditions involving the petrous bone, skull base and cranial nerves, orbit, nasopharynx and sinuses, oral cavity, the oro- and hypopharynx, larynx, salivary glands, facial skeleton including the teeth, mandible and temporomandibular joints, deep spaces of the face and neck, thoracic inlet, brachial plexus, and thyroid gland.

More detailed explanatory notes on this curriculum may be obtained by application to the European Society of Head and Neck Radiology.

2 – EXPERTISE AND FACILITIES

Before undertaking this curriculum, radiologists in training will have completed the curriculum for general training and will have acquired a thorough knowledge of the physical principles of the different imaging methods, the contra-indications and complications of different imaging techniques, and the effects and side-effects of contrast media. In addition, they will be familiar with imaging topics specific for the head and neck, including:

- Positioning/views of the face, temporal bone, and mandible
- The principles of radiation protection in the head and neck, as well as of justification of referrals
- Mean exposure doses at skin entrance, lens and thyroid gland for conventional radiography, sialography, dacryocystography, and CT
- Digital imaging and image processing pertinent to head and neck radiology
- Multislice CT, 2D and 3D reconstructions and virtual endoscopy techniques
- MRI sequences commonly used in head and neck imaging

During the subspecialty training period, the trainee must spend most of his/her time in this field. They should acquire an in-depth knowledge of radiological manifestations of disease and should also be acquainted with the clinical and pathologic presentation. They should have a basic understanding of clinical tests which are prerequisite for imaging (e.g. endoscopy, audiometry) and should acquire extensive experience in all the diagnostic modalities listed below and in non- angiographic interventional procedures.

- The trainee should be familiar with clinical terminology so as to communicate without difficulty. They should attend weekly multidisciplinary meetings to obtain thorough understanding of how patients are treated as well as the role of radiology in treatment planning.
  The following list gives examples of the types of conferences that should be considered part of the head and neck curriculum. Some of these conferences may be run by the Radiology Department, others may be run by other departments or multidisciplinary programmes. It is recommended that the latter type of conference be included to facilitate the trainee's understanding of the use of imaging and clinical circumstances in which imaging is requested:
  - Radiology resident/fellow-specific head and neck teaching conference
  - An appropriate proportion of radiology grand rounds devoted to head and neck radiology
  - Multidisciplinary head and neck tumor board
  - Multidisciplinary dysphagia conference
  - Radiologic-pathologic correlation rounds
  - Maxillofacial surgery conference
  - Emergency radiology conference

The trainee should have at least 30 hours of formal teaching at his/her institution during these two years. In addition, during these two years, the trainee should attend at least two annual meetings of the ESHNR or ASHNR or other specialised meetings where head and neck radiology plays a major role.

They should be familiar with the current literature on head and neck radiology, both from standard books and original articles. They should be encouraged to participate in research projects to acquire knowledge of the design, execution, and analysis of scientific projects. They should be encouraged to present papers at international congresses and meet others involved in the field of head and neck radiology to exchange ideas and experiences.

3 – THEORETICAL KNOWLEDGE

At the end of the training period, the trainee should have achieved the **knowledge-based objectives** listed below. Reasonable continuous progression is to be expected

during the training period, bearing in mind that training institutions organise their training in different ways.

- Normal Morphology and Function

The trainee will have a sound knowledge of the anatomic regions listed below, including their correct terminology, inter-relationships and appearance on the full range of imaging used in head and neck radiology:

- The petrous bone and contents
- The skull base and cranial nerves
- The orbit and visual pathways
- The sinuses
- The nasopharynx, oropharynx and hypopharynx
- The oral cavity
- The larynx
- The neck and vasculature
- The salivary glands
- The facial skeleton including the teeth, the mandible and temporomandibular joints
- The deep spaces of the face and neck
- The thoracic inlet and the brachial plexus
- The thyroid gland and the parathyroid glands

- Pathology

The trainee will have a sound knowledge of the following diseases affecting the head and neck, including their presentation, natural history, diagnostic criteria and post-therapeutic findings, including complications of therapy:

- Temporal bone
  - Transmission deafness
  - Perception deafness
  - Embryology and congenital anomalies of the outer ear and middle ear
  - Temporal bone inflammatory disease
  - Temporal bone fractures
  - Otospongiosis and dysplasias of the temporal bone
  - Tumors of the temporal bone and cerebello-pontine angle, tumors involving the facial nerve, bone tumors of the temporal bone, metastases, lymphoma, and endolymphatic sac tumors
  - Vascular tinnitus

- The skull base and cranial nerves
  - Embryology, congenital and developmental anomalies of the skull base
  - Inflammatory conditions
  - Tumors and tumor-like conditions, including those arising from bone, meninges, nerves, or vessels
  - Secondary tumor involvement of the skull base, particularly direct invasion, perineural spread and hematogenous metastasis; to be able to recognise them on CT/MRI
  - Trauma and resulting complications
  - Dysplasias
  - Cerebrospinal fluid leaks and rhizotomy injections
  - Pathologic conditions involving the cranial nerves and their nuclei

- Orbit and visual pathways
  - Ocular pathology, including congenital, traumatic, vascular and neoplastic lesions.
  - Orbital pathology, including developmental abnormalities, inflammatory diseases, autoimmune disorders, tumors and tumor-like conditions, vascular malformations, neural tumors, and lacrimal gland lesions
  - Pathology of the lacrimal apparatus
  - Pathology of the visual apparatus

- The sinuses
  - Anatomical variations and congenital anomalies of the paranasal sinuses
  - Inflammatory conditions and orbital complications of sinusitis, mucoceles, cysts, and polyps
  - Tumors and tumor-like conditions
  - Common endoscopic techniques and their relevance to imaging and presence of disease

- The pharynx
  - Pathologic conditions of the nasopharynx, particularly benign mucosal lesions, inflammatory conditions, tumors such as nasopharyngeal carcinoma, lymphoma, minor salivary gland tumors, schwannomas and traumatic conditions
  - Pathologic conditions of the oropharynx, including functional disorders of deglutition, inflammatory conditions, tumors such as oropharyngeal carcinoma, lymphoma, minor salivary gland tumors, schwannomas, rhabdomyosarcomas, and traumatic conditions
  - Pathologic conditions of the hypopharynx, particularly non-neoplastic conditions, such as diverticula, functional disorders of deglutition and extrinsic lesions, inflammatory conditions, tumors such as hy-

popharyngeal, lymphoma, minor salivary gland tumors, schwannomas, lipomas and other tumors and traumatic conditions
  - Congenital malformations of the pharynx, particularly branchial cleft cysts and sinuses, teratoma, and heterotopic pharyngeal brain

- The oral cavity
  - Pathologic conditions of the oral cavity, including functional disorders of the tongue, congenital anomalies, vascular lesions, dermoid cysts, thyroglossal duct cysts, lingual thyroid, infectious and inflammatory lesions such as Ludwig's angina, ranula, benign tumors, nerve sheath tumors, malignant tumors such as carcinoma, lymphoma, adenoid cystic carcinoma, rhabdomyosarcoma, denervation muscle atrophy, macroglossia and benign masseteric hypertrophy, and traumatic conditions.

- The larynx
  - Pathologic conditions of the larynx, including functional disorders of the larynx, congenital anomalies, webs and atresia, inflammatory lesions, including rheumatoid and collagen vascular disease, benign tumors such as lipoma, rhabdomyoma, nerve sheath tumors, pleomorphic adenoma, malignant tumors such as carcinoma, chondrosarcoma, lymphoma, adenoid cystic carcinoma, and traumatic conditions

- The neck
  - Congenital lesions, in particular cystic lesions, thyroid anomalies, malformations of the lymphatic system, and classification of lymphangiomas
  - Lymph node disease including clinical significance, metastatic disease including imaging criteria of disease, extranodal tumor spread and arterial invasion, lymphomas, tuberculosis, nodal calcifications and their significance
  - Inflammatory and infectious conditions, including abscess, myositis, necrotizing fasciitis, and suppurative adenopathy
  - Non-nodal masses of the neck including angiomas, nerve sheath tumors and paragangliomas, lipomas, and cystic lesions
  - Vascular pathologies of the internal jugular vein and carotid artery

- The salivary glands
  - Inflammatory disorders, in particular infection, sialolithias, chronic recurrent sialadenitis, autoimmune diseases, sialosis, and infectious disorders
  - Cystic lesions
  - Tumors particularly pleomorphic adenoma, Warthin's tumor, adenoid cystic carcinoma, mucoepidermoid carcinoma, metastases, lymphoma, lipoma, neurogenic tumors
  - Vascular malformations, particularly lymphangioma and hemangioma
  - Periglandular lesions, such as masseteric hypertrophy

- The facial skeleton including the teeth, the mandible, and temporomandibular joints
  - Congenital lesions of the midface, including midline cleft lip and defects and inclusion disease, cephaloceles, and premature cranial synostosis
  - Pathologic conditions of the mandible, including cysts, odontogenic tumors, non-odontogenic tumors, vascular lesions, neurogenic lesions, malignant tumors, and dental inflammatory lesions
  - Pathologic conditions of the temporomandibular joint, including disk, osteoarthritis, avascular necrosis, osteoarthritis dissecans, tumors of the TMJ, trauma and congenital anomalies

- The deep spaces of the face and neck
  - Common pathologic conditions involving the different spaces of the supra- and infrahyoid neck, in particular the masticator space, parapharyngeal space, retropharyngeal space, carotid space and perivertebral space, and the role of disease location in determining differential diagnosis

- The thoracic inlet and the brachial plexus
  - Pathologic conditions of the thoracic inlet and brachial plexus, particularly traumatic conditions such as avulsion, elongation, compression by hematoma or callus, thoracic outlet syndrome, schwannoma, su-

perior sulcus carcinoma, lymphoma, adenopathies, and metastasis

- The thyroid gland and the parathyroid glands
  - Congenital lesions including thyroglossal duct cyst, lingual thyroid gland
  - Inflammatory lesions, including thyroiditis
  - benign thyroid masses
  - Malignancies of the thyroid gland
  - Metabolic diseases of the thyroid gland
  - Pathologic conditions of the parathyroid glands, in particular hyperparathyroidism, adenoma, carcinoma, cysts, and hypoparathyroidism

4 – THEORETICAL, COMMUNICATION AND DECISION-MAKING SKILLS

The aim of the head and neck radiology subspecialty training curriculum is to prepare the radiologist for activity to which he/she will dedicate a substantial amount of time. Specific skills training should include the following:

- The ability to act as a consultant in regular multidisciplinary meetings
- Knowledge of the indications and contraindications of diagnostic procedures in the area of the head and neck
- The ability to instruct clinical colleagues about major changes in diagnostic procedures, thereby preventing unnecessary examinations
- A thorough knowledge of the current literature
- The ability to transmit this specific knowledge to colleagues in general radiology and to educate radiologists in speciality training in head and neck radiology

At the end of the training period, the trainee should have achieved the technical, **communication and decision-making skills** listed below. Reasonable continuous progression is to be expected during the training, bearing in mind that institutions organise their rotations differently.

- Patient Information
  - To be able to inform the patient in detail about the diagnostic procedure and obtain informed consent where relevant
  - To be able to explain to the patient how to cooperate during the examination
- Clinical Background
  - To have a thorough knowledge of the pathology investigated so as to tailor the examination
  - To have a basic understanding of clinical tests which have been performed prior to imaging (e.g. endoscopy, audiometry)
- Communication skills
  - To be able to produce accurate, informative and clinical "effective reports", explaining imaging findings in a clinical context
  - To be able to advise referrers on the appropriate use of imaging studies
  - To be able to present head and neck examinations effectively in a conference setting
  - To be able to recognise when significant or unexpected radiological findings should be communicated urgently to the referrer
- Technique
  - To be able to supervise technical staff to ensure quality control
  - To be able to justify, conduct and interpret the imaging studies listed below, with particular attention to the features listed below:

US (B mode, Doppler, FNP)
- Choice of probe
- Examination of the major salivary glands, thyroid gland, and neck
- Doppler examination of the major salivary glands, thyroid gland, and neck

Barium swallow for deglutition disorders
- Choice of contrast media
- Standard examination for the oral phase, pharyngeal phase, and oesophageal phase
- How to document the examination: video alone, video and spot images
- When to tailor the examination and limit it to a minimum so as to answer the clinical relevant questions
- How to alter the consistency of the bolus and test its influence on deglutition
- How to test various deglutition manoeuvres

CT (diagnostic, angiography, and FNP):
- Radiation dose, technical parameters, and image quality
- Acquisition and reconstruction parameters

- Post-processing techniques
- Appropriate use of contrast media
- Indications to extend the CT examination to other body areas

MRI (diagnostic and angiography)
- Choice of coil
- Identification of imaging volume
- Appropriate use of contrast media
- Technical parameters for acquisition, reconstruction, and post-processing evaluation
- MR angiography
- MR sialography

Conventional Radiographs
- How to avoid artifacts
- How to alter parameters to obtain adequate quality

Sialography
- How to interpret the images and judge the quality of the examination

Dacryocystography
- Choice of instruments and contrast media, and interpretation

Guided biopsy
- In relation to the thyroid or cervical nodes and other masses
- Choice of guidance method, US, CT, or MRI
- Choice of biopsy instrument
- Appropriate care of the specimen
- Complications and after-care

5 – APPRAISAL AND ASSESSMENT

Assessment of the progress of the trainee should be consistent with national requirements. The performance of the trainee should be appraised at least on annual basis. A logbook account of experience may be helpful in evaluating the trainee's progress. The trainee's progress should be reviewed by consultant trainers with particular attention to practical skills in conducting examinations, efficacy of clinical requesting, and growth of knowledge.

The European Society of Head and Neck Radiology may offer a diploma of subspecialty expertise to trainees who have completed this programme, the latter being subject to other conditions specified by the Society.

Interventional Radiology

1 – INTRODUCTION

- Interventional radiology includes all image-guided therapeutic procedures. These procedures have an important role in clinical management. Although invasive, they are associated with very low morbidity and mortality rates and offer improved outcomes compared with similar procedures performed without image guidance. As image interpretation is an essential skill in their performance, such procedures are best performed by radiologists trained in diagnostic imaging.

- Procedures that may lead to further image-guided therapy, e.g. PTA or biliary stenting, should be carried out by appropriately trained interventionists, as they will be the ones to perform such therapy. These procedures replace surgery and carry morbidity and mortality rates, which, although less than surgery, are greater than other invasive radiological procedures such as biopsy or simple drainage. Drainage procedures in the urinary tract, gastrointestinal tract or hepatobiliary system fall into this category and therefore should be performed by those who have received special training in interventional radiology. Complex vascular procedures, whether diagnostic or therapeutic, should be performed by those trained in interventional radiology (IR) for similar reasons. Interventional procedures requiring a substantial clinical commitment, such as vertebroplasty and thermal ablation of tumors, should be performed by radiologists acting as the primary clinicians responsible for the medical care of the patient.

- The principles are:

  - All diagnostic radiologists should be able to perform image-guided biopsy and abscess or fluid drainage.
  - Invasive procedures that may progress to complex therapeutic radiological procedures should be performed by those trained in interventional radiology.
  - Individual interventional radiologists may not perform the whole range of procedures (just as diagnostic radiologists do not perform every type of diagnostic procedure), but they will have undergone basic training in vascular and non-vascular interventional radiology,

which will allow them to provide an out-of-hours service.

- The aim of subspecialised training is to prepare the radiologist for a career in which he/she devotes a substantial portion of his/her time to interventional radiology. Such individuals will be expected not only to carry out interventional procedures but also to discuss medical management with refering clinicians. A strong clinical background is essential to the fulfillment of this role. It is essential that interventional radiology training follow general radiological training and that interventional radiologists have a good grounding in the diagnostic radiology of the organ systems in which they carry out therapeutic procedures.

2 – EXPERTISE AND FACILITIES

- Training must be undertaken in (a) hospital(s) with clinical departments of vascular surgery, cardiology, and preferably cardiac surgery. Emergency and intensive care units as well as departments related to the fields in which interventional techniques are carried out are clearly mandatory as well.

- Initially, when subspecialised interventional training is introduced, a radiologist eligible for full CIRSE fellowship should supervise it. In the future, there may be certified subspecialists in interventional radiology who may supervise training.

- The training department(s) must have a full range of diagnostic equipment, including CT, MRI, colour Doppler ultrasound, angiography, and other interventional radiology equipment. There must be adequate monitoring and access to anaesthetic skills when required. There must be access to a radiological library containing e-learning facilities, textbooks, and the most important journals.

3 – OVERVIEW

- The training period will be equivalent to two years of full-time practice.
- It is essential that interventional radiology training initially follow general radiological training and that interventional radiologists have a good grounding in the diagnostic radiology of the organ systems in which they carry out therapeutic procedures.
- Trainees should develop their IR skills by working within the IR team under direct supervision, but should also have performed sufficient numbers of procedures as first operator, both electively and on call, so as to be competent when taking up an IR post at the end of the training period.
- They should acquire a detailed knowledge of sedation and analgesia techniques.
- They should acquire a detailed knowledge of the pathological and clinical basis of the specialty.
- Trainees must attend regular clinico-radiological conferences (at least weekly).
- Trainees should take part in outpatient clinics and ward work in order to develop clinical skills.
- Trainees will be expected to be familiar with the current subspecialised literature, both from standard textbooks and original articles.
- They should be encouraged to develop a critical approach in their assessment of literature.
- They should be involved in research and scientific publication.
- They should acquire knowledge of the design, execution, and analysis of research projects.
- Trainees should enhance their theoretical knowledge by attending and participating actively in the scientific programme and educational activities of CIRSE and SIR.
- During their training period, trainees should spend the equivalent of 4 months´ clinical training in a department of vascular surgery, internal medicine, or any subspecialty of surgery or internal medicine relevant to their IR training. They should also attend weekly outpatient clinics and ward rounds. They should undergo training in communication skills, including the ethics of informed consent and the process of giving bad news to patients.

4 – THEORETICAL KNOWLEDGE

- Technique, indications, contraindications and complications of the following diagnostic modalities:
  - Doppler and color Doppler ultrasound
  - CT (including CT angiography)
  - Magnetic resonance angiography and cardiac imaging
  - Angiography

- The factors affecting the choice of contrast media and radiopharmaceuticals and the effects and side effects of these agents

- Normal radiological anatomy, anatomy of the vascular system and all anatomical regions using any imaging modality
- Normal physiology of the cardiovascular system
- In-depth knowledge of the physiopathology of cardiovascular diseases
- Pharmacotherapy of the cardiovascular system
- Basic knowledge of chemotherapy
- Knowledge of physiopathology of all diseases in which interventional radiology plays a role
- Techniques and indications of:
  - Pre-procedural patient assessment
  - Peripheral angioplasty (incl. recanalisation and stenting)
  - Renal angioplasty (incl. recanalisation and stenting)
  - Supra-aortic angioplasty (incl. recanalisation and stenting)
  - Venous angioplasty (incl. recanalisation and stenting)
  - Thrombectomy and thrombolysis
  - Treatment of arteriovenous malformations
  - Treatment of bleeding
  - Gynecological interventions
  - Non-vascular upper gastrointestinal, liver and renal interventions
  - Post-procedure patient management
- Theory of advanced life support techniques (including ECG)
- Pharmacotherapy and practice of sedation and analgesia

5 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

The trainee must have a deep knowledge of all imaging modalities including newer imaging modalities of the cardiovascular system, such as CT angiography, colour Doppler ultrasound, and magnetic resonance. In addition, as more non-invasive diagnostic tools are used, the amount of aortography available to the trainee will diminish. Virtual Reality Training is now through its infancy and is a training reality. This must be borne in mind when considering practical experience. A single week in a VR laboratory with appropriate trainers has been shown by laparoscopic surgeons to move trainees much more rapidly along the learning curve.

Procedures performed must be kept in a logbook.

The numbers indicated for each procedure are for guidance only. They are not intended to be an indicator of competence at the end of the training period.

Diagnostic	**procedures**
Aortography and/or runoff	100
Selective angiography including head and neck	100
Doppler ultrasound and/or duplex ultrasound	50
CT angiography	50
MRI angiography and cardiac imaging	50
Phlebography	50
Any other imaging method related to the field of interventional procedures	

Interventional	**procedures**
Peripheral PTA	100
Other PTA (renal, etc.)	20
Complex PTA	20
Thrombectomy and thrombolysis	20
Vascular stenting	10
Embolisation	20
Complex embolisation	5
Techniques of intravascular chemotherapy	10
Venous interventions	20
Complex venous interventions (e.g. TIPS)	5
Vena cava filters	10
PTC, PTCD, and gallbladder interventions	20
Percutaneous biopsy	20
Drainage	20
Foreign body retrieval	5
Non-vascular interventions & stenting	20
Genitourinary tract procedures (nephrostomy, nephrolithotomy, ureteral procedures, tubal recanalisation)	20
Combined surgical and percutaneous procedures	
Combined endoscopic and percutaneous procedures	
Non-vascular interventions & stenting	20
In-depth practice of advanced life-support techniques	

6 – APPRAISAL AND ASSESSMENT

If written examinations are considered necessary, these should include both general and IR modules.

Basic reporting sessions could be the same for IR and DR candidates. In addition, the IR candidate would undergo a long reporting session dedicated to IR, which would require diagnosis and treatment options based on the imag-

ing and clinical scenarios. This should include statements of success and complication rates.

For IR candidates, one oral examination could be general and the second could be dedicated to IR. This could test thought process and manual dexterity using models, a range of equipment, and computer simulations. Logbooks would also be examined.

Musculoskeletal Radiology

1 – INTRODUCTION

Musculoskeletal (MSK) imaging involves all aspects of medical imaging which provide information about anatomy, function, disease states and those aspects of interventional radiology or minimally invasive therapy appertaining to the musculoskeletal system. This will include imaging in orthopaedics, trauma, rheumatology, metabolic and endocrine disease as well as aspects of paediatrics, oncology, and sports imaging.

The aim of subspecialised training in MSK imaging is to prepare a **radiologist for a career in which a significant portion of his/her time will be devoted to MSK imaging.** Such individuals will be expected to provide and promote MSK imaging and interventional methods.

The aims of establishing subspecialty training in MSK radiology is to ensure:

- An in-depth understanding of diseases of the MSK system;
- A clear understanding of the role of imaging in the diagnosis and treatment of MSK diseases;
- The development of the necessary clinical and management skills;
- The ability of the MSK specialist to perform (complex) MSK interventional procedures;
- The ability of the MSK specialist to act as a consultant in regular multidisciplinary meetings in the field of MSK imaging;
- The ability of the MSK specialist to transmit his/her specific knowledge to his/her colleagues in general radiology and to assume the continuity and evolution of radiological diagnosis in the field of MSK radiology (teaching skills).

2 – EXPERTISE AND FACILITIES

- Training must be undertaken in a team with access to full clinical service in radiology, orthopaedic surgery, rheumatology, and pathology. If possible, dialysis, paediatric orthopaedic surgery, orthopaedic oncology, medical genetics and sports medicine should also be offered.

- Training should be supervised by a group or a department or training schemes with extensive experience in MSK imaging.

- The training department(s) should have access

to conventional radiography, CT scan, ultrasonography, MR Imaging, interventional equipment, and bone densitometry.

- A database of "interesting cases" or "teaching files" should be present at the training department. Alternatively and/or additionally, the training department can refer to interesting educational sites on the internet.

- Trainees must also have access to radiological library containing textbooks of MSK radiology, orthopaedic surgery, rheumatology, and related sciences and journals.

- The training department must provide access to appropriate computed tomography (CT), magnetic resonance imaging (MRI), radionuclide imaging (optional), and fluoroscopy. Centres should also provide access to relevant specialised radionuclide imaging, e.g. positron emission tomography (PET) (where relevant). Practical training and/or theoretical teaching and training in bone densitometry techniques should be available.

3 – OVERVIEW

- Trainees should have completed the core skills and knowledge programme according to the EAR/UEMS curricula which will include basic knowledge of diagnosis of MSK diseases in their initial training.

- The subspecialty specialists/consultants in MSK imaging undertake 12 months or its equivalent of subspecialty training, either during the fourth and fifth year of the 5-year radiology training programme or as additional training after their 5-year residency/training scheme has been completed.

- The training outlined below will extend this into the practical role.

- They must obtain extensive experience in the diagnostic procedures listed below and will be expected to be familiar with the current MSK imaging literature, both from standard textbooks and original articles.

- They should participate in audit and research and should be encouraged to pursue a project up to and including publication. An understanding of the principles and techniques used in research, including the value of clinical trials and basic biostatistics should be acquired.

4 – THEORETICAL KNOWLEDGE

- Trainees should attend regular sessions of theoretical training in the form of locally delivered tutorials, specialist MSK imaging courses, as well as local, national and international MSK imaging conferences including formal lectures, scientific presentations or both, and E-learning.

- Trainees will acquire an extensive knowledge of the pathology, frequency and epidemiology of MSK diseases both in the paediatric and adult population. They should have a basic knowledge of the treatment of MSK disease by conservative treatment, surgery, radiotherapy and chemotherapy (if applicable) and be aware of the diagnostic needs of their surgical, radiotherapy and oncology colleagues. They must therefore attend regular multi-disciplinary conferences (e.g. with rheumatologists, orthopaedic surgeons, oncologists, etc.).

- Trainees should acquire a knowledge of:
  - The embryology, anatomy and physiology of the musculoskeletal system including normal anatomical variants
  - The pathological processes of both benign and malignant disease in the musculoskeletal system
  - Local, national and, where appropriate, international imaging guidelines and protocols

- Knowledge of the full range of radiological diagnostic modalities and techniques available, in particular:
  - The indications, contra-indications and complications of each imaging method
  - The factors affecting the choice of contrast media and radiopharmaceuticals
  - The effects and side effects of these agents
  - Optimisation of imaging protocols of diagnostic procedures

- Particular emphasis should be placed on the strengths and weaknesses of the different imaging methods in various pathological conditions. The appropriate choice of imaging techniques and/or the appropriate sequence of imaging techniques in the investigation of specific clinical problems should be emphasised.

5 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

- Technical skills

Acquisition of specific skills to enable:

- The conduct, supervision and accurate interpretation of all imaging techniques used in the investigation of musculoskeletal diseases to a high professional standard
- The accurate localisation and the biopsy of soft tissue, bone and lymph node masses
- Where appropriate, the safe and effective practice of interventional techniques
- Good communication with patients and professional colleagues
- Accurate informed consent to be obtained
- Continuing accreditation of intermediate life-support status

Procedural competence will need to be reviewed at intervals, and this regular review should also assess the number of cases required in order to ensure competence. During the training period it is recommended that the trainee obtain experience in the following:

- Plain radiography including:
  - primary care examinations
  - trauma cases
  - rheumatological disorders
  - general and paediatric orthopaedics

- Ultrasonography including:
  - joints
  - soft tissues
  - orthopaedic and sports injuries
  - Doppler studies applied to the musculoskeletal system

- CT
  - the use of CT for the primary diagnosis of benign and malignant pathology
  - staging of tumors involving the musculoskeletal system
  - detection of direct extension and metastatic spread of musculoskeletal tumors
  - the investigation of rheumatological disorders
  - the investigation of trauma and sports injuries
  - the use of reconstruction algorithms, multiplanar reconstruction, and volume rendering

- MRI
  - knowledge of basic and new MRI sequences applied to the musculoskeletal system, such as cartilage sequences, diffusion, etc.
  - the use of MRI for the primary diagnosis of benign and malignant pathology
  - staging of tumors involving the musculoskeletal system
  - detection of direct extension and metastatic spread of musculoskeletal tumors
  - demonstration of spinal anatomy and pathology
  - demonstration of joint anatomy and pathology, including direct and indirect MR arthrography
  - the investigation of rheumatological disorders
  - the investigation of acute trauma and trauma sequels
  - the investigation of sports injuries, both traumatic and overuse

- Fluoroscopic procedures including arthrography

A trainee will keep abreast of all other imaging techniques relevant to their practice.

Trainees should acquire experience in the following interventional procedures guided with fluoroscopy, ultrasound, or CT:

- Biopsy of bone and soft tissue lesions
- Arthrography
- Non-spinal image-guided diagnostic and therapeutic procedures
- Spinal image-guided therapeutic procedures, such as facet joint injections, sacroiliac injections, epidural, and periradicular infiltrations
- Discography
- Optional experience
- CT myelography
- Vertebroplasty

Trainees should acquire experience in all the practical procedures listed above, and the number of cases undertaken should be recorded in their logbook.

The trainee should become familiar with providing analgesia and/or sedation where required, as well as the necessary continuous monitoring required to perform this safely.

Regardless of the imaging technique or procedure con-

cerned, the consultant trainer must be satisfied with the trainee´s clinical competence, as determined by an in-training performance assessment, and can consistently interpret the results of investigations accurately and reliably, and formulate correct management plans.

- Communication and decision-making skills

A clear understanding of the role of multidisciplinary meetings, including:

- Planning of investigations including the selection of appropriate tests and imaging techniques for the diagnosis of benign and malignant disease
- Staging of malignant disease
- Planning and outcomes of treatment
- The detection of errors in diagnosis and complications of treatment
- Promoting an understanding of relevant musculoskeletal pathology

Clinical knowledge will be acquired by a variety of means, including close liaison with appropriate medical, surgical and oncological teams as well as combined clinical and radiological meetings. Multidisciplinary meetings should be emphasised. The following inter-relationships are important:

- Orthopaedics (general and paediatric) and rehabilitation
- Rheumatology
- Metabolic and endocrine medicine
- Bone and soft tissue oncology
- Trauma, including accident and emergency
- Spinal surgery
- Sports medicine/surgery
- Nuclear medicine

The trainee should be encouraged and given the opportunity to attend and lead appropriate clinico-radiological and multidisciplinary meetings.

The trainee should be encouraged to attend appropriate educational meetings and courses.

The trainee should participate in relevant clinical audit, management, and clinical governance, and have a good working knowledge of local and national guidelines in relation to radiological practice.

Trainees will be expected to be familiar with current musculoskeletal radiology literature.
The trainee should be encouraged to participate in research and pursue a project up to and including publication. An understanding of the principles and techniques used in research, including the value of clinical trials and basic biostatics, should be acquired. Presentation of research and audit results at national and international meetings should be encouraged.

The trainee should have on-call commitments on a regular basis.

Knowledge and understanding of the importance of effective communication with both the patient and the members of the multidisciplinary team.

Knowledge of roles and responsibilities of other members of the MSK imaging team, e.g. radiographers, nurses, support staff, secretaries, etc.

Knowledge of roles and responsibilities of other members of the Multi-Disciplinary Team.

Knowledge and understanding of how imaging findings influence decisions by others, e.g. surgeons, pathologists, oncologists, etc.

- Training schedule and content

During the training period, the following weekly commitments are suggested as a work profile for subspecialty trainees for the 12-month period, which will permit an integrated use of different modalities for the diagnosis and treatment of MSK disorders.

- MRI (two to three sessions)
- CT (one to two sessions)
- US (one to two sessions)
- Radionuclide imaging (one session) (where available)
- Plain film reporting (two to three sessions)
- Fluoroscopy with or without intervention (one session)
- Bone densitometry: 100 examinations have to be supervised and reported
- Trainees must attend regular clinico-radiological conferences (at least weekly)
- Optional experience in radionuclide reporting of the MSK system

The techniques listed and the time devoted to each will be reviewed at intervals. It is recognised that some studies will become obsolete and new imaging techniques will be developed.

The training department is free to organise an alternative framework throughout the year as long as an equivalent amount of examinations for each modality is met at the completion of the training. This includes a modality-based programme where the trainee sequentially spends dedicated periods of time in MRI, CT, US, etc.

For image-guided interventional procedures, hands-on experience with graded supervision will be required depending on the trainees' future career goals. The training in and supervision of such procedures may be provided by musculoskeletal or interventional trainers, depending on the local practices and expertise.

Experience will be documented in a logbook, including a summary of the theoretical (documented by CME certificates) and practical training and certified by the supervising radiology department or group (3). The numbers indicated for each procedure are for guidance only. They are not intended to be an indicator of competence at the end of the training period.

The contents of the training needs to be flexible and appropriate to the career goal of the trainee. Musculoskeletal radiology is an expanding and evolving specialty, with developments of different imaging techniques and interventional procedures. Some trainees may require additional training in such developing areas.

6 – APPRAISAL AND ASSESSMENT

At the end of the training, a certificate of subspecialty expertise will be awarded by the training department in accordance with the law of each country.
Formal testing should be up to the authority of the respective country in which the training has been fulfilled.

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Neuroradiology

1 – INTRODUCTION

- Neuroradiology is a branch of medicine concerned with both diagnostic imaging and interventional procedures related to brain, spine and spinal cord, head, neck, and organs of special senses in adults and children.

- The aim of specific training in neuroradiology is to prepare a specialist for a career in which his/her clinical and research time will be devoted to diagnosis and treatment of diseases of the areas cited above using imaging modalities.

- Neuroradiologist will also be expected to adopt and develop new imaging and interventional methods, to disseminate neuroradiological knowledge and, from a basis of strong clinical background, be able to discuss with the refering clinicians the diagnosis and treatment.

- This curriculum outlines the subspecialty training requirements for neuroradiology, including interventional neuroradiology as a subspecialty of radiology.

- In Europe, trainees will enter into neuroradiology training during the fourth and fifth years of clinical training. This training is in diagnostic neuroradiology and may have some components of interventional neuroradiology.

- All residents in radiology will have obtained basic knowledge of neuroradiology diagnosis during core training and will have already acquired basic skills.

- This document outlines the training curriculum for a consultant neuroradiologist. A minimum of 24 months of full-time training in neuroradiology is recommended. A trainee undertaking additional training in neurointerventional procedures requires more than two years neuroradiological training.

- Dedicated neuroradiology training received at a neuroscience centre within an accredited radiology-training scheme may be taken into consideration.

- The aim of subspecialty training in neuroradiology is to enable the trainee to become clinically competent and to consistently interpret the results of neuroradiological investigations accurately and reliably. Where appropriate, trainees should also be capable of providing a comprehensive and safe interventional diagnostic and therapeutic service.

- The content of training needs to be flexible and appropriate to the ultimate goal of the trainee. Neuroradiology is an expanding specialty with development of interventional services, paediatric neuroradiology, and functional brain imaging, including MR spectroscopy. Some trainees may wish to obtain extra training in these areas.

2 – OVERVIEW

- Basic skills in neuroradiology will have been acquired before subspecialty training.

- A training scheme responsible for training in neuroradiology must provide access to appropriate CT, MRI, digital subtraction angiography, ultrasound and radionuclide imaging facilities. Trainees should also have access to neonatal cranial ultrasound.

- Clinical knowledge will be obtained by a variety of means. This will include close liaison with the appropriate surgical and medical teams and participation in combined clinical and radiological meetings. Clinical interrelationships are necessary with:
  - Neurosurgery (paediatric and adult)
  - Neurology (paediatric and adult)
  - Neuropathology
  - Neurophysiology
  - Neuroanaesthesia/critical care and emergency medicine
  - Trauma

- Other specialties will also provide important training opportunities, in particular ophthalmology, otology, genetics, endocrinology, psychiatry, neuro-oncology, maxillo-facial surgery, spinal surgery, and rehabilitation services.

- It may be appropriate for the trainee to have a regular attachment to ward rounds, outpatient clinics and theatre sessions in order to further clinical knowledge relevant to the subspecialty.

- The trainee should be encouraged and given the opportunity to attend and lead appropriate clinico-radiological meetings.

- The trainee should participate in relevant clinical audit, management and clinical governance and have a good working knowledge of local and national guidelines in relation to radiological practice.

- The trainee should be involved in research and have the opportunity to attend and present at national and international meetings. The progression of research projects to formal peer-reviewed publication should be supported and encouraged by the supervising consultant(s).

- Attendance at National, European and American Neuroradiology Societies should be encouraged.

- The trainee should be encouraged to become an associate member of the appropriate National Neuroradiology Society and the European Society of Neuroradiology.

- The trainee is expected to participate in undergraduate and postgraduate teaching, including the European Course in Neuroradiology or other courses of similar scope and quality.

- The trainee should, where possible, participate in the neuroradiology on-call rota, after adequate training with appropriate consultant cover.

- Subspecialty training in neuroradiology is assessed and accredited by the Provisional European Board of Neuroradiology under the approval by European Society of Neuroradiology.

3 – THEORETICAL KNOWLEDGE

The accredited training of neuroradiologists will have to achieve the following:

- An in-depth knowledge of anatomy, including developing anatomy and its radiological applications to the central and peripheral nervous system, organs of special senses, head and neck, and spine and spinal cord in adults and children.

- Knowledge of and radio-pathological correlation of diseases and variations of the CNS, including the spine and cranium and disorders of the oph-

talmological and otorhinolaryngological systems, including appropriate indications, contraindications and complications of imaging studies of neurological diseases and interpretation of the various imaging modalities.

- Knowledge of proper experience and understanding of physical principles and technical background for performance and interpretative skills of computed tomography (CT), magnetic resonance imaging (MRI), angiography, ultrasound, conventional imaging, and myelography for the diagnostic imaging of the head and spine and spinal cord, head, neck, and organs of special senses in adults and children so that they can, with confidence, discuss with their colleagues the choice of best imaging method for a particular clinical problem.

- Knowledge of functional and imaging aspects of MR spectroscopy, MR functional imaging, and nuclear medicine studies (SPECT & PET) as they relate to neuroradiology.

- Knowledge and commitments to the clinical applications of neuroradiology as they apply to all aspects of neuroradiology so that the trainee may confidently discuss patients with colleagues.

- Knowledge of indications, techniques and clinical outcome of interventional neuroradiology, as well as the hazards and potential complications of invasive procedures, both diagnostic and therapeutic.

- Knowledge of pharmacology, particularly with respect to contrast material and invasive procedures.

- Knowledge of patient's protection and safety in neuroradiology.

- The trainee should be fully competent in intermediate and advanced life-support.

- Knowledge of the importance of informed consent and patient information.

- Understanding of fundamentals of quality assurance in neuroradiology.

- Understanding risk management, data banking, and evidence-based medicine.

- Knowledge of the current developments in neuroradiology.

- If experience to fulfill the requirements of subspecialty training cannot be gained in one training center, it will be necessary for the trainee to have a period of attachment(s) to other training centers. There are, in any case, advantages for trainees in visiting other departments at home or abroad to follow particular interests in greater depth.

- The expected outcome at the end of this subspecialty training in neuroradiology will be for the resident to be competent in all aspects of diagnostic neuroradiology imaging and, where applicable, basic interventional neuroradiology.

4 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

- Essential is competence in clinical neuroradiological skills in adults and children, including:
  - Diagnostic and interpretative skills
  - Manual and procedural skills
  - Basic endovascular and therapeutic knowledge
  - Computer skills in imaging acquisition and post-processing
  - Outpatient consultation when relevant

- Ability to manage post-procedural care for invasive diagnostic and therapeutic techniques as well as neuroradiological emergencies

- Ability to manage patients and to obtain valid informed consent for all procedures

- Competence in effective consultation, presentation of scholarship material and ability to teach neuroradiology to peers and residents in other disciplines

- Ability to evaluate medical literature critically and to conduct neuroradiological research

- Competence in style of reporting

- Ability to conduct or supervise quality assurance

- To keep an authorised logbook of experience

- Competence in communicating clinical and sci-

entific topics to various learned and scientific communities within neuroscience

- Responsible use of financial and other resources
- Interactions with colleagues and administration
- Ethical and responsible
- Appropriate and considerate with patients
- Respecting confidentiality in patient care
- Ability to interact well with peers and the rest of staff
- Awareness of the obligation of continuing medical education and commitment to the continuing assessment of the quality of neuroradiology

5 – REQUIREMENTS OF SUBSPECIALTY TRAINING

- A comprehensive knowledge of normal brain function and neurological diseases, including:
  - The embryology, anatomy, normal variants and physiology of the central and peripheral nervous system, organs of special senses, head and neck, and spine and spinal cord in adults and children
  - The pathological correlation of diseases and variations of the CNS, including the spine and cranium and disorders of the ophthalmological and otorhinolaryngological systems, including appropriate applications and interpretation of the various imaging modalities
  - Local, national and, where appropriate, international imaging guidelines
- Knowledge and understanding of the physical principles and technical background for the performance of CT, MRI, angiography, ultrasound, conventional imaging, and myelography for the diagnostic imaging of the head, spine and spinal cord, neck, and organs of special senses in adults and children. Exposure to MRS/functional imaging and nuclear medicine studies (SPECT, PET) related to neuroradiology should be available.
- To develop the interpretative skills of CT, MRI, angiography, ultrasound, conventional imaging and myelography for the diagnostic imaging of the head, spine and spinal cord, neck, and organs of special senses in adults and children.
- The subspecialty resident should know the inherent strengths and limitations of these modalities, as well as appropriate imaging protocols for neuroradiological consultation.
- Knowledge of the techniques involved in the imaging used to evaluate and treat neurological diseases, including interventional procedures and the management of the complications of these procedures.
- Knowledge and competence at imaging of brain function.
- Knowledge of pharmacology, particularly with respect to contrast media and invasive procedures.
- Knowledge of patient protection and safety in neuroradiology.
- Understanding of fundamentals of quality assurance (management) in neuroradiology.
- Acquisition of specific skills to enable competence in clinical neuroradiological skills in children and adults, including:
  - Diagnostic and interpretative skills
  - Manual and procedural skills
  - Basic endovascular and therapy skills
  - Computer skills in imaging acquisition and post-processing
  - The conduct, supervision and accurate interpretation of all imaging techniques used in the investigation of neurological diseases to a high professional standard
  - Good communication with patients and professional colleagues
  - Competence in the style of reporting
  - Ability to manage post-procedure care for invasive diagnostic and therapeutic techniques as well as neuroradiological emergencies
  - Ability to manage patients and to obtain valid informed consent for all procedures
  - Competence in effective consultation, presentation of scholarship material, and ability to teach neuroradiology to peers and residents in other disciplines
  - Ability to evaluate medical literature critically and to conduct neuroradiological research

  - Ability to conduct or supervise quality assurance

- The core requirements for a neuroradiologist or a specialist interventional neuroradiologist are similar, apart from the total number of interventional procedures performed (see below).

- Regardless of the imaging technique concerned, the consultant trainer must be satisfied with the trainee being clinically competent, as determined by an in-training performance assessment, and being able to consistently interpret the results of such investigations accurately and reliably.

- During the training period it is recommended that the trainee receive the following:
  - CT – the equivalent of one or two sessions per week
  - MRI – the equivalent of two or three sessions per week
  - Angiography – the equivalent of two sessions per week
  - Interventional neuroradiology – see below
  - Study/meetings – the equivalent of one session per week
  - Research – the equivalent of one session per week
  - Myelography – the opportunity to observe and, whenever possible, obtain hands-on experience of the limited number of these procedures now carried out

- During the training period the trainee should also gain experience in the following:
  - Plain radiography, including:
  - Primary care examinations
  - Skull, facial and spinal trauma
  - Paediatric examinations including child abuse

- Optional experience:
  - Radionuclide radiology including SPECT imaging and PET
  - Ultrasound including neonatal cranial US and Doppler

- The techniques listed and the time devoted to each will be reviewed at intervals along with the number of cases required, as it is recognised that some procedures may become obsolete and new techniques will be developed (e.g. functional brain imaging and MR spectroscopy).

- The trainee should become familiar with providing analgesia and/or sedation where required, as well as the necessary continuous monitoring required to perform this safely.

- The trainee should become fully aware of the local and national guidelines in obtaining informed patient consent.

6 – INTERVENTIONAL NEURORADIOLOGY REQUIREMENTS

- All subspecialist residents training in neuroradiology should have a basic understanding of interventional techniques so that they have full knowledge of indications, technical problems, contraindications, and risks of procedures. Trainees with a special interest in interventional neuroradiology will need more extensive experience.

- All trainees in interventional neuroradiology should complete at least one year of diagnostic neuroradiology training.

- Trainees who wish to spend a significant part of their work as a consultant in interventional neuroradiology should spend around one year in a training post in which substantially the whole time is devoted to interventional neuroradiology.

- These trainees will need to extend their subspecialty training beyond two years required for neuroradiology. However, earlier and more focussed individualised training in neuroradiology is being encouraged for those trainees with previous neuroscience/neurovascular experience.

- Trainees need to develop clinical judgement. The risks and benefits of each therapeutic procedure need to be appreciated. Training might include a clinical attachment.

- Trainees should have adequate exposure to neurosurgical operations and ward/HDU management of acutely ill patients.

- Regular involvement in neurosciences audit and mortality/morbidity meetings is necessary to understand risk management for different clinical conditions.

- It is the responsibility of the trainee to be aware of

the current local and national guidelines in obtaining informed patient consent.

- All interventional trainees must have thorough knowledge of techniques of sedation and analgesia required to perform these procedures, as well as patient monitoring throughout and following the procedures.

- Trainees should be aware of the full range of intra- and post-operative complications and their management.

- The interventional trainee should participate in around 80 neuroradiological interventional procedures, of which a substantial proportion will be for intracranial vascular lesions. The trainee should be the first operator in around a third of cases.

- It is desirable that the trainee also attend other centers, especially if range and quantity of interventional procedures are limited.

7 – APPRAISAL AND ASSESSMENT

- Regular appraisal of the trainee will occur according to national guidelines.

- Methods of trainee assessment will include:
  - Regular direct observation of clinical techniques (including communication skills, ability to obtain informed consent and sedation skills) by the trainer and/or external observer
  - Regular formal review of the trainee's skills in the accurate interpretation of investigations for neurological diseases
  - Final assessment of overall professional competence

- Review of subspecialty curriculum
  - The Training Committee of the European Society of Neuroradiology will regularly review this subspecialty curriculum to ensure that it complies with current neuroradiological practice.

Paediatric Radiology

1 – INTRODUCTION

The aim of sub-specialised training in paediatric radiology is to prepare the radiologist for a career in which a substantial proportion of his/her time will be devoted to paediatric radiology. Such individuals will be expected not only to provide a paediatric radiology service but also adopt and develop new imaging and interventional methods and to disseminate paediatric radiological knowledge to their colleagues in general radiology.

2 – EXPERTISE AND FACILITIES

Specialist training in paediatric radiology must take place in hospitals with the full range of clinical paediatric specialities available on site. These include gastrointestinal tract, genito-urinary tract, chest, endocrine, neonatal, musculoskeletal, neurology and neurosurgery, cardiovascular, and A&E facilities. Medical and surgery facilities must be available. Where facilities are not available on site, arrangements should be made for secondment to an appropriate unit so that such training is available.

The training department must have a full range of diagnostic equipment, including access to specialised sessions on nuclear medicine, CT and MRI. Interventional radiology experience, both angiographic and non-angiographic, must also be available. There must be access to a library with radiological and clinical textbooks and journals. A film library must also be available.

3 – OVERVIEW

The training period will be the equivalent of one - two years of practice. During this period, the trainee must devote his/her time to paediatric radiology. Trainees should acquire a deep knowledge of the pathological and clinical basis of the specialty. They should obtain extensive experience in all of the diagnostic methods listed in the syllabus. Trainees must attend regular clinicoradiological conferences (at least weekly) with their clinical colleagues. Trainees will be expected to be familiar with the current paediatric radiological literature, both from standard textbooks and original articles. They should be encouraged to develop a critical approach in their assessment of the literature. They should be involved in a research project (or projects) and should acquire knowledge of the design, execution, and analysis of research projects.

4 – THEORETICAL KNOWLEDGE

- Theoretical training

Teaching is organised on the basis of lectures, tutorials, and workshops. Trainees are to be encouraged to attend national and international conferences on paediatric radiology, such as those given by the European Society of Paediatric Radiology (ESPR), the Society of Paediatric Radiology (SPR), and the European Congress of Radiology (ECR).

- General principles

    - Understanding of the principles of paediatric radiology as an integrated imaging concept.
    - Knowledge of special needs of children: environment, sedation, psychology of handling children. Organisation of a paediatric section within a general department, guidelines for investigation, contrast: factors affecting the choice of contrast, indications and contraindications, including radiopharmaceuticals.
    - Detailed knowledge of dose reduction techniques in paediatric radiology:
        - Equipment choice, film/speed combination, use of grids/video, Q.A. [quality assurance] programme
        - Role of lateral film, PA v AP views, comparison view, choice of examination, cost/risk benefit
        - To understand the ALARA [as low as reasonably achievable] principle. IRMER 2000 regulations

- Knowledge relevant to normal anatomy, normal variations, development, and physiology of the prenatal, neonate and growing child

- In-depth understanding and knowledge relevant to medical and surgical management of paediatric diseases.

    - The Chest
        - Neonatal: to include surgical problems
        - Infection: bacterial, viral, opportunistic, TB and ITU complications
        - Cardiac
        - Trauma
        - Foreign bronchial bodies
        - Infiltrative disease
        - Asthma
        - Mass lesions
        - Clinical problems, e.g. investigations of stridor
        - Investigation of recurrent chest infection
        - Intensive care chest radiology

    - The Musculoskeletal System
        - Trauma: Salter classification of physeal injuries
        - Fracture complications
        - Cervical Spine
        - Pelvic Fractures
        - Irritable hip, Perthes' disease
        - Sports injuries
        - Polytrauma
        - Infection/bone – joint – disc/how to approach diagnosis and integrated imaging
        - Multifocal osteomyelitis/chronic granulomatous diseases
        - Scoliosis and orthopaedic problems
        - Arthritis and metabolic disease
        - Neoplastic: benign and malignant bony and soft tissue tumors
        - Skeletal dysplasia

    - The Abdomen
        - Neonate
        - Oesophageal disease, reflux
        - Pyloric stenosis
        - GI bleeding
        - Inflammatory bowel disease, appendicitis and gastro-enteritis
        - Constipation
        - Intussusception
        - Ulcer disease
        - Malabsorption
        - Obstruction
        - Pancreatitis
        - Abdominal trauma – to include liver, spleen and pancreas, and bowel tumors (liver, small bowel and pancreas)
        - To understand the limits of ultrasound in the evaluation of traumatic lesions of the liver and spleen
        - To know the indications of CT/to be able to perform CT

    - Genito-urinary tract
        - Infection – UTI [Abscess and pyonephrosis and how to investigate)
        - To recognise the normal appearance of the organs in any imaging modality
        - To understand the urethral anatomy of the boy

- To understand the clinical and biological criteria of UTI
- To be able to perform ultrasound of the urinary tract on infants using Doppler
- To know when and how to perform a VCUG and how to read it
- To detect and evaluate VUR
- Congenital anomalies and hydronephrosis
- Haematuria and stones
- Renal mass lesions (incl. polycystic disease)
- Pelvic tumors
- Trauma
- Neuropathic bladder
- Diverticula
- Urodynamic studies
- Gynecological disease
- Intersex
- Testicular diseases

- Neuro
  - Trauma: Skull and facial injury
  - Intracranial injury
  - Infection
  - Tumors (including spinal cord)
  - Ultrasound of the neonatal brain
  - Premature brain disease
  - Developmental anomalies (structural)
  - Normal myelination
  - Craniosynostosis
  - Ophthalmology: trauma
  - Tumor
  - Infection
  - FB
  - Developmental anomalies: migrational
  - Epilepsy
  - Hydrocephalus
  - Vascular disease (including malformations and acquired)
  - Spinal cord malformations (including imaging for clinical presentations, e.g. back pain, claw foot)
  - Craniofacial malformations
  - ENT congenital ear disease and deafness
  - Infection
  - Trauma
  - Airway
  - Dental radiology
- Miscellaneous
  - AIDS in children
  - Lymphoma in children
  - Vascular malformations (limb, lymphoedema)
  - Collagen vascular disease (+ myofibromatosis, etc.)
  - Endocrine disease
  - Investigation of small stature + growth disorders
  - Non-accidental injury (NAI)
  - Teeth (incl. craniofacial malformations)
  - Phakomatoses [tuberose sclerosis, neurofibromatosis, etc].
  - Langerhans Cell Histioctytosis

5 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

- The trainees must know in depth the full range of paediatric radiological diagnostic techniques detailed below. They should understand the principles of all the methods, and in particular emphasis should be placed on the strengths and weaknesses of the different imaging methods in the diagnosis of the different pathological conditions. The proper choice of imaging techniques and/or the appropriate sequence of imaging techniques to solve specific clinical problems should be emphasised. The ability to discuss with parents/carers and older children should be demonstrated.

- During the training period, it is recommended that the trainee obtain experience in the following:
  - Plain radiography, to include the full range of clinical subspecialties, e.g. trauma, accident and emergency, orthopaedics, rheumatology, chest, and abdomen
  - Undertaking and reporting ultrasound examination:
    - of the abdomen, gastrointestinal tract (including bowel), genitor-urinary tract, chest, head, and musculoskeletal system
    - Doppler studies, including spectral, basic colour and power Doppler, as well as basic calculations
  - Undertaking and reporting routine fluoroscopic examinations of the gastrointestinal and urinary tract, together with more complex investigation, such as:
    - Small bowel enema
    - Reduction of intussusception
    - Management of neonatal distal intestinal obstruction

- Velopalatal competence and studies of phonation
- Disorders of swallowing
- Undertaking and reporting paediatric CT and MR examination
- Undertaking (optional) and reporting basic paediatric radionuclide imaging examinations:
  - Static and dynamic renal studies, including cystography
  - Musculoskeletal imaging
  - Ventilation and perfusion lung scintigraphy
  - Gastrointestinal studies, including pertechnetate studies for Meckel's diverticulum
  - Identification of a GI bleeding site
  - Thyroid imaging
  - MIBG studies
  - Dynamic biliary examination
- Interventional techniques
  - Trainees should acquire experience in the following procedures:
  - Biopsy procedures
  - Abscess drainage
  - Insertion of percutaneous nephrostomies
  - Joint aspiration (e.g. hip)
- Optional experience may include:
  - Arthrography
  - Angiography
  - Balloon dilatation of oesophageal strictures
  - Embolisation techniques
  - Musculoskeletal intervention

6 – APPRAISAL AND ASSESSMENT

- Methods of trainee assessment will include:
  - regular direct observation of clinical techniques (including communication skills, ability to obtain informed consent and sedation skills) by the trainer and/or external observer
  - regular formal review of the trainee's skills in the accurate interpretation of investigations for paediatric diseases
  - a final assessment of overall professional competence

Urogenital Radiology

1 – INTRODUCTION

The aim of establishing a curriculum for subspecialty training in urogenital imaging is to prepare trainees for an activity in which he/she will dedicate a substantial amount of time to radiology of the urogenital system. His/her specific skill should include the following:

- In-depth knowledge of the relevant embryological, anatomical, pathophysiological, and clinical aspects of radiology in the field of uronephrology and gynecology.
- A clear understanding of the role of radiology in the management of these specialist areas.
- Complete knowledge of the indications, contraindications, complications, and limitations of procedures.
- In-depth knowledge and expertise in the examination techniques for imaging procedures to urological, nephrological, and gynecological diseases and problems.

Furthermore, the subspecialist should be able to promote and advance urogenital imaging in his/her environment. Then, the curriculum is aimed at developing the following:

- The ability to act as a consultant in multidisciplinary meetings
- The ability to transmit subspecialty knowledge to other radiology colleagues
- The ability to assume the continuity and the evolution of radiology in the field of urological, nephrological, and gynecological diseases and problems

2 – EXPERTISE AND FACILITIES

- Training in urogenital imaging must be undertaken in a training center with access to full clinical services in radiology, nephrology and dialysis, urology, obstetrics and gynecology and pathology; it is preferable that also radiation therapy and oncology be available.

- The radiology department should have access to all routine and advanced imaging modalities (conventional radiology, CT, MRI, ultrasound, Doppler, and interventional radiology). Equipment should be in sufficient number and of state-of-the-art quality.

- A library must be readily accessible. It should contain an adequate selection of the major textbooks in urogenital radiology, as well as provide access to major radiology journals. The library should allow also access to major journals in urology, nephrology, and gynecology.

- A teaching file should be available and continuously updated. The trainee will be expected to contribute with cases from his/her experience during his/her training period.

3 –OVERVIEW

- During the training in urogenital radiology, the trainee must spend most of his/her time in this field of interest. Although the primary scope of the curriculum is to acquire in-depth knowledge of radiological techniques and imaging findings, the trainee is expected to acquire knowledge of the clinical and pathologic presentation of diseases of the urogenital system too, as well as an understanding of the tests which are the prerequisites for imaging examinations (i.e. laboratory, endoscopy, urodynamics).

- Because angiographic interventions require additional special skills, they are not required for the curriculum in urogenital imaging. However, the trainee is expected to develop capabilities in image-guided biopsy procedures (renal and adrenal masses, prostate, lymph nodes) and drainages of lesions and organs of the urogenital system (nephrostomy, abscess drainage). Additional training may be required for procedures such as varicocele embolisation, renal tumor embolisation, and fibroid embolisation. Management of renal artery stenosis may at times be under the remit of urogenital radiology.

- The trainee should be familiar with clinical terminology so as to communicate without difficulty with clinical colleagues. He/she should attend multidisciplinary meetings to get a thorough idea of patient treatment, as well as of the role of imaging methods in clinical practice.

- The trainee should become familiar with the current literature in urogenital imaging, both from standard textbooks and original articles. They should be encouraged to participate in research projects and acquire knowledge of the design, execution, and analysis of scientific projects. They should be encouraged to present papers at international congresses, to meet other people involved in the field of urogenital imaging in order to exchange ideas and experiences.

4 – THEORETICAL KNOWLEDGE

At the end of the training period, the trainee should have achieved the knowledge-based objectives listed below. Reasonable progression is to be expected during training, with responsibilities assumed gradually until complete professional independence is reached.

- Urinary & Male Genital Tract

  - Renal physiology and kinetics of contrast agents
    - To understand the physiology of renal excretion of contrast medium (both iodinated and gadolinium-based ones)
    - To understand the enhancement curves within renal compartments after injection of contrast agents (both iodinated and gadolinium-based ones)
    - To know the concentrations and doses of contrast agents used intravenously (both iodinated and gadolinium-based ones).
    - Knowledge on the following aspects of contrast media (both iodinated and gadolinium-based ones) nephrotoxicity would be required:
      - Definition of contrast media nephrotoxicity;
      - Risk factors of contrast media nephrotoxicity;
      - How to identify patients at high risk of contrast media nephrotoxicity;
      - Measures to reduce the risk of contrast nephrotoxicity;
      - Precautions in diabetics taking metformin and requiring intravascular administration of CM;
      - For these items, please refer to the ESUR guidelines on CM.

  - Normal anatomy and variants
    - *Retroperitoneum*
      - To recognise retroperitoneal spaces and pathways
    - *Kidney*
      - To understand the triple obliquity of the kidney
      - To know the criteria of normality of

pyelocaliceal system on IVU and CTU
- To recognise normal variants, such as junctional parenchymal defect column of Bertin hypertrophy, fœtal lobulation, and lipomatosis of the sinus
- To identify the main renal malformations such as horseshoe kidney, duplications, ectopia, and fusions

- *Bladder and urethra*
  - To know the anatomy of bladder wall and the physiology of micturition
  - To identify the segments of male urethra and location of urethral glands
- *Prostate*
  - To recognise zonal anatomy of the prostate
  - To identify prostatic zones with US and MRI
- *Scrotum*
  - To know the US and MRI anatomy of intra-scrotal structures (testicular and extratesticular)
  - To know the Doppler anatomy of testicular and extratesticular vasculature

- Imaging techniques
  - *Sonography of urinary tract*
    - To choose the appropriate transducer according to the organ imaged
    - To optimise scanning parameters.
    - To recognise criteria for a good sonographic image
    - To recognise and explain the main artifacts visible in urinary organs
    - To be able to obtain a Doppler spectrum on intrarenal vessels (for resistive index measurement) and on proximal renal arteries for velocity calculation
  - *IVU*
    - To list the remaining indications of IVU.
    - To know the main technical aspects, including:
      - Choice of the contrast agent
      - Doses
      - Film timing and sequences
      - Indication for ureteral compression
      - Indication of frusemide
  - *Cysto-urethrograpy*
    - To list the main indications of cystourethrography
    - To know the main technical aspects:
      - Choice of technique: trans-urethral, transabdominal
      - Choice of the contrast agent
      - Film timing and sequences
    - To remember aseptic technique
  - *CT of the urinary tract*
    - To define the normal level of density (in HU) of urinary organs and components
    - To know the protocol for a renal and adrenal tumor
    - To know the protocol for urinary obstruction (including stones)
    - To know the protocol for a bladder tumor
    - CT urography (CTU): techniques, indications, contraindications, and limitations
  - *MR of the urinary tract*
    - To know the appearances of urinary organs on T1 and T2 images
    - To know the appearances of urinary organs on T1 and T2 contrast-enhanced sequences
    - To know the protocol for a renal and adrenal tumor
    - To know the protocol for urinary obstruction.
    - To know the protocol for a bladder tumor
    - To know the protocol for a prostatic tumor
      - "Conventional" pelvic MRI for the prostate: possibilities and limits
      - Use of rectal probes
      - Prostate MRI spectroscopy
    - MR Urography (MRU)
      - T2 MRU
      - Excretory MRU: technique, indications, contraindications, and limitations

- To accurately diagnose the presence of the following pathologies:
  - *Kidney and ureter*
    - Congenital
    - Obstruction
    - Calculus
    - Infection
    - Tumors
    - Cystic diseases
    - Medical renal diseases
    - Vascular

- Renal transplantation
- Trauma
- *Retroperitoneum*
  - Congenital
  - Infection
  - Trauma
  - Tumors
- *Bladder*
  - Congenital
  - Obstruction
  - Inflammatory
  - Tumors
  - Trauma
  - Incontinence & functional disorders
  - Urinary diversion
- *Urethra*
  - Congenital
  - Strictures
  - Diverticula
  - Trauma
- *Prostate & Seminal Vesicles*
  - Congenital
  - Benign prostatic hypertrophy
  - Inflammatory
  - Tumors
- *Testis & scrotum*
  - Congenital
  - Inflammatory
  - Torsion
  - Trauma
  - Tumors
- *Penis*
  - Impotence
  - Trauma
  - Tumors
- *Adrenal*
  - Masses

- Interventional
  - *In general*
    - To verify indications to the procedure and patient risk factors (such as satisfactory blood count, coagulation status, etc.)
    - To explain the procedure and follow-up to the patient
    - To obtain informed consent
    - To know what equipment is required
    - To know what aftercare is required
    - To know the complications, importance of early detection, and management
  - *US-guided biopsies/cystic drainage, e.g. kidney mass, prostate*
    - To become familiar with ultrasound probes
    - To become familiar with different guidance techniques
      - free hand
      - guidance devices
    - To become familiar with different biopsy devices and needles
    - To become familiar with drainage tubes and fixation devices
    - To become able to liaise with pathologists and refering physicians
  - *CT-guided biopsies*
    - To become familiar with CT scanners and CT-guided biopsy/drainage techniques
  - *Percutaneous nephrostomy*
    - To verify and discuss indication with refering clinicians
    - To verify patient preparation and positioning
    - To become familiar with sedo-anelgesia, local anaesthesia, and antibiotic policies
    - To become familiar with guidance techniques
    - US guidance
    - Fluoroscopic guidance
    - To become familiar with puncture techniques
    - To become familiar with guidewires and tissue dilatators
    - To become familiar with nephrostomy tubes:
      - locked
      - unlocked
    - To become familiar with fixation devices, dressings, and drainage bags
    - To become proficient in nephrostomy placement as well as in nephrostomy change
  - *Antegrade ureteric stent insertion*
    - To become proficient in nephrostomy insertion (see above)
    - To become familiar with guidance catheters
    - To become familiar with ureteric dilatators
      - Teflon
      - Balloon

- To become familiar with ureteric stents
  - double J stents
  - metallic stents
- To liaise with urologists for stent management
- *Percutaneous nephrolithotomy*
  - To work in close cooperation with endo-urologists
  - To discuss case preoperatively.
  - To become familiar with access techniques and tract dilatation
  - To become familiar with available lithotripsors
- *Angiography*
  Detailed angiographic techniques, including selective angiography and embolisation techniques, are better acquired during an attachment to a vascular angiography slot during training.

At the end of the training period the trainee should become proficient with performing the basic interventional techniques and be familiar with the more complex procedures (exact number of different procedures is not always relevant, as the degree of dexterity and proficiency will vary from trainee to trainee).

- Female genital tract

  - Techniques
    - *US examination*
      - To be able to explain the value of an US examination
      - To be able to explain the advantages and limits of abdominal vs. transvaginal approach
      - To be able to perform a transvaginal US examination
      - To know indications and contra-indications of hysterosonography
      - To be able to perform a hysterosonographic examination
    - *Hysterosalpingography*
      - To be able to describe the procedure
      - To know the possible complications of hysterosalpingography
      - To know the contra-indications of hysterosalpingography
      - To explain the choice of contrast agent
      - To know the different phases of the examination
      - To be able to perform the procedure
    - *CT scan*
      - To be able to explain the technique of a pelvic CT
      - To know the possible complications of CT
      - To know the contra-indications of CT
      - To know the irradiation delivered by a pelvic CT
      - To know the required preparation of the patient and the choice of technical parameters (slice thickness, Kv, mA, number of acquisitions, etc.) depending on indications
    - *MRI*
      - To be able to explain the technique of a pelvic MRI
      - To know the contra-indications of MRI.
      - To know the required preparation of the patient and the choice of technical parameters (slice thickness, orientation, weighting, etc.) depending on indications, including pelvic floor disorders
    - *Angiography*
      - To know the main indications of pelvic angiography in women
      - To know how to perform a pelvic angiography
    - *Anatomy*
      - To know main normal dimensions of uterus and ovaries with US
      - To describe variations of uterus and ovaries during genital life
      - To describe variations of uterus and ovaries during the menstrual cycle
      - To describe normal pelvic compartments
      - To identify normal pelvic organs and boundaries on CT and MRI
      - To explain the role of levator ani in the physiology of the pelvic floor
      - To know what imaging modalities can be used to visualise the pelvic floor
      - To know the factors responsible for urinary incontinence

  - To accurately diagnose the presence of the following pathologies:
    - *Uterus*
      - Congenital anomalies
      - Tumors (benign and malignant)
        - Myometrium
        - Endometrium

    - Cervix
  - Inflammation
  - Adenomyosis
  - Functional disorders
- *Ovaries/Tubes*
  - Ovary
    - Tumors (benign and malignant)
    - Functional disorders, e.g. functional cysts of the follicle or corpus luteum, precocious puberty, and polycystic ovaries
    - Endometriosis
  - Tubes
    - Inflammatory disorders
    - Tumors
- *Pelvis*
  - Prolapse
  - The "acute female pelvis"
  - Endometriosis, includine extra-ovarian locations of endometriosis
  - Pelvic location of peritoneal pathology
- *Infertility*
- *Vagina*
  - Congenital abnormalities
  - Benign and malignant tumors

Depending on clinical practices and availabilities, training in fetal US and MRI can be offered.

5 – TECHNICAL, COMMUNICATION AND DECISION-MAKING SKILLS

At the end of the training period, the trainee should have achieved the following technical, communication and decision-making skills. Reasonable progression is to be expected during the two years of training, with responsibilities assumed gradually until complete professional independence.

- Before the examination
  - To check the clinical information and risk factors (diabetes, allergy, renal failure, etc.)
  - To validate the request and the choice of examination
  - To know the specific preparation, if necessary, and protocols
  - To explain the examination to the patient and inform him/her about risks

- To justify the examination request based on:
  - Risk factors
  - Irradiation involved
  - Possible (better?) alternatives.

- To perform the examination
  - To know the clinical history and the clinical questions to be answered
  - To know the protocol of examination
  - To assess the anxiety of the patient before, during and after the examination and provide appropriate reassurance

- Communication with the patient and recommendations for follow-up
  - To explain clearly the results to the patient
  - To assess the level of understanding of the patient
  - To explain the type of follow-up
  - To assess the degree of emergency
  - To produce a clear report of the examination
  - To discuss strategies for further investigation, if necessary

- Communications and interaction with colleagues
  - To dictate useful and intelligible reports
  - To be able to discuss significant or unexpected imaging findings with colleagues and to know when to contact a clinician
  - To be able to interact with colleagues in clinico-radiological conferences
  - To be able to take part in multidisciplinary teams dealing with patients with urological, nephrologic, or genital diseases

The following documents can be downloaded from the
EAR website at www.ear-online.org

EAR Annual Report 2005

European Training Charter for Clinical Radiology, Detailed Curriculum for the Initial Structured Common Programme, Detailed Curriculum for Subspecialty Training

Radiological Training Programmes in Europe - Analysis of Survey

EIBIR Newsletter, November 2005

Teleradiology 2004

Good Practice Guide for European Radiologists

Risk Management in Radiology in Europe

CME / CPD Guidelines

EAR Annual Report 2003 / 2004

Benchmarking Radiological Services in Europe

European Association of Radiology
For further information please visit the EAR website at www.ear-online.org

www.ear-online.org