

# European Curriculum and Syllabus for Interventional Radiology

Second Edition



**Second Edition,**  
February 2017

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First Edition, March 2013

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### **European Curriculum and Syllabus for Interventional Radiology**

The content of the curriculum and syllabus is subject to continuous review and will be updated at least every 5 years. In case of any enquiries or comments, please contact us at

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# The European Curriculum and Syllabus for Interventional Radiology

published by the Cardiovascular and Interventional Radiological Society of Europe, is kindly endorsed by

## European IR Societies

ÖGIR – Austrian Society of Interventional Radiology  
BSR – IR Section of the Belgian Society of Radiology  
BSIR – British Society of Interventional Radiology  
BGSIR – Bulgarian Society of Interventional Radiology  
sIRcro – Croatian Society for Interventional Radiology  
CSIR – Czech Society of Interventional Radiology  
DFIR – Danish Society of Interventional Radiology  
NGIR – Dutch Society of Interventional Radiology  
FSIR – Finnish Society of Interventional Radiology  
SFR-FRI – French Society of Radiology – Federation of Interventional Radiology  
DeGIR – German Society of Interventional Radiology  
GSIR – Greek Society of Interventional Radiology  
HSIR – Hungarian Society of Interventional Radiology  
ISIR – Irish Society of Interventional Radiology  
RCSI – Faculty of Radiologists, Royal College of Surgeons in Ireland  
IESIR – Italian European Society of Interventional Radiology  
ICIR – Italian College of Interventional Radiology  
LAIR – Latvian Association of Interventional Radiology  
NFIR – Norwegian Society of Interventional Radiology  
PLTR – Polish Society of Interventional Radiology  
NURIP – Portuguese Section of Interventional Radiology  
RSIOR – Russian Society of Interventional Radiology  
SIRS – Serbian Society of Interventional Radiology  
SKVIR – Slovakian Society of Vascular and Interventional Radiology  
SERVEI – Spanish Society of Vascular and Interventional Radiology  
SSVIR – Seldinger Society of Vascular and Interventional Radiology (Sweden)  
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IRSA – Interventional Radiology Society of Australasia  
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GACIR – Georgian Association of Cardiovascular and Interventional Radiology  
HKSIR – Hong Kong Society of Interventional Radiology  
ISVIR – Indian Society of Vascular and Interventional Radiology  
ILSIR – Israeli Society of Interventional Radiology  
JSIR – Japanese Society of Interventional Radiology  
SIDI – Sociedad Iberoamericana de Intervencionismo



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The European Board of Interventional Radiology is celebrating another milestone in its 7 year history. **The European Union of Medical Specialists (UEMS)** has officially granted its endorsement in early 2017.

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Based on this Curriculum and Syllabus, the EBIR stands for global validation of excellent IR knowledge.

Take part – submit your online application now.

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## Foreword

Interventional Radiology (IR) is a new and rapidly evolving field of medicine requiring regular curriculum review and it is essential that interventional radiologists of the future develop and maintain both clinical and technical skills in carrying out safe and effective treatments for patients<sup>1</sup>. This needs to be reflected in curriculum-based training and certification of training by the European Board of Interventional Radiology (EBIR) examination or its equivalent.

The aim of this IR revised curriculum is to ensure that the highest quality training standard is achieved for all those performing IR procedures within Europe. The curriculum seeks to harmonise training, so that patients and those commissioning health care are reassured that all IRs trained in Europe have achieved a minimum standard and are competent and safe to practice. The curriculum has been used as the foundation for setting the syllabus for the European Board of Interventional Radiology examination. The key aim remains to harmonise European IR training and to certify IR training based on the EBIR.

With such a wide range of specialist practice, it is acknowledged that not all interventional radiologists will carry out every procedure listed in the syllabus. Nonetheless, the specific modules of this syllabus can be followed to deliver the appropriate training in these specialist areas of IR and the EBIR can be used for summative assessment.

IR training institutions need to meet a certain basic standard so that trainers are appropriately qualified, there is exposure to the range of procedures in the curriculum and there are sufficient volumes to achieve competency. Reaching the appropriate target range and volume of procedures may mean trainee rotation between hospitals to achieve training goals.

We would like to sincerely thank Antonio Basile, Anna-Maria Belli, Afshin Gangi, Klaus Hausegger, Michael Lee, Stefan Müller-Hülsbeck, Thomas Rand, Pramod Rao, Dimitrios Tsetis, Otto van Delden, and the CIRSE office for their invaluable help in producing this document. Our thanks equally go to the members of the previous task force whose work was essential for publishing the first edition of the European Curriculum and Syllabus for Interventional Radiology.

Elias Broutzos  
*CIRSE President*

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*Task Force Leader*

<sup>1</sup> *The Provision of Interventional Radiology Services in Europe: CIRSE Recommendations. Tsetis D, Uberoi R, Fanelli F, Roberston I, Krokidis M, van Delden O, Radeleff B, Müller-Hülsbeck S, Szerbo-Trojanowska M, Lee M, Morgan R, Broutzos E, Belli AM. Cardiovasc Intervent Radiol. 2016 Apr; 39(4): 500-6. doi: 10.1007/s00270-016-1299-0. Epub 2016 Feb 9.*

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# 1 CURRICULUM



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# Introduction

The European Interventional Radiology (IR) Curriculum is intended to promote the harmonisation of medical education and training in Interventional Radiology in Europe. The document consists of two parts – the curriculum and the syllabus.

The syllabus comprises the specific knowledge and skills interventional radiologists should acquire throughout their training. The IR curriculum outlines a framework for the process of training and the competencies needed for its successful completion. It is an educational guide to be implemented, interpreted and evaluated by local faculties, radiology schools and local training programme committees.

The first edition of the curriculum was published in March 2013. Since that time, there has been a significant evolution of the European Board of Interventional Radiology examination and there have also been significant changes and developments in IR practice.

The revised second edition of the curriculum is designed to reflect and incorporate these changes and new developments.

## 1.1 Objectives

The IR Curriculum aims to support the highest quality of training to ensure that all interventional radiologists are competent to provide a high-quality service, enabling them to take primary clinical responsibility for the patients they treat and to fulfil their role safely and effectively. It also aims to ensure that all interventional radiologists show medical professionalism by supporting the values expressed in the Global Statement Defining Interventional Radiology<sup>2</sup>.

By setting a common European standard in IR education, the curriculum aims to assure the quality of IR practice. This, along with the European Board of Interventional Radiology (EBIR), will contribute to patient safety with cross-border movement of IRs in Europe.

The programme provides the educational experiences necessary to fulfil the Essential Roles and Key Competence of Specialist Physicians as defined in CanMEDS 2000<sup>3</sup>:

### Medical expert

- Demonstrate diagnostic and therapeutic skills for ethical and effective patient care
- Access and apply relevant information to clinical practice
- Demonstrate effective consultation services with respect to patient care, education and legal opinions

### Communicator

- Establish therapeutic relationship with patients/families
- Obtain and synthesise relevant history from patients/families/communities and listen effectively
- Discuss appropriate information with patients/families and the health care team

<sup>2</sup> *Global Statement Defining Interventional Radiology. 2010 Cardiovasc Intervent Radiol; 33:672–674*

<sup>3</sup> *Frank JR, Jabbour M, Tugwell P, et al. Skills for the new millenium: report of the societal needs working group, CanMEDS 2000 Project. Annals Royal College of Physicians and Surgeons of Canada 1996; 29:206-216*

**Collaborator**

- Consult effectively with other physicians and health care professionals
- Contribute effectively to other interdisciplinary team activities

**Manager**

- Utilise resources effectively to balance patient care, learning needs, and outside activities
- Allocate finite health care resources wisely
- Work effectively and efficiently in a health care organisation
- Utilise information technology to optimise patient care, life-long learning and other activities

**Health advocate**

- Identify the important determinants of health affecting patients
- Contribute effectively to improved health of patients and communities
- Recognise and respond to those issues where advocacy is appropriate

**Scholar**

- Develop, implement and monitor a personal continuing education strategy
- Critically appraise sources of medical information
- Facilitate learning of patients, house staff/students and other health professionals
- Contribute to development of new knowledge

**Professional**

- Deliver highest quality care with integrity, honesty and compassion
- Exhibit appropriate personal and interpersonal professional behaviour
- Practise medicine ethically consistent with the obligations of a physician

## 1.2 Recommendations for the Training Pathway

Entry into specialist training in IR will be after a suitable period of training in diagnostic radiology and a suitable period of training in clinical medicine/surgery (i.e. in many countries this is two years). Training in diagnostic radiology is required as a core skill to provide the IR with the skills required to investigate and diagnose patients. Experience with all cross-sectional imaging modalities and ultrasonography is mandatory before starting specialised IR training.

The curriculum for the initial structured common training programme is in line with the revised European Training Curriculum Level I + II and is available at the website of the European Society of Radiology, who provide a template for the first 3 years of training. Subspecialty training builds on the core knowledge and skills of diagnostic radiology to develop the competencies to treat patients. The European Interventional Radiology syllabus defines the specific knowledge and skills required for trainees in IR over a two-year period and is intended to be combined with modular training in diagnostic radiology.

**Training Centres**

Specialist training in IR should take place within a recognised radiology training programme.

All training centres should comply with local national requirements for radiology training. These centres should be able to provide a sufficient mix of cases for training purposes with at least 2 experienced full-time IR trainers, at least one of whom should be EBIR certified. Training should culminate in the successful completion of the EBIR examination. It is anticipated that information about each European training centre will eventually be collated in a central register maintained by CIRSE.

## 1.3 General Topics in IR

The following elements are central to safe and effective IR practice.

### 1.3.1 Patient Safety

Patient safety must be central to healthcare. Use of a safety checklist is mandatory to help reduce errors in IR. CIRSE has compiled a patient safety checklist for IR which is available on the CIRSE website at [www.cirse.org/Checklist](http://www.cirse.org/Checklist).

There should also be a commitment to clinical governance and risk management in daily clinical practice as part of an integrated practice-based learning programme which should include regular audit and comparison with national or international standards. There should be regular attendance to morbidity and mortality meetings and a commitment to life-long learning. Outcome data should be entered into local or, where available, national/international registries.

#### **Understanding:**

- Methods for dose reduction and image optimisation
- The importance of working according to the ALARA principle<sup>4</sup>
- The risks of pathogens, drugs and other hazardous material and the risk of injury to patients and staff including how to manage and control infection including cross infection
- The clinical aspects of patient care that may influence patient safety in the peri-procedural period such as drug interactions, diabetes, renal impairment, performance status, multiorgan disease, etc.

### 1.3.2 The IR Team

Understanding and promoting a team environment and recognition of the roles of radiographers/technicians, nurses and other assistants in IR practice and maintaining a good professional relationship are essential to promote good working practices.

### 1.3.3 IR Clinical Practice

An IR should act as the patient's primary doctor and be clinically responsible for the patient whilst under his/her care. The IR should evaluate patients before and after a procedure, obtain valid consent and communicate effectively with referring physicians and patients and develop strategies to deal with complex clinical situations and difficult attitudes. The IR should inform patients about the risks of the procedure and about possible alternative treatment options both on the ward and outpatient clinical environments.

The Clinical Practice in IR Manual gives guidance for providing a comprehensive approach to patient care, emphasising the role of IRs as specialists assessing and treating organ systems or diseases and offers practical guidance on principles of clinical care. Numerous well-structured forms for gathering data on patient or social history and conducting examinations are part of its content. [www.cirse.org/Clinical\\_Practice](http://www.cirse.org/Clinical_Practice).

<sup>4</sup> For more information on ALARA please refer to <http://www.eurosafeimaging.org/eman>, the website of the European Medical ALARA Network.

### 1.3.4 Professionalism and Ethics

IRs should show professionalism in the workplace interacting and communicating with adults, children and those who care for them, according to legislation. They should understand and apply the principles and laws regarding medical ethics and confidentiality.

### 1.3.5 Good Clinical Practice

Patient treatment should be based on the principles of evidence-based medicine and be in accordance with national and international guidelines, when available. All research in IR should be in-line with the international rules of Good Clinical Practice<sup>5</sup>: [http://www.ema.europa.eu/docs/en\\_GB/document\\_library/Scientific\\_guideline/2009/09/WC500002874.pdf](http://www.ema.europa.eu/docs/en_GB/document_library/Scientific_guideline/2009/09/WC500002874.pdf)

In addition, the trainee will gain an understanding of the various disease processes they will encounter in terms of:

- Anatomy
- Epidemiology
- Pathophysiology
- Presentation and clinical manifestations
- Investigations
- Management strategies: treatment alternatives and expected outcomes/prognoses

### 1.3.6 Pharmacological Agents in IR

It is essential to understand the interactions, side effects, indications and contraindications of the pharmacological and contrast agents in common use in IR.

### 1.3.7 Practice-based Learning

IRs should recognise the need for monitoring performance and continued learning as a fundamental component of medical practice. They should also understand the value of teaching and research and the need to apply an evidence-based approach to IR practice. Their performance should be reviewed by regular audit and/or submission of data to national/international registries. Reflection and discussion at morbidity/mortality meetings is vital for continued learning and improvement in personal skills as well as departmental logistics.

### 1.3.8 Technical Skills

The trainee will develop the necessary practical skills to perform key IR procedures independently. Additional skills will be acquired to a variable degree. This will lead to achievement of different levels of competence in performing a range of procedures.

<sup>5</sup> EMEA ICH Topic E(R2) Guideline for Good Clinical Practice. EMA/CHMP/ICH/135/1995, June 2017

## 1.4 Acquisition of Experience and Clinical Competence

Experience will be gained in a progressive manner. For instance, a trainee pursuing a career in Vascular IR might progress through their radiology training based on a core diagnostic radiology programme followed by 2-3 years of specialist training in vascular intervention. It is appreciated that trainees progress at different rates and training should be flexible to accommodate this. The training should be adjusted appropriately for other subspecialties.

A radiologist wishing to subspecialise would complete training in their chosen area, e.g. interventional urology, musculoskeletal, oncology, etc., during years 4-6. A more general based IR would require a greater breadth of interventions over a two-year period. The aim in each case is to produce a highly competent and skilled clinician within their chosen specialty.

Trainees will achieve the competencies described in the curriculum through a variety of learning methods.

### **Work-based experience**

This is the apprenticeship model where there is gradual reduction in supervision according to increasing competence as judged by trainers. More responsibility is taken by the experienced trainee in performing the procedures that form the case mix of his/her training, but always with the appropriate level of supervision.

This should also include:

- Participation in ward rounds and outpatient clinics to understand the pre- and post-procedural care and management issues of patients undergoing IR procedures
- Involvement in multidisciplinary meetings, audits, morbidity meetings and on-call work

### **Formal teaching**

Formal teaching can be provided by:

- Lectures and small group teaching, journal clubs, clinical governance meetings, research and audit projects
- Attendance at national meetings and courses
- Attendance at international scientific society meetings and courses. Courses and workshops of the European School of Interventional Radiology (ESIR) are highly recommended. Each year a broad variety of IR topics for IRs are offered in different European cities. (Check the CIRSE events page for upcoming courses)
- Practice on simulators and virtual reality models

### **Independent self-directed learning**

Suggested activities include:

- Preparation for assessments and examinations
- Reading scientific, peer-reviewed journals
- Utilisation of society and university sponsored web-based material (e.g. ESIRonline)
- Maintenance of personal portfolio and logbooks which should document the skills and experience attained and facilitate reflective learning. Each year a broad variety of IR topics is offered in different European cities (Check the CIRSE events page for upcoming courses)

- Practice on simulators and virtual reality models
- Preparation of scientific abstracts for presentation at scientific meetings or publication in peer-reviewed journals
- Trainees should develop skills and be able to write up protocols for research studies
- Trainees should be able to critically review different studies and give their opinion on the advantages and disadvantages of each (see appendix 1)

## 1.4.1 Clinical Competence in Interventional Radiology

The curriculum, including the training and assessment/evaluation of competence and knowledge, should be geared towards producing well-rounded clinicians whose practice will reflect:

- Understanding of the disease processes relevant to their specialty interest
- Understanding of the respective disease prognoses, with and without treatment
- Understanding of the respective treatment alternatives
- Understanding of the indications, contraindications, limitations and expected outcomes of IR procedures including complications
- Understanding of radiation protection and dose limitation
- Ability to perform IR procedures responsibly
- Ability to recognise and manage complications of IR procedures
- Ability to obtain consent from patients by explaining the above in a clear manner
- Ability to select the appropriate patients for treatment
- Ability to clinically manage patients under their care
- Ability to work within multidisciplinary teams for optimal treatment strategy
- Ability to recognise their limitations and refer cases accordingly

## 1.4.2 Levels of Competence

Within the IR curriculum, the following competencies will need to be achieved in each disease-specific area. It is desirable to have a stratification of escalating competencies and a formal process of assessing these during training. An example is given below:

- Knowledge
- Clinical skills
- Technical skills

"Knowledge" competencies will be assessed sequentially for levels as;

- 1) Knows of
- 2) Knows basic concepts
- 3) Knows generally
- 4) Knows specifically and broadly



"Clinical and Technical skills" will be assessed sequentially for levels as;

- 1) Has observed
- 2) Can do with assistance
- 3) Can do but may need assistance
- 4) Competent to do without assistance including dealing with complications

To achieve level 4, the trainee must be able to work at a level expected from a specialist in the field.

### 1.4.3 Recommendations for the Assessment of Competence

#### a) Continuous assessment

Regular appraisal with review of logbooks and constructive feedback by the IR responsible for training is not only pivotal to demonstrate up-to-date competence but is also important for a continuous learning process.

#### b) Workplace based assessment

This assesses daily practice. The following recommended tools can be utilised:

- Case based discussion (CBD)
- Direct observation of practice and procedures (DOPP)
- Objective structured clinical examination (OSCE)
- Peer assessment tools (PAT, 360-degree appraisal)
- IR specific Procedural Based Assessments (PBA)
- Review of complications

#### c) Assessment by formal examination

Participation in the European Board of Interventional Radiology (EBIR) tests knowledge through single best answer questions and oral examination. Passing the EBIR provides objective evidence of attainment of a satisfactory level of knowledge.

### 1.4.4 Recommendations for the Maintenance of Competence

To maintain competence, regular peer review and appraisals should take place. IRs are required to attend national and international scientific IR meetings regularly.

Participating in relevant courses for trained IRs encourages continuous advancement of skills and knowledge. Courses or workshops of the European School of Interventional Radiology (ESIR) are especially recommended.

Even though device-oriented industry courses represent a convenient method for acquiring a specific technique or experience with a particular device, they do not compare with training in a hospital under supervision of an experienced IR. Completion or "graduation" certificates attained at the end of such courses do not correspond to formalised credentialing standards endorsed by the respective scientific specialty societies and other national bodies responsible for training.<sup>6</sup>

<sup>6</sup> *Society of Interventional Radiology Position Statement: Mini Training Courses in Interventional Radiology Techniques 2010. SIR.*

Besides regular training courses, IRs should also be able to attain CME credits via participation in web-based self-assessment modules on the internet. These should only be from recognised national or European accredited bodies.

Every IR has the responsibility to seek further education and self-improvement on a regular basis. Evidence of maintenance of competence may be required for the purpose of revalidation.

## 1.5 Curriculum Review

The Executive Committee of CIRSE is responsible for review of the curriculum. Formal review by a task force nominated by the EC will take place every 3–5 years as IR training and education must reflect modern practice in a new and rapidly evolving field of medicine. The regular meetings of the Examination Board will allow opportunities for the curriculum to be discussed and amendments proposed in advance of any formal review.



# 2 SYLLABUS

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## 2.1 Fundamental Topics in Interventional Radiology

The appropriate training of IRs is defined by the curriculum (see curriculum).

### 2.1.1 Core Syllabus

For those radiologists who do not intend to specialise in IR but practice diagnostic radiology with an interest in basic IR skills, it is expected that access to parts of the modular training programme will be available. Such trainees should have a thorough knowledge of the performance and interpretation of diagnostic vascular techniques and a basic understanding of common IR procedures. All trainees should have this core set of skills before embarking on specialist IR training and will have obtained diagnostic skills during their initial diagnostic radiology training. This core syllabus also forms part of the specialised IR curriculum for practitioners who wish IR to be the major aspect of their professional practice.

At the conclusion of training, the trainee will be familiar with the following aspects:

- Relevant anatomy for all the various organ systems in the body relevant to IR practice including embryology and normal variants
  - Understand the complementary roles of the various imaging modalities in the assessment planning, treatment and overall management of the system
- Epidemiology including expected outcomes
- Pathophysiology including:
  - Aetiology
  - Risk factors
- Clinical presentation
  - Be able to elicit appropriate clinical history, perform physical examination and assess and classify patients
- Investigation
  - Select appropriate laboratory and imaging investigations pertinent to treatment for all the relevant organ systems
- Therapeutic options
  - Know the indications, contraindications and understand the range of treatment strategies including medical, endovascular/interventional and surgical alternatives to a level sufficient to be able to discuss management with patients and formulate appropriate treatment plans within an MDT
  - Know the outcomes of interventional procedures including complications, how to avoid them and their management
  - Understand pre-, peri- and post-procedural drug requirements including the use of chemotherapeutic drugs used in oncology and embolisations
  - Patient selection and appropriate use of local sedo-analgesia and general anaesthesia

### 2.1.1.1 The EBIR Examination – Using the Syllabus

Based on this Curriculum and Syllabus, the EBIR strengthens careers in IR, helps to demonstrate clinical competence and skills, proves dedication to improving patient safety and promotes proficient practice of a broad range of minimally-invasive procedures.

The contents of the syllabus are used to create balanced examinations, taking into consideration each topic's relevance reflected through the overall frequency with which a procedure is carried out in Europe.

Every edition of the EBIR examination follows a plan, which in assessment theory is called 'examination blueprint', to make sure that relevant topics are examined often and those which may not occur in every day practice are examined less frequently.

In order to provide future candidates with maximum transparency and help in exam preparation, the EBIR Examination Committee has created an outline of the EBIR blueprint below.

Questions are drawn from 5 sections, A – F, and the traffic light system represents usage in the single examination blueprint.

- green: this is a frequently encountered topic and will be tested at almost every examination
- yellow: this a topic that will be tested in most examinations
- red: this is a less frequently encountered topic and will be tested on rare occasions
- purple: aspects of these topics are verified by the IR Programme Director, the Radiology Head of Department, a fellowship supervisor or a senior IR colleague by signing the EBIR Competency Checklist

Revision of the blueprint happens in accordance with the revision of the European Curriculum for Interventional Radiology.

## 2 SYLLABUS

### Section A

#### 2.1 Fundamental Topics in Interventional Radiology

- 2.1.1 Core Syllabus
  - 2.1.1.1 The EBIR Examination – Using the Syllabus
- 2.1.2 Patient Safety
- 2.1.3 Recognising and Reducing Occupational Hazards
- 2.1.4 The Interventional Radiology Team
- 2.1.5 Interventional Radiology Clinical Practice
- 2.1.6 Pharmacology of Interventional Radiology
- 2.1.7 Imaging
- 2.1.8 Core Procedures in Interventional Radiology

#### 2.2 Specific Topics in Interventional Radiology

### Section B

#### 2.2.1 Vascular Diagnosis and Intervention

- 2.2.1.1 Arterial Disease
  - 2.2.1.1.1 Peripheral Arterial Disease
  - 2.2.1.1.2 Aortic and Upper Extremity Arterial Disease
  - 2.2.1.1.3 Aortic Dissection and Aneurysmal Disease
  - 2.2.1.1.4 Supra-aortic Arterial Disease
  - 2.2.1.1.5 Stroke
  - 2.2.1.1.6 Vascular Malformations
  - 2.2.1.1.7 Vascular Trauma
  - 2.2.1.1.8 Visceral Arterial Disease
  - 2.2.1.1.9 Arterial Problems in Obstetrics and Gynaecology
  - 2.2.1.2 Prostate Artery Embolisation (PAE)
    - 2.2.1.2.1 Priapism
  - 2.2.1.3 Venous Disorders
    - 2.2.1.3.1 Venous Thrombosis and Insufficiency
    - 2.2.1.3.2 Pulmonary Thromboembolic Disease
    - 2.2.1.3.3 Disease of the Superior and Inferior Vena Cava
      - 2.2.1.3.4 Portal and Hepatic Venous Interventions
        - 2.2.1.3.4.1 Portal Venous Disease and Transjugular Intrahepatic Portosystemic Shunt (TIPS) and Balloon-Occluded Retrograde Transvenous Obliteration (BRTO)
        - 2.2.1.3.4.2 Hepatic Venous Disease and Budd-Chiari syndrome
      - 2.2.1.3.5 Gonadal Venous Interventions
      - 2.2.1.3.6 Haemodialysis Access
      - 2.2.1.3.7 Central Venous Access
      - 2.2.1.3.8 Venous Sampling

### Section C

#### 2.2.2 Non-Vascular Interventions in the Chest, Gastrointestinal Tract and Hepatobiliary Systems

- 2.2.2.1 Image-Guided Biopsy (Excluding MSK)
- 2.2.2.2 Image-Guided Aspiration and Drainage of Collections and Abscesses
- 2.2.2.3 Gastrointestinal Interventions
  - 2.2.2.3.1 Enteral Tube Placement (Gastrostomy, Gastrojejunostomy, Jejunostomy, Caecostomy)
  - 2.2.2.3.2 Gastrointestinal Stenting
- 2.2.2.4 Hepato-Pancreatico-Biliary (HPB) Intervention

### Section D

#### 2.2.3 Intervention of the Genito-Urinary Tract and Renal Transplants

- 2.2.3.1 Pelvicalyceal and Ureteric Obstruction
- 2.2.3.2 Renal Stone Disease
- 2.2.3.3 Renal Masses and Perirenal Collections
- 2.2.3.4 Genito-Urinary Interventions
  - 2.2.3.4.1 Prostatitis (Abscess)
- 2.2.3.5 Renal Transplant Interventions

### Section E

#### 2.2.4 Interventional Radiology of the Musculoskeletal System

- 2.2.4.1 Image-Guided Biopsy
- 2.2.4.2 Percutaneous Ablation of Bone and Soft Tissue Lesions
- 2.2.4.3 Intra-Articular Injections Under Image Guidance
- 2.2.4.4 Percutaneous Osteoplasty
- 2.2.4.5 Spinal Intervention
  - 2.2.4.5.1 Interventions in Vertebral Body Compression Fractures (VBCF)
  - 2.2.4.5.2 Spinal Procedures for Disc, Nerves and Facet Joints

### Section F

#### 2.2.5 Interventional Oncology IO

- 2.2.5.1 Fundamental IO
- 2.2.5.2 Vascular Interventional Oncology
- 2.2.5.3 Non-Vascular Interventional Oncology





## 2.1.2 Patient Safety

### Objectives

Appropriate care is central to patient safety and satisfaction with a procedure. Trainees must learn to assess and manage patients before, during and after procedures. At the conclusion of training, the trainee will be able to:

#### Select patients for invasive procedures

- Determine which patients will benefit from an invasive diagnostic or therapeutic procedure and advise on the most appropriate course of management through a review of:
  - Clinical history and examination
  - Pre-procedural non-invasive imaging studies
  - Results of laboratory investigations
  - Proposed and expected outcomes of the procedure
- The trainee is expected to recognise when there is insufficient information to allow adequate evaluation of the patient
- Use a dedicated IR patient safety checklist [www.cirse.org/Checklist](http://www.cirse.org/Checklist)
- The trainee will demonstrate proper communication with the patient and referring physician(s) regarding procedure appropriateness
- If a procedure is deemed inappropriate, the trainee should be able to establish the correct management pathway in conjunction with the patient and the referring physician

#### Properly evaluate a patient before an IR procedure

- Elicit a relevant clinical history
- Perform a focused physical examination
- Demonstrate understanding of history/physical findings or treatment scenarios that require discussion with/referral to other disciplines
- Identify medications that may require adjustment before any proposed therapeutic procedure

#### Identify factors that increase procedural risk and risk for conscious sedation and assign an ASA score from

- Patient history and physical examination
- The results of appropriate laboratory tests
- A request for any appropriate further support from other clinical teams (e.g. anaesthetics)

#### Obtain informed consent after a review of the procedure with the patient to explain

- The purpose of the intervention
- The likely outcome of the therapeutic intervention regarding:
  - Technical success
  - Clinical success
  - Rate of recurrence
- The risks of the intervention
- The benefits of the intervention
- Any follow-up studies/procedures required
- Alternative therapeutic options

**The trainee will demonstrate**

- Proper communication with the patient and relevant clinicians regarding potential risks and their implications for management
- Ability to assign the proper medication regimens/precautions before, during or after a procedure for:
  - Blood sugar abnormalities
  - High or low blood pressure
  - Infection/Antibiotic therapy
  - Renal dysfunction
  - Coagulopathy/Anticoagulation
  - Drug/Contrast reactions and interactions
  - Conscious sedation
  - Anaesthesia/Analgesia
- Familiarity with up-to-date methods of resuscitation
- Ability to recognise peri-procedural complications or problems and know how to manage them and when to call for specialist help, e.g.:
  - Contrast reaction
  - Excessive sedation
  - Pain and anxiety
  - Nausea/Vomiting
  - Decreased oxygen saturation
  - Arrhythmia and cardiac arrest
  - Sepsis
  - Hypertension/Hypotension
  - Abnormal blood sugar
  - Haemorrhage/Haematoma

**Ensure appropriate peri-procedural care for the patient including**

- Adequate staffing levels: nurse, radiographic, operating department assistant (ODA), etc.
- Adequate monitoring: pulse, BP, oxygen saturation, etc.
- Prompt recognition (by operator or other trained staff) of monitoring abnormalities
- Prompt recognition (by operator or other trained staff) of physical signs and symptoms that need immediate attention
- Implementation of appropriate treatment of any problem

**Ensure appropriate aftercare for the patient by**

- Recording a plan of aftercare in the patient record
- Communicating the plan effectively to radiology, clinical ward staff and to the patient
- Ensuring unusual elements of care are expressly relayed to ward teams

**Provide appropriate patient follow-up in the inpatient and outpatient settings by**

- Reviewing the patient post-procedure and ensuring appropriate care
- Managing and advising on issues related to the procedure such as:
  - Drainage tubes
  - Pain control
  - Post-embolisation syndrome
  - Haematoma and false aneurysm
- Communicating with other appropriate physicians, the patient and their relatives
- Providing appropriate procedure specific literature on discharge with regard to discharge instructions
- Arranging appropriate outpatient review and follow-up investigations
- Ensuring all procedural specimens reach the appropriate laboratory

## 2.1.3 Recognising and Reducing Occupational Hazards

### Objectives

At the conclusion of training, the trainee will be able to minimise:

- Complications of IR procedures
- The risks of ionising radiation to the patient and IR staff

The trainee will build on the radiation protection module taken during diagnostic radiology training as depicted in the European Training Curriculum Level I + II. In addition, those trainees specialising in IR will achieve the learning outcomes set out in table 1.

- The risks from pathogens, hazardous drugs and materials
- Identify patients at high risk for blood and body fluid borne pathogens
- Knowledge of the incidence and methods of transmission of common pathogens, e.g. viral hepatitis, HIV and MRSA in the IR patient population
- Understand the methods of reducing transmission to attending staff and other patients including:
  - Protective clothing
  - Proper use and disposal of contaminated clothing and sharp instruments
  - Immunological protection
- Understand how to prevent and manage needlestick injury

Risks of injury during patient transfers

- Describe how to limit/reduce work related musculoskeletal injuries

Table 1: Additional learning Outcomes for IRs in Radiation Protection

**Table 1: Additional Learning Outcomes for Interventional Radiologists in Radiation Protection**

<p><b>Knowledge</b> <i>(facts, principles, theories, practices)</i></p>	<p><b>Skills</b> <i>(cognitive and practical)</i></p>	<p><b>Competence</b> <i>(responsibility and autonomy)</i></p>
<p><b>Radiation physics K1.</b> Understand special requirements of image formation and image quality aspects with respect to fluoroscopy</p>	<p><b>S1.</b> Apply radiation physics to optimise interventional protocols, using minimal exposure to reach the desired procedure outcome</p>	
<p><b>K2.</b> Understand and explain in detail the following features of fluoroscopes: flat-panel/image intensifier detectors (including problems with image intensifiers such as geometric distortion, environmental magnetic field effects), continuous and pulsed acquisition including frame rate, automatic brightness control, high dose rate fluoroscopy, cine runs, last image hold, roadmap mapping</p>	<p><b>S2.</b> Use the technical features of the specific equipment, on a daily basis, applying all quality-improving and dose-sparing factors but recognising the limits of the imaging machine and interventional devices in use</p>	<p><b>C1.</b> Choose the best interventional equipment for your patient spectrum based on the resources available</p> <p><b>C2.</b> Be informed of maintenance procedures and supervise these in cooperation with local legislative and hospital authorities</p>
<p><b>K3.</b> Explain the principles of medical device (including associated software) management including planning, evaluation of clinical needs, specification for tender purposes, evaluation of tendered devices, procurement, acceptance testing, commissioning, constancy testing, maintenance and decommissioning; service contract management</p>		

Table 1: Additional Learning Outcomes for Interventional Radiologists in Radiation Protection

	Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
<b>Radiobiology</b>	<b>K4.</b> Explain radiobiological dose-effect relationships relevant to Interventional Radiology with respect to patient safety including discussion of the physical and biological background, response of tissues to radiation on molecular, cellular and macroscopic level, models of radiation induced cancer and hereditary risks and radiation effects on humans in general, children and the conceptus		
<b>Radioprotection in Interventional Radiology (X-rays)</b>	<b>K5.</b> Define ALARA and its applicability to Interventional Radiology settings <b>K6.</b> Explain the meaning of justification and optimization as applied to Interventional Radiology practices <b>K7.</b> Explain the concepts and tools for dose management in Interventional Radiology of adult and paediatric patients <b>K8.</b> Explain the factors influencing image quality and dose in Interventional Radiology <b>K9.</b> Describe the methods and tools for dose management in Interventional Radiology <b>K10.</b> Explain the basic concepts of patient dose measurement and calculation in Interventional Radiology <b>K11.</b> Describe the key considerations relevant to radiation protection when designing an Interventional Radiology unit <b>K12.</b> List expected doses (to a reference person) for the main Interventional Radiology procedures <b>K13.</b> Explain quantitative risk and dose assessment for workers and public in Interventional Radiology	<b>S3.</b> Optimise procedure protocols by using standard operating procedures (SOPs) for interventional radiology and by adapting these to the specific patient size <b>S4.</b> Individually choose the best compromise between risk-benefit ratio, image quality, procedure outcome and radiation exposure <b>S5.</b> Supervise the use of personal protective equipment of interventional staff, support the regular workplace and individual monitoring and exposure assessment, investigation and follow up, health surveillance and records <b>S6.</b> Apply and advise on the use of radiation protection measures in Interventional Radiology <b>S7.</b> Estimate effective doses from Interventional Radiology procedures based on measurable exposure parameters (KAP, skin dose) <b>S8.</b> Estimate high skin dose cases <b>S9.</b> Calculate patient risk from measured data of the dosimetry quantities used to assess adverse biological effects	<b>C5.</b> Advise patients on the radiation-related risks and benefits of a planned interventional procedure <b>C6.</b> Take responsibility for justification of radiation exposure in any individual patient undergoing Interventional Radiology procedures, with special consideration of pregnant (or possibly pregnant) patients <b>C7.</b> Take responsibility for optimizing the technique/protocol used for a given Interventional procedure based on patient-specific needs <b>C8.</b> Take responsibility for applying the principles of justification (risk/benefit assessment), optimization (including ALARA) and the setting up of reference levels to protect the patient from unnecessary risk from radiation <b>C9.</b> Take responsibility for applying the optimal size- and problem-adapted individual protocol for high-dose procedures (TIPS etc.) <b>C10.</b> Take responsibility for avoiding very high skin doses causing deterministic effects <b>C11.</b> Follow-up patients for checking for appearance of deterministic effects

**Table 1: Additional Learning Outcomes for Interventional Radiologists in Radiation Protection**

	Knowledge <i>(facts, principles, theories, practices)</i>	Skills <i>(cognitive and practical)</i>	Competence <i>(responsibility and autonomy)</i>
<b>Quality</b>	<p><b>K14.</b> Define Quality Assurance (QA) in Interventional Radiology, QA management and responsibilities, outline a QA and radiation protection program for Interventional Radiology</p> <p><b>K15.</b> List the key components of image quality and their relation to procedural patient exposure during</p> <p><b>K16.</b> Explain the principle of diagnostic reference levels (DRLs) in Interventional Radiology procedures</p>	<p><b>S10.</b> Understand the effects of poor-quality images in Interventional Radiology procedures</p> <p><b>S11.</b> Avoid unnecessary patient radiation exposure in Interventional Radiology procedures by optimizing the techniques performed, (size and positioning of the x-ray field, gonad shielding, tube-to-skin distance, correct beam filtration, minimizing and recording the fluoroscopy time, excluding non-essential projections)</p> <p><b>S12.</b> Develop an organizational policy to keep doses to the IR personnel as low as reasonably achievable (ALARA)</p>	
<b>Law and regulations</b>	<p><b>K17.</b> Specify the relevant regulatory framework governing Interventional Radiology practice in your country</p>	<p><b>S13.</b> Find and apply the relevant regulations in any clinical situation in Interventional Radiology</p>	<p><b>C12.</b> Take responsibility for conforming with patient protection regulations (including procedural reference levels, where applicable)</p>

## 2.1.4 The Interventional Radiology Team

### Objectives

At the conclusion of training, the trainee will be able to:

Recognise and promote a team environment in the practice of IR including:

- Radiographers/Technicians
- Nurses
- Radiology Helpers
- Other Clinicians

Help to provide a safe, stimulating working environment in which all IR team members are encouraged to participate

- Support the continuing medical education of IR team members
- Involve team members in research and audit
- Integrate the various members of the IR team in quality assurance programmes

Teaching and Mentoring

As trainees progress, their role evolves to becoming trainers and mentors in their own right to the more junior trainees and other staff. They will need to acquire the skills to teach and encourage skills development of members of the IR team

- Understand the potential responsibilities and limitations in IR practice of:
  - Radiographers/Technicians
  - Nurses
- Encourage team members to acquire new skills which will improve job satisfaction and career advancement, e.g. vascular ultrasound, insertion of central lines

## 2.1.5 Interventional Radiology Clinical Practice

### Objectives

At the conclusion of training, the trainee will be able to:

**Understand the importance of interprofessional communication.**

- To ensure appropriate prioritisation and management of all referrals
- To ensure that patients are assessed and advised by an appropriate clinician
- To ensure awareness of the entire skills repertoire of the IR
- To ensure they are informed regarding management of their patients
- To ensure appropriate management and follow-up by other clinical teams
- Nurses and nurse practitioners
- Junior medical staff
- Consultants from other relevant disciplines
- Clerical staff
- To ensure that information is readily available to other clinical care teams
- To facilitate research and audit



**Understand the necessity of developing and maintaining an IR clinic in order to**

- Evaluate patients pre- and post-procedure
- Provide information and obtain informed consent in advance of procedures
- Facilitate formal documentation in the patient's case records
- Promote IR as a clinical practice

**Understand healthcare coding systems**

- To understand the financial and business model for the IR service
- To ensure appropriate contracts for safe and sustainable service provision

**Provide care for patients as necessary utilising the IR clinic**

- To ensure optimal patient care
- To effectively communicate and build a rapport with patients
- To properly assess outcome measures
- To facilitate research and audit

**Recognise the value of becoming a hub for patient referrals**

- To promote effective team working within the hospital
- To ensure prompt referral to the appropriate clinical teams
- To facilitate obtaining relevant clinical advice for patient management
- To understand the importance of attending relevant MDT meetings

**Data protection, adhere to institutional and national information privacy and ethical standards with regard to:**

- All medical records
- Correspondence
- Use of patient information for research purposes

**Understand the mechanisms and requirement for continually monitoring quality assurance including:**

- Regular documentation and classification of complications from IR procedures
- Regular morbidity and mortality meetings
- Effective audit
- Contribution to national audits of practice and outcomes in IR

## 2.1.6 Pharmacology of Interventional Radiology

### Objectives

At the end of training the trainee will understand the indications, contraindications, interactions and side effects of the principal pharmacological agents in common usage in IR, including but not restricted to:

- Aetiology, prevention and treatment of contrast reactions
- Local anaesthetics
- Analgesics
- Sedatives
- Vasoactive drugs
- Drugs affecting coagulation including new oral anticoagulants
- Drugs used in diabetes
- Drugs used in hypertension control
- Statins
- Antibiotics
- Antiemetics
- Management of circulatory collapse and shock
- Management/Pharmacology of cardiorespiratory arrest

## 2.1.7 Imaging

### Objectives

At the end of training, the trainee should be competent in carrying out imaging and integrating the different range of imaging modalities for the relevant organ systems for diagnosis, staging, follow-up and directing therapies including Ultrasound, MR Angiography, CT, PET CT and Scintigraphy.

The trainee should understand the mechanisms, complementary roles and limitations of the different imaging techniques including ultrasonography, magnetic resonance angiography, computed tomography angiography, catheter angiography (including Digital Subtraction Angiography and 3-D Rotational Angiography) cone beam CT and image fusion in the investigation and treatment guidance of the different organ systems.

### 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 arterial and venous Doppler waveforms
- Common Doppler examinations, such as carotid, hepatic, mesenteric and renal arterial Doppler studies and lower extremity venous and arterial duplex examinations
- Contrast-enhanced imaging

### **CT and CT Angiography**

The trainee should have a thorough understanding of:

- The basic physics of helical CT and multi-detector CT
- CT and 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

### **MR Angiography (MRA)**

The trainee should be familiar with:

- MR physics and MRA techniques
- Advantages and disadvantages of different contrast materials used for MR and MRA
- The significance of renal impairment with regard to the use of gadolinium-based contrast agents
- Differences between time of flight, phase contrast, and contrast-enhanced techniques pertaining to MRA
- Advantages and disadvantages of MRA compared to other techniques

## **Diagnostic Angiography/Venography**

The trainee should be competent to carry out these procedures in an emergency and elective setting.

### **General Principles**

The trainee should be familiar with:

- The basic chemistry of the different contrast materials used including CO<sub>2</sub> and Gadolinium when necessary, and the indications, contra-indications, advantages and disadvantages of each for angiography
- Mechanisms to minimise nephrotoxicity in high risk patients, such as patients with diabetes or renal impairment
- Treatment of minor and major allergic reactions to contrast media

### **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
- Ultrasound-guided vessel puncture
- Mechanisms for guidewire, sheath and catheter insertions into the groin
- Mechanisms of puncture site haemostasis including manual compression and the use of common closure devices
- Alternative sites of arterial puncture, such as brachial, axillary, popliteal, tibial, pedal, radial and ulnar
- Understand the roles and the advantages and disadvantages of each access

## Diagnostic Angiography

The trainee should be familiar with:

- Guidewires, sheaths and catheters (pigtail and selective) used for common diagnostic angiographic procedures
- Digital subtraction angiographic techniques, bolus chase techniques, road mapping, smart mask 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
- Post-procedural care regimens for standard diagnostic vascular procedures

Trainees should understand the risks associated with the different imaging modalities including:

- Contrast medium related: Iodinated contrast
- The risk factors for developing nephrogenic systemic fibrosis (NSF) with differing Gadolinium agents
- The complication rates for common diagnostic catheter procedures
- Exposure to ionising radiation, both for the patient and the IR team
- Magnetic resonance imaging including the effects of and on implanted materials, e.g. pacemakers, vascular stents and implants, prosthetic joints
- Physical injury during/as a result of arterial catheterisation

## 2.1.8 Core Procedures in Interventional Radiology

The following procedures are deemed vital in ensuring a safe and sustainable 24/7 emergency IR service. Regardless of subspecialty interests, these are considered core skills that all IRs should be able to deliver. Trainees should ensure that they learn and maintain these competencies during training and as established, practising IRs. These topics will be tested more frequently in the EBIR examination.

1. Haemorrhage control
  - a) Embolisation of GI bleeding
  - b) Embolisation of Trauma Bleeding
  - c) Stentgrafting in trauma
2. Sepsis control
  - a) Biliary drainage and stenting
  - b) Nephrostomy
  - c) Abscess drainage
3. Thrombolysis
  - a) Arterial for acute limb ischemia
  - b) Venous for Phlegmasia

## 2.2 Specific Topics in Interventional Radiology

### 2.2.1 Vascular Diagnosis and Intervention

Vascular interventional radiologists encounter a wide range of conditions affecting almost every organ system and affecting both arteries and veins.

#### 2.2.1.1 Arterial Disease

##### 2.2.1.1.1 Peripheral Arterial Disease

###### Knowledge

###### Anatomy

###### Upper limb

- Describe the anatomy relevant to thoracic outlet syndrome (TOS)
- Describe provocative measures for eliciting subclavian steal on non-invasive studies
- Describe measures for accentuating thoracic compression syndromes

Describe and recognise collateral pathways for patients with arterial occlusive disease:

- Describe the important branches of the external iliac, internal iliac, common femoral and profunda femoris, arteries and their role in collateral pathways of the pelvis, abdomen, and lower extremity
- Describe the collaterals/anastomoses around the shoulder which supply the upper extremity in a case of proximal occlusion, thoracic compression syndromes

Understand the bony and soft tissue anatomy of arterial puncture sites and recognise their importance in avoiding complications of arterial puncture when accessing:

- The common femoral artery
- The brachial artery
- The radial or ulnar artery
- The popliteal artery
- The pedal arteries
- The axillary artery
- The common carotid artery

###### PAD

- Recognise the association with coronary artery disease and cerebrovascular disease
- Recognise the prognostic implication of PAD in terms of life expectancy compared to age matched controls and related to aetiology of the disease
- Recognise differences in incidence and prognosis for upper and lower limb vascular disease
- Know the:
  - Causes of peripheral ischaemia, e.g. atherosclerosis, peripheral emboli, arteritis, fibromuscular dysplasia, congenital and acquired coarctation of aorta, endofibrosis of the external iliac artery, popliteal aneurysm (with secondary thromboembolism), popliteal entrapment, adventitial cyst of the popliteal artery, trauma and irradiation injury, thromboangiitis obliterans (Buerger's disease), thrombosis of a persistent sciatic artery
  - Rheological factors, e.g. viscosity, clotting mechanism, prothrombotic states
  - Recognition of the risk factors for development and progression of PAD
  - The specific significance of diabetes-related PAD

### Atherosclerosis

- Major histological and biochemical features and associations of atheroma
- Know the SVS/ISVS PAD grading systems
- Describe and categorise intermittent claudication (including Leriche syndrome) according to CIRSE/SVS/ISVS
- Categorise chronic critical limb ischaemia according to current systems, i.e. SVS/ISVS
- Describe and categorise acute critical limb ischaemia according to SVS/ISVS systems
- Recognise and understand the clinical management of thrombangiitis obliterans (Buerger's Disease)

### Diabetic foot syndrome

- Understand the specific features of Diabetic Foot Syndrome
- Understand how diabetic angiopathy differs from atherosclerotic disease
- Understand the difference between an ischemic ulcer and a neuropathic ulcer

### Peripheral Embolism

- Understand the sources of emboli the clinical manifestations and management strategies for peripheral arterial emboli
- Understand the nature, cause and treatment of blue digit syndrome
- Understand how to investigate other sources of embolism including cardiac
- Describe management strategies for peripheral arterial emboli
- Understand factors that influence the management strategy
- Recognise the appearance and causes of livedo reticularis

### Aortic Dissection

- Describe major histological and biochemical features and associations
- Recognise clinical manifestations of aortic dissection

### Fibromuscular Dysplasia

- Describe histological and angiographic findings common to the forms of fibromuscular dysplasia that may affect the medium-size aortic branches
- Recognise signs or symptoms of the disease, depending on what artery is affected by fibromuscular dysplasia
- Describe associations with other disease entities (e.g. pheochromocytoma, Ehlers-Danlos syndrome type IV, neurofibromatosis, Alport's syndrome, cystic medial necrosis, coarctation of the aorta)

### Vasculitis

- Describe the typical findings of vasculitis including Takayasu arteritis, giant cell arteritis and polyarteritis nodosa
- Define Raynaud disease and Raynaud phenomenon
- List disease processes that demonstrate Raynaud phenomenon
- Recognise the anatomic distribution of lesions in collagen vascular diseases including scleroderma, polyarteritis nodosa, rheumatoid arthritis and systemic lupus erythematosus
- Recognise clinical signs of thromboangiitis obliterans and its association with smoking

### Trauma

- Recognise the clinical manifestations and angiographic findings of blunt or penetrating trauma
- Recognise the clinical manifestations and angiographic findings of irradiation vascular injury and endofibrosis of the external iliac artery
- List occupations or activities that may contribute to hypothenar hammer syndrome and recognise the associated angiographic findings

**Entrapment Syndromes**

- Understand the anatomy relevant to popliteal entrapment syndrome: Describe the anatomical relationships between the popliteal artery and the gastrocnemius or popliteus muscles in the four types of popliteal entrapment

**Neoplastic Disease**

- Know the pathophysiological process with regard to tumour angiogenesis and invasion of blood vessels

**Syndromes with a major vascular component**

- Have a practical and working knowledge of the management of an assortment of uncommon syndromes and generalised diseases all of which have a major vascular component such as Behçet's, Marfan's, middle aortic syndrome, William's syndrome, neurofibromatosis, polyarteritis nodosa, systemic lupus erythematosus, Ehlers-Danlos, rubella and cholesterol embolisation

**Clinical Skills**

- Be able to elicit the Ankle Brachial Index (ABI) measurement and assess and classify patients with acute and chronic peripheral ischaemia
- Understand the complementary roles of the various imaging modalities in the assessment of PAD

**Imaging**

Describe strategies for imaging patients with PAD including algorithms for patients with:

- Acute and chronic ischaemia
- Diabetic foot syndrome
- Critical ischaemia and claudication
- Absent femoral pulses
- Contraindications to iodinated intravascular contrast
- Arterial bypass grafts
- Endografts
- Vascular trauma
- Entrapment syndromes including the use of stress and postural manoeuvres

**Specific imaging modalities****Non-invasive Imaging**

Be familiar with ankle-brachial index, toe pressure, TcPo<sub>2</sub> measurements and their interpretation

- Ultrasonography
  - Be familiar with the indications for ultrasound imaging in surveillance of vascular grafts and the assessment of post-angioplasty/stenting patients
  - Describe the sonographic findings of the complications of femoral artery puncture; e.g. haematoma, arterial occlusion or dissection, pseudoaneurysm and arteriovenous fistula
  - Understand the role of ultrasonography in guiding access to vessels
- MRA
  - Understand the compromise that must be made between resolution, acquisition time and scan volume
  - Recognise artefacts associated with MRI/MRA, e.g. susceptibility, wrap, and venous contamination and be able to suggest strategies to minimise them
  - Understand the potential for MRA to both overestimate and underestimate stenosis and the reasons for this
  - Understand how to set up for a peripheral arterial scan including positioning of volumes of interest, contrast dose and injection rates and timing
  - Understand the role of open MRA in procedural imaging guidance

- CTA
  - Understand the methods used to time imaging in relation to contrast bolus injection
  - Understand how to set up for a peripheral arterial scan including contrast dose and injection rates and timing of image acquisition
  - Understand the method of acquisition of volume data using CT systems, e.g. multidetector arrays
  - Recognise artefacts associated with CT, e.g. metallic densities, physiological movement and be able to suggest strategies to minimise them
  - Understand the limitations of CTA in lower limb critical ischaemia

### **Invasive imaging:**

- Catheter angiography
  - List advantages and disadvantages of various forms of angiography of the lower extremity including bolus chase DSA and incremental or stepped static stations for DSA
  - Describe strategies for optimising lower extremity angiography when only limited amounts of iodinated contrast may be used, or if Gd or CO<sub>2</sub> angiography is to be utilised
  - List strategies for optimising tibial and foot vessel visualisation during angiography including selective angiography and pharmacological vasodilatation
  - Understand the contraindications for catheter angiography including abnormal coagulation, renal dysfunction, contrast reaction, absent pulses
  - Understand how to image those patients in whom catheter angiography is contraindicated
  - Describe the angiographic features of vasospasm in the lower extremities
  - Describe a "standing wave" seen on angiography and discuss its clinical significance
  - Describe the complications of catheter angiography and their management
- Intra-vascular ultrasound
- Be aware of the limited applications in vascular disease
- Be able to understand the specific clinical presentation of the diabetic foot
- Be able to evaluate patients after vascular reconstruction or by-pass surgery and:
  - List causes of bypass graft failure
  - Understand the role and limitations of ABI in evaluating the patient with a bypass graft
  - Describe an imaging strategy for bypass graft surveillance
  - Recognise the sonographic features of a failing bypass graft
  - Recognise the angiographic findings in anastomotic pseudoaneurysms
  - Recognise the angiographic findings in thrombosis of bypass grafts
  - Describe angiographic findings associated with graft failure
  - Recognise the angiographic features of a clamp injury to an artery or a bypass graft
- Understand the range of treatment strategies including medical, endovascular/interventional and surgical alternatives sufficiently to discuss management with patients and formulate appropriate treatment plans
- Differentiate between venous and arterial ischaemia
- Recognise the difference between arterial and spinal "claudication"
- Be able to describe the signs and symptoms of acute and chronic critical limb ischaemia and the clinical findings in blue toe syndrome
- Understand the concept of angiosomes
- Recognise compartment syndromes
- Recognise the non-viable limb which requires primary amputation rather than revascularisation
- Describe the presentation of thoracic outlet syndrome
- Describe the presentation of popliteal entrapment syndrome
- Describe the presentation of cystic adventitial disease
- Describe strategies for modifying/managing risk factors for cardiovascular disease
- Understand the various strategies for management of chronic and acute limb ischaemia
- List the absolute and relative contraindications to pharmacologic and mechanical thrombolysis
- Understand the treatment options for thoracic outlet syndrome
- Understand the treatment options for popliteal entrapment syndrome



- Understand the treatment options for cystic adventitial disease
- Understand pre-procedure, intra-procedure and post-procedure pharmacological management for patients undergoing peripheral vascular interventions including:
  - Anticoagulation
  - Thrombolytic agents
  - Antiplatelet agents
  - Vasodilators
- Be able to define primary patency, assisted primary patency and secondary patency, target vessel revascularisation, target lesion revascularisation
- Understand the use of life table analysis of outcomes
- Be up to date with the evidence for different technologies in treating PAD, e.g. drug-eluting balloons, stents, atherectomy devices, etc.

### Technical Skills

- Demonstrate ability to plan optimal vascular access and vascular closure
- Demonstrate technical competence of puncture site management
- Be able to categorise arterial lesions according to the expected outcome, e.g.:
  - Technical success
  - Complications
  - Clinical outcome
  - Restenosis
- Demonstrate technical competence in the performance of peripheral vascular interventions including:
  - Crossing stenosis with selective catheters and guidewires
  - Recanalisation techniques of total occlusions including subintimal recanalisation and use of re-entry devices
  - Balloon angioplasty and stent placement
  - Catheter-directed thrombolysis and Percutaneous Aspiration and Mechanical Thrombectomy
  - Management of complications
- Demonstrate correct selection and use of equipment including:
  - Guidewires
  - Catheters
  - Sheaths
  - Balloons
- Atherectomy devices
  - Stents and stent-grafts
- Understand the role of intravascular pressure gradients including the use of vasodilators to assess the outcome of vascular interventions
- Differentiate between embolic occlusion and in situ thrombosis in cases of acute limb ischaemia and tailor therapy accordingly
- Demonstrate ability to recognise and manage the potential complications of endovascular procedures such as balloon angioplasty, stenting, stent grafting and catheter-directed thrombolysis/percutaneous aspiration and mechanical thrombectomy
- Understand the indications, contraindications and limitations of puncture site closure devices
- Recognise the role of emerging treatments for restenosis including:
  - Local drug delivery
- Percutaneous atherectomy
  - Endovascular brachytherapy

### 2.2.1.1.2 Aortic and Upper Extremity Arterial Disease

#### Knowledge

- Know the potential causes of "dysphagia aortica" and "dysphagia lusoria"
- Know the difference between an aortic pseudoaneurysm and a ductus diverticulum

#### Clinical Skills

- Know the clinical presentation of upper extremity arterial pathology
- Describe the imaging findings in atherosclerotic, syphilitic, mycotic, post-traumatic and congenital aneurysms
- Recognise chest radiography and CT findings in the setting of traumatic disruption of the aorta
- Recognise the indications for and angiographic findings in various forms of trauma including blunt trauma, penetrating trauma, blast trauma and iatrogenic trauma
- Recognise the angiographic findings associated with different forms of aortitis
- Recognise imaging findings and typical distribution of abnormalities in Takayasu's disease
- Recognise the imaging findings in the vascular components of connective tissue disorders (e.g. Marfan syndrome and Ehlers-Danlos syndrome)

#### Technical Skills

- Demonstrate technical competence in catheterising the great vessels in normal and variant anatomy
- Demonstrate competence in performing angioplasty, stenting and embolisation of supra-aortic branches
- Demonstrate competence in detecting and managing angiographically induced complications of any of the above vessels
- Demonstrate competence in detecting and managing puncture site complications

### 2.2.1.1.3 Aortic Dissection and Aneurysmal Disease

#### Knowledge

- Know the levels of arterial connection between the aorta and the spinal cord, the angiographic appearance of the artery of Adamkiewicz and understand its clinical significance
- Know the pathological spectrum of aortic intramural haematoma, aortic ulceration and aortic dissection
- Know the factors predisposing to aortic dissection, e.g. atherosclerosis, hypertension, connective tissue disorders, arterial inflammatory conditions, bicuspid aortic valve, and pregnancy
- Know the natural history of aortic dissection including acute and chronic phases, the potential for late aneurysm formation and the implications for treatment
- Know the mechanisms for traumatic pseudo-aneurysm formation in the thoracic aorta as a result of deceleration injury

#### Clinical Skills

- Recognise the symptoms and physical signs associated with:
  - Compression of adjacent structures by large arch or descending aortic aneurysms
  - Distal embolisation of aneurysm thrombus
  - Aorto-caval fistula
  - Aorto-enteric fistula
  - Intra-thoracic rupture of aortic aneurysm
  - Intra-abdominal rupture of aortic aneurysm

- Recognise the symptoms and physical signs associated with aortic dissection and its complications
- Recognise the difference between an aortic pseudo-aneurysm and a ductus diverticulum
- Be able to integrate appropriate pre-procedural imaging workup for aortic aneurysms and dissection
- Be able to define the imaging criteria for the presence of aortic aneurysm and describe the common configurations and classifications
- Be able to define and distinguish the imaging criteria for the presence of aortic dissection, intramural haematoma and penetrating ulcer
- Be able to identify the typical signs of the true and false lumen of a dissection on catheter angiography, CTA and MRA
  - Recognise the difference between static and dynamic type of dissection
- Understand how intravascular US can be an adjunct to identifying the true and false lumen and how it may impact endovascular interventions for the treatment of dissection
- Be able to identify the typical signs of branch vessel compromise
- Know the full range of endovascular and surgical treatment options currently available for aortic aneurysms and dissections
- Understand the endovascular and surgical strategies for isolated iliac artery aneurysms
- Classify thoracic and abdominal aortic aneurysms with respect to suitability for endovascular repair and define the anatomical information required in case selection and planning, including:
  - Condition and dimensions of the proximal sealing zone
  - Presence of significant angulation of the proximal neck
  - Centre line distance between the limits of the proximal and distal fixation zones
  - Condition and dimensions of distal sealing zone
  - Condition and dimensions of the access vessels
  - For thoracic lesions: the need for adjunctive carotid-subclavian bypass, carotid-carotid bypass or elephant trunk procedure
  - For peri-renal and Group IV thoracoabdominal aortic aneurysms: suitability for fenestrated or branched stent-grafts
  - For aneurysms involving the iliac segments: the need for embolisation of the internal iliac arteries or suitability for a branched stent-graft
  - Assessment of the need for occlusion of large branch vessels involved in an aneurysm sac
- Recognise the limitations of endovascular treatment for thoracic and abdominal aortic aneurysms and identify those patients best suited for open surgical repair
- Classify aortic dissection and:
  - Define the indications for medical treatment as opposed to surgical intervention
  - Define the indications for the use of aortic stent-grafts in acute or chronic aortic dissection
  - Define the indications for the use of alternative endovascular interventions such as fenestration and/or bare stent placement in order to restore patency in compromised branch vessels
- Define the anatomical information required in case selection and planning, including:
  - The site and extent of the primary intimal tear
  - The level of the distal re-entry site
  - Extent of involvement and compromise of significant branch vessels
  - Extent and diameter of any associated aortic aneurysm
  - Condition and dimensions of the proximal and distal sealing zones
- Understand the requirements for medium and long-term surveillance of aortic stent-grafts, including the detection of:
  - Structural failure
  - Device migration
  - Component dislocation within modular devices
  - Graft occlusion
  - Endoleaks
  - Sac expansion with or without endoleak

- Describe the methods available for medium and long-term surveillance of aortic stent-grafts including:
  - Plain radiographs
  - Contrast-enhanced ultrasound
  - CTA (all stent-grafts)
  - MRA (nitinol stent-grafts)
  - Intra-sac pressure monitoring devices
  - Define the concept of 'endoleak', the imaging criteria by which the 5 sub-types may be classified and the indications for reintervention
- Understand the advantages and limitations of endovascular stent-grafts for aortic dissections or aneurysms with specific attention to:
  - Morbidity and mortality in comparison to open repair
  - Quality of life
  - Financial implications
  - Durability of current devices

### Technical Skills

- Demonstrate competence in planning stent-graft repair using cross sectional imaging on a high-quality workstation
- Demonstrate competence in the techniques of endovascular repair of aortic aneurysms or dissections, including:
  - Pre-/peri-procedural transcatheter occlusion of significant branch vessels
  - Preparation, insertion and deployment of the current aortic stent-graft devices
  - Post-deployment manoeuvres required to safely remove the device introducer and close the access site
- Recognise patients with anatomy unsuitable for conventional access for endovascular repair and suggest alternative methods of stent-graft placement
- Recognise the complications that may arise during endovascular repair and their appropriate management:
  - Dissection, occlusion or rupture of the access vessels, the aorta or the aneurysm sac
  - Coverage of important branch vessels, e.g. the carotid, subclavian, spinal, renal or internal iliac arteries
  - Distal embolisation of the arch vessels or the mesenteric, renal or lower limb vessels
  - Contrast reactions and contrast induced nephropathy (CIN)
  - Cardio-respiratory complications related to prolonged general anaesthesia in patients with poor cardiovascular reserve
- Demonstrate competence in the techniques for the management of endoleaks including:
  - Balloon remodelling, deployment of large bare stents or extension cuffs and occasionally transcatheter embolisation of the endoleak lumen to achieve seal in type I endoleaks
  - Transcatheter embolisation of feeding and draining branch vessels or percutaneous trans-sac injection of embolic materials to treat type II endoleaks
  - Insertion of extensions, cuffs, new bifurcated stent-grafts or conversion to aortouniiliac stent graft to treat type III endoleaks

## 2.2.1.1.4 Supra-aortic Arterial Disease

### Knowledge

- Understand the role of cerebral protection devices in percutaneous carotid interventions
- Categorise carotid bifurcation lesions as to their appropriateness for percutaneous therapy
- Know the current treatment algorithms for asymptomatic and symptomatic carotid artery lesions

## Clinical Skills

- Be able to identify patients with symptomatic carotid, vertebral and subclavian stenosis, occlusion and aneurysm disease
- Integrate and evaluate pre-intervention non-invasive imaging in patients with supra-aortic vascular disease
- Understand pre-, peri- and post-procedural pharmacology requirements
- Be familiar with the variety of available angioplasty balloons, stents, stent-grafts, guiding catheters, wires and cerebral protection devices
- Recognise the role of endovascular treatment of traumatic carotid injuries such as dissection and pseudoaneurysm

## Technical Skills

- Demonstrate technical competence performing carotid and supra-aortic interventions including but not limited to balloon angioplasty, stent placement and use of cerebral protection devices
- Know the types and rates of expected complications of percutaneous interventions and how to manage them
- Manage acute embolic complications during percutaneous carotid interventions with catheter-directed thrombolysis and other techniques

### 2.2.1.1.5 Stroke

#### Knowledge

- Be familiar with the most up-to-date literature on this topic

#### Clinical Skills

- Know the differences between a stroke event in the posterior and anterior circulation
- Know the most commonly used neurological classifications/scores (NIHSS; modified Rankin scale)
- Know and understand the indications and contraindications for mechanical thrombectomy
- Be familiar with the factors which strongly influence the indication for stroke treatment (time window; imaging findings)
- Have knowledge of the most important drugs used in the acute and post-acute phase (Aspirin, Clopidogrel, Glycoprotein IIb/IIIa inhibitors)
- Understand the most commonly used scales for angiographic outcome (TICI score)
- Understand the discrepancy between angiographic and clinical outcome

#### Technical Skills

- Demonstrate competence in performing a mechanical thrombectomy procedure
- Be familiar with the materials needed for transarterial thrombectomy (i.e. guiding catheters, microcatheters, microguidewires)
- Know the most commonly used thrombectomy devices (stent-retrievers, hydrodynamic devices)
- Know the potential risks and complications (dissection, perforation, thrombus dislodgement) and their management
- Demonstrate competence in performing intra-arterial thrombolysis

## 2.2.1.1.6 Vascular Malformations

### Knowledge

- Know how to classify vascular malformations according to their clinical presentation and natural history
- Know syndromes in which a vascular malformation is part of the clinical features, e.g. Klippel-Trenaunay syndrome, hereditary haemorrhagic telangiectasia, Kasabach-Merritt syndrome
- Understand the role of IR and its place in the multidisciplinary team

### Clinical Skills

- Be able to evaluate patients and categorise lesions as either high-flow or low-flow based on history, physical examination and imaging findings
- Recognise the clinical presentation of congenital haemangioma and understand the role of intervention in this condition
- Recognise the clinical presentation of lymphatic malformation and understand treatment options
- Recognise the clinical presentation of patients with low-flow vascular malformations and the indications for treatment and the possible complications
- Recognise the clinical presentation of patients with high-flow vascular malformations and the indications for treatment and the possible complications

### Technical Skills

- Demonstrate competence and understanding of the principles, agents and techniques used in treatment of high-flow vascular malformations
- Demonstrate competence in managing complications of treatment of high-flow vascular malformations
- Demonstrate competence and understanding of the principles, agents and techniques used in treatment of low-flow vascular malformations
- Demonstrate competence in managing complications of treatment of low-flow vascular malformations
- Demonstrate competence and understanding of the principles, agents and techniques used in the treatment of lymphatic malformations
- Demonstrate competence in managing complications of treatment of lymphatic malformations

## 2.2.1.1.7 Vascular Trauma

### Knowledge

- Know the typical mechanism of trauma leading to vascular injuries
- Know the typical patterns of vascular injuries
- Know the staging of major trauma to solid organs

### Clinical Skills

- Know the indication for endovascular treatment of vascular injuries
- Identify and stage major trauma to solid organs as well as vascular injuries on CTA and arteriography
- Understand the principles of selecting an embolic agent

- Recognise the potential role for bare and covered stents in treating traumatic vascular injuries
  - With regard to blunt and penetrating injuries to the **liver, spleen and kidneys:**
    - Understand the roles of exploratory laparotomy and non-operative management in patients with traumatic hepatic injuries
    - Understand the relevance of grading systems
    - List the indications and contraindications for embolisation and/or stenting
    - Be familiar with the success and complication rates for embolisation and/or stenting
    - Be familiar with the complications of splenectomy
  - With regard to blunt and penetrating injuries to the **pelvis:**
    - Understand the limitations of surgical exploration in patients with pelvic haemorrhage
    - Understand the commonly injured vessels that are associated with specific patterns of pelvic fracture
    - Understand the role of diagnostic arteriography and arterial embolisation in haemodynamically stable and unstable patients
    - Be familiar with appropriate timing of pelvic arteriography with other interventions such as exploratory laparotomy or external fixation of pelvic fractures in patients with multiple traumatic injuries
    - Be familiar with different strategies for treating pelvic haemorrhage
    - Know the success and complications rates of pelvic embolisation
  - With regard to blunt and penetrating injuries to the **extremities:**
    - Demonstrate competence in identifying various clinical findings of extremity arterial injury based on the clinical examination
    - Identify traumatic arterial injury on angiography, CTA, Doppler US and eventual MRA
    - Know the potential collateral pathways and identify the role of embolisation proximal and distal to the level of arterial injury
  - With regard to blunt and penetrating injuries to the **face and neck:**
    - Know the zonal classification of penetrating injuries to the neck including which proximity injuries warrant angiographic evaluation
    - List the indications and contraindications for transcatheter embolisation of vascular injuries involving the face and neck
    - Identify the potential collateral pathways between the intracranial and extracranial circulation that may determine a patient's candidacy for embolisation

### Technical Skills

- Demonstrate competence in placement of aortic occlusion balloons in major haemorrhage without image guidance
- Demonstrate competence in selective catheterisation skills, including the use of microcatheters and guidewires
- Demonstrate familiarity with the characteristics of various embolisation agents, stents and stent-grafts
- Demonstrate competence in the selection of the appropriate embolisation material in accordance to the vascular lesion
- Demonstrate competence with the use of stent-grafts and/or stents in vascular trauma
- Demonstrate competence in the management of endovascular complications

## 2.2.1.1.8 Visceral Arterial Disease

### Knowledge

- Know the strategies for imaging of the arterial, portal and mesenteric venous systems

### Clinical Skills

- Describe angiographic techniques and catheters that help in selective catheterisation of the visceral arteries

### Technical Skills

- Demonstrate competence in superselective catheterisation and selection of wires, catheters, stents and suitable embolic materials according to anatomical site
- Demonstrate technical competence in performing angioplasty, stenting, stent-grafting and embolisation in these vascular territories
- Demonstrate competence and understanding in the management of complications

## Gastrointestinal Haemorrhage

### Knowledge

- Understand the role of anticoagulants, vasodilators and thrombolytic agents in the complete evaluation of occult acute and chronic gastrointestinal blood loss
- Understand and evaluate the potential medical, surgical and endovascular treatment options in acute and chronic gastrointestinal blood loss

### Clinical Skills

- Recognise the clinical presentations and relevant physical signs in acute and chronic gastrointestinal blood loss
- Be able to interpret the imaging findings in patients with acute and chronic gastrointestinal blood loss

### Technical Skills

- Demonstrate competence in the techniques and equipment used in embolisation for acute and chronic gastrointestinal blood loss
- Demonstrate familiarity in the selection of the appropriate embolisation materials
- Demonstrate knowledge of the potential complications and preventative strategies
- Demonstrate competence in the management of complications

## Visceral Artery Aneurysms

### Knowledge

- Know and understand the differences in treatment strategies between true aneurysms and pseudoaneurysms



## Clinical Skills

- Understand the clinical presentations and relevant physical signs in visceral artery aneurysms and the indications for treatment
- Integrate and direct the non-invasive imaging evaluation of patients with suspected visceral artery aneurysms
- Describe the cross sectional and angiographic findings in a patient with a visceral artery aneurysm
- Describe appropriate follow-up strategies

## Technical Skills

- Demonstrate competence in the techniques and the range of equipment used in embolisation and exclusion of visceral artery aneurysms
- Demonstrate knowledge of potential complications and preventative strategies in the treatment of visceral artery aneurysms

## Visceral Artery Ischaemia

### Knowledge

- Know the potential presentations of celiac artery compression syndrome
- Know the significance of the median arcuate ligament and the celiac neural plexus and understand the potential treatment options

### Clinical Skills

- Know the expected immediate and long-term results for percutaneous interventions in mesenteric vascular disease
- Understand the endovascular management option for the treatment of non-occlusive mesenteric ischaemia

### Technical Skills

- Demonstrate competence in the angiographic techniques for the assessment of acute and chronic mesenteric ischaemia
- Understand and evaluate suitability for endovascular treatment
- Demonstrate competence in the techniques and equipment used in the endovascular management
- Demonstrate knowledge of the potential complications and their preventative strategies and competence in their management including

## Vasculitis

### Knowledge

- Know the anatomic distributions of disease in patients with vasculitis

## Clinical Skills

- Know the clinical presentations and relevant physical signs in the common forms of vasculitis including Polyarteritis Nodosa, Giant cell arteritis, Takayasu's arteritis, Buerger's disease and Behçet's disease
- Understand the role of treatment options including medical therapy, surgery and endovascular therapy and expected outcomes

## Technical Skills

- Demonstrate competence in performing angiography in a patient with vasculitis
- Demonstrate competence in the endovascular treatment of vasculitis
- Know the potential complications and demonstrate competence in their management

## Renovascular Disease

### Knowledge

- Understand the potential role for current and future treatment for restenosis in renovascular interventions

### Clinical Skills

- Recognise the angiographic findings and indications for intervention in patients with fibromuscular dysplasia as well as the appropriate treatment and expected results in this specific patient population
- Recognise the role of renal protective agents in the pre- and post-procedure management of patients with renovascular disease to minimise contrast induced nephropathy

### Technical Skills

- Demonstrate competence with the equipment and techniques used in the treatment of renal artery stenosis
- Integrate the use of intra-procedural intra-arterial pressure measurements in assessing the results of renovascular interventions
- Know the types and rates of complications of renovascular interventions and demonstrate competence in the management of those
- Demonstrate competence in the techniques and equipment used in the treatment of renal haemorrhage secondary to iatrogenic or direct trauma

## Bronchial and Pulmonary Arteries

### Knowledge

- Understand the role of bronchial and pulmonary arterial embolisation for patients with recurrent haemoptysis
- Recognise normal and abnormal arterial patterns seen in patients presenting with haemoptysis
- Recognise the artery of Adamkiewicz and its clinical significance

### Clinical Skills

- Describe important potential collateral pathways from non-bronchial systemic arteries and pulmonary arteries
- Understand when to perform and when to avoid bilateral bronchial artery embolisation in patients with haemoptysis

### Technical Skills

- Demonstrate competence in catheterising and embolising the bronchial and pulmonary arteries
- Demonstrate familiarity with the technique and equipment used in embolisation of these vessels

## 2.2.1.1.9 Arterial Problems in Obstetrics and Gynaecology

### Knowledge

- Know the indications for uterine artery embolisation for the following patient groups:
  - Uterine fibroids
  - Adenomyosis
  - Post-partum haemorrhage
  - Malignancy
  - Abnormal Placentation, i.e. Placenta accreta and precreta
  - Post-surgery
  - Other indications, e.g. trophoblastic disease, uterine arteriovenous malformation

### Clinical Skills

- Direct and interpret imaging for patient selection, and specific issues regarding appropriate selection, e.g. fibroid location, presence of adenomyosis, endocavitary lesions
- Understand the presence of collateral blood flow between the uterus and the ovaries, and physiologic ramifications of embolisation in these territories
- Be able to work in a multi-disciplinary team in the treatment and prevention of post-partum haemorrhage
- Direct post-procedural imaging, patient management and appropriate laboratory evaluation
- Understand the principles of post-fibroid embolisation care with special attention to pain control and post-embolisation syndrome
- Understand the principles of patient care after prophylactic occlusion balloon placement and removal, with or without uterine artery embolisation

### Technical Skills

- Demonstrate technical competence in pelvic angiography and uterine artery catheterisation and embolisation
- Be familiar with a wide variety of catheters and embolic agents
- Be familiar with the placement of occlusion balloons
- Know potential complications of occlusion balloons, UAE and their management

## 2.2.1.2. Prostate Artery Embolisation (PAE)

### Knowledge

- Understand the indication and place for prostate artery embolisation

### Clinical Skills

- Understand the clinical presentation of BPH
- Understand the concepts of lower urinary tract symptoms in men (LUTS) and understanding of voiding (obstructive) symptoms and storage (irritative) symptoms
- Acquire the necessary competence to perform and interpret TRUS
- Have a good understanding of surgical and non-surgical treatment options including minimally invasive surgical treatments such as Holmium laser, endoscopic prostatic surgery, UroLift and prostatic stents
- Knowledge of symptom assessment in BPH using IPSS (International prostate symptom score) and other questionnaire-based assessments

### Technical Skills

- Acquire the necessary competence to carry out prostate artery embolisation
- Understand the complications of PAE and how to manage them

## 2.2.1.2.1 Priapism

### Knowledge

- Understand the postulated mechanism of both high (arterial or non-ischemic) and low flow (venous or ischemic) priapism

### Clinical Skills

- Be able to make the clinical and radiological evaluation of priapism
- Understand the surgical and radiological treatments for high flow priapism and their relative merits and discuss these with your patient
- Be familiar with embolic agents for endovascular treatment (temporary embolisation material: autologous clots, gelatinous foam and permanent embolisation material: endovascular coils or N-butyl-cyanoacrylate)
- Describe the expected clinical outcome and the short-term and long-term morbidity

### Technical Skills

- Demonstrate technical competence in internal pudendal and cavernosal artery cannulation and embolisation by being able to
  - Choose and discuss the correct equipment including selective and microcatheters
  - Describe the hazards and how to minimise and deal with complications

## 2.2.1.3 Venous Disorders

### Contents:

- **Venous Thrombosis and Insufficiency**
- **Pulmonary thromboembolic disease**
- **Superior and inferior vena cava disease**
- **Portal and hepatic venous interventions**
- **Gonadal venous interventions**
- **Central venous access**
- **Venous sampling**

### 2.2.1.3.1 Venous Thrombosis and Insufficiency

#### Knowledge

- Know the anatomy of varicose veins and clearly distinguish:
  - Perforating veins
  - Lipodermatosclerosis
  - Phlegmasia cerulea dolens
- Describe the haemodynamics of chronic venous insufficiency
- Outline the major risk factors for venous thrombosis including acquired and hereditary hypercoagulable conditions
- Know the consequences of venous thrombosis on normal venous patency and valve function
- Know the definition of chronic venous insufficiency, its relationship with acute deep vein thrombosis and the long-term sequelae
- Know the manifestations of May Turner and Nutcracker syndromes
- Know the manifestations of Paget Schroetter syndrome

#### Clinical Skills

- Be able to diagnose peripheral venous thrombosis and phlegmasia cerulea dolens
- Be able to differentiate congenital from acquired forms of venous insufficiency
- Differentiate the clinical features of superficial venous insufficiency from deep vein insufficiency and/or combination of the two
- Describe the "CEAP" classification system of chronic venous insufficiency
- Describe the characteristics of venous stasis ulcers and differentiate from other types of ulcers (e.g. arterial)
- Understand the principles of conservative management of lower extremity chronic venous insufficiency: ambulation, elevation, exercise therapy and elastic support
- Be able to discuss the types of available therapy for superficial venous insufficiency (varicose veins) including elastic stockings, elevation, sclerotherapy, laser and radiofrequency ablation, stab avulsion, stripping and their relative merits and potential complications
- Understand the use of various mechanical devices and techniques available for thrombolysis and their indications and contraindications

#### Technical Skills

- Demonstrate competence in percutaneous therapies such as laser, radiofrequency ablation and foam sclerotherapy and avoidance of complications
- Recognise the relative risks and benefits associated with treatment of varicose veins including DVT, infection, skin slough, etc.
- Demonstrate competence in mechanical and pharmacological thrombolysis and its complications
- Demonstrate knowledge of various venous stents and appropriate placement of venous stents

### 2.2.1.3.2 Pulmonary Thromboembolic Disease

#### Knowledge

- Be familiar with guidelines for management of venous thromboembolism
- Understand the medical, surgical and endovascular treatment options in these patients

#### Clinical Skills

- Classify patients with acute and chronic thromboembolic disease based on history and physical as well as physiologic and imaging findings
- Understand pre-procedural, intra-procedural and post-procedural pharmacological management for patients undergoing IVC filter placement including anticoagulation
- Understand how to use thrombolytics, aspiration and mechanical thrombectomy devices in treating thrombo-embolic disease

#### Technical Skills

- Be familiar with a wide range of interventional equipment including guidewires, catheters, aspiration and mechanical thrombectomy catheters and permanent and optional IVC filters
- Understand the potential advantages and limitations of various types of filters including the maximal caval diameter in which each type of device may be placed
- Demonstrate technical competence in the performance of femoral and jugular venous access using ultrasound guidance, pulmonary angiography, pulmonary thrombolysis and mechanical thrombectomy, inferior vena cavography, IVC filter placement and retrieval
- Integrate the use of intraprocedural pressure monitoring in performing pulmonary angiography
- Ensure post-procedural protocols are in place, including date for retrieval of optional filters

### 2.2.1.3.3 Disease of the Superior and Inferior Vena Cava

#### Knowledge

- Know the causes and clinical manifestations of SVC and IVC obstruction (SVCO and IVCO)

#### Clinical Skills

- To advise on the optimal treatments based on the clinical success rates and complication rates reported for SVC and IVC stenting in the current medical literature compared to other treatment options

#### Technical Skills

- Demonstrate technical competence in the performance of SVC and IVCO recanalisation, including venous access using ultrasound guidance, catheter-directed thrombolysis, balloon dilatation and stent placement
- Be familiar with the interventional equipment including guidewires, sheaths, catheters, balloons and various types of stents/stent-grafts
- Be familiar with the use of re-entry devices

## 2.2.1.3.4 Portal and Hepatic Venous Interventions

### 2.2.1.3.4.1 Portal Venous Disease and Transjugular Intrahepatic Portosystemic Shunt (TIPS) and Balloon-Occluded Retrograde Transvenous Obliteration (BRTO)

#### Knowledge

- Demonstrate a fundamental knowledge of chronic liver disease and its clinical manifestations
- Integrate patient clinical information into a classification scheme such as the Child-Pugh score and MELD score

#### Clinical Skills

- Evaluate laboratory data in patients with chronic liver disease, with a specific understanding of liver function studies and other parameters useful in classifying liver disease
- Demonstrate clinical skill in distinguishing prehepatic, intrahepatic, and posthepatic portal hypertension
- Know the medical indications and contraindications for TIPS
- Demonstrate a fundamental knowledge of portal hypertension, including its clinical manifestations, and potential complications including ascites, hepatic hydrothorax, gastro-oesophageal varices, portal gastropathy, hepatorenal syndrome, and hepatic encephalopathy
- Know the role of balloon dilation and stent placement in the management of extrahepatic vein stenosis
- Understand the role of TIPS in patients being considered for liver transplantation
- Understand the role of variceal embolisation in patients undergoing TIPS for variceal bleeding
- List frequent surgical locations for the creation of porto-systemic shunts and be able to recognise them with angiography and CT-angiography
- Outline a strategy for TIPS surveillance using colour Doppler ultrasound and list expected shunt velocities and profiles in a patent shunt
- Describe abnormal Doppler ultrasound findings and their importance to outcome
- Understand the rationale of BRTO as a good alternative for the treatment of gastric varices

#### Technical Skills

- Recognise the patterns of portal vein occlusion including cavernous transformation of the portal vein and the important collateral pathways
- Be familiar with the equipment used in the TIPS procedure including guidewires, sheaths, catheters, balloons, stents, embolic materials, and transhepatic cannulation kits
- Discuss the benefits of using covered stents versus bare stents
- Know the normal ranges for portal venous pressures, central venous pressures, and portosystemic pressure gradients, including target ranges for post-TIPS portosystemic pressure gradients
- Demonstrate knowledge of the anatomical relationship between portal vein and systemic intrahepatic veins and their impact for TIPS
- Demonstrate technical competence in the performance of all procedural aspects of TIPS using fluoroscopic and ultrasound guidance
- Recognise and manage intra- and post-procedural complications of TIPS, including haemoperitoneum, haemobilia, biliary-shunt fistula formation, progressive liver failure, shunt thrombosis or occlusion, right heart failure, and hepatic encephalopathy
- Demonstrate competence in the performance of TIPS revision procedures, including the management of shunt stenosis or occlusion
- Demonstrate competence in the performance of variceal embolisation using a variety of agents including coils, plugs, glue, Onyx, etc.
- Demonstrate competence in the performance of BRTO

### 2.2.1.3.4.2 Hepatic Venous Disease and Budd-Chiari syndrome

#### Knowledge

- Understand the role of TIPS and variceal embolisation in patients with hepatic venous outflow obstruction

#### Clinical Skills

- Evaluate laboratory data in patients with chronic liver disease, with a specific understanding of liver function studies and other parameters useful in classifying liver disease
- Demonstrate a fundamental knowledge of Budd Chiari, including its clinical manifestations, and potential complications including ascites, hepatic failure and the sequelae of portal hypertension including hydrothorax, gastro-oesophageal varices, portal gastropathy, hepatorenal syndrome, and hepatic encephalopathy
- Understand the clinical utility and performance of hepatic vein recanalisation/dilatation and/or stent insertion (through a transjugular approach, a percutaneous transhepatic and a combined approach)
- Understand the role of TIPS and variceal embolisation, in patients with hepatic venous outflow obstruction
- Understand the role of TIPS in Budd Chiari s treatment
- Know the role of anticoagulant therapy after TIPS procedure

#### Technical Skills

- Be familiar with the equipment used including guidewires, sheaths, catheters, balloons, stents, embolic materials, TIPS sets and transhepatic cannulation kits
- Know the normal ranges for portal venous pressures, central venous pressures, and portosystemic pressure gradients, including target ranges for post-TIPS portosystemic pressure gradient
- Demonstrate technical competence in performing hepatic vein recanalisation, dilatation and stent insertion
- Demonstrate technical competence in the performance of TIPS
- Demonstrate competence in the performance of variceal embolisation
- Recognise and manage intra- and post-procedural complications including haemoperitoneum, haemobilia, biliary-shunt fistula formation, progressive liver failure, shunt thrombosis or occlusion, right heart failure, and hepatic encephalopathy
- Ensure post-procedural management protocols for follow-up are in place

### 2.2.1.3.5 Gonadal Venous Interventions

#### Knowledge

- To be aware of the different possible cause of pelvic pain in women
- Clinical manifestations of varicocele in men

#### Clinical Skills

- Understand informed consent issues, including specific reproductive/fertility/menopausal effects, symptom resolution, and comparison to standard genitourinary or obstetrics and gynaecology surgical techniques, as well as the standard angiographic and embolisation risks
- Be familiar with normal sperm range values in male patients to correctly assess the results of spermatic vein embolisation with regards to fertility



## Technical Skills

- Demonstrate technical competence in performing venous access from different routes (jugular, antecubital, femoral) under ultrasound guidance and performing venography
- Be familiar with different embolic agents used in embolisation of gonadal veins and internal iliac veins in women
- Be aware of complications and their management

### 2.2.1.3.6 Haemodialysis Access

#### Knowledge

- Know the anatomical locations and their preferred order of creation, of fistulae and synthetic grafts together with their expected outcomes
- Know the pathophysiology of arteriovenous access failure including failure of maturation of fistula, central venous stenosis, aneurysms and steal phenomena
- Understand the preferred access sites and preferred duration of temporary haemodialysis catheters

#### Clinical Skills

- Understand the preferred venous access sites for the placement of haemodialysis catheters and the evaluation of patients with physical examination and ultrasound prior to their placement
- Be aware of the need to avoid certain sites for venepuncture in patients with renal impairment
- Have familiarity with the recommendations of the American National Kidney Foundation Dialysis Outcomes Quality Initiative for vascular access (DOQI)
- Understand the clinical methods for surveillance and evaluation of dialysis access fistulae using physical examination and volume flow methods, as well as imaging (see below)
- Be familiar with the clinical presentation and signs of complicated, failing or failed haemodialysis access including failure of maturation of a native fistula, prolonged post-dialysis bleeding, decreased Kt/V, decreased creatinine clearance, arm oedema and steal syndrome
- Have knowledge of the evaluation of patients with malfunctioning haemodialysis catheters
- Understand the causes of catheter malfunction and the expected outcomes of intervention in malfunctioning catheters
- Have knowledge of the rationale, indications and contraindications for the various techniques for intervention in failing dialysis access
- Have knowledge of the most common sites for fistula and graft stenosis
- Have knowledge of the treatment of patients with infected haemodialysis catheters
- List alternative access possibilities when conventional venous access is not available
- Understand the clinical aspects of the pre-operative workup of patients for permanent haemodialysis
- Demonstrate knowledge of the incidence of central vein stenosis in dialysis patients including risk factors and preventive strategies
- List the surveillance methods for assessing vascular access including their advantages and disadvantages
- Understand the differences between primary, primary-assisted and secondary patency and the published literature relating to these different outcome points

## Technical Skills

- Demonstrate competence in the techniques for the insertion of temporary dialysis catheters including preferred sites and the DOQI guidelines for maximum recommended duration of temporary catheters
- Have knowledge of and competence in the techniques of placement of a number of different tunnelled haemodialysis catheters, and describe their advantages and disadvantages
- Describe the advantages and disadvantages of different line tip positions
- Demonstrate competence in the treatment of venous, arterial and anastomotic stenoses and occlusions related to fistulae including angioplasty, cutting balloon angioplasty, stenting, drug-eluting balloon and stents, stent-grafting, catheter-directed thrombolysis, thromboaspiration and mechanical thrombectomy
- Be competent in techniques for haemostasis post-fistula or graft salvage
- Understand the advantages and disadvantages of the various techniques of catheter-directed thrombolysis used in thrombosed access fistulae
- Demonstrate knowledge and competence in treating steal syndrome including angioplasty, fistula restriction, surgical bypass and ligation
- Demonstrate competence in percutaneous radiological placement of peritoneal dialysis catheters, their complications and their management
- Demonstrate competence in the management of false aneurysms

### 2.2.1.3.7 Central Venous Access

#### Knowledge

##### Neck

- Describe ways to augment jugular venous size to facilitate venous access
- Recognise the differences between veins and lymphadenopathy and thyroid cysts
- Describe the position and relevance of valves in the internal jugular and subclavian veins

##### Upper limb

- Describe preferred sites for placement of upper limb lines and ports
- Describe how the tip position of central lines placed from the arm may vary depending on the position of the arm
- Understand the effect that the phases of respiration have on venous size and central venous pressure

##### Lower limb

- Know the common sites for access

##### Chest

- Describe preferred sites for the exit points of subcutaneous tunnels on the anterior chest wall and how these may vary depending on the body habitus of the patient
- Describe preferred sites for placing subcutaneous ports on the chest wall
- Understand the physiology of venous endothelium and how this can be impaired with intravenous catheters
- Describe the interaction between venous catheters and the venous circulation and heart
- Know the advantages and disadvantages of the different types of catheter and ports
- Know when to use ports or catheters

## Clinical Skills

- Understand the causes of venous stenosis and venous occlusion
- Understand approaches to prevention of line infection and how the risk of infection varies according to the anatomical site of access
- Understand the complications of line infection
- Understand the pathophysiology and treatment of air embolus
- Understand the cause of "pinch off" syndrome leading to fragmentation of infraclavicular central catheters via the axillary/subclavian route
- Understand the rationale for the use of central venous access and the interaction of drugs and other solutions with venous endothelium
- Understand how fibrin sheaths develop and how these compromise catheter function
- Understand the materials used in central venous catheters and their failure mechanisms
- Be able to interpret venous anatomy by various imaging modalities including ultrasound, plain radiography, fluoroscopy, venography, CT and MR
- Describe strategies for imaging the venous circulation in patients with suspected or documented venous occlusive disease
- Be able to instigate and interpret the imaging of patients with suspected complications of central venous access, including venous thrombosis, atrial thrombus, endocarditis, pulmonary embolus, catheter fracture, fibrin sheaths, pseudoaneurysm, arteriovenous fistula and lines suspected to be inadvertently in the arterial tree
- Recognise that a central catheter is abnormally sited on post-procedural radiographs and know the range of possible locations for line tips that are in branch veins or outside the venous system

## Technical Skills

- Demonstrate proficiency in Doppler US for demonstrating and assessing venous anatomy
- Demonstrate competence in US-guided puncture of the internal jugular, external jugular, axillary, subclavian, upper limb and femoral veins
- Be competent in insertion of temporary and tunnelled lines via the jugular, subclavian and femoral approaches
- Be competent in placement of arm and chest wall ports
- Recognise when a central catheter is in an abnormal position on post-procedural imaging
- Be aware of alternative strategies where standard routes of access are unavailable, including tunnelled femoral lines, translumbar IVC lines, transhepatic lines, US-guided puncture of the innominate veins and recanalisation of occluded central veins to facilitate access

Management of complications, i.e.:

- Be competent in insertion of chest drains for pneumothorax
- Be competent in management of massive air embolus
- Be competent in snare retrieval of intra-vascular catheter fragments
- Know techniques for repositioning malpositioned lines
- Be able to perform fibrin sheath stripping
- Know the range of central venous catheters, ports, PICCs, dialysis and apheresis lines
- Know maximum flow rates achievable with different catheters
- Know the maximum pressures to which lines may be subjected

### 2.2.1.3.8 Venous Sampling

#### Knowledge

- Know the clinical presentation of endocrine disease requiring functional investigation

#### Clinical Skills

- Understand the use of provocative medication, e.g. calcium, secretin
- Be able to interpret laboratory results
- Be able to select patients suitable for venous sampling in a multi-disciplinary team setting

#### Technical Skills

- Demonstrate competence in performing venous sampling and peripheral venous or arterial stimulation
- Be familiar with the catheters and wires used in venous sampling
- Recognise and manage complications

## 2.2.2 Non-Vascular Interventions in the Chest, Gastrointestinal Tract and Hepatobiliary Systems

### 2.2.2.1 Image-Guided Biopsy (Excluding MSK)

#### Knowledge

- Know which lesions are best diagnosed and/or approached with fine needle aspiration versus core biopsy and when and how to send the material for microbiological evaluation if infection is suspected

#### Clinical Skills

- Appropriately manage pre-procedure workup including coagulation status and appropriate laboratory values
- Identify alternatives to percutaneous biopsy where suitable, e.g. EUS (endoscopic ultrasound)-guided biopsy for pancreatic and subcarinal masses

#### Technical Skills

- Demonstrate competence in safely performing percutaneous biopsy of lesions in the chest, abdomen and pelvis
- Be familiar with a variety of biopsy needles (histology, cytology) and techniques
- Be able to treat patients with post-biopsy pneumothorax including conservative management or placement of a chest drain if necessary
- Be familiar with how to treat patients with significant haemorrhage following biopsy

## 2.2.2.2 Image-Guided Aspiration and Drainage of Collections and Abscesses

### Knowledge

- Be aware of intestinal perforations, focal infections (primary and secondary), acute pancreatitis, acute cholecystitis, and post-operative surgical complications
- Understand the clinical indications relative and absolute contraindications and risk factors according to site, general patient factors and significant comorbidities (e.g. describe the indications and contraindications of diagnostic aspiration of pleural fluid collections and percutaneous chest tube drainage of complicated pleural effusion/empyema)

### Clinical Skills

- Assess appropriate laboratory investigations confirming clinical picture and procedural risks (access routes, coagulopathy, etc.)
- Know how to select patients for whom percutaneous interventions would be appropriate
- Understand and recognise the common patterns and variety of presentations of loculated sepsis
- Understand the range of treatment strategies including conservative, interventional and surgical alternatives sufficient to be able to discuss management with referring physicians and patients and formulate appropriate treatment plans
- Show an understanding of the advantages and disadvantages of CT guidance, CT fluoroscopy and ultrasound guidance for different types of fluid collections in different locations
- Assess complications including drain displacement, bowel perforation, worsening sepsis, haemorrhagic complications, multiple organ dysfunction
- Attend and review the clinical progress of the patient
- Arrange and interpret appropriate post-procedural imaging
- Demonstrate a fundamental knowledge of chest tube drainage systems including water seal drainage systems and evaluation for persistent air leaks in patients with pneumothorax

### Technical Skills

- Identify the safest and most expeditious route of drainage for abscess collections in various anatomic locations throughout the chest, abdomen and pelvis
- Demonstrate skill at image-guided puncture and drainage of a range of target lesions in common sites and conditions
- Demonstrate understanding of dilatation of established drainage tracks for placement of larger bore catheters
- Identify potentially difficult cases such as multiloculated abscess cavities that may require placement of multiple catheters for adequate drainage or instillation of fibrinolytic agents to aid in drainage
- Be familiar with a wide variety of coaxial needles drainage catheters and guidewires for the purposes of percutaneous abscess drainage
- Demonstrate basic knowledge of chemical sclerotherapy techniques for pleurodesis and other types of sclerotherapy
- Administer adequate sedo-analgesic regimens, IV hydration and antibiotic therapy for safe and comfortable interventional procedures
- Demonstrate knowledge of patient monitoring requirements during and after procedures with the use of sedation including knowledge of the use of antidotes for sedatives and treatment of complications of sedation
- Recognise and appropriately manage procedural complications
- Provide optimal follow-up care post-percutaneous abscess drainage with post-procedural imaging and with repositioning or replacement of drainage catheters as necessary
- Understand when percutaneous abscess drainage catheters can be removed and demonstrate experience in their removal

## 2.2.2.3 Gastrointestinal Interventions

### 2.2.2.3.1 Enteral Tube Placement (Gastrostomy, Gastrojejunostomy, Jejunostomy, Caecostomy)

#### Knowledge

- Know when to place a gastrostomy and when gastrojejunostomy or jejunostomy

#### Clinical Skills

- Consider ethical factors prior to placement of enteral feeding access in this patient population
- Ensure adequate patient preparation including oral contrast to opacify the colon
- Identify patients who may benefit from percutaneous gastrostomy, jejunostomy, gastrojejunostomy and caecostomy procedures and understand the basic principles of these procedures
- Understand the strengths and weaknesses of the different tube systems
- Understand the role of T-fasteners
- Be familiar with a wide variety of tubes as well as retention systems
- Understand the role of surgical placement of tubes and other methods of feeding or decompression
- Understand the need to be part of a multidisciplinary team to coordinate care

#### Technical Skills

- Demonstrate technical competence in carrying out the procedures with selection of the most appropriate image guidance
- Demonstrate how to use guidewires and catheters to primarily place a gastrostomy or use these for a retrograde approach to allow placement of a pull type gastrostomy
- Converting a gastrostomy to a gastrojejunostomy
- Recognise and treat complications including pain, bleeding, tube displacement and peritonitis
- Ensure clear pre-procedural and post-procedural instructions (fasting, antibiotics, etc.) and pathways for tube care
- Administer adequate sedo-analgesic regimens, IV hydration and antibiotic therapy for safe and comfortable interventional procedures
- Demonstrate knowledge of patient monitoring requirements during and after procedures with the use of sedation including knowledge of the use of antidotes for sedatives and treatment of complications of sedation

### 2.2.2.3.2 Gastrointestinal Stenting

#### Knowledge

- Understand the natural history and complications of benign and malignant upper and lower gastrointestinal strictures
- Know and understand the role of stent insertion for palliation of malignant dysphagia and malignant enteric obstruction and alternative treatment options
- Know and understand the 'bridge-to-therapy' concept and the limited role of temporary stenting for benign lesions (e.g. strictures resistant to conventional therapy and the use of stents for bleeding varices)
- Know and understand the different properties of different stent constructions, stent materials, the role and relative merits of biodegradable, covered and uncovered stents and the options offered by removable and anti-reflux stents

### Clinical Skills

- Be able to advise on the appropriate combination of pre-stent imaging procedures including endoscopy
- Be able to understand the information provided by EUS
- Know and understand the indications, complications and contraindications for insertion of self-expanding stents for the oesophagus, stomach, duodenum and colon
- Identify patients requiring endoscopic assistance for duodenal and colonic strictures
- Be able to advise patients regarding complications and their rate of occurrence
- Be able to discuss aspects of disease process, progress and survival with patients and their relatives
- Appreciate the importance of a multi-disciplinary workup and continued follow-up of stent patients

### Technical Skills

- Be able to perform and interpret imaging investigations such as a barium/water soluble enema, enteroclysis, and CT colonography
- Be familiar with the wide variety of stents and delivery systems
- Understand the technical aspects of catheter and wire combinations for crossing strictures and occlusions and the types and roles of support wires and sheaths
- Demonstrate technical competence in crossing occlusions and strictures and in the use of support wires and other techniques like "buddy wires" in straightening out tortuous anatomy prior to stent insertion and the implications of this for stent length and type
- Demonstrate technical competence in stent insertion and retrieval
- Be able to advise and manipulate through an endoscope in combined procedures
- Recognise and treat complications of stent insertion, including secondary stent failures such as migration and re-occlusion

## 2.2.2.4 Hepato-Pancreatico-Biliary (HPB) Intervention

### Knowledge

- Understand the variety of causes of jaundice, e.g. obstructive (stone, benign and malignant strictures, extrinsic causes) and non-obstructive (drugs, infections, autoimmune, toxic etc.)
- Understand how disease processes alter anatomy and the implications for interventional strategies (e.g. level of obstruction and endoscopic vs. percutaneous approaches)
- Understand the causes of biliary leaks

### Clinical Skills

- Understand and recognise the common patterns and variety of presentations of HPB disease
- Be able to assess the patients overall clinical status with regard to the risks and benefits of intervention
- Recognise the various clinical presentations in patients with benign and malignant biliary strictures including obstructive jaundice, cholangitis and biliary stone disease
- Understand disorders of haemostasis/multiple organ dysfunction in jaundiced patients and the impact of additional sepsis and the implications for patient selection, optimising medical condition pre-, intra- and post-procedurally
- Know various methods for obtaining biopsies and/or cytology of biliary strictures
- Know the complications of HPB disease (ascites, portal hypertension/thrombosis)
- Be able to interpret laboratory investigations
- Integrate proper pre-procedure imaging workup in patients with benign and malignant biliary obstruction
- Know the anatomical changes following surgical intervention for HPB cancer

- Be able to discuss prognostic issues with the patient and allow the patient to have realistic expectations where appropriate
- Discuss imaging strategies for patients with suspected HPB diseases including algorithms for jaundice, sepsis, cholangitis, biliary colic, biliary leak and fistula as well as non-specific presentations of suspected HPB malignancy

### Technical Skills

- Demonstrate an understanding of:
  - The advantage of the endoscopic approach to obstructions and stone disease at different levels in the biliary tree
  - The selection of endoscopic, percutaneous transhepatic or roux loop approaches
  - The selection of a drainage route(s) most appropriate to segmental anatomy and disease distribution
  - The assessment of potential complications related to individual patient anatomy
- Demonstrate familiarity with a wide array of percutaneous biliary access systems, and all equipment available for HPB interventional procedures including access and drainage systems, balloons, baskets, stents and stent grafts
- Demonstrate skills in percutaneous transhepatic cholangiography and biliary drainage under a combination of fluoroscopic and ultrasound guidance
- Demonstrate skills in percutaneous biliary duct occlusion using a variety of embolic materials
- Organise appropriate post-procedural management following drainage procedures to assess response to the intervention and recognise and manage complications including haemorrhage, infection, drain displacement
- Arrange post-drainage procedures and interventions including, as appropriate, check cholangiography, conversion to internal drainage, biliary stenting by percutaneous or combined radiological – endoscopic methods
- Identify patients who will benefit from an expanding metal stent
- Demonstrate awareness of the various techniques of percutaneous management of biliary calculi including assisting endoscopic access, percutaneous sphincterotomy, stone crushing and retrieval
- Describe the major complications associated with percutaneous transhepatic cholangiography and biliary drainage and management of them
- Recognise patients at high risk of sepsis following biliary interventions and understand how to treat post-procedural sepsis
- Manage patients with arterio-biliary fistulae or bleeding following percutaneous biliary drainage
- Demonstrate skills in treating complications of pancreatitis including recognising and treating further complications such as haemorrhage
- Demonstrate skills in treating focal liver diseases such as liver abscess and symptomatic liver cysts (e.g. drainage and sclerotherapy)

## Spinal Intervention

### Interventions in Vertebral Body Compression Fractures (VBCF)

#### Knowledge

- Understand bone repair and changes post-radiotherapy of vertebrae
- Understand how to approach soft tissue extensions of bone lesions

#### Clinical Skills

- Appropriately identify patients with symptomatic VBCF
- Categorise VBCF as to their appropriateness and expected response for treatment with percutaneous techniques



- Know when there is a benefit to the patient by doing a combination therapy
- Know when an embolisation is indicated before ablation or surgery
- Identify unstable fractures and the surgical options in these patients
- Understand when the patient may need a surgical intervention immediately after treatment (such as laminectomy post-sclerotherapy for vertebral hemangiomas)
- Know which patients with metastatic disease need to be addressed for radiotherapy before or after the procedure. Discuss with the radiotherapy team prior to treatment for better planning
- Identify patients who might benefit from vertebral augmentation techniques (use of stents, peek cages, etc.) and understand the differences between these methods and their indications

### Technical Skills

- Demonstrate knowledge of proper vertebral body access techniques (transpedicular, parapedicular)
- Be familiar with interventional equipment used in including cements and cement delivery systems, needles, vertebroplasty-vertebral height enhancing devices (stents, peek cages, etc.) and x-ray screening facilities
- Be aware of CE marking and licensing for cements and additional agents used in vertebroplasty
- Understand when PV can be combined with other curative or palliative minimally invasive techniques of ablation (thermal and cryoablation)
- Be familiar with all measures to protect and monitor sensitive neural structures in the spine (including active and passive thermoprotection by means of air or CO<sub>2</sub> injection, thermocouples, evoked potentials, etc.)
- Be familiar with sclerotherapy for vertebral haemangioma, how to use sclerogel as well as how to monitor the patient for need of emergency decompression if need be, or plan as simultaneous decompression procedure after the sclerotherapy
- Be aware of when to plan a vertebroplasty after a sclerotherapy procedure

## Percutaneous Osteoplasty

### Knowledge

- Be familiar with interventional equipment used in percutaneous osteoplasty including cements and cement delivery systems and needles
- Be aware of CE marking and licensing for cements and additional agents used in percutaneous osteoplasty

### Clinical Skills

- Select patients with peripheral bone lesions who will benefit from osseous augmentation
- Identify patients who may benefit from combination of osteoplasty and ablation techniques

### Technical Skills

- Demonstrate knowledge of proper osseous access techniques
- Understand when percutaneous osteoplasty can be combined with other minimally invasive techniques of ablation (thermal and cryoablation) aiming for cure or palliation or screw fixation. In these cases of combined treatments, one should be familiar with all protective measures (including active and passive thermoprotection by means of air or CO<sub>2</sub> injection, thermocouples, evoked potentials, etc.)

## Soft Tissue Tumours (Desmoids, Lymph Nodes, etc.)

Soft tissue tumours such as desmoids, sarcomas and lymph node metastases require a basic knowledge of their pathology and management using the principles as described previously

## 2.2.3 Intervention of the Genito-Urinary Tract and Renal Transplants

### Knowledge

- Know the bladder anatomy including post-cystectomy or post-bladder augmentation
- Understand the causes of acute and chronic renal obstruction, both benign and malignant
- Understand the renal physiological changes pre- and post-ureteric obstruction

### Clinical Skills

- Understand the common disorders of the genito-urinary tract (including renal transplants)
- Be able to plan the appropriate biochemical, radiological and physiological investigations appropriate for planning of interventional procedures
- Understand upper and lower tract urodynamics
- Plan the radiological investigation of suspected ureteric obstruction or ureteric leaks
- Understand contrast agents, renal toxicity and how this may be limited
- Understand the role of interventional radiology in the overall management of the common disorders of the genito-urinary tract and renal transplants

### Technical Skills

- Demonstrate competence in planning and performing interventional procedures applicable to the genito-urinary tract and renal transplants

### 2.2.3.1 Pelvicalyceal and Ureteric Obstruction

#### Knowledge

- Understand the causes of pelvicalyceal and ureteric obstruction and their impact on planning interventions

#### Clinical Skills

- Understand the clinical presentation and physical signs associated with upper urinary tract obstruction

#### Technical Skills

- Demonstrate knowledge of correct patient positioning for percutaneous interventions
- Demonstrate competence and correct selection of equipment needed to perform percutaneous ureteric interventions
  - Needles (18-22G, sheathed and non-sheathed, standard and diamond-tip)
  - Guidewires (0.018-0.035 inch, flexible, stiff and hydrophilic)
  - Dilators and sheaths (including peel-away sheaths)
  - Manipulation catheters
  - Drainage catheters and various locking mechanisms available
- Demonstrate competence in performing percutaneous nephrostomy and ureteric interventions (see below)

**Percutaneous Nephrostomy Insertion**

- Understand the technical aspects for diagnostic evaluation of pelvicalyceal and ureteric obstruction
- Describe the interventional technique used for a Whitaker test
- Interpret the results, including equivocal findings, for the Whitaker test
- Describe the various imaging techniques for accessing the upper tracts safely and successfully:
  - Ultrasound (freehand and guided techniques)
  - Fluoroscopy
  - Computed tomography (freehand and guided techniques)
  - Blind puncture
- Demonstrate knowledge and understanding of planning access intervention
- List the relative risks related to a different choice of calyceal access
- Describe the various puncture techniques to access the upper tracts safely and successfully
- Describe the use of contrast, air and CO<sub>2</sub> to identify appropriate calyx for puncture
- Describe and demonstrate knowledge of parallax fluoroscopy to access the upper tracts
- Understand the correct technique for placement of external drainage nephrostomy catheter
- Understand the various catheter fixation techniques available
- Understand the various techniques used to opacify the collecting system in native kidneys, transplant kidneys and ileal conduits
- Demonstrate awareness and understanding of the specific problems relating to calyx access and the interventional techniques employed for percutaneous nephrostomy in the following special situations:
  - Malrotated and horseshoe kidneys
  - Pregnancy
  - Intensive care
  - Non-dilated obstructed uropathy
  - Transplant nephrostomy
  - Ileal conduits
  - Delivery of chemotherapy
  - Access for antegrade and retrograde endourological interventions (laser, resection, ablation, etc.)
- Describe the maintenance of long-term nephrostomy drainage, catheter exchange and replacement of dislodged catheters

**Ureteric Stent Insertion**

- Understand the clinical considerations for ureteric stent insertion
- Demonstrate knowledge of the types of ureteric stent available
- Demonstrate knowledge of the different stent delivery systems
- Understand the physiology behind ureteric stent drainage with reference to ureteric stent size and patient morbidity
- Understand the need for regular stent changes
- Describe the available techniques for ureteric stent insertion and potential benefits of each
  - Antegrade ureteric stenting (AUS)
  - Retrograde ureteric stenting (RUS)
  - Combined ureteric stenting

**Antegrade Ureteric Stent Insertion**

- Demonstrate knowledge of the difference between internal and external-internal ureteric stenting
- Describe the difference in inserting and removing internal and external-internal stents
- Demonstrate knowledge of correct calyx access for secondary ureteric intervention
- Demonstrate understanding of catheter exchange
- Understand the differences between primary and secondary ureteric stent placement
- Demonstrate understanding of catheter and guidewire manipulation within a tortuous ureter, ureteric kink and ureteric occlusions

- Be familiar with various techniques used to cross an obstructed ureter, including use of balloon dilatation, micro guidewires and catheters
- Understand the correct technique for insertion of an antegrade ureteric stent, use of guidewire, peel-away sheath and covering nephrostomy drainage catheter types
- List the types and rates of complications of antegrade ureteric stent insertion and their management

#### **Retrograde Ureteric Stent Insertion**

- Understand the role in rendezvous procedures
- Understand the role of retrograde urological interventions in ileal conduits and retrograde stent insertion
- Demonstrate knowledge of the different surgical techniques used to form ureteroileal anastomosis in ileal conduits
- Know the percutaneous and endoscopic techniques for retrograde ureteric stent exchange

#### **Ureteric Balloon Dilatation**

- Demonstrate competence in the technique of balloon dilatation

#### **Ureteric Therapeutic Occlusions**

- List the various techniques available for achieving ureteric occlusion
- Understand the expected outcomes from ureteric occlusion
- Understand the role of renal ablation

#### **Removal of Foreign Bodies**

- Demonstrate competence in the techniques to remove foreign bodies from the urinary tract
- Understand the limitations of the techniques
- Demonstrate knowledge of the equipment available for foreign body removal

## **2.2.3.2 Renal Stone Disease**

### **Knowledge**

- Understand stone structure and composition and the value of dual energy CT in their assessment for planning therapeutic options

### **Clinical Skills**

- Understand and describe the different clinical presentation of stone disease
- Understand the differential diagnosis of presenting symptoms and signs (e.g. haematuria, flank pain, etc.)
- Understand the associated morbidity and urgency of management in the presence of obstruction and infection
- Understand and list the factors affecting the choice of management options (presentation, size, site, anatomical, etc.)
- Understand planning of safe access sites to treat stones in different calyces
- Understand the indications for conservative management and importance of follow-up

### **Technical Skills**

- Be familiar with all instruments used to establish a percutaneous track
- Demonstrate competence in handling needles, guidewires and dilatation kits
- Demonstrate competence in nephrostomy placement, antegrade ureteric dilatation, stent insertion and PCNL
- Demonstrate competence in the management of complications

## 2.2.3.3 Renal Masses and Perirenal Collections

### Knowledge

- Know the incidence and classification of solid and cystic renal mass lesions

### Clinical Skills

- Understand the clinical presentation of, and physical findings in, patients with renal masses and perirenal collections
- Understand the pre-procedure workup of patients undergoing drainage and biopsy procedures, including laboratory examinations
- Demonstrate detailed understanding of patient preparation, local anaesthetic administration and sedation
- Understand the role of diagnostic aspiration

### Technical Skills

- Be familiar with a range of needles, guidewires, drainage catheters and drainage kits
- Demonstrate technical competence in image-guided aspiration and drainage
- Understand the role of sclerotherapy in the management of cystic renal lesions
- List common sclerosant agents available
- Be familiar with a range of needles and devices available for percutaneous biopsy
- Understand the techniques available to access difficult lesions with CT and ultrasound
- Provide optimal follow-up care for patients following percutaneous biopsy and drainage including catheter care, further imaging and intervention and catheter removal

## 2.2.3.4 Genito-Urinary Interventions

### 2.2.3.4.1 Prostatitis (Abscess)

#### Knowledge

- Know the treatment options

#### Clinical Skills

- Understand the clinical presentations
- Be familiar with methods of diagnosis of prostate abscess
- Describe the expected clinical outcome
- Demonstrate knowledge and competence in the use of prophylactic antibiotics in urological intervention

#### Technical Skills

- Be competent in methods of draining prostate abscess using image guidance (CT or TRUS) as well as different approaches (trans-rectal, trans-perineal)
- Be familiar with all instruments used to establish a percutaneous track
- Demonstrate competence in handling needles, guidewires and dilatation kits

## 2.2.3.5 Renal Transplant Interventions

### Knowledge

- Understand the various late and early causes of transplant dysfunction
  - The role of intravenous urography, antegrade pyelography and upper tract urodynamics in the assessment of dilatation of the transplant kidney pelvicalyceal system
  - Understand the role of grey scale ultrasound, diagnostic aspiration and biochemical analysis in the evaluation of the origin and relevance of peri-nephric collections

### Clinical Skills

- Be able to discuss:
  - The clinical evaluation of transplant renal artery stenosis (TRAS)
  - The relevance of TRAS in the context of post-transplant hypertension, dysfunction and unstable pulmonary oedema
  - The role of catheter angiography and intra-arterial pressure measurement in defining the grade of stenosis
  - The reasons for, the risks of and outcomes of renal angioplasty and stenting with the patient
  - The advantages of ipsilateral and contralateral arterial approach, as tailored to the surgical anastomosis
  - To recognise the role of renal protective agents in the pre- and post-procedure management of patients with TRAS to minimise contrast-induced nephropathy
- Understand the surgical aspects of ureteric and vascular anastomosis and the surgical orientation of the renal transplant and how this impinges on interventional approaches to the transplanted kidney. The differences between a live donor and cadaver kidney should be understood, and how this influences surgical anastomosis
- Be able to discuss the investigation and management of transplant ureteric dilatation:
  - Understand the pathological conditions that affect the transplant ureter
  - Understand the differences between native and transplant pelvicalyceal dilatation and differentiate between simple pelvicalyceal dilatation and true ureteric obstruction
  - List the indications and role for percutaneous nephrostomy, ureteric dilatation and stenting in the short- and long-term management of ureteric obstruction, stenosis and leak
  - Have knowledge of the risk, contraindications, advantages and success rate of each procedure
  - List the complications of renal transplant ureteric intervention and their management

### Technical Skills

- Demonstrate competence in performing angiography and vascular interventions on transplant kidneys
- Utilise alternative contrast agents in the evaluation and treatment of renovascular disease
- Demonstrate competence with the equipment and techniques used in the treatment of renal artery stenosis
- Integrate the use of intra-procedural intra-arterial pressure measurements in assessing the results of renovascular interventions
- Demonstrate competence in selecting the safest percutaneous approach to the calyceal system of the transplant kidney, using either ultrasound or fluoroscopic guidance or both
- Demonstrate knowledge of the differences between native and transplant calyx access and nephrostomy insertion techniques
- Demonstrate knowledge in selecting the types and size of ureteric stent used in a transplant ureter
- Demonstrate awareness of the role of perinephric collections in the causation of ureteric obstruction, their evaluation and percutaneous management, including sclerotherapy

## 2.2.4 Intervention of the Musculoskeletal System

### 2.2.4.1 Image-Guided Biopsy

#### Knowledge

- Know the advantages and disadvantages of various imaging modalities for guiding biopsy of soft tissue lesions in the chest, cervical region, abdomen and musculoskeletal lesions
- Know the advantages and disadvantages of various imaging modalities for the biopsy of ribs, long bones and spinal lesions

#### Clinical Skills

- Identify safe approaches to percutaneous biopsy of bone and soft tissue lesions demonstrating knowledge of overlying neurovascular and compartmental anatomy
- Recognise which lesions are best suited for fine needle aspiration versus core biopsy
- List the indications and contraindications for bone/ST biopsy
- Be aware of the consequences of inappropriate biopsy of primary bone/ST sarcomas
- Appropriately manage pre-procedural workup including appropriate laboratory values
- Have knowledge of when to send material for appropriate microbiological evaluation if infection is suspected

#### Technical Skills

- Be familiar with the variety of biopsy needles and techniques including the use of different imaging modalities and various targeting technologies for accessing difficult lesions
- Be aware of how many samples one should try to obtain in one biopsy session
- Appreciate the suitability of different needle types for dense cortical bone, trabecular bone, lytic bone lesions and marrow aspirates
- Be able to treat patients who develop post-biopsy pneumothorax including appropriate drainage
- Be familiar with the management algorithm of patients experiencing significant haemorrhage following biopsy
- Be aware of the requirements for correct preservation, preparation and packaging and specimens for histological, cytological, microbiological investigations and ensure their prompt transfer to appropriate laboratory
- Be aware of the requirement for correct labelling of specimens and completion of request forms for histological, cytological or microbiological investigation

### 2.2.4.2 Percutaneous Ablation of Bone and Soft Tissue Lesions

Please see the Interventional Oncology Section (2.2.5 pages 67-74)

### 2.2.4.3 Intra-Articular Injections Under Image Guidance

#### Knowledge

- Understand the possible surgical options for the patient

#### Clinical Skills

- Be able to identify the articulation to be injected and the planned percutaneous approach

#### Technical Skills

- Demonstrate competence in both diagnostic and therapeutic image-guided injections
- Understand the pharmacological agents to inject for diagnostic or therapeutic purposes

### 2.2.4.4 Percutaneous Osteoplasty

Please see the Interventional Oncology Section (2.2.5 pages 67-74)

### 2.2.4.5 Spinal Intervention

#### 2.2.4.5.1 Interventions in Vertebral Body Compression Fractures (VBCF)

Please see the Interventional Oncology Section (2.2.5 pages 67-74)

#### 2.2.4.5.2 Spinal Procedures for Disc, Nerves and Facet Joints

(e.g. Selective Nerve Root Blocks, Epidural Steroid Injections, Facet Joint Blocks, Discography, Percutaneous Decompression of Intervertebral Discs)

#### Knowledge

- Understand the medical and surgical treatment options in these patients
- Demonstrate appropriate knowledge of steroids and anaesthetics used in spinal injection procedures

#### Clinical Skills

- Appropriately identify patients with spinal pain syndrome
- List the absolute and relative contraindications for spinal injection and percutaneous disc decompression procedures

#### Technical Skills

- Be familiar with interventional equipment as used in spinal injection procedures
- Be familiar with the subtypes (mechanical, thermal and chemical) of disc decompression techniques and the appropriate equipment



## 2.2.5 Interventional Oncology (IO)

### 2.2.5.1 Fundamental IO

All the general training requirements for training from preceding sections apply to IO

#### Knowledge

##### Pathology Tumour Biology

- Trainees should learn and understand tumour biology and pathology
- Trainees should understand tumour microenvironments and their importance
- Understand tumour biology relevant to molecular targeting agents
- Understand tumour proliferation and changes occurring in the genome
- Understand differences in tumour pathology and their effects on survival
- Know the relevant tumour classifications
- Know the patterns of tumour recurrence and nodal spread

##### Tumour Markers

It is important for trainees to know the currently used tumour markers in clinical practice and their significance in tumour detection and follow-up surveillance of patients

Knowledge of tumour makers such as Alpha fetoproteins, CEA, CA 19.9, etc.

Trainees should know the genes (mutations) associated with tumours and their significance and how they affect prognosis

##### Imaging and Treatment

- Know the different IR treatment options for the relevant tumours in the various systems, i.e. ethanol, Cryotherapy, RF, microwave, irreversible electroporation, laser, HIFU, etc. and their outcomes
- Know which device, probe, probe size and positions relevant to the tumour, location and size
- Recognise the imaging appearances and end points during treatment i.e. progress of the ice ball and when to stop
- Know the radiological staging by Radioactive isotope scan, CT, PET and MR where necessary

##### Radiation Physics and Dose

IO trainees should understand how to reduce radiation doses to patients during IR therapeutic procedures and follow good practice guidelines for dose reduction

For more information on dose reduction and management please refer to section 2.1.2

##### Pharmacology

As well as knowledge pertaining to standard medications used in IR, IO requires knowledge of chemotherapeutic agents such as doxorubicin, irinotecan, cisplatin, etc.

##### Chemotherapy

Chemotherapy plays an important role in the management of cancer. A trainee should know the chemotherapy regimens available for different tumours, their mode of delivery and have an understanding of the terminologies used, e.g. adjuvant, neoadjuvant, first line, etc.

Know the best possible chemotherapy regime for a given cancer

## Clinical Skills

- Understand the importance of patient positioning required for a procedure to avoid injury
- Know how to avoid trauma to local structures or nerves, i.e. the brachial plexus in patients whose arm will need to be extended over the head in a prone position over an extended period of time
- Know which are the pressure points and how to protect them from trauma during procedures
- Know how to prevent trauma to joints and muscles during positioning and transfer of patients
- Understand surgical oncology procedures in different organs, their complications and post-operative imaging features
- Know the most appropriate imaging guidance for the different organs and tumour sites
- Understand the anatomical changes with regard to vascular and organ anatomy following surgery to plan IR therapeutic procedures
- Have a basic understanding of chemotherapeutic, radiotherapeutic procedures and the relevant terminology (see appendix 2)
- Understand the effect of thermal ablation on the adjacent structure and the adverse effects of thermal ablation and how to use separation techniques in avoiding collateral injury
- Assess the patient during and following image-guided ablation and other cancer therapies
- Recognise the prognostic implications of active surveillance of certain tumours, such as in renal cancer with metastatic, small volume or indolent disease
- Be able to determine patient fitness for discharge
- Devise, with the referring clinician, a plan for patient follow-up with imaging, laboratory tests and clinical evaluation in order to assess treatment success and detect disease recurrence or new lesions
- Decide when to treat bilateral disease in the same setting or in a second setting
- Recognise the differences between the lung and parenchymal organs such as liver and kidney in terms of thermal and electrical conductivity which result in differences in ablation times and protocols
- Understand the concept of hormone receptors positive, negative and triple negative and its impact on therapy

## Technical Skills

- **Intraarterial infusion**  
Hepatic arterial perfusion (oxalipatin, 5FU, irinotecan)  
Isolated perfusion for limb, peritoneal, pelvic and hepatic disease (melphalan, etc.)
- **Drug delivery systems**  
Drug-eluting particles (DC beads, Hepasphere)  
Drug emulsions with Lipiodol for TACE (Doxorubicin, cisplatin, epirubicin, idarubicin, etc.)  
Future drug delivery systems like Liposomes (Doxorubicin)
- Palliative IR procedures such as gastrostomy insertion, drains, nephrostomies, ascites drainage catheters or ports, etc.
- Patients in palliative care are often referred for pain management amongst other things

### Mode of action and types of drugs (see appendix 2)

### Know the surgical oncology techniques relevant to breast, lungs, abdominal organs, stomach, bowel, prostate, bladder and bone tumours

### Palliative care

The trainee should be aware of the palliative care department and the types of patients that come under this department

- Be able to interpret post-treatment images and follow-up images with reference to post-treatment sequelae
- Be able to identify local post-treatment recurrences
- Be able to interpret imaging changes in post-operative patients
- Be able to interpret imaging changes in patients on antiangiogenics

## 2.2.5.2 Vascular Interventional Oncology

At completion of training, the trainee should have the following:

### Knowledge

- Understanding the concept of "end" arteries
- Know the pathophysiological process with regard to:
  - Tumour angiogenesis
  - The process of tumour invasion of blood vessels
  - The natural history and patterns of response of tumours suitable for arterial embolisation

### Clinical Skills

- Know the clinical presentation of common tumours where either assessment of vascular invasion or treatment by embolisation plays an important part
- Understand and interpret imaging, in particular:
  - Have knowledge of characteristic patterns of vascularity in tumours particularly those which are hypervascular
  - Have knowledge of radiographic features of vascular invasion
  - Have knowledge of signs of vascular invasion with respect to assessing resectability
- Understand the potential objectives of arterial embolisation (e.g. palliation, cure, control of haemorrhage, etc.)
- Be aware of the signs, symptoms and natural history of post-embolisation syndrome and their management

### Technical Skills

- Demonstrate technical competence in bland, chemo and radio-embolisation
- Have knowledge of embolisation materials and technique
- Have knowledge of the advantages and disadvantages of materials used in embolisation
- Demonstrate knowledge of the potential complications and how these may be avoided
- Demonstrate competence in the endovascular management of complications

## Hepatic Disease

### Knowledge

- Understand hepatic anatomy in terms of right/left lobar dominance and recognise the alterations caused by portal vein insufficiency and/or thrombosis (both bland and tumoural)
- Understand and look for parasitisation of blood supply to hepatic tumours prior to vascular treatments
- Understand the alterations of hepatic anatomy caused by Budd Chiari syndrome, cirrhotic disease and large volume, indolent intrahepatic malignant disease
- Understand how the malignant process within the liver can alter hepatic blood supply and the bearing this will have on vascular and non-vascular interventions
- Recognise the relationship between the malignant process and major hepatic vascular and biliary structures, which can be damaged during therapies, and their bearing on any proposed intervention
- Understand the relations between the liver and other structures such as extrahepatic bile ducts, gallbladder, bowel, diaphragm and body wall, and their bearing on any proposed intervention

- Understand the process of development of metastatic malignancy in the liver with particular reference to tumour vascularisation and its bearing on appropriate therapies, both vascular and non-vascular
- Know the causes of cirrhosis and implications for therapy in patients with coexisting hepatic malignancy

### **Clinical Skills**

- Evaluate hepatic reserve using clinical and laboratory criteria and understand the impact on therapeutic options
- Understand how previous liver and visceral surgery will bear upon proposed interventions in terms of altered anatomy, hypertrophic change, vascular insufficiency, etc.
- Know about MR contrast agents such as Gadolinium, Gd-EOB, Gd-BOPTA and other hepatocyte-specific MR contrast agents and their utility in imaging hepatic disease
- Know the role of DWI (diffusion weighted imaging) in the detection and characterisation of liver lesions
- Be able to describe strategies for imaging of patients with hepatic malignancy including algorithms for metastatic colorectal disease and metastatic neuroendocrine tumours (including gut carcinoid)
- Other metastatic hepatic malignancy including breast, lung, kidney, etc.
- Have an understanding of assessment for anaesthetic risk and patient performance status. To independently determine patient fitness with regards to undertaking interventions and thereby to determine the appropriateness of any such intervention
- Be able to balance the relative merits of various oncologic interventions in the setting of metastatic colorectal disease, neuroendocrine disease and primary hepatic malignancy besides other metastatic disease processes
- Have an understanding of the relative merits of adjunctive treatments such as embolisation and chemoembolisation prior to IGA
- Identify tumour types that respond well to chemoembolisation and or radioembolisation
- Identify tumours that will respond to intra-arterial chemoperfusion
- Identify patients at high risk for infectious complications following chemo/radioembolisation/ ablations and strategies to prevent them

## **Vascular Hepatic Oncologic Interventions**

### **Technical Skills**

- Demonstrate technical competence in performing lobar, segmental and targeted embolisation therapy
- Know the different types of catheters, guidewires and sheaths available to make access easier
- Know the use of micro-catheters and micro-guidewires for superselective treatments (especially chemo-embolisation)
- Know when to use classical TACE (chemolipiodol) and when to use DC bead (drug-eluting bead) TACE
- Know when to use embolic material in combination therapies
- Know where selective or superselective treatments will be beneficial over lobar treatments
- Know how to protect adjacent structures (duodenum, stomach, skin, etc.) during radioembolisation
- Know the different radioembolic particles available and the difference between them
- Understand how to plan a dose for radioembolisation
- Know when a single lobar treatment needs to be done and where both lobes can be treated simultaneously

- Understand the concept of radiation segmentectomy
- Know the types and sizes of drug-eluting beads available
- Know which size of beads to use in which size of tumours
- Know which chemotherapy to charge the beads with depending upon the tumour
- Understand the difference between cTACE and DCB TACE
- Understand the concept of bland embolisation for neuroendocrine metastases
- Be able to manage tumour bleeds (intra and extra tumoural)

## **Preoperative Portal Vein Embolisation**

### **Knowledge**

- Understand the concept of anticipated future liver remnant volumes (FLR) prior to major hepatectomy and the concept of flow redistribution related hypertrophy of the liver

### **Clinical Skills**

- Know which subsets of patients may need a larger FLR because of reduced hepatic regeneration after liver resection (patients with liver cirrhosis/fibrosis, diabetes, concomitant extrahepatic or pancreatic surgery)
- Know how to calculate FLR volume on CT images and how to adjust it to individual patient size
- Outline a strategy for FLR hypertrophy surveillance using imaging studies and software-assisted volumetric evaluation

### **Technical Skills**

- Recognise the anatomy of intrahepatic portal vein branches and their relationships with tumour bearing liver segments
- Know the differences and indications for ipsilateral and contralateral transhepatic approaches in PVE
- Be familiar with the equipment used in PVE including guidewires, sheaths, catheters, embolic materials and transhepatic cannulation kits
- Be competent at US-guided transhepatic puncture of intrahepatic portal vein branches
- Demonstrate technical competence in the performance of all procedural aspects of PVE, for ipsilateral and contralateral transhepatic approaches

## **2.2.5.3 Non-Vascular Interventional Oncology**

### **Chest and Abdominal Organs**

#### **Knowledge**

- Know the different tumour types and presentations in the relevant territories
- Know the optimal timing for interventional procedures in relation to other therapies

#### **Clinical Skills**

- Understand the value of tumour biopsy, its indications and accuracy
- Be able to perform image-guided fine needle aspiration or biopsy of tumours

## Technical Skills

- Demonstrate competence in the current technologies available in IGA including ethanol, radiofrequency and microwave ablation
- Have an understanding of evolving technologies in this area including cryotherapy and irreversible electroporation
- Recognise the limitations of current ablation technologies and have knowledge of techniques used to achieve larger volumes of ablation (e.g. overlapping ablations, perfused devices and adjunctive techniques)

## Biliary Disease

### Knowledge

- Understand sclerosing cholangitis and other precursors to cholangiocarcinoma like Caroli's syndrome
- Understand tumour markers and their variations in patients with cholangio carcinoma
- Understand biliary obstruction secondary to primary disease, metastases and surgical resection and anastomoses

### Clinical Skills

- Describe signs and symptoms of malignant biliary obstruction
- Demonstrate skill to identify biliary sepsis and know when to intervene effectively to avoid severe morbidity and mortality
- Know how to identify acute cholangitis secondary infection in an obstructed (completely or partially) or in a non-dilated biliary system
- Know how to identify cholangitis and cholestasis on serum biochemistry results
- Know how to identify metastatic disease
- Know how the procedure will affect future therapies (chemotherapy, surgery, ablation or chemoembolisation/ radioembolisation, etc.)
- Know the effects of previous therapies (surgical resection, portal vein embolisation, chemoembolisation, recent chemotherapy, etc.) will affect the outcome of the procedure

## Prostate Cancer

### Knowledge

- Be familiar with the different probes and needles/biopsy devices used for biopsies (TRUS-guided and MRI-guided)
- Understand the concept of multiple zones sampling during biopsies for malignancy and mapping of the prostate gland

### Clinical Skills

- Understand the clinical presentation of prostate cancer and importance of PSA, DRE and prostate biopsies
- Acquire the necessary competence to perform and interpret transrectal ultrasound (TRUS)
- Understand the triaging of patients presenting with high PSA

## Technical Skills

- Acquire the necessary competence to carry out TRUS-guided prostate biopsies according to local protocols
- Competence in guidance for brachytherapy implants
- Know how to plan for cryotherapy of prostate gland
- Understanding of planning for HIFU and how to place the probe for tumour ablation
- Understanding and planning for laser ablation
- Know how many laser fibers will be needed and where to place them to achieve an effective and complete ablation

## Musculo-Skeletal Disease

### Knowledge

- Know benign bone tumours especially those that can be treated with ablation
- Recognise the progressive features of bone metastases in the appropriate clinical setting, depending on the type and stage of primary tumour

### Clinical Skills

- Recognise features of progressive and metastatic disease which would guide appropriate therapy
- Be able to anticipate potential injuries, such as articular cartilage necrosis, epiphyseal growth plate injury and neural injury and be able to inform patients about these risks
- Understand the clinical case for image-guided ablation of bone tumours and its feasibility in different locations and clinical settings
- Be aware of new and evolving technologies for the treatment of primary and secondary bone neoplasms

### Technical Skills

- Understand adjunctive interventions (e.g. embolisation) that can be performed to improve the outcome of image-guided ablation
- Recognise the need to place thermocouples to monitor the temperature of sensitive structures during ablative procedures
- Recognise bone lesions at risk of fracture and understand when to combine ablation with cementoplasty in order to provide additional structural support
- Know how to place osteosyntheses in the pelvic bones, neck of femur, sacrum and scapula
- Plan the placement of screws in optimal position and be able to decide on the number of screws required
- Know the type and size of screws to place
- Be able to decide if there is a need to inject cement along with the screws
- Be able to monitor motor and sensory functions of the extremities to rule out neural damage after ablation of lesions close to major nerve bundles

## Acronyms

<b>ABI</b>	Ankle Brachial Index
<b>ALARA</b>	As Low As Reasonably Achievable
<b>ASA Score</b>	American Society of Anaesthesiology
<b>AUS</b>	Antegrade Ureteric Stenting
<b>BP</b>	Blood Pressure
<b>BPH</b>	Benign Prostatic Hyperplasia
<b>BRTO</b>	Balloon-occluded Retrograde Transvenous Obliteration
<b>CA 19.9</b>	Cancer Antigen 19.9
<b>canMEDS</b>	Canadian Medical Education Directives for Specialists
<b>CBD</b>	Common Bile Duct / Case-based Discussion
<b>CEA</b>	Carcino-embryonic Antigen
<b>CEAP score</b>	Clinical severity Etiology Anatomy Pathophysiology
<b>CE Marking</b>	European Conformity Marking
<b>CIN</b>	Contrast Induced Nephropathy
<b>CIRSE</b>	Cardiovascular and Interventional Radiological Society of Europe
<b>CME</b>	Continuing Medical Education
<b>CT</b>	Computed Tomography
<b>CTA</b>	Computed Tomographic Angiography
<b>cTACE</b>	Conventional Transcatheter Arterial Chemoembolisation
<b>CVA</b>	Cerebro-Vascular Accident
<b>DCB TACE</b>	Drug-Coated Bead Transcatheter Arterial Chemoembolisation
<b>DSA</b>	Digital Subtraction Angiography
<b>DOPP</b>	Direct Observation of Practice and Procedures
<b>DOQI</b>	Dialysis Outcomes Quality Initiative (US National Kidney Foundation)
<b>DRE</b>	Digital Rectal Examination
<b>DVT</b>	Deep Vein Thrombosis
<b>DWI</b>	Diffusion Weighted Imaging
<b>EBIR</b>	European Board of Interventional Radiology
<b>ESIR</b>	European School of Interventional Radiology
<b>EUS</b>	Endoscopic Ultrasound
<b>FLR</b>	Future Liver Remnant
<b>Gd-BOPTA</b>	Gadobenate dimeglumine (Contrast agent)
<b>Gd-EOB</b>	Gadolinium Ethoxybenzyl (Contrast agent)
<b>HIFU</b>	High Intensity Focused Ultrasound
<b>HNSCC</b>	Head and Neck Squamous Cell Carcinoma
<b>HPB</b>	Hepato-Pancreatico-Biliary
<b>HPV</b>	Human Papillomavirus
<b>IGA</b>	Image-Guided Ablation
<b>IMRT</b>	Intensity Modulated Radiotherapy
<b>IO</b>	Interventional Oncology
<b>IR</b>	Interventional Radiology
<b>ISVS</b>	International Society for Vascular Surgery
<b>IV</b>	Intravenous



<b>IVC</b>	Inferior Vena Cava
<b>IVCO</b>	Inferior Vena Cava Obstruction
<b>LUTS</b>	Lower Urinary Tract Symptoms
<b>MDT</b>	Multi-Disciplinary Team
<b>MELD score</b>	Model for End-stage Liver Disease
<b>MIBG</b>	Meta -Iodo Benzyl Guanidine
<b>MR</b>	Magnetic Resonance
<b>MRA</b>	Magnetic Resonance Angiography
<b>MRI</b>	Magnetic Resonance Imaging
<b>MRSA</b>	Methicillin-Resistant Staphylococcus Aureus
<b>NIHSS</b>	National Institute of Health Stroke Scale
<b>NSF</b>	Nephrogenic Systemic Fibrosis
<b>ODA</b>	Operating Department Assistant
<b>OSCE</b>	Objective Structured Clinical Examination
<b>PAD</b>	Peripheral Arterial Disease
<b>PAT</b>	Peer Assessment Tools
<b>PBA</b>	Procedural Based Assessment
<b>PCNL</b>	Percutaneous Nephrolithotomy
<b>PET</b>	Positron Emission Tomography
<b>PICC</b>	Peripherally Inserted Central Catheter
<b>PSA</b>	Prostate Specific Antigen
<b>PV</b>	Percutaneous Vertebroplasty
<b>PVE</b>	Portal Vein Embolisation
<b>QA</b>	Quality Assurance
<b>RCT</b>	Randomised Controlled Trial
<b>RF</b>	Radiofrequency Ablation
<b>RUS</b>	Retrograde Ureteric Stenting
<b>SR</b>	Systematic Reviews
<b>ST</b>	Soft Tissue
<b>SVC</b>	Superior Vena Cava
<b>SVCO</b>	Superior Vena Cava Obstruction
<b>SVS/</b>	Society of Vascular Surgery/
<b>TACE</b>	Transcatheter Arterial Chemoembolisation
<b>TcPo2</b>	Transcutaneous Oxygen Pressure
<b>TICI</b>	Thrombolysis in Cerebral Infarction
<b>TIPS</b>	Transjugular Intrahepatic Portosystemic Shunt
<b>TOS</b>	Thoracic Outlet Syndrome
<b>TRAS</b>	Transplant Renal Artery Stenosis
<b>TRUS</b>	Transrectal Ultrasound
<b>UAE</b>	Uterine Artery Embolisation
<b>UFE</b>	Uterine Fibroid Embolisation
<b>US</b>	Ultrasound
<b>VBCF</b>	Vertebral Body Compression Fractures

## APPENDIX 1: Different Types of Studies and Trials

### **Randomised controlled trial**

A clinical trial to study the effect of a type of therapy. It helps compare between the study group and a control group. Can be blinded (less bias) or non-blinded. It is a planned experiment providing sound evidence.

### **Systematic reviews (SR)**

They focus on a clinical topic or answer a specific question. Selection of studies with sound methodology is done from a collection of all studies on the topic found after an extensive literature search. These studies are reviewed, assessed for quality and the results are summarised with reference to specific predetermined criteria set to answer the question.

### **Meta-analyses**

Examines thoroughly all valid studies in literature on the study topic, uses the data from all of them as a single large data which is then used in accepted statistical models to give results.

### **Observational studies**

#### **Case studies and reports**

Are presentation of a series of cases or some cases with similar clinical problems and their outcomes after a particular therapy. However, no control group or comparison group exists. This has low statistical evidence but can form the basis or stepping stones for future trials.

#### **Case control studies**

It is a type of observational study in which two existing groups differing in outcome are identified and compared on the basis of some supposed cause. They are less expensive and easier to do however they do not give robust evidence as RCT or cohort studies. These are retrospective studies.

#### **Cohort studies (retrospective cohort or historical cohort)**

They are generally prospective studies. These are comparative studies of two groups in which one receives the treatment compared with another that receives another treatment. These can be expensive and time consuming. However, retrospective cohort or historical cohort studies can also be conducted.

#### **Cross sectional studies**

A study that examines the relationship between diseases (or other health-related characteristics) and other variables of interest as they exist in a defined population at one particular time (i.e. exposure and outcomes are both measured at the same time). This is a snap study done at the same time of the intervention.

### Levels of Evidence and Grades of Recommendation: Interventional Radiology

#### Grade of Recommendation and Level of Evidence Therapy or Harm\*

#### A

- 1a Systematic review, with homogeneity, of RCTs
- 1b Individual RCT with narrow confidence interval
- 1c "All-or-none" case series

#### B

- 2a Systematic review, with homogeneity, of cohort studies
- 2b Individual cohort study or low-quality RCT (e.g. 80% follow-up)
- 2c Outcomes research, Ecological studies
- 3a Systematic review, with homogeneity, of case-control studies
- 3b Individual case-control study

#### C

- 4 Case series (and poor-quality cohort and case-control studies)

#### D

- 5 Expert opinion without explicit critical appraisal; based on physiologic information, "bench" research results, or "first principles"

#### Grades of Recommendations

- A consistent level 1 studies
- B consistent level 2 or 3 studies or extrapolations from level 1 studies
- C level 4 studies or extrapolations from level 2 or 3 studies
- D level 5 evidence or troublingly inconsistent or inconclusive studies of any level

## APPENDIX 2: Common Terminology Used in Oncology Treatments

General Tumours have a subpopulation of actively dividing cells termed the Principles growth fraction; other cells will be in growth arrest or necrotic. The growth fraction cells tend to be the ones that are most sensitive to chemotherapy. Some agents act only in certain cell cycle phases whereas others may act at any cell cycle phase. Agents may act by a range of mechanisms to damage DNA, prevent DNA synthesis or arrest the cell cycle. Principles of combination chemotherapy to reduce the occurrence of drug resistance. Regime types by intent: induction, consolidation, adjuvant, neoadjuvant and maintenance.

### Drug side effects

Understanding of key common toxicities for chemotherapy generally and more detailed toxicity profiles for agents relative to their field of specialisation and action is important.

Some chemotherapy drugs induce leukopenia, therefore it is important to know when to avoid performing procedures and which is the best window in which procedures can be performed on patients receiving this type of chemotherapy.

### Radio-resistance

Certain molecular markers suggest relative radio-resistance: hypoxia, P21 and P53 mutations and a low proliferation rate. Absence of HPV- influence in head and neck cancer patients (HPV-positive HNSCC are more radiosensitive).

### Types of radiotherapy

#### External beam

May be delivered as electrons, photons or protons. Tumour targeting is achieved by beam collimation and image guidance, shielding and selection of the optimal type of radiation and energy which dictates the depth of penetration.

#### IMRT

Intensity modulated radiotherapy (IMRT): Highly targeted RT using computer and CT controlled multiple beams with automatic collimation in linear accelerators. Used in avoiding radiation damage to critical structures and target dose escalation such as CNS in sarcomas, parotid gland in head and neck cancers, bowel in prostate cancer, etc.

**Brachytherapy**

Direct placement of radioactive sources into the tumour or tumour bed. Able to deliver higher focal RT doses with relative sparing of normal tissue due to rapid dose fall-off around the sources (e.g. Iridium 192 after-loading for cervical and breast cancer, radioactive iodine seeds for prostate cancer). These produce mainly electrons and photons.

**Intra-operative**

A number of applications for intra-operative radiotherapy such as in breast conservation surgery.

**Stereotactic radiotherapy**

Systems such as cyber knife, external beam radiotherapy, tomotherapy, gamma knife or linear accelerator based used to deliver RT to the brain, liver and lung metastases and small primary tumours. They may achieve highly targeted treatment areas by means of multiple highly collimated beams with a need for precise fixation of the target area.

**Proton therapy**

Protons can be precisely targeted, with little side scatter, at a well-defined range and release most of their energy in the last few mm of this range. Protons are useful for specific indications (e.g. chordoma, ocular melanoma). Limited equipment availability.

**Radio-pharmaceuticals**

Use of Iodine 131 bound either to thyroxine or Meta Iodo Benzyl Guanidine (MIBG) to treat thyroid cancer or neuroendocrine tumours.

**Radiotherapy side effects****Acute (within 3 months after treatment)**

Skin desquamation, nausea, diarrhoea, oedema. Specific side effects by disease site (proctitis in pelvic RT, dysphagia in head and neck RT, etc.).

**Chronic (more than 3 months)**

Radiation fibrosis, vascular obliteration: complex cellular mechanism including myofibroblast activation and up-regulated fibrogenesis.





