

European Curriculum and Syllabus for Interventional Radiology

First Edition

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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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European Curriculum and Syllabus for Interventional Radiology



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European Board of Interventional Radiology
The European qualification in Interventional Radiology

Foreword

The rapid expansion of the specialty of IR and the widespread adoption of novel IR techniques into standard medical practice, predicates that patients have a right to expect well trained Interventional Radiologists who will practise safely and effectively.

Patients expect, and healthcare demands, well-trained professional IR doctors who will take care of patients before, during and after IR procedures. EU Directives also stipulate high standards of medical professional qualifications and practice across Europe.

Interventional Radiology by definition is a distinct subspecialty of radiology because it requires a specific field of knowledge, skills and procedures separate from the diagnostic radiology curriculum. However, not all countries follow a standard curriculum for IR training or indeed perform summative assessment by means of an examination at the end of IR training.

This new IR curriculum, which describes the objectives, learning methods, outcomes, supervision and assessment of IR training, together with the enclosed syllabus (describing the content of required knowledge and competencies to be covered) is designed to address a perceived gap in European IR training.

The aim is that this IR curriculum/syllabus, with the addition of centralised summative assessment by means of the European Board of Interventional Radiology (EBIR), will help to standardise IR training and assessment across Europe.

The free movement of doctors and patients throughout the European Union is a key principle of many EU directives. However, in reality, the movement of Interventional Radiologists across European borders is problematic because every country does not follow a standard IR training curriculum and many do not have established mechanisms to assess trainees at the end of their training period before they are accredited as specialists.

This new curriculum, if widely adopted throughout Europe and with the addition of summative assessment by the EBIR, offers a means of ensuring quality control, skill and competency levels among European IRs. Clearly, there are many non-European countries also, who do not have an official IR curriculum, where this IR curriculum can be used to compliment or can be adapted to fulfil specific training requirements.

We realise that not all Interventional Radiologists perform every procedure listed in the syllabus and that some sub-specialise in disciplines such as Oncologic Intervention or Musculoskeletal Intervention. 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.

Lastly, it is important to recognise that 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.

Currently, the recognition of training centres for Diagnostic Radiology is under the auspices of national training bodies but there is varied accreditation of IR training centres. In the future, it is hoped that an accrediting body for IR training will be instituted which will inspect IR training centres, on request.

It is our aspiration to harmonise European IR training with this curriculum and to certify IR training based on the European Board of Radiology (EBIR). These are important steps to ensure that patients are treated safely and effectively throughout Europe.

We would like to thank sincerely Jim Reekers, Elias Brountzos, Jan Peregrin, Mario Bezzi, Klaus Hausegger, Tony Nicholson, Philippe Pereira, Raman Uberoi and the CIRSE office for their invaluable help in producing this document.

Mick Lee
CIRSE President

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Task Force Leader

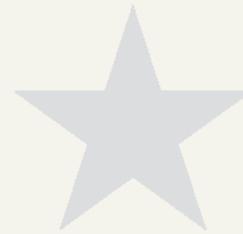
Table of Contents

1	CURRICULUM	7
1.1	Objectives	9
1.2	Recommendations for the Training Pathway	10
1.3	General Competencies in IR	11
1.3.1	Patient Safety	11
1.3.2	The IR Team	11
1.3.3	IR Clinical Practice	11
1.3.4	Professionalism and Ethics	11
1.3.5	Good Clinical Practice	12
1.3.6	Pharmacological Agents in IR	12
1.3.7	Practice-based Learning	12
1.3.8	Technical Skills	12
1.4	Acquisition of Experience and Clinical Competence	12
1.4.1	General Competence in Interventional Radiology	13
1.4.2	Levels of Competence	14
1.4.3	Recommendations for the Assessment of Competence	14
1.4.4	Recommendations for the Maintenance of Competence	15
1.5	Curriculum Review	15
2	SYLLABUS	17
2.1	General Topics in Interventional Radiology	19
2.1.1	Patient Safety	19
2.1.2	Recognising and Reducing Occupational Hazards	21
2.1.3	The Interventional Radiology Team	25
2.1.4	Interventional Radiology Clinical Practice	25
2.1.5	Pharmacology of Interventional Radiology	26
2.1.6	Core Syllabus	27
2.2	Specific Topics in Interventional Radiology	31
2.2.1	Vascular Diagnosis and Intervention	31
2.2.1.1	Arterial Disease	32
2.2.1.1.1	Peripheral Arterial Disease	32
2.2.1.1.2	Aortic and Upper Extremity Arterial Disease	37
2.2.1.1.3	Aortic Dissection and Aneurysmal Disease	38
2.2.1.1.4	Supra-Aortic Arterial Pathology	40
2.2.1.1.5	Cerebrovascular Accident/Stroke	41
2.2.1.1.6	Abnormal Arteriovenous Communications	42
2.2.1.1.7	Vascular Trauma	43
2.2.1.1.8	Visceral Arterial Pathology	44
2.2.1.1.9	Arterial Problems in Obstetrics and Gynaecology	50
2.2.1.1.10	Vascular Interventional Oncology	51
2.2.1.1.10.1	Vascular Management of Hepatic Malignancy	52

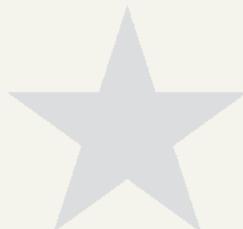
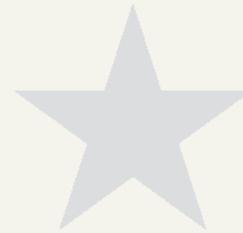
2.2.1.2	Venous Disorders	53
2.2.1.2.1	Peripheral Venous Disease	53
2.2.1.2.2	Pulmonary Thromboembolic Disease	54
2.2.1.2.3	Disease of the Superior and Inferior Vena Cava	54
2.2.1.2.4	Portal and Hepatic Venous Interventions	55
2.2.1.2.4.1	Portal Venous Disease and Transjugular Intrahepatic Portosystemic Shunt (TIPS)	55
2.2.1.2.4.2	Hepatic Venous Disease and Budd-Chiari syndrome	56
2.2.1.2.4.3	Preoperative Portal Vein Embolisation	57
2.2.1.2.5	Gonadal Venous Interventions	58
2.2.1.2.6	Haemodialysis Access	59
2.2.1.2.7	Central Venous Access	60
2.2.1.2.8	Venous Sampling	62
2.2.2	Non Vascular Intervention	62
2.2.2.1	Image-Guided Biopsy	62
2.2.2.2	Image-Guided Aspiration and Drainage of Collections and Abscesses	63
2.2.2.3	Gastrointestinal Interventions	65
2.2.2.3.1	Enteral Tube Placement (Gastrostomy, Jejunostomy, Caecostomy)	65
2.2.2.3.2	Gastrointestinal Stenting	65
2.2.2.4	Hepato-Pancreatico-Biliary (HPB) Intervention	66
2.2.2.5	Non-Vascular Interventional Oncology	68
2.2.2.5.1	Image-Guided Ablation (IGA)	68
2.2.3	Intervention of the Genito-Urinary Tract and Renal Transplants	73
2.2.3.1	Pelvic/lyceal and Ureteric Obstruction	74
2.2.3.2	Renal Stone Disease	77
2.2.3.3	Renal Masses and Perirenal Collections	78
2.2.3.4	Renal Tumours	78
2.2.3.5	Genito-Urinary Interventions	79
2.2.3.5.1	Gonadal Venous Interventions	79
2.2.3.5.2	Fallopian Tube Obstruction	79
2.2.3.5.3	Male Infertility	80
2.2.3.5.4	Prostate	80
2.2.3.5.4.1	Prostate Cancer	80
2.2.3.5.4.2	Prostatitis (Abscess)	81
2.2.3.5.5	Priapism	81
2.2.3.6	Renal Transplant Interventions	82
2.2.3.7	Renal Artery Sympathetic Denervation	83
2.2.4	Interventional Radiology of the Musculoskeletal System	83
2.2.4.1	Image-guided Biopsy	83
2.2.4.2	Percutaneous Ablation of Bone and Soft Tissue Lesions	84
2.2.4.3	Intra-articular Injections under Image Guidance	84
2.2.4.4	Percutaneous Osteoplasty	85
2.2.4.5	Spinal Intervention	86
2.2.4.5.1	Interventions in Vertebral Body Compression Fractures (VBCF)	86
2.2.4.5.2	Spinal Procedures for Disc, Nerves and Facet Joints	87
	Acronyms	88



1 CURRICULUM



1.1 Objectives	9
1.2 Recommendations for the Training Pathway	10
1.3 General Competencies in IR	11
1.4 Acquisition of Experience and Clinical Competence	12
1.5 Curriculum Review	15



Introduction

The European Interventional Radiology (IR) Curriculum is intended to promote the harmonisation of medical education and training in Interventional Radiology. 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.

Since Interventional Radiology is a dynamic and rapidly developing specialty, this curriculum will be subject to continuous review. Based on regular surveys on the effects of its implementation, a dedicated task force will revise the contents of the curriculum every 5 years.

1.1 Objectives

The IR Curriculum aims to ensure that all interventional radiologists are competent to provide a high quality service, enabling them to take 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 Radiology¹.

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 fulfill the Essential Roles and Key Competence of Specialist Physicians as defined in CanMEDS 2000 [1]:

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

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

¹ *Global Statement Defining Interventional Radiology. 2010 Cardiovasc Intervent Radiol; 33:672–674.*

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

* *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.*

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 ideally a suitable period of training in clinical medicine/surgery. Training in diagnostic radiology is required as a core skill to provide the interventional radiologist with the skills required to investigate and diagnose patients. Experience with all cross-sectional imaging modalities and ultrasonography is mandatory before starting specialised interventional training.

The curriculum for the initial structured common training programme is taken from the revised European training charter for diagnostic radiology and is available at www.cirse.org/ESR_Training_Charter from 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 interventional radiologists, 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 programme will eventually be collated in a central register maintained by CIRSE.

1.3 General Competencies 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 internet at 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. A commitment to life long learning is also an integral part of IR practice.

Understanding methods for dose reduction and image optimisation are central requirements to effective and safe exposure to ionising radiation. IRs should work according to the ALARA principle².

Understanding the risks of pathogens, drugs and other hazardous material and the risk of injury to patients and staff is essential including how to manage and control infection including cross infection.

1.3.2 The IR Team

Understanding and promoting a team environment and recognition of the roles of radiographers, 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 their 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.

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.

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.

² For more information on ALARA please refer to <http://www.eman-network.eu/> the website of the European Medical ALARA Network.

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 Practice³. 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/prognosis

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 Interventional Radiology which enables IRs to prescribe, administer and monitor their appropriate use.

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 interventional radiology practice. Their performance should be reviewed by regular audit.

1.3.8 Technical Skills

The trainee will develop the necessary practical skills to perform key interventional 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.

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 Interventional Radiology might progress through their radiology training based on a core diagnostic radiology programme followed by 2 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 nominate and gain training in their chosen area e.g. interventional urology, musculoskeletal, GI, etc., during years 4-6. A more wide based interventional radiologist 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.

³ EMEA ICH Topic E 6 (R1) Guideline for Good Clinical Practice. CPMP/ICH/135/95, July 2002.

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 Radiology (ESIR) are highly recommended. Each year a broad variety of topics for IRs of varying expertise from learner to expert is offered in different European cities (<http://www.esir.org>)
- 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. The EBIR logbook is available at www.cirse.org/ebir.
- Preparation of scientific abstracts for presentation at scientific meetings or publication in peer reviewed journals.

1.4.1 General 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, limitations and expected outcomes of interventional procedures
- Understanding of radiation protection and dose limitation
- Ability to perform interventional radiological procedures responsibly
- Ability to recognise and manage complications of interventional 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 appropriately manage patients under their care
- Ability to work within multidisciplinary teams
- 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

- 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 interventional radiologist. 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.⁴

Besides regular training courses, IRs should also be able to attain CME credits via participation in web-based self-assessment modules on the internet.

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 5 years as IR training and education must reflect modern practice in a rapidly changing and evolving specialty. The regular meetings of the Examinations Board will allow opportunities for the curriculum to be discussed and amendments proposed in advance of any formal review.

⁴ *Society of Interventional Radiology Position Statement: Mini Training Courses in Interventional Radiology Techniques 2010. SIR.*



2 SYLLABUS

2.1 General Topics in Interventional Radiology 19

- 2.1.1 Patient Safety 19
- 2.1.2 Recognising and Reducing Occupational Hazards 21
- 2.1.3 The Interventional Radiology Team 25
- 2.1.4 Interventional Radiology Clinical Practice 25
- 2.1.5 Pharmacology of Interventional Radiology 26
- 2.1.6 Core Syllabus 27

2.2 Specific Topics in Interventional Radiology 31

- 2.2.1 Vascular Diagnosis and Intervention 31
- 2.2.2 Non Vascular Intervention 62
- 2.2.3 Intervention of the Genito-Urinary Tract and Renal Transplants 73
- 2.2.4 Interventional Radiology of the Musculoskeletal System 83

2.1 General Topics in Interventional Radiology

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

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

- **Relevant anatomy**
 - understand the complementary roles of the various imaging modalities in the assessment and 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
- **Therapeutic options**
 - 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

2.1.1 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 the procedure. 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.
- 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 establish the correct management pathway in conjunction with the patient and the referring team

Properly evaluate a patient before an interventional procedure

- Elicit a relevant history
- Perform a focused physical examination
- Demonstrate understanding of history/physical findings or treatment scenarios that require discussion with/referral to other specialty disciplines

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 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
- The alternative therapeutic options to the intervention

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

- Record plan of aftercare in the patient record
- Communicate the plan effectively to radiology and ward staff
- Ensure unusual elements of care are expressly relayed to ward teams

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

- Review the patient post procedure and ensure appropriate care
- Manage and advise on issues related to the procedure such as
 - Drainage tubes
 - Pain control
 - Post embolisation syndrome
 - Haematoma and false aneurysm
- Communicate with the appropriate clinicians, the patient and their relatives
- Arrange appropriate outpatient review and follow up investigation

2.1.2 Recognising and Reducing Occupational Hazards

Objectives

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

- **Complications of interventional radiology**
- **The risks of ionising radiation for the patient and IR staff**

The trainee will build on the radiation protection module taken during diagnostic radiology training as depicted in the ESR training curriculum www.cirse.org/ESR_Training_Charter. 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 Interventional Radiologists in Radiation Protection

Knowledge <i>(facts, principles, theories, practices)</i>	Skills <i>(cognitive and practical)</i>	Competence <i>(responsibility and autonomy)</i>
<p>Radiation physics K1. Understand special requirements of image formation and image quality aspects with respect to fluoroscopy</p>	<p>S1. Apply radiation physics to optimise interventional protocols, using minimal exposure to reach the desired procedure outcome</p>	
<p>Equipment K2. 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>K3. 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>	<p>S2. 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>C1. Choose the best interventional equipment for your patient spectrum based on the resources available</p> <p>C2. Be informed of maintenance procedures and supervise these in cooperation with local legislative and hospital authorities</p>

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>
Radiobiology	K4. 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		
Radioprotection in Interventional Radiology <i>(X-rays)</i>	<p>K5. Define ALARA and its applicability to Interventional Radiology settings</p> <p>K6. Explain the meaning of justification and optimization as applied to Interventional Radiology practices</p> <p>K7. Explain the concepts and tools for dose management in Interventional Radiology of adult and paediatric patients</p> <p>K8. Explain the factors influencing image quality and dose in Interventional Radiology</p> <p>K9. Describe the methods and tools for dose management in Interventional Radiology</p> <p>K10. Explain the basic concepts of patient dose measurement and calculation in Interventional Radiology</p> <p>K11. Describe the key considerations relevant to radiation protection when designing an Interventional Radiology unit</p> <p>K12. List expected doses (to a reference person) for the main Interventional Radiology procedures</p> <p>K13. Explain quantitative risk and dose assessment for workers and public in Interventional Radiology</p>	<p>S3. Optimise procedure protocols by using standard operating procedures (SOPs) for interventional radiology and by adapting these to the specific patient size</p> <p>S4. Individually choose the best compromise between risk-benefit ratio, image quality, procedure outcome and radiation exposure</p> <p>S5. 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</p> <p>S6. Apply and advise on the use of radiation protection measures in Interventional Radiology</p> <p>S7. Estimate effective doses from Interventional Radiology procedures based on measurable exposure parameters (KAP, skin dose)</p> <p>S8. Estimate high skin dose cases</p> <p>S9. Calculate patient risk from measurement data of the dosimetry quantities used to assess adverse biological effects</p>	<p>C5. Advise patients on the radiation-related risks and benefits of a planned interventional procedure</p> <p>C6. Take responsibility for justification of radiation exposure in any individual patient undergoing Interventional Radiology procedures, with special consideration of pregnant (or possibly pregnant) patients</p> <p>C7. Take responsibility for optimizing the technique/protocol used for a given Interventional procedure based on patient-specific needs</p> <p>C8. 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</p> <p>C9. Take responsibility for applying the optimal size- and problem-adapted individual protocol for high-dose procedures (TIPS etc.)</p> <p>C10. Take responsibility for avoiding very high skin doses causing deterministic effects</p> <p>C11. Follow-up patients for checking for appearance of deterministic effects</p>

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>
Quality	<p>K14. Define Quality Assurance (QA) in Interventional Radiology, QA management and responsibilities, outline a QA and radiation protection program for Interventional Radiology</p> <p>K15. List the key components of image quality and their relation to procedural patient exposure during</p> <p>K16. Explain the principle of diagnostic reference levels (DRLs) in Interventional Radiology procedures</p>	<p>S10. Understand the effects of poor-quality images in Interventional Radiology procedures</p> <p>S11. 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>S12. Develop an organizational policy to keep doses to the IR personnel as low as reasonably achievable (ALARA)</p>	
Law and regulations	<p>K17. Specify the relevant regulatory framework governing Interventional Radiology practice in your country</p>	<p>S13. Find and apply the relevant regulations in any clinical situation in Interventional Radiology</p>	<p>C12. Take responsibility for conforming with patient protection regulations (including procedural reference levels, where applicable)</p>

2.1.3 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 interventional radiology including

- Radiographers
- 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

Encourage skills development of members of the IR team

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

2.1.4 Interventional Radiology Clinical Practice

Objectives

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

Understand the importance of the relationship with all sources of referral to the IR service

- 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 interventional radiologist

Understand the necessity of developing and maintaining an interventional radiology 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 interventional radiology as a clinical practice

Understand healthcare coding systems

- To allow proper interaction with the financial aspects of the IR service
- To ensure appropriate contracts for service provision

Provide care for patients as necessary utilising the IR clinic

- To ensure optimal patient care
- 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

Communicate effectively with referring physicians

- To ensure they are informed regarding management of their patients
- To ensure appropriate management and follow up by other clinical teams

Integrate patient care coordinators to staff a functional IR clinic

- Nurses and nurse practitioners
- Junior medical staff
- Consultants from other relevant disciplines
- Clerical staff

Keep adequate medical records for interventional radiology patients and integrate with the hospital information systems

- To ensure that information is readily available to other clinical care teams
- To facilitate research and audit

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
- Effective audit
- Contribution to national audits of practice and outcomes in IR

2.1.5 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 interventional radiology, including but not restricted to:

- Aetiology, prevention and treatment of contrast reactions
- Local anaesthetics
- Analgesics
- Sedatives
- Vasoactive drugs
- Drugs affecting coagulation
- Drugs used in diabetes
- Antibiotics
- Antiemetics
- Management of circulatory collapse
- Management/Pharmacology of cardiorespiratory arrest

2.1.6 Core Syllabus

For those radiologists who do not intend to specialise in interventional radiology 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 interventional 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.

Non-Invasive Vascular Imaging

Doppler Ultrasound

The trainee should demonstrate a thorough understanding and be able to interpret the following:

- Duplex ultrasound, including both arterial and venous examinations
- Normal and abnormal Doppler waveforms
- Common Doppler examinations, such as carotid, hepatic and renal Doppler studies and lower extremity venous duplex examinations

CT Angiography

The trainee should have a thorough understanding of:

- The basic physics of helical CT and multi-detector CT
- CTA protocols including contrast materials used and reconstruction techniques
- Radiation doses for CTA and methods to reduce these
- Advantages and disadvantages of CTA versus other techniques

MR Angiography (MRA)

The trainee should be familiar with:

- MR physics and MRA techniques
- Advantages and disadvantages of different contrast materials used for MRA
- The risk factors for developing nephrogenic systemic fibrosis
- 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

General Principles

The trainee should be familiar with:

- The basic chemistry of the different contrast materials used, and the indications, contraindications, 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
- Mechanisms for guidewire, sheath and catheter insertions into the groin
- Mechanisms of puncture site haemostasis including manual compression and common closure devices
- Alternative sites of arterial puncture, such as brachial, axillary, popliteal, tibial, radial and ulnar.

Diagnostic Angiography

The trainee should be familiar with:

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

Vascular Intervention

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

Angioplasty

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

Arterial/Venous Stenting

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

Arterial/Venous Thrombolysis

- Indications and contraindications to pharmacological thrombolysis
- Drugs used for pharmacological thrombolysis and their doses
- Mechanical thrombectomy
- Complications and results
- Post procedural care

Venous Access

The trainee should be familiar with the various forms of venous access including:

- PICC lines, Hickman catheters, dialysis catheters and ports
- Indications for use of the above venous access catheters
- The technique of venous access in jugular and subclavian veins
- Results and complications

Caval Interruption

The trainee should be familiar with:

- Indications for permanent caval filter placement
- Indications for optional caval filter placement
- Different filter types available
- Indications for optional filter removal

- The techniques for filter removal
- Success rates and complications
- Post-procedural care

Embolisation

The trainee should:

- Know and understand the basic equipment used in embolisation procedures
- Understand the rationale for selecting particular embolic agents
- Know the imaging appearance of embolics
- Know the indications for embolisation in common disease processes
- The trainee should be familiar with:
 - Coils and Plugs
 - Liquid embolics
 - Particle embolics and gelfoam
 - Microcatheters, endhole catheters, luer lock syringes
- Understand trauma embolisation, embolisation for GI haemorrhage, uterine fibroid embolisation, chemoembolisation and bland embolisation for tumour therapies, embolisation for major haemoptysis, embolisation for postpartum bleeding
- Know post embolisation syndrome and its management

Non-Vascular Intervention

The trainee should have performed and have a thorough understanding of the basic nonvascular interventional techniques described below.

Biopsy

The trainee should be familiar with:

- Pre-procedure coagulation tests and correction of abnormalities
- Differences in image modalities used for guiding biopsy, including fluoroscopy, CT, MR and ultra-sound
- Needles used for biopsy procedures including fine gauge needles, large gauge needles and core tissue biopsy
- Planning a safe access route to the lesion to be biopsied
- Complication rates associated with individual organ biopsy
- Indications for fine needle biopsy versus large gauge or core biopsy
- Post-procedural care for chest and abdominal biopsy
- Algorithms for treatment of common complications, such as pneumothorax and haemorrhage

Fluid Aspiration and Abscess Drainage

The trainee should be familiar with:

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

Gastro-Intestinal Intervention

The trainees should be familiar with:

- Pre-procedure workup
- Indications and contra-indications for insertion of intestinal stents and feeding/draining tubes
- Equipment available for gastro-intestinal interventions
- Complications of gastro-intestinal interventions and their management
- Aftercare, including knowledge of complications, catheter care, and ward rounds

Hepatobiliary Intervention

The trainees should be familiar with:

- Pre-procedure workup, including antibiotic regimens, coagulation screening and intravenous fluid replacement
- Indications for and technique of transhepatic cholangiography
- Variety of needle systems for biliary drainage
- Catheters and stents used for biliary decompression
- Complications of biliary procedures
- Aftercare, including knowledge of complications, catheter care, and ward rounds

Genitourinary Intervention

The trainee should be familiar with:

- Pre-procedural workup including coagulation screens and antibiotic regimens
- Indications for and technique of percutaneous nephrostomy
- Ultrasound/Fluoroscopic guidance mechanism for percutaneous nephrostomy
- Catheters and technique used for percutaneous nephrostomy
- Complications of percutaneous nephrostomy
- Aftercare, including catheter care and removal

Technical, Communication and Decision Making Skills

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

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

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.

Trainees must appreciate and be familiar with

- **The role of the different imaging modalities in the assessment of vascular disease**
- **The scope of vascular interventional radiology and other medical and surgical strategies for the management and treatment of arterial and venous disease**

At completion of training, the trainee will have the following;

Knowledge

- Demonstrate knowledge of topic specific educational objectives described in the following sections

Clinical Skills

- Understand and be able to perform pre-procedural evaluation, peri- and post-procedural management and follow-up for these patients
- Obtain complete and appropriate informed consent for all procedures
- Understand the principles of patient selection and the therapeutic options for the conditions described below

Technical Skills

- Demonstrate competence at obtaining vascular access at common sites with and without the use of ultrasound guidance
- Demonstrate technical competence in performing the following index vascular interventional procedures
 - Elective and emergency diagnostic peripheral angiography
 - Elective and emergency diagnostic visceral angiography
 - Elective and emergency peripheral and visceral arterial angioplasty and stenting
 - Elective and emergency supraortic branch arterial angioplasty and stenting
 - Elective and emergency mechanical and pharmacological thrombolysis and thrombectomy
 - Elective and emergency aortic stent grafting
 - Elective and emergency embolisation therapy with various embolic agents

2.2.1.1 Arterial Disease

2.2.1.1.1 Peripheral Arterial Disease

Knowledge

- Know the anatomy relevant to PAD

Anatomy

Lower limb

- Name the major branches from the aortic bifurcation to the common femoral
- Describe the normal arterial anatomy below the inguinal ligament
- Understand the anatomy relevant to popliteal entrapment syndrome
- Understand the pelvic anatomy of the internal pudendal artery and its role in angiography for vasculogenic impotence

Upper limb

- Understand the arterial anatomy of the aortic arch, neck and shoulder region
- Describe the arterial anatomy of the upper limb
- Describe the arterial anatomy of the hand
- 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

Recognise common or significant normal vascular anatomical variants, e.g.:

- Persistent sciatic artery
- High bifurcation of the common femoral artery
- Duplication of the SFA
- High bifurcation of the popliteal artery
- Anatomical variants of the infra-geniculate arteries and their territories of distribution
- Aberrant proximal origin of the radial or ulnar artery

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

- Describe the important branches of the common femoral and profunda femoris artery 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 infra popliteal artery
- The axillary artery
- The aorta

- Know the epidemiology of PAD including expected outcomes in patients with PAD compared to age matched controls

Epidemiology of PAD

- Understand the incidence, prevalence and gender distribution of PAD
- Understand the incidence and consequences of diabetic foot syndrome
- 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 pathophysiology of PAD (see section below on Pathophysiology) including
 - Causes of peripheral ischaemia e.g. atherosclerosis, embolus, arteritis, fibromuscular disease, trauma, entrapment syndromes, cystic adventitial disease, Buerger's disease
 - Rheological factors, e.g. viscosity, clotting mechanism, prothrombotic states
 - Recognition of the risk factors for development and progression of PAD
 - The specific role of diabetes related PAD

Pathophysiology of PAD

Atherosclerosis

- Understand the pathophysiology, clinical manifestations and management strategies of atherosclerosis
 - Risk factors for peripheral vascular atherosclerosis
 - Natural history of peripheral vascular disease
 - Major histological and biochemical features and associations of atheroma
 - Gross pathological features including occlusive disease and ectatic atherosclerosis (arteriomegaly)
 - Describe and categorise intermittent claudication (including Leriche syndrome) according to SVS/ISVS and Fontaine systems
 - Categorise chronic critical limb ischaemia according to SVS/ISVS systems
 - Describe and categorise acute critical limb ischaemia according to SVS/ISVS systems
 - Recognise and understand the clinical management of thrombangitis obliterans (Buerger Disease)

Diabetic foot syndrome

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

Embolus

- 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

- List causative factors for aortic dissection
- Major histological and biochemical features and associations

Fibromuscular Dysplasia

- Describe histological and angiographic findings common to the forms of fibromuscular disease that may affect the aorta and its branches
- Associations with other disease entities (e.g. Von Recklinghausen's disease)

Vasculitis

- Describe the pathophysiological basis and typical findings of vasculitis including Takayasu's arteritis, polyarteritis nodosa and radiation damage:
- 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 the signs of thromboangitis obliterans and its association with smokers

Trauma

- Recognise the manifestations of blunt or penetrating trauma
- List occupations or activities that may contribute to hypothenar hammer syndrome and recognise the associated angiographic findings

Entrapment Syndromes

- Popliteal entrapment syndrome: Describe the anatomical relationships between the popliteal artery and the gastrocnemius or popliteus muscles in the four types of popliteal entrapment
- Describe the anatomic relationships responsible for TOS
- Describe the natural history and pathophysiological sequelae with/without treatment in these conditions

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 Behcet's, Marfan's, middle aortic syndrome, Williams' syndrome, neurofibromatosis, polyarteritis nodosa, systemic lupus erythematosus, Ehlers Danlos, rubella and cholesterol embolisation

Clinical Skills

- Be able to elicit the appropriate clinical history, perform physical examination and assess and classify patients with acute and chronic peripheral ischaemia
- Select and interpret appropriate laboratory and imaging investigations
- Understand the complementary roles of the various imaging modalities in the assessment of PAD

Imaging

Understand the mechanisms, complementary roles and limitations of ultrasound, magnetic resonance angiography, computed tomography angiography, catheter angiography and rotational angiography in the investigation of PAD.

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

- Acute and chronic ischaemia
- The 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

Understand the risks associated with the different imaging modalities including

- Contrast medium related
- Exposure to ionising radiation, both for the patient and the interventional 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

Specific imaging modalities

- Ultrasound
 - Understand the specific role and limitations of Duplex and Doppler imaging in the evaluation of lower extremity ischaemia including contrast enhanced ultrasound
 - Be familiar with the indications and limitations of ultrasound imaging in selecting management strategies for patients with PAD
 - Be familiar with the indications for ultrasound imaging in surveillance of vascular grafts and the assessment of post angioplasty patients
 - Describe the sonographic findings of the complications of femoral artery puncture; e.g. haematoma, arterial occlusion or dissection, iatrogenic pseudoaneurysm and arteriovenous fistula
 - Understand the role of ultrasound in guiding access to vessels
- MRA
 - Recognise the role of MRA in assessing arterial disease (e.g. in the lower extremities, including pedal vessels)
 - Understand the limitations of MRA in lower limb critical ischemia
 - Understand the compromise that must be made between resolution, acquisition time and scan volume
 - Recognise artifacts 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
 - Recognise the value of CTA in assessing arterial obstruction, e.g. in the lower extremities
 - 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 artifacts 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 ischemia
- Catheter angiography
 - List advantages and disadvantages of various forms of angiography of the lower extremity including bolus chase DSA, incremental stations for DSA
 - Describe strategies for optimising lower extremity angiography when only limited amounts of iodinated contrast may be used, or if CO₂ 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
- 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 ankle-brachial indices in evaluating the patient with a bypass graft
 - Describe an imaging strategy for bypass graft surveillance
 - List 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
- 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 and stents

Technical Skills

- Demonstrate ability to plan optimal vascular access
- 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
 - Recanalisation techniques
 - Balloon angioplasty and stent placement
 - Thrombolysis
 - Management of complications

- Demonstrate correct selection and use of equipment including:
 - Guidewires
 - Catheters
 - Sheaths
 - Balloons
 - 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 ischemia and tailor therapy accordingly
- Demonstrate ability to recognise and manage the potential complications of endovascular procedures such as balloon angioplasty, stenting, stent grafting and thrombolysis
- Understand the indications, contraindications and limitations of puncture site closure devices
- Recognise the role of emerging treatments for restenosis including
 - Pharmacology
 - Brachytherapy

2.2.1.1.2 Aortic and Upper Extremity Arterial Disease

Knowledge

- Know the basic embryology of the thoracic and abdominal aorta
- Know the normal anatomy of the ascending, transverse arch, descending thoracic and abdominal aorta including the great vessels to the head and neck, the intercostal and bronchial arteries and branches of the abdominal aorta
- Know congenital variants of the aorta and great vessels and understand how they may present with clinical abnormalities. Recognise chest radiograph findings in these variant anatomies. In particular, recognise the MRA, and CTA findings of the following:
 - Left aortic arch with aberrant right subclavian artery
 - Right aortic arch with mirror image branching
 - Right aortic arch with aberrant left subclavian artery
 - Cervical aortic arch
 - Coarctation of the aorta
 - Horse-shoe kidney
- Know the anatomy of the artery of Adamkiewicz and understand its clinical significance
- Know the potential causes of ‘dysphagia aortica’ and ‘dysphagia lusoria’
- Know the difference between an aortic pseudoaneurysm and a ductus diverticulum
- Know the pathophysiology of aortic and upper extremity arterial disease

Clinical Skills

- Understand the correct use of ultrasound, CT or MR angiography for the identification of thoracic and upper extremity arterial pathology
- 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 angiographic findings and typical distribution of abnormalities in Takayasu’s aortitis
- Recognise the angiographic and non-invasive findings in the vascular components of connective tissue disorders (e.g. Marfans syndrome and Ehlers-Danlos syndrome)

Technical Skills

- Demonstrate competence in performing emergency aortography for suspected traumatic disruption of the thoracic aorta
- Demonstrate competence and knowledge of the advantages and disadvantages of axillary, brachial or radial artery puncture as alternatives to common femoral artery puncture for arteriographic procedures
- 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 normal anatomy of the aorta and its branches
- Know the levels of arterial connection between the aorta and the spinal cord and the angiographic appearance of the artery of Adamkiewicz and understand its clinical significance
- Know the epidemiology and pathophysiology of thoracic and abdominal aortic aneurysms and the implications for treatment
- Know the pathological spectrum of aortic intramural haematoma, aortic ulceration and aortic dissection
- Know the factors predisposing to aortic dissection e.g. atherosclerosis, hypertension, collagen vascular disease 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

- Be able to perform a directed history and physical examination in patients with aortic aneurysm
- 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 work-up 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

- Understand how intravascular US can be an adjunct to identifying the true and false lumen and may impact catheter 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 aneurysms: suitability for fenestrated or branched stent-grafts
 - For aneurysms involving the iliac segments: the need for embolisation of the internal iliac ostium 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 stentgrafts, 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 stentgrafts 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 re-intervention
- 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-grafts 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 endovascular 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
 - Covering 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:
 - Insertion of a giant Palmaz stent to achieve a proximal seal
 - Insertion of additional proximal or distal cuffs
 - Transcatheter embolisation of branch vessels
 - Percutaneous trans-sac injection of embolic materials

2.2.1.1.4 Supra-Aortic Arterial Pathology

Knowledge

- Know the arterial anatomy of the great vessels
- Know the epidemiology of diseases involving the supra-aortic vessels
- Understand the pathophysiology of diseases involving the supra-aortic vessels

Clinical Skills

- Be able to identify patients with symptomatic carotid, vertebral and subclavian stenosis
- Be able to perform a directed history and physical examination in patients
- Understand the role of MRA, CTA, and ultrasound in diagnosis of supra-aortic pathology
- Integrate and evaluate pre-intervention non-invasive imaging in patients with supra-aortic vascular disease
- Categorise carotid bifurcation lesions as to their appropriateness for percutaneous therapy
- Understand the indications, contra-indications and potential complications of percutaneous intervention in patients with carotid, vertebral and subclavian vascular disease and the appropriate medical and surgical therapeutic options
- Understand the role of cerebral protection devices in percutaneous carotid interventions
- Understand pre-, per- and postprocedural pharmacology requirements
- Be familiar with the variety of available angioplasty balloons, stents, 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 Cerebrovascular Accident/Stroke

Knowledge

- Know the intracerebral arterial anatomy
- Understand the pathophysiology of ischaemic CVA/stroke
- Know the most important risk factors for ischaemic CVA/stroke

Clinical Skills

- Recognise and be able to elicit the basic neurological symptoms and signs caused by acute stroke
- Know the differences between a stroke event in the posterior and anterior circulation
- Know the most commonly used neurological classifications/scores (NIHSS; modified Ranking score)
- Be familiar with non-invasive stroke imaging (CT/CTA; MR/MRA; Diffusion-Perfusion imaging)
- Be familiar with the “penumbra-concept”
- Know and understand the indications and contra-indications of intervention
- Understand the indications for transarterial stroke treatment
- Be familiar with the factors which strongly influence the indication for stroke treatment (time window; findings in non-contrast enhanced CT; collateral flow)
- Have knowledge of the most important drugs used in the acute and postacute phase (Aspirin, Clopidogrel, others)
- Understand the role of and be able to interpret post interventional imaging (CT; MR)
- Know about timing of follow-up examinations
- Understand the most commonly used scales for angiographic outcome (TICI score)
- Understand the problems of clinical outcome (i.e. discrepancy between angiographic and clinical outcome)
- Be familiar with the most up-to-date literature on this topic

Technical Skills

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

2.2.1.1.6 Abnormal Arteriovenous Communications

Knowledge

- Know how to classify vascular malformations according to their clinical presentation and natural history. Understand the difference between endothelial proliferative disorders (haemangioma) and developmental lesions - arteriovenous malformations (AVM), low flow and lymphatic malformations
- Understand various classification schemes for vascular malformations
- Understand the role of interventional radiology 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
- Be able to arrange and interpret appropriate imaging studies to evaluate the extent and nature of vascular malformations. Understand that invasive vascular studies are rarely required in assessment
- Understand the typical MR appearances of low-flow and high flow malformations
- Understand the need for multidisciplinary management of patients with vascular malformations
- Understand the indication, contra-indications and complications of IR procedures
- Recognise the clinical presentation of congenital haemangioma and understand the limited 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
- Understand the clinical presentation of patients with high-flow vascular malformations and the indications for treatment and the possible complications
- Understand when patients with vascular malformations should be referred to large centres with concentrated experience in treating these patients
- 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 likely imaging findings

Technical Skills

- Demonstrate competence and understanding of the principles and agents used in treatment of high-flow vascular malformations
- Demonstrate competence in the techniques for treating high flow malformations e.g. direct injection of the nidus, use of tourniquets or balloon occlusion
- 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

2.2.1.1.7 Vascular Trauma

Knowledge

- Know the vascular anatomy, including anatomic variants
- Know the appropriate triage of patients suffering from blunt or penetrating trauma, with consideration of mechanism of injury and the patient's haemodynamic status

Clinical Skills

- Integrate laboratory data and haemodynamic parameters with knowledge of the location of injury, type of injury, and anatomic considerations in formulating an appropriate treatment algorithm for patients suffering from potential traumatic vascular injuries
 - Identify traumatic vascular injuries on CTA and arteriography, including active extravasation, pseudoaneurysm, arterio-venous fistula, arterial transection, traumatic occlusion, intimal flap, and intramural haematoma
 - 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**:
- Understand the roles of exploratory laparotomy and non-operative management in patients with traumatic hepatic injuries.
 - Identify and stage hepatic injuries on CT and angiography that may potentially be treated by transcatheter intervention, including active extravasation, hepatic artery pseudoaneurysm, arterio-venous fistula, or arterio-biliary fistula
 - List the indications and contraindications for hepatic artery embolisation
 - Be familiar with the success and complication rates for hepatic artery embolisation in patients with penetrating or blunt injuries to the liver
- With regard to blunt and penetrating injuries to the **spleen**:
- Understand the roles of exploratory laparotomy, splenectomy, and non-operative management in patients with splenic trauma
 - Be familiar with the complications of splenectomy, including the frequency of overwhelming sepsis
 - Identify and stage splenic injuries on CT and angiography that may potentially be treated by transcatheter intervention
 - List the indications and contraindications for splenic artery embolisation
 - Know of the different strategies for splenic artery embolisation
 - Know the success and complication rates for splenic artery embolisation in patients with splenic injury
- With regard to blunt and penetrating **renal** injuries:
- Understand the roles of operative and non-operative management of traumatic renal injuries
 - Identify and stage traumatic renal injuries on CT and angiography, including urinoma, arterial extravasation, renal artery pseudoaneurysm, arterial-venous fistula, and traumatic arterial dissection
 - List the indications and contraindications for renal artery embolisation in patients with renal trauma
 - Know the success and complication rates for renal artery embolisation in patients with renal trauma
- 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 embolisation strategies for pelvic haemorrhage, including both selective and non-selective (empiric) iliac artery embolisation
- Know the success and complications rates of pelvic embolisation, such as ischaemia, infarction, infection, non-targeted embolisation, impotence, and claudication

With regard to blunt and penetrating injuries to the **extremities**:

- Demonstrate competence in identifying various clinical findings of extremity arterial injury, such as pulse deficit, limb ischaemia, bruit, or expanding haematoma
- Understand the role of Doppler evaluation in patients with suspected arterial injury of the extremities
- Identify traumatic arterial injury on angiography, with a specific understanding of which vessels are expendable and potential candidates for transcatheter embolisation
- 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 selective catheterisation skills, including the use of microcatheters and guidewires
- Demonstrate familiarity with the various equipment used in arteriography, and embolisation, with specific understanding of the characteristics of the different embolic materials with regard to their speed and reliability of delivery, duration of occlusive effect, preservation of normal tissue, and level of blockade of the arterial tree
- Demonstrate competence in transcatheter embolisation techniques, including the delivery of various embolic materials such as coils, gelfoam, particulate material, and the use of stents or stent-grafts
- Demonstrate competence in the management of endovascular complications

2.2.1.1.8 Visceral Arterial Pathology

The trainee should be familiar with the aims of training in each of the subsections detailed.

Knowledge

- Know the anatomy relevant to visceral arterial pathology (see section below)
- Understand the epidemiology of visceral arterial pathology
- Understand the pathophysiology of visceral arterial pathology including atherosclerosis, arteritis, fibromuscular disease, trauma, entrapment syndromes

Gastrointestinal Tract Vascular Anatomy

- Name the three major branches of the abdominal aorta that supply the gastrointestinal tract. Identify their approximate origins in relationship to the vertebral column in order to aid in catheterisation
- Describe the most common branching patterns of the celiac axis and list common normal variants
- Identify the major branches of the splenic artery including the dorsal pancreatic artery, pancreatic magna artery, caudal pancreatic arteries, short gastric arteries and left gastroepiploic artery
- Identify the common hepatic artery, gastroduodenal artery, superior pancreaticoduodenal arteries, right gastroepiploic artery, proper hepatic artery, right and left hepatic arteries, supraduodenal artery, cystic artery, left gastric artery, and right gastric artery. Recognise common normal variants of these vascular territories
- Identify the superior mesenteric artery, inferior pancreaticoduodenal branches, jejunal branches, ileal branches, middle colic artery, right colic artery and the ileocolic artery. Recognise common normal variants
- Identify the inferior mesenteric artery, left colic artery, sigmoid arteries, and superior haemorrhoidal artery
- Discuss and be able to identify the following anastomotic arteries: marginal artery of Drummond, arc of Rioloan, arc of Buehler, arc of Barkow, meandering central anastomotic artery
- Recognise major branches of the mesenteric and portal venous systems
- Describe major portosystemic collateral venous systems and their significance in patients with portal hypertension
- List the major blood supplies to the oesophagus, stomach, duodenum, jejunum, ileum

Clinical Skills

- Be able to elicit the appropriate clinical history and physical examination
- Understand the complementary roles of the various imaging modalities in the assessment of visceral arterial disease
- Understand the range of treatment strategies including medical, endovascular and surgical alternatives sufficiently to be able to discuss management with patients and formulate appropriate treatment plans
- Describe angiographic techniques and catheters that may help in selective catheterisation of the visceral arteries
- List angiographic strategies for imaging the portal and mesenteric venous systems

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

- Know the potential aetiologies of acute and chronic gastrointestinal haemorrhage and the most frequently involved populations
- Know the pathophysiology of acute and chronic G-I haemorrhage

Clinical Skills

- Recognise the clinical presentations and relevant physical signs in acute and chronic gastrointestinal blood loss
- Understand and evaluate the potential medical, surgical and endovascular treatment options in acute and chronic gastrointestinal blood loss
- Integrate and direct the non-invasive imaging evaluation of patients with acute and chronic gastrointestinal blood loss including CT and nuclear medicine and recognise the utility of standard and capsular endoscopic studies
- Discuss the imaging strategies for the evaluation of a suspected aorto-enteric fistula including CT and angiography. Describe common scenarios for suspicion of aortoenteric fistulae
- Be able to interpret the imaging findings in patients with acute and chronic gastrointestinal blood loss including arterial extravasation within bowel, angiodysplasia, pseudoaneurysms and tumour circulation
- Understand the role of anticoagulants, vasodilators and thrombolytic agents in the complete evaluation of occult acute and chronic gastrointestinal blood loss
- Recognise the importance of collateral pathways in the evaluation and treatment of acute and chronic gastrointestinal blood loss
- Recognise the role of hepatic sources of haemobilia as a source of gastrointestinal blood loss

Technical Skills

- Demonstrate competence in the techniques and equipment used in embolisation for acute and chronic gastrointestinal blood loss including the use of co-axial systems, micro-catheters and coils
- Demonstrate a knowledge of the potential complications and preventative strategies
- Demonstrate competence in the management of complication including but not limited to vasospasm, arterial dissection, thrombosis, catheterisation failure (alternative access/catheters/guidecatheters), coil migration and malpositions

Visceral Artery Aneurysms

Knowledge

- Know and understand visceral artery anatomy and collateral pathways
- Know the aetiologies of visceral artery aneurysms and the most frequently involved populations
- Know and understand the differences in aetiology, pathophysiology and treatment strategies between true 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
- Understand and evaluate for an individual patient the potential medical, surgical and endovascular treatment options for visceral artery aneurysms and be able to discuss these with the patient
- Recognise the importance of collateral pathways in the treatment of visceral artery aneurysms
- Describe the cross sectional and angiographic findings in a patient with a visceral artery aneurysm including an assessment of the suitability for endovascular treatment with reference to:
 - Access vessels
 - Site of origin
 - Aneurysm neck size
 - Aneurysm size
 - Potential sacrificed territory for successful exclusion

Technical Skills

- Demonstrate competence in the techniques and the range of equipment used in embolisation and exclusion of visceral artery aneurysms
- Demonstrate a knowledge of potential complications and preventative strategies in the treatment of visceral artery aneurysms including management of the following:
 - Aneurysm rupture
 - Coil migration and displacement
 - Catheterisation failure

Mesenteric Ischaemia

Knowledge

- Know the arterial anatomy and requirements for a diagnosis of mesenteric ischaemia
- Know the aetiologies of acute and chronic mesenteric ischaemia and the most frequently involved populations

Clinical Skills

- Be able to take a relevant clinical history and elicit the relevant physical signs in acute and chronic mesenteric ischaemia
- Integrate and evaluate the non-invasive imaging of a patient with acute and chronic mesenteric ischaemia including Duplex US, MRA, CT
- 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
- Understand and evaluate the potential medical, surgical and endovascular treatment options for acute and chronic mesenteric ischaemia
- 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
- Understand the pre-procedural, intraprocedural and post-procedural pharmacological management of acute and chronic mesenteric ischaemia

Technical Skills

- Demonstrate competence in the angiographic techniques for the assessment of acute and chronic mesenteric ischaemia including:
 - The value of lateral aortography
 - Evaluation of collateral pathways
- Understand and evaluate suitability for endovascular treatment including:
 - Site of lesion
 - Length of lesion
 - Side branch involvement
 - Appropriate access routes
- Demonstrate competence in the techniques and equipment used in the endovascular management of acute and chronic mesenteric ischaemia. In particular
 - Plan appropriate access (route, guidecatheters, etc.)
 - Use of suitable stents/angioplasty equipment

- Demonstrate knowledge of the potential complications and their preventative strategies and competence in their management including
 - Catheterisation failure
 - In-situ thrombosis
 - Stent migration
 - Failure of angioplasty
 - Cholesterol embolisation

Vasculitis

Knowledge

- Know the anatomic distributions of disease in patients with vasculitis
- Know the aetiologies of vasculitis and the most frequently involved populations
- Know the pathophysiology of 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, Beurger's disease and Bechet's disease
- Understand the role of treatment options including medical therapy, surgery and endovascular therapy and expected outcomes
- Integrate and direct non-invasive imaging evaluation of patients with vasculitis in particular discuss the limitations of non-invasive imaging for the assessment of small vessel vasculitis

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

Visceral and Gastrointestinal Tumours

Knowledge

- Know the epidemiology and pathophysiology of benign and malignant gastro-intestinal tumours

Clinical Skills

- Understand the clinical presentations and relevant physical signs in the common gastrointestinal tumours including neuroendocrine tumours such as carcinoid tumours
- Know the imaging characteristics of these tumours
- Be familiar with the assessment and medical, surgical and endovascular treatment options for patients with these tumours

Technical Skills

- Demonstrate technical competence in the endovascular management of these tumours

Renovascular Disease

Knowledge

- Know the renal arterial anatomy
- Know the aetiology and risk factors for renovascular disease
- Know the pathophysiology of renovascular disease

Clinical Skills

- Be able to perform a directed clinical history and physical examination in patients with renovascular disease
- Understand and evaluate the potential medical, surgical and endovascular treatment options for a patient with renovascular disease
- Know the indications and the expected outcomes of percutaneous treatment of renovascular hypertension and ischaemic nephropathy including long-term patency rates
- Be able to evaluate non-invasive imaging in the work-up of patients with suspected renovascular disease including the advantages and limitations of Duplex, MRA, CTA and nuclear medicine studies
- 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
- Understand pre-procedural, intra-procedural and post-procedural pharmacologic management in patients undergoing percutaneous therapy for renovascular disease
- Understand the potential role for current and future treatment for restenosis in renovascular interventions

Technical Skills

- 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
- Know the types and rates of complications of renovascular interventions and demonstrate competence in the management of
 - Arterial dissection
 - In-situ thrombosis
 - Stent migration
 - Cholesterol embolisation
- 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

- Know the normal anatomy of the bronchial, intercostals and pulmonary arteries and the common normal variants of these vessels
- Know the aetiology and epidemiology of diseases affecting these arteries and the rate of pulmonary arterial involvement
- Understand the pathophysiology of diseases affecting these arteries

Clinical Skills

- Perform a directed history and physical examination in patients with haemoptysis
- Integrate and evaluate non-invasive imaging in the work-up of patients with haemoptysis including the advantages and limitations of chest radiography, CTA and bronchoscopy
- Understand the role of bronchial and pulmonary arterial embolisation for patients with recurrent haemoptysis

Technical Skills

- Recognise normal and abnormal arterial patterns seen in patients presenting with haemoptysis
- Recognise the artery of Adamkiewicz and its clinical significance
- Describe important potential collateral pathways from non-bronchial systemic arteries and pulmonary arteries
- Demonstrate competence in catheterising and embolising the bronchial and pulmonary arteries
- Demonstrate familiarity with the technique and equipment used in embolisation of these vessels
- Demonstrate knowledge of potential complications and their preventative strategies, including paraplegia, chest pain, oesophageal necrosis, and bronchial necrosis

2.2.1.1.9 Arterial Problems in Obstetrics and Gynaecology

Knowledge

- Know the arterial anatomy and collateral pathways
- Know the aetiology, epidemiology and pathophysiology of the following:
 - Uterine fibroids
 - Post-partum haemorrhage
 - Malignancy
 - Other indications, e.g. trophoblastic disease, uterine arteriovenous malformation, morbidly adherent placenta

Clinical Skills

- Be able to clinically assess, evaluate and advise regarding treatment options
- Direct and interpret imaging for patient selection, and specific issues regarding appropriate selection e.g. fibroid location, presence of adenomyosis, endocavitary lesions
- Demonstrate familiarity with informed consent issues, including specific reproductive/fertility/menopausal effects, symptom resolution, and comparison to standard O&G techniques, as well as the standard angiographic and embolisation risks
- Understand the presence of collateral blood flow between the uterus and the ovaries, and physiologic ramifications of embolisation in these territories
- Know the indications for uterine artery embolisation for the following patient groups:
 - Uterine fibroids
 - Post-partum haemorrhage
 - Malignancy
 - Other indications, e.g. trophoblastic disease, uterine arteriovenous malformation
- Be able to work in a multi-disciplinary team in the treatment and prevention of post partum haemorrhage
- Direct post-procedural imaging and appropriate laboratory evaluation
- Understand the principles of post-fibroid embolisation care with special attention to pain control and post-embolisation syndrome

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 UAE and their management

2.2.1.1.10 Vascular Interventional Oncology

(see section 2.2.2.5 for Non-Vascular Interventional Oncology)

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

Knowledge

- Know arterial anatomy with regard to:
 - the normal course and relationships of arteries so as to recognise displacement or potential for invasion by tumour
 - the blood supply to major organs and muscle groups with knowledge of potential collateral supply
 - 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
 - have knowledge of the use of ultrasound, CT and MR in the assessment of tumour vascularity and the role of these modalities in helping differentiate between benign and malignant lesions
- Understand the role of medical and surgical therapeutic options to embolisation
- Understand the staging and classification systems for correct patient classification e.g. Barcelona clinic liver cancer classification
- Work within a multidisciplinary team to optimise patient care
- Understand the potential objectives of arterial embolisation (e.g. palliation, cure, control of haemorrhage etc.)
- Have knowledge of common chemotherapeutic agents used in arterial chemotherapy
- Understand the indications for intra-arterial bland, chemoembolisation and radioembolisation
- 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

2.2.1.1.10.1 Vascular Management of Hepatic Malignancy

Knowledge

- Know the arterial anatomic variants which affect feasibility and safety of chemo/radio-embolisation
- Know the causes of cirrhosis and implications for therapy in patients with co-existing hepatic malignancy
- Have an understanding of tumour markers and their role in evaluating tumour response to therapy

Clinical Skills

- Perform a directed history and physical examination in patients with hepatic malignancy
- Consult with patients and their families regarding treatment options, risks and benefits of various interventional oncologic therapies for hepatic malignancy
- Understand available surgical and medical treatment options in patients with primary and metastatic hepatic malignancy
- Work within a multidisciplinary team to optimise patient care in this population
- Evaluate hepatic reserve using clinical and laboratory criteria and understand the impact on therapeutic options
- Categorise patients with cirrhosis according to their CHILD-PUGH status and Okuda classification and understand the implications for survival
- Identify tumour types that respond well to chemoembolisation and or radioembolisation
- Identify patients at high risk for infectious complications following chemo/radioembolisation and strategies to prevent them
- Understand pre-and-post procedure care for chemo/radio-embolisation patients
- Understand the role of various imaging studies (CT, MRI, PET and ultrasound) in diagnosis and staging of patients with hepatic malignancy and be able to integrate and interpret imaging

Technical Skills

- Know the indications and absolute and relative contraindications to chemo/radioembolisation
- Demonstrate technical competence in performing lobar, segmental and targeted embolisation therapy
- Be able to recognise potential complications and know how to manage them

2.2.1.2 Venous Disorders

Contents:

- **Peripheral venous disease including deep venous thrombosis, varicose veins**
- **Pulmonary Thromboembolic disease**
- **Superior and Inferior Vena Cava disease**
- **Portal and Hepatic venous interventions**
- **Gonadal venous interventions**
- **Central venous access**
- **Venous sampling**

2.2.1.2.1 Peripheral Venous Disease

Knowledge

- Know normal venous anatomy and major anatomic variants of clinical importance
- Know the anatomy of varicose veins and understand
 - Perforating veins
 - Lipodermatosclerosis
 - Phlegmasia cerulea dolens
- Describe the epidemiology and 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

Clinical Skills

- Be able to integrate, perform and interpret venous imaging including US, MR venography and catheter venography
- Be able to take a clinical history and perform a directed physical examination for 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 (or combined) insufficiency
- Describe the “CEAP” classification system of chronic venous insufficiency: clinical condition, aetiology, anatomic distribution and pathophysiology
- 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 treatment, stab avulsion, stripping and their relative merits
- Know the medical, surgical and endovascular treatment options for upper and lower limb venous thrombosis
- Understand the various devices and techniques available for thrombolysis and their indications and contra-indications

Technical Skills

- Demonstrate competence in common 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

2.2.1.2.2 Pulmonary Thromboembolic Disease

Knowledge

- Know the venous and pulmonary arterial anatomy and anatomical variants
- Know the aetiology and epidemiology of pulmonary thromboembolic disease

Clinical Skills

- Perform a directed history and physical examination in patients with thromboembolic disease
- Classify patients with acute and chronic thromboembolic disease based on history and physical as well as physiologic and imaging findings
- Integrate non-invasive imaging, and physical findings to plan management and assess extent of thrombus burden
- Know the indications for pulmonary angiography, pulmonary thrombectomy, catheter directed thrombolysis or mechanical thrombectomy and IVC filter placement
- Understand the medical, surgical and endovascular treatment options in these patients
- Know anatomical variants and pathology identified at inferior vena cavography that will affect the location of the IVC filter deployment
- List the indications and complications of pulmonary angiography, inferior vena cavography, vascular access, and IVC filter placement and their incidence as documented in the literature
- Understand preprocedural, intraprocedural and postprocedural pharmacological management for patients undergoing IVC filter placement including anticoagulation

Technical Skills

- Be familiar with a wide range of interventional equipment including guidewires, 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, 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

2.2.1.2.3 Disease of the Superior and Inferior Vena Cava

Knowledge

- Know the relevant venous anatomy and anatomical variants
- Know the epidemiology and pathophysiology of diseases affecting the SVC and IVC

Clinical Skills

- Perform a directed history and physical examination in patients with SVCO and IVCO
- Know the causes and clinical manifestations of SVC and IVC obstruction (SVCO and IVCO)
- Understand the potential advantages and limitations of various medical and surgical treatment options available for managing SVCO and IVCO including medical/surgical management, radiotherapy and radiological intervention
- Be able to integrate, perform and interpret imaging
- Know the clinical success rates and complication rates reported for SVC and IVC stenting in the current medical literature, comparing it to other treatment options

Technical Skills

- Demonstrate technical competence in the performance of SVC and IVCO treatment, including venous access, thrombolysis, balloon dilatation and stent placement
- Be familiar with the interventional equipment including guidewires, sheaths, catheters, balloons and various types of stents
- Recognise and manage intra- and post-procedural complications of SVC and IVC stenting

2.2.1.2.4 Portal and Hepatic Venous Interventions

2.2.1.2.4.1 Portal Venous Disease and Transjugular Intrahepatic Portosystemic Shunt (TIPS)

Knowledge

- Know portal venous anatomy and common portosystemic collateral pathways
- Know the epidemiology and pathophysiology of diseases involving the portal venous system
- Know the possible causes of extrahepatic portal vein stenosis, such as surgery, radiation therapy, and pancreatic disease
- Know the aetiologies and significance of prehepatic, intrahepatic, and posthepatic portal hypertension

Clinical skills

- Perform a history and physical examination in patients with liver disease and portal hypertension
- 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
- Be able to integrate, perform and interpret imaging
- Demonstrate a fundamental knowledge of chronic liver disease and its clinical manifestations
- Integrate patient clinical information into a classification scheme such as the Childs-Pugh score and MELD score.
- 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
- Know the clinical success rates, patency rates, and complication rates reported for TIPS in current medical literature, including data comparing TIPS to endoscopic and surgical treatment options
- 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
- Understand the potential advantages and limitations of various medical and surgical treatment options available for managing portal hypertension and its complications. This includes medical management, endoscopic interventions, and surgical by-pass procedures for patients with gastro-oesophageal bleeding
- List frequent surgical locations for the creation of porto-systemic shunts and be able to recognise them with angiography and CT-angiography
- Demonstrate knowledge of the clinical success rates, patency rates, and complication rates reported for TIPS in current medical literature, including data comparing TIPS to endoscopic and surgical treatment options
- Outline a strategy for TIPS surveillance using colour Doppler ultrasound and list expected shunt velocities in a patent shunt. Describe abnormal Doppler ultrasound findings that would lead to further shunt evaluation

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
- 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 technical competence in the performance of all procedural aspects of TIPS
- 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 knowledge of potential complications and their preventative strategies in the treatment of:
 - Venous laceration and bleeding
 - Shunt stenosis
 - 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

2.2.1.2.4.2 Hepatic Venous Disease and Budd-Chiari syndrome

Knowledge

- Know hepatic segmental anatomy, hepatic and portal venous anatomy and common portosystemic collateral pathways
- Know the epidemiology and pathophysiology of diseases involving the hepatic veins and causing hepatic venous outflow obstruction (Budd-Chiari syndrome)

Clinical skills

- Perform a history and physical examination in patients with known or suspected Budd Chiari syndrome
- 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
- Be able to integrate, perform and interpret invasive and non-invasive imaging
- Demonstrate a fundamental knowledge of liver disease and the clinical manifestations of hepatic 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 potential advantages and limitations of various medical and surgical treatment options available for managing Budd Chiari and its complications. This includes medical management, endoscopic interventions, and surgical by-pass procedures
- 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
- Know the indications and contraindications (relative and absolute) of TIPS

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

2.2.1.2.4.3 Preoperative Portal Vein Embolisation

Knowledge

- Know extrahepatic and intrahepatic portal venous anatomy as well as the segmental anatomy of the liver
- Know the epidemiology and pathophysiology of neoplastic diseases involving the liver which may benefit from portal vein embolisation (PVE) followed by liver surgery
- 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

- Perform a history and physical examination in patients with primary or secondary liver neoplastic disease
- Evaluate laboratory data in patients with primary or secondary liver neoplastic disease, with a specific understanding of liver function studies and other parameters useful in classifying neoplastic liver disease
- Be able to perform and interpret liver imaging in candidates for PVE
- Demonstrate a fundamental knowledge of the surgical strategies in the management of liver tumours and indications for portal vein embolisation in patients who are candidates for hepatic resection
- 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
- Know the clinical success rates, complication rates and liver regeneration rates reported for PVE in the current medical literature
- Know the absolute and relative contraindications for PVE
- 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
- Recognise and manage intra- and post-procedural complications of PVE including subcapsular haematoma, haemoperitoneum, haemobilia, AV fistula formation, and sepsis
- Demonstrate knowledge of clinical post-procedural management of patients undergoing PVE

2.2.1.2.5 Gonadal Venous Interventions

Knowledge

- Know the venous anatomy and variations of gonadal veins
- Know the epidemiology and pathophysiology of diseases affecting the gonadal veins

Clinical skills

- Be able to take a directed history and physical examination
- Be able to integrate, perform and interpret imaging investigations
- Understand informed consent issues, including specific reproductive/fertility/menopausal effects, symptom resolution, and comparison to standard genitourinary or obstetrics and gynaecology techniques, as well as the standard angiographic and embolisation risks
- Be able to identify proper indications and patient selection parameters for gonadal vein embolisation:
 - In males, varicoceles
 - In females, pelvic congestion syndrome
- Understand the principles of post procedure care, post gonadal vein embolisation

Technical Skills

- Demonstrate technical competence in performing venography and embolisation
- Be familiar with embolic agents and approaches used in embolisation of gonadal veins
- Be aware of complications and their management

2.2.1.2.6 Haemodialysis Access

Knowledge

- Know the anatomy relevant to haemodialysis fistulae
- Know the patho-physiology of arteriovenous access failure including failure of maturation of fistula, central venous stenosis, aneurysms and steal phenomena

Clinical Skills

- Be able to perform and interpret imaging appropriate for the pre-operative assessment of patients undergoing fistula formation, including conventional angiography, CT, MR and US
- 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)
- Know the anatomical locations and their preferred order of creation, of fistulae and synthetic grafts together with their expected outcomes
- 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 indications and contra-indications, preferred access sites and preferred duration of temporary haemodialysis catheters
- Understand the causes of catheter malfunction and the expected outcomes of intervention in malfunctioning catheters
- Have knowledge of the rationale, indications and contra-indications 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 indications and contraindications for peritoneal dialysis
- Understand the clinical aspects of the pre-operative work-up of patients for permanent haemodialysis
- 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)
- 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
- Have knowledge of the imaging techniques for the surveillance and detection of complications related to fistula formation and venous access
- 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, indications and contraindication 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, stentgrafting, thrombolysis, thrombosuction, mechanical thrombectomy and mechanical revision
- Be competent in techniques for haemostasis post fistula or graft salvage
- Know the expected outcomes and complications of these interventions
- Understand the advantages and disadvantages of the various techniques of 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

2.2.1.2.7 Central Venous Access

Knowledge

- Know the venous anatomy and other relevant anatomy of the neck, upper and lower limbs, chest and abdomen

Neck

- Outline the position of the external and internal jugular veins
- Know the relationship of the carotid artery, vertebral artery, subclavian artery, sternocleidomastoid muscle, apical pleura and vagus nerves to the jugular veins
- 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

- Know the anatomy of the cephalic, basilic, brachial, axillary and subclavian veins
- Outline the normal arterial and variant arterial anatomy of the upper limb and why this is relevant to upper limb venous access
- Describe the relationship of the upper limb veins to their accompanying nerves and arteries
- Know the relationship of the axillary and subclavian veins to the brachial plexus, lung pleura and adjacent arteries
- Describe preferred sites for placement of upper limb 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

- Describe the anatomy of the common femoral vein and the saphenofemoral junction
- Describe the anatomy of the femoral triangle

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
- Know the anatomy of the SVC, brachiocephalic, azygos, hemiazygos and intercostals veins
- Describe the anatomy of the SVC in relation to the pericardial reflection
- Describe the branches of the brachiocephalic veins
- Describe the anatomical variants of central venous anatomy

Abdomen

- Describe the anatomy of the iliac veins and IVC
- Describe the branches of the iliac veins and IVC
- Describe the anatomy of the translumbar route to the IVC and transhepatic approach to the hepatic veins
- Describe the anatomy of the hepatic venous system
- Describe the anatomical variants in iliac venous and IVC anatomy

Knowledge (cont)

- 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

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
- 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

2.2.1.2.8 Venous Sampling

Knowledge

- Know the normal and variant vascular anatomy relevant to venous sampling for endocrine disease with or without arterial stimulation testing
- Understand the pathophysiology of endocrine disease requiring functional investigations

Clinical skills

- Know the clinical presentation of endocrine disease requiring functional investigation and be able to perform a directed clinical history and physical examination
- Understand the use of provocative medication e.g. calcium, secretin
- Be able to interpret and integrate imaging
- 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 Intervention

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

- Demonstrate learning of the topic specific educational objectives
- Understand proper patient selection and therapeutic options for the interventional procedures described below
- Understand pre-procedure evaluation and post procedure management and follow-up for these procedures and patients
- Obtain complete and appropriate informed consent for all procedures
- Demonstrate technical competence in the performance of these procedures

2.2.2.1 Image-Guided Biopsy

Knowledge

- Have detailed knowledge of the anatomy relevant to the site of biopsy

Clinical skills

- Describe advantages and disadvantages of various imaging modalities in guiding biopsy of the chest, neck, abdomen, pelvis and musculoskeletal system
- Appropriately manage pre-procedure work-up including appropriate laboratory values
- Identify alternatives to percutaneous biopsy where suitable e.g. EUS (endoscopic ultrasound) guided biopsy for pancreatic and subcarinal masses
- List the indications and contraindications for transthoracic needle biopsy
- Recognise 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

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 and techniques including the use of CT fluoroscopy and various targeting technologies for difficult lesions
- Recognise patients at risk for post biopsy pneumothorax and apply techniques to reduce this risk if applicable
- 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

- Know the anatomy of the relevant organs, pleural and peritoneal spaces, significant anatomical variants and adjacent structures pertinent to:
 - understanding disease processes
 - planning interventional strategies
 - minimising, recognising and managing complications
 - assessing evolution of the collection after percutaneous drainage
- Understand the epidemiology of diseases associated with fluid collections and abscesses sufficient to aid diagnosis, understand disease progression and inform outcomes of interventions
- Be aware of intestinal perforations, focal infections (primary and secondary), acute pancreatitis, acute cholecystitis, and post operative surgical complications
- Understand the pathophysiology, evolution and the timing/indication for drainage of fluid collections

Clinical Skills

- Be able to elicit an appropriate clinical history, perform a physical examination and assess the patients overall clinical status with regard to the risks and benefits of intervention
- Assess appropriate laboratory investigations confirming clinical picture and procedural risks (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
- Demonstrate an understanding of the mechanisms, complementary roles and limitations of radiography, ultrasound, MRI, CT, and radionuclide scans relevant to the detection of focal 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
- Integrate a variety of imaging modalities (CT, US and fluoroscopy) to optimise percutaneous drainage of intra-abdominal abscesses
- Show an understanding of the advantages of CT guidance for deep seated/retroperitoneal disease and the practical advantages of ultrasound scanning whenever suitable
- Understand the advantages of CT fluoroscopy in accessing difficult fluid collections and placing drainage catheters
- Understand the clinical indications, relative and absolute contraindications and risk factors according to site, general patient factors and significant co-morbidities (e.g. describe the indications and contraindications of diagnostic aspiration of pleural fluid collections and percutaneous chest tube drainage of complicated pleural effusion/empyema)
- Assess complications including drain displacement, worsening sepsis, haemorrhagic complications, multiple organ dysfunction
- Attend and review the clinical progress of the patient
- Arrange and interpret appropriate post procedural imaging including sinograms
- 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

- Select the guiding imaging modality most suitable to the nature and site of the target collection
- 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 co-axial needles drainage catheters and guidewires for the purposes of percutaneous abscess drainage
- Demonstrate basic knowledge of chemical sclerotherapy techniques for pleurodesis
- Administer adequate sedo-analgesic regimens, i.v. hydration and antibiotic therapy for safe and comfortable interventional procedures
- Recognise and appropriately manage procedural complications
- Provide optimal follow-up care post percutaneous abscess drainage with post-procedural imaging and sinograms 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, Jejunostomy, Caecostomy)

Knowledge

- Know the relevant anatomy
- Understand the pathophysiology of patients requiring enteral tube placement

Clinical Skills

- Consider ethical factors prior to placement of enteral feeding access in this patient population
- Ensure adequate patient preparation
- Identify patients who may benefit from percutaneous gastrostomy, jejunostomy and caecostomy procedures and understand the basic principles of these procedure
- Know the indications and contra-indications of these procedures
- 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 co-ordinate care

Technical Skills

- Demonstrate technical competence in carrying out the procedures with selection of the most appropriate image guidance
- Recognise and treat complications including bleeding
- Ensure clear post-procedural instructions and pathways for tube care

2.2.2.3.2 Gastrointestinal Stenting

Knowledge

- Know the relevant anatomy
- Know the pathophysiology relevant to G-I obstruction
- Understand the natural history of benign and malignant upper and lower gastrointestinal strictures

Clinical Skills

- Be able to advise on the appropriate combination of pre-stent imaging procedures, including endoscopy
- Be able to diagnose, stage malignant disease and plan treatment based on plain film CT and MR imaging. 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
- 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
- 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 work-up 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, US, CT 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
- 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

- Know the anatomy of the liver, pancreas and biliary tree, significant anatomical variants and adjacent structures pertinent to understanding disease processes, planning interventional strategies, minimising, recognising and managing complications
- Know the epidemiology of HPB diseases, sufficient to aid diagnosis, understand disease progress and inform outcomes of interventions
- Know the pathophysiology of HPB disease

Clinical Skills

- Understand and recognise the common patterns and variety of presentations of HPB disease. Be able to elicit an appropriate clinical history, perform a physical examination and 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 colic
- 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 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 work-up in patients with benign and malignant biliary obstruction
- Understand the range of treatment strategies including medical, endoscopic, interventional and surgical alternatives to a level sufficient to discuss management with patients and formulate appropriate treatment plans

- Understand those strategies which may best be decided in a multidisciplinary forum
- 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
- Have an understanding of the mechanisms, complementary roles and limitations of US, MR, MRCP, ERCP, CT and radionuclide imaging investigations relevant to the detection of HPB diseases
- Discuss imaging strategies for patients with suspected HPB diseases including algorithms for jaundice, sepsis, cholangitis, biliary colic and non-specific presentations of suspected HPB malignancy
- Interpret pre-procedural imaging to produce an effective interventional strategy for relief of obstructive jaundice

Technical Skills

- Demonstrating an understanding of:
 - The advantage of the endoscopic approach to subhilar obstructions and stone disease at any level
 - 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
- Administer adequate sedo-analgesic regimens, hydration and sepsis risk for safe comfortable interventional procedures and describe and manage related complications
- Demonstrate skills in percutaneous transhepatic cholangiography and biliary drainage under a combination of fluoroscopic and ultrasound guidance
- 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
- Integrate biliary manometry in the management of patients with benign biliary strictures
- 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

2.2.2.5 Non-Vascular Interventional Oncology

2.2.2.5.1 Image-Guided Ablation (IGA)

- Hepatic Disease
- Renal Disease
- Lung Disease
- Skeletal Disease
- Other Disease Locations e.g. Prostate (cf section 2.2.3.5.4.1 page 80)

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

Knowledge

- An understanding of anatomic criteria for IGA in different locations
- Know the natural history of treated and untreated malignancy
- Understand the pathophysiological process in terms of vascular recruitment and tumour angiogenesis relevant to vascular and non-vascular intervention

Clinical Skills

- Elicit an appropriate clinical history, perform a physical examination and assess the patient's overall clinical status with regard to the risks and benefits of intervention
- Select and interpret appropriate laboratory and imaging investigations
- Understand the range of treatment strategies including medical, interventional and surgical alternatives and be able to balance and assess the relative merits of the various strategies and thereby select patients who will benefit from IGA
- Know and understand tumour staging
- Work within a multidisciplinary team to optimise patient care
- Recognise the differences between organs in terms of thermal and electrical conductivity which result in differences in ablation times and protocols

Technical Skills

- Plan optimal procedural access, patient positioning and relevant/optional image guidance methods. Be able to utilise multiple guidance methods if necessary
- Demonstrate competence in performing IGA
- Be able to use adjunctive procedures such as hydro dissection, CO₂ dissection etc. in order to optimise procedural outcome
- Be able to recognise adverse events promptly and be able to advise on appropriate medical, interventional radiological or surgical intervention
- Devise 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

Hepatic Disease

Knowledge

- Know mesenteric vascular anatomy. Understand variant hepatic vascular anatomy and intrahepatic segmental anatomy relevant to liver disease from the viewpoint of IGA and surgical resection
- 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 tumoral)
- Understand the alterations of hepatic anatomy caused by Budd Chiari syndrome, cirrhotic disease and large volume, indolent intrahepatic malignant disease

- Understand biliary anatomy and its bearing on targeted interventions
- 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 IGA, 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 incidence and prevalence of metastatic colorectal and neuroendocrine tumours with respect to the primary disease
- Understand the place of hepatocellular carcinoma within the disease spectrum of cirrhotic liver disease
- Recognise the incidence and progression of metastatic liver disease with respect to breast, lung and renal cancer and malignant melanoma. Thereby to understand the place of cytoreductive therapy in the overall management of the disease process
- 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
- Understand the evolution of hepatocellular carcinoma as part of the cirrhotic liver disease process. Understand the pattern of evolution of a nodule from pre-malignant lesions to fully developed HCC and understand vascular recruitment and tumour angiogenesis and their bearing on the choice of intervention

Clinical Skills

- Demonstrate skill in history taking and physical examination with reference to metastatic and primary malignant liver disease
- Describe the signs and symptoms of these disease processes
- Understand how previous liver and visceral surgery will bear upon proposed interventions in terms of altered anatomy, hypertrophic change, vascular insufficiency etc.
- Understand the mechanisms, complementary roles and limitations of US, MR, CT +/- angiography, and contrast-enhanced cross-sectional imaging relevant to the detection of liver malignancy
- Understand the roles of PET/CT and contrast agents used in imaging hepatic malignancy
- Understand FDG PET-CT tracer avidity in different disease processes
- 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
 - Metastatic neuroendocrine tumours (including gut carcinoid)
 - Other metastatic hepatic malignancy including breast, lung, kidney etc.
 - Hepatocellular carcinoma
- 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
- Understand the UICC TNM staging system in patients presenting with metastatic liver disease in terms of indications for treatment and have thorough knowledge of the clinical staging systems of HCC and cirrhosis (e.g. BCLC system, Child-Pugh class, MELD score, CLIP system and Okuda classification)
- 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 knowledge of current chemotherapeutic and radiotherapeutic regimes for different hepatic malignancies

- Understand the place of surgical management of liver disease by traditional resection or in combination with ablative therapies
- Understand the role of liver transplantation in patients with hepatocellular carcinoma and other hepatic malignancies
- Have an understanding of the relative merits of adjunctive treatments such as embolisation and chemoembolisation prior to IGA
- Plan optimal patient follow-up with imaging, laboratory tests and clinical evaluation in order to assess treatment success and detect disease recurrence or new lesions

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 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)
- Recognise that energy-based IGA in specific locations may cause injury to non-target areas, such as diaphragm, bowel, stomach and major bile ducts and know strategies to reduce these risks and so perform IGA with greater safety, better patient tolerance, and a reduced risk of treatment failures (e.g. technique of artificial ascites, bile duct cooling, artificial pneumothorax and separation of organs with CO₂)
- Be able to recognise intraoperatively and postoperatively the complications of IGA and undertake appropriate investigation and management of complications such as haemorrhage, infection and gastrointestinal perforation

Renal Disease

Knowledge

- Know normal and variant vascular and parenchymal anatomy of the kidney. In particular issues pertaining to tumour vascularisation and the potential for energy-based IGA techniques to cause vascular, pelvicalyceal, urethral or collateral organ injury
- Understand the incidence, prevalence and gender distribution of renal cancer. Have knowledge of syndromal diseases such as Von Hippel Lindau syndrome and other hereditary renal cancers where ongoing renal cancer management is an issue
- Understand the aetiology and clinical manifestations of renal cancer

Clinical Skills

- Be able to elicit a clinical history and physical examination relevant to renal cancer and assessment of patient fitness for proposed intervention
- Have an understanding of assessment for anaesthetic risk and patient performance status
- Be able to assess imaging and staging investigations performed for renal cancer. Understand the radiological features relevant to renal cancer and its differential diagnosis and to recognise the features which would influence proposed resection, ablation and other interventions
- Understand the strategies for medical management, palliative embolisation and image-guided ablation and partial or radical nephrectomy and the morbidity and mortality of these interventions
- Understand the complementary roles of medical, interventional radiological and surgical treatment strategies
- Recognise the prognostic implications of active surveillance of renal cancer in case of metastatic, small volume and indolent disease
- With the referring clinician, devise 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

Technical Skills

- Plan optimal procedural access, patient positioning and relevant/optional image guidance methods. Be able to utilise multiple guidance methods if necessary
- Demonstrate competence in using the current technologies for IGA
- Be able to use adjunctive procedures such as hydro dissection, CO₂ dissection, ureteral stenting etc. in order to optimise procedural outcome
- Demonstrate competence in the embolisation techniques used to modify tumour perfusion prior to kidney ablation or in case of haemorrhage caused by renal intervention
- Be able to recognise adverse events promptly and be able to advise on appropriate medical, interventional radiological or surgical intervention

Lung Disease

Knowledge

- Understand lobar and fissural anatomy and anatomical variants
- Understand pulmonary venous and arterial anatomy and bronchial arterial anatomy
- Understand segmental and lobar airway anatomy relevant to intervention
- Understand the relations of the lungs with other organs relevant to thermal ablation
- Understand the incidence and prevalence of the various types of primary lung carcinoma such as small cell and non-small cell (squamous, adenocarcinoma, large cell carcinoma, etc.)
- Understand the prevalence, incidence and prognostic significance of common lung metastases such as breast, kidney, thyroid, testis, colorectal and lung and the relevance of any proposed image-guided ablation in these cases
- Know causes and evolution of lung carcinoma, small cell and non-small cell

Clinical Skills

- Be able to elicit an appropriate clinical history and perform a relevant clinical examination prior to intervention
- Recognise features of progressive and metastatic disease which would guide appropriate therapy
- Determine cardiorespiratory reserve and performance status with regards to the proposed intervention. Understand the need for assessment of anaesthetic risk and patient performance status
- Select and interpret appropriate laboratory and imaging investigations relevant to patients with lung malignancy prior to intervention
- Understand the UICC TNM staging classification of lung carcinoma and its relevance to therapy
- Determine radiological staging by CXR, CT, PET and MR where necessary
- Be able to explain the appropriateness of intervention to the patient in light of the staging of the disease
- Understand the range of treatment strategies for primary lung carcinoma including chemotherapy, radiotherapy, the relevance of surgical resection according to TNM staging and the role of image-guided ablation
- Discuss with the anaesthetist the need for sedation versus general anaesthesia and understand the advantages of each technique
- Assess the patient during and following image-guided ablation and other cancer therapies. Be able to determine patient fitness for discharge and elicit complications following intervention
- 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
- Understand the role of PET/PET-CT before and after IGA of lung malignancy

Technical Skills

- Plan optimal procedural access, patient positioning and relevant/optional image guidance methods. Be able to use separation techniques to help create a buffer zone between tumour and neighbouring vital structures such as pleura, mediastinum and diaphragm (e.g. artificial pneumothorax)
- 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
- Be able to recognise intraprocedural pneumothorax or haemorrhage as soon as feasible and be able to establish appropriate management by aspiration or placement of a chest tube or embolisation

Musculo-skeletal Disease

Knowledge

- Know the anatomy of long bones, pelvic bones and spine and their relation to surrounding muscle, soft tissues, vascular structures, nerves and neighbouring organs
- Know vertebral anatomy, especially spinal fluoroscopic anatomy, and its bearing on proper vertebral body access techniques
- Understand the incidence and prevalence of the various types of primary bone tumours which may benefit from IGA
- Understand the prevalence, incidence and prognostic significance of common bone metastases such as lung, breast, colorectal, kidney and thyroid, and the potential role of IGA in these cases
- Recognise the progressive features of bone metastases in the appropriate clinical setting, depending on the type and stage of primary tumour

Clinical Skills

- Be able to elicit an appropriate clinical history and perform relevant clinical examinations prior to intervention
- Recognise features of progressive and metastatic disease which would guide appropriate therapy
- Understand the need for assessment of anaesthetic risk and patient performance status
- Select and interpret appropriate laboratory and imaging investigations relevant to patients with skeletal neoplasms prior to intervention
- Be able to explain the appropriateness of intervention to the patient with metastatic disease in the light of staging of the disease and the purpose of pain palliation
- Know the indications and contraindications to IGA according to type and extent of disease and lesion location
- Be able to recognise and explain risk and therapeutic options to patients in these disease settings
- 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 able to place oncologic and palliative interventions for metastatic disease in their appropriate clinical place alongside medical treatment, radiotherapy and surgical interventions
- Be aware of new and evolving technologies for the treatment of primary and secondary bone neoplasms
- Devise, with the referring clinician, a plan for patient follow-up with imaging, laboratory tests and clinical evaluation. Understand the role of a VAS score in evaluating the response of pain to IGA of bone lesions

Technical Skills

- Plan optimal procedural access, patient positioning and relevant/optional image guidance methods
- Understand adjunctive interventions e.g. embolisation, that can be performed to improve the outcome of image-guided ablation
- Discuss with the anaesthetist the need/advantages of sedation, spinal anaesthesia, regional nerve block or general anesthesia according to the type of procedure planned, the site and extent of disease
- Be able to use separation techniques to help create a buffer zone between tumour and neighboring vital structures (e.g. hydrodissection or dissection with CO₂)
- Recognise bone lesions at risk of fracture and understand when to combine IGA with cementoplasty in order to provide additional structural support
- Be able to recognise intraprocedural and postprocedural complications and arrange interventional radiological management if appropriate
- 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

Other Disease Locations

Many of the patient management processes regarding IGA apply generically to malignancy at other sites. Please see section 2.2.3.5.4.1 on page 80 for management of prostate cancer

2.2.3 Intervention of the Genito-Urinary Tract and Renal Transplants

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

Knowledge

- Know the normal and variant calyceal and vascular radiological anatomy of the upper renal tract
- Know the normal and variant ureteric and bladder anatomy (including post-cystectomy or post bladder augmentation)
- Know the anatomy of the various retroperitoneal spaces
- Know the radiological and glandular anatomy of the prostate gland
- Know the surgical and radiological anatomy of renal transplants
- Be familiar with the risk factors and epidemiology of the common GU disorders:
 - Renal stone disease
 - Urinary tract cancers
 - Benign tumours and cysts
 - Male and female infertility
 - Renal failure, replacement therapy and transplantation
- Understand the causes and the pathophysiology of the common GU disorders; in particular the causes, risk factors and pathology of renal stone disease and the common urinary tract cancers
- 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 carry out a problem-orientated clinical, radiological and biochemical evaluation of the genito-urinary tract

- 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 the use and limitations of the various radiological modalities for the diagnosis and planning of renal stone management
- Understand the role of CT and MR for the investigation of the common urinary tract cancers and their complications. The role of imaging in the diagnosis and evaluation of the renal mass and its place in the planning of imaging-guided therapy
- Understand the role of angiography, Duplex US, CTA and MRA for the evaluation of renovascular disorders and transplant dysfunction
- 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
- Be able to discuss the likely outcome and complications of the proposed intervention procedure and the alternative surgical or medical options

Technical skills

- Demonstrate competence in planning and performing interventional procedures applicable to the genito-urinary tract and renal transplants Recognise and manage any complications that may occur

2.2.3.1 Pelvicalyceal and Ureteric Obstruction

Knowledge

- Know the normal anatomy of the pelvicalyceal system and ureter with particular detail of the calyceal anatomy
- Know the common normal anatomical variants and congenital anomalies of the pelvicalyceal system, ureter and bladder
- Know the vascular anatomy of the kidney and common variants
- Know the anatomical relations of adjacent organs and structures, the common anatomical variations, changes with respiratory phases and patient positioning
- Understand the causes of pelvicalyceal and ureteric obstruction and how they impact on planning interventions

Clinical Skills

- Understand the clinical presentation and physical signs associated with upper urinary tract obstruction
- Describe the various modalities for the diagnosis of pelvicalyceal and ureteric obstruction
- Integrate and interpret the pre-procedural evaluation including laboratory and imaging investigations and pharmacological management of patients requiring urological intervention
- Demonstrate knowledge and understanding of patient selection
- Demonstrate knowledge of alternative therapeutic options, including retrograde, rendezvous procedures and endourological interventions
- Demonstrate knowledge and competence in the use of sedation and analgesia for optimum patient comfort and tolerance
- Discuss the use of prophylactic antibiotics in urological intervention
- Demonstrate understanding of the alternative endourological procedures available, with reference to the advantages and disadvantages, complications and outcomes
- Understand the clinical follow-up of patients following interventional procedure

Technical Skills

- Demonstrate understanding 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
 - Dilators and sheaths (including peelaway sheaths)
 - Manipulation catheters
 - Drainage catheters and various locking mechanisms available
- Demonstrate competence in performing percutaneous nephrostomy and ureteric interventions (see below)
- Demonstrate competence in managing complications

Percutaneous Nephrostomy Insertion

- List the indications for nephrostomy insertion
- Understand the technical aspects for diagnostic evaluation of pelvicalyceal and ureteric obstruction
- Describe the indications for antegrade puncture of the pelvicalyceal system
- List the relative and absolute contraindications for nephrostomy insertion
- 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
 - 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 CO₂ 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
- List the types and rates of complications of nephrostomy insertion and their management
- Be technically competent in performing percutaneous nephrostomy insertions
- 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.)
- Understand the expected outcomes for percutaneous nephrostomy insertion
- 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

- List the indications for antegrade ureteric stent insertion
- List the contraindications to 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, peelaway sheath and covering nephrostomy drainage catheter types
- List the types and rates of complications of antegrade ureteric stent insertion and their management
- Understand the expected outcomes for antegrade ureteric stent insertion
- Demonstrate knowledge of follow up of patients with a ureteric stent

Retrograde Ureteric Stent Insertion

- List the indications for retrograde ureteric stent insertion
- List the contraindications for 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
- List the types and rates of complications of retrograde ureteric stent insertion and their management
- Understand the expected outcomes for a retrograde ureteric stent insertion
- Know the percutaneous and endoscopic techniques for retrograde ureteric stent exchange

Ureteric Balloon Dilatation

- List the indications for ureteric balloon dilatation
- Demonstrate competence in the technique of balloon dilatation
- Understand the expected outcomes for balloon dilatation
- List the complications of balloon dilatation and their management

Ureteric Therapeutic Occlusions

- List the indications for occluding the ureter
- 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
- Understand the expected outcomes and complications

2.2.3.2 Renal Stone Disease

Knowledge

- Understand the aetiological and epidemiological factors influencing stone formation (geographical, dietary, inhibitors and promoters of crystallisation, stasis, dehydration, infection, metabolic factors)
- Understand stone structure and composition

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 the different imaging modalities used in demonstrating stones and their limitations
- Understand the indication for each modality (diagnosis, planning, follow up)
- Understand and list the different management options
- Understand and list the factors affecting the choice of management options (presentation, size, site, anatomical, ...)
- Understand planning of safe access sites to treat stones in different calyces
- Understand the indications for conservative management and importance of follow up
- Understand the indications and contra-indications of extracorporeal shock wave lithotripsy (ESWL), ureteroscopy and percutaneous nephrolithotomy (PCNL), laparoscopic and open surgery in the management of renal stone disease and their complications
- Understand the rationale for follow up and its routines
- Understand the use of different imaging modalities for follow up

Technical skills

- Be familiar with all instruments used to establish a percutaneous track
- Demonstrate competence in handling needles, guide wires 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 normal anatomy of the kidney, adjacent relations, perirenal spaces and routes of spread of disease
- Know the incidence and classification of solid and cystic renal mass lesions
- Know the underlying aetiology of common perirenal collections

Clinical skills

- Understand the clinical presentation of, and physical findings in, patients with renal masses and perirenal collections
- Understand the indications for percutaneous intervention in patients with a solid renal mass, cystic renal mass and perirenal collections
- Integrate and interpret imaging modalities to facilitate successful drainage
- Understand the pre-procedure work-up of patients undergoing drainage and biopsy procedures, including laboratory examinations
- Understand the clinical indications and contraindications for renal biopsy
- 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
- Demonstrate competence in the management of significant complications following percutaneous biopsy
- 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 Renal Tumours

(cf Sections 2.2.1.1.10 page 51 and 2.2.2.5.1 page 68)

Knowledge

- Know the vascular anatomy of the kidney
- Know the incidence, and types of benign and malignant renal tumours
- Understand the biology of renal tumours with reference to their routes of spread (direct and metastatic) and growth
- Understand the natural history and patterns of response of tumours suitable for embolisation or ablation

Clinical Skills

- Be able to interpret the various imaging modalities for the diagnosis and classification of renal tumours
- Demonstrate knowledge of the various surgical (including nephron sparing and laparoscopic techniques) and medical options available for the management of renal tumours
- Demonstrate knowledge of the advantages and disadvantages of surgical, medical and interventional radiological techniques, including morbidity, mortality and outcomes
- Understand the role of embolisation and ablation in the management of patients with renal tumours (benign and malignant)
- Demonstrate knowledge of the clinical indications for renal tumour embolisation or ablation
- Describe the pre-procedural evaluation including laboratory investigations, imaging and pharmacological management
- Understand the different types of embolic agents available and the advantages and disadvantages for their use in renal tumour embolisation
- Understand the outcomes of renal tumour embolisation
- Understanding of the management and follow-up of patients following renal tumour embolisation
- Understand the role for the embolisation of renal tumour metastasis
- Understand the indications for primary embolisation, pre-operative and post operative embolisation
- Understand the indications for renal tumour ablation

Technical Skills

- Demonstrate knowledge in selecting the correct equipment for embolisation or ablation
- Demonstrate technical competence in performing renal tumour embolisation and ablation
- List the risks and complications related to embolisation and ablation
- Understand the management of complications relating to tumour embolisation and ablation
- Demonstrate knowledge of new and novel techniques for the use in renal tumour embolisation or ablation

2.2.3.5 Genito-Urinary Interventions

2.2.3.5.1 Gonadal Venous Interventions

(see section 2.2.1.2.5 page 58)

2.2.3.5.2 Fallopian Tube Obstruction

Knowledge

- Know the anatomy and pathophysiology relevant to fallopian tube interventions
- Understand the aetiology of fallopian tube occlusion

Clinical skills

- Be able to make the clinical and radiological diagnosis of fallopian tube obstruction
- Understand the postulated role of fallopian tube obstruction in infertility
- Know the evidence base for the role of the treatment of fallopian tube obstruction
- Know the surgical and radiological treatments for the treatment fallopian tube obstruction and their relative merits and be able to discuss these with your patient
- Describe the expected clinical outcome and the short term and long term morbidity

Technical Skills

- Demonstrate technical competence in performing hystero-salpingography
- Demonstrate technical competence in fallopian tube recanalisation by being able to choose
 - Choose and discuss the choice of equipment
 - Describe the hazards and how to minimise and deal with complications

2.2.3.5.3 Male Infertility

Knowledge

- Understand the anatomy of the male reproductive system
- Understand the congenital and acquired conditions associated with male infertility

Clinical Skills

- Understand and acquire the ability to interpret the imaging modalities used (TRUS, MRI)

Technical Skills

- Be competent to carry out contrast studies to demonstrate patency of the reproductive system
 - Seminal vesiculography
 - Vasography

2.2.3.5.4 Prostate

2.2.3.5.4.1 Prostate Cancer

Knowledge

- Understand zonal and vascular anatomy of the prostate gland
- Understand the pathophysiological processes affecting the prostate
- Understand the incidence and aetiology of prostate cancer

Clinical Skills

- Understand the clinical presentation of prostate cancer and importance of PSA, DRE and prostate biopsies
- Be able to perform and interpret the imaging modalities used in prostate disease for diagnosis, staging and follow up (TRUS, CT, MRI, PET)
- Acquire the necessary competence to perform and interpret transrectal ultrasound (TRUS)
- Be familiar with the different probes and needles/biopsy devices used for biopsies (TRUS-guided)
- Understand the triaging of patients presenting with high PSA
- Understand the management of prostate cancer and different treatment modalities and be involved in the appropriate MDT meetings
- Be familiar with the set-up and role of the interventional radiology in brachytherapy
 - Understand the indications and limitations of brachytherapy
 - Understand and list the complications of brachytherapy
 - Have a good knowledge of follow-up protocols

- Be familiar with the setup and role of interventional radiology in High Intensity Focused Ultrasound (HIFU)
 - Understand the indications and limitations of HIFU
 - Understand and lists the complications of HIFU
 - Have a good knowledge of the follow up protocols
- Be familiar and understand other minimally invasive treatment modalities (cryotherapy, laser)
- Have a good understanding of the surgical procedures and indications for post-operative imaging
- Have a good understanding of hormonal treatment as well as the management of advanced disease
- Have a good understanding of the indications and methods of external beam radiotherapy

Technical Skills

- Acquire the necessary competence to carry out TRUS-guided prostate biopsies according to local protocols
- Understand and list the complications of the procedure and how to avoid them
- Demonstrate competence in performing prostate ablation therapies

2.2.3.5.4.2 Prostatitis (Abscess)

Knowledge

- Understand the pathology of prostatitis
- Understand the aetiology of prostatitis

Clinical Skills

- Understand the clinical presentations
- Be able to interpret the imaging modalities
- Be familiar with methods of diagnosis of prostate abscess

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)
- Understand the complications of prostate abscesses and drainage

2.2.3.5.5 Priapism

Knowledge

- Know the normal and variant vascular anatomy of the male pelvis
- Understand the postulated mechanism of both high and low flow 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
- 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
 - Describe the hazards and how to minimise and deal with complications

2.2.3.6 Renal Transplant Interventions

Knowledge

- Know the anatomy relevant to transplant kidneys
- Understand the various late and early causes of transplant dysfunction
- The radiological evaluation of transplant dysfunction
 - Be able to discuss the role and limitations of Grey scale and Doppler ultrasound, scintigraphy, CTA, MRA, catheter angiography and intra-arterial pressure measurement in the evaluation of renovascular 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
- 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
 - Understand the indications and complications of surgical intervention
 - 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
- Demonstrate competence in managing vascular complications
- 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

2.2.3.7 Renal Artery Sympathetic Denervation

Knowledge

- Understand the anatomical distribution of the sympathetic nerves in the renal artery
- Know the pathophysiology of hypertension
- Know the anatomical indications for renal artery sympathetic denervation using different devices
- Understand the rationale for this therapy

Clinical Skills

- Understand the clinical outcomes of this treatment
- Be able to instigate and interpret imaging investigations to assess suitability
- Be able to discuss treatment options with your patient

Technical Skills

- Be familiar with the devices for ablation and how they differ
- Demonstrate competence in renal artery catheterisation and manipulation
- Be competent in limiting and managing complications

2.2.4 Interventional Radiology of the Musculoskeletal System

2.2.4.1 Image-guided Biopsy

Knowledge

- Know the detailed bone and soft tissue anatomy of the region being biopsied

Clinical Skills

- 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
- 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 contra-indications for bone/ST biopsy.
- Be aware of the consequences of inappropriate biopsy of primary bone/ST sarcomas
- Appropriately manage pre-procedural work-up 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 CT fluoroscopy 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 labeling 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

(see section 2.2.2.5.1 page 68)

2.2.4.3 Intra-articular Injections under Image Guidance

Knowledge

- Know articular anatomy
- Understand the pathophysiology and aetiology of joint disease

Clinical Skills

- Be able to take a directed history and physical examination
- Be able to integrate and interpret imaging
- Be able to identify the articulation to be injected and the planned percutaneous approach
- Demonstrate knowledge of appropriate imaging for guidance of the selected access techniques
- Know the indications and contra-indications
- Understand the possible surgical options for the patient

Technical skills

- Demonstrate competence in both diagnostic and therapeutic image-guided injections
- Understand the pharmacological agents to inject for diagnostic or therapeutic purposes
- List the absolute and relative contra-indications, as well as complications associated with intra-articular injections

2.2.4.4 Percutaneous Osteoplasty

Knowledge

- Know the anatomy relevant to peripheral osseous structures
- Understand the pathophysiology of neoplastic disease as it relates to peripheral osseous structures

Clinical Skills

- Integrate and interpret non-invasive testing (CT, MRI, Radionuclide Scintigraphy), physical findings and past surgical history to identify proper target areas and lesions
- Select patients with peripheral bone lesions who will benefit from osseous augmentation
- Identify the indications for percutaneous osteoplasty in patients with benign and malignant lesions and understand the medical and surgical options in these patients
- Categorise these patients as to their appropriateness and expected response to treatment with percutaneous techniques
- Identify patients who may benefit from combination of osteoplasty and ablation techniques
- List the absolute and relative contra-indications to percutaneous osteoplasty
- List the complications of percutaneous osteoplasty and their incidence as documented in the literature
- Understand the role of an anaesthetist/sedationist during percutaneous osteoplasty

Technical Skills

- Demonstrate knowledge of proper osseous access techniques
- 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
- Understand pre-procedural, intra-procedural and post-procedural pharmacological management for patients undergoing percutaneous osteoplasty including conscious sedation, narcotic and non-narcotic allergies
- Understand when percutaneous osteoplasty can be combined with other minimally invasive techniques of ablation (thermal and cryo-ablation) aiming for cure or palliation. In these cases of combined treatments, one should be familiar with all protective measures (including active and passive thermoprotection by means of air or CO₂ injection, thermocouples, evoked potentials, etc.)

2.2.4.5 Spinal Intervention

2.2.4.5.1 Interventions in Vertebral Body Compression Fractures (VBCF)

Knowledge

- Know the anatomy of the spine and adjacent structures
- Understand the pathophysiology of osteoporosis, haemangioma and neoplastic disease as it relates to the spine
- Be familiar with the pathophysiology of traumatic fracture as it relates to the spine

Clinical Skills

- Integrate non-invasive testing (CT, MRI, Radionuclide Scintigraphy), physical findings and past surgical history to identify symptomatic levels
- Appropriately identify patients with symptomatic VBCF
- Know the indications for percutaneous vertebroplasty (PV) in patients with VBCF and understand the medical and surgical options in these patients
- Categorise VBCF as to their appropriateness and expected response for treatment with percutaneous techniques
- Identify patients who may benefit from kyphoplasty and the differences between kyphoplasty and vertebroplasty
- 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
- List the complications of these techniques and their incidence as documented in the literature for VBCF secondary to osteoporosis and neoplastic spinal involvement
- List the absolute and relative contra-indications
- Understand pre-procedural, intra-procedural and post-procedural pharmacological management for patients undergoing these techniques including constant sedation, narcotic and non-narcotic allergies
- Understand the role of an anaesthetist/sedationist

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-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 cryo- ablation)
- 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 CO₂ injection, thermocouples, evoked potentials, etc.)

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

- Demonstrate appropriate knowledge of spinal anatomy and spinal fluoroscopic anatomy
- Understand the pathophysiology and aetiology of various spinal pain syndromes including discogenic pain, facet joint syndrome, spinal stenosis and nerve root impingement

Clinical Skills

- Perform a directed history and physical exam in patient with back pain and/or radicular pain
- Be able to direct and interpret imaging
- Integrate non-invasive testing (CT, MRI, Radionuclide Scintigraphy), physical findings and part surgical history to plan appropriate treatment strategies
- Appropriately identify patients with spinal pain syndrome
- Identify the indications for spinal injection procedures on patients with back pain and/or radicular pain
- Understand the medical and surgical treatment options in these patients
- List the complications of spinal injection procedures and their incidence as documented in the literature
- List the absolute and relative contra-indications 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
- Understand pre-procedural, intra-procedural and post-procedural pharmacological management for patients undergoing spinal injection procedures including conscious sedation, narcotic and non-narcotic analgesics
- Demonstrate appropriate knowledge of steroids and anesthetics used in spinal injection procedures

Acronyms

ALARA	As Low As Reasonably Achievable
ASA Score	American Society of Anaesthesiology
AUS	Antegrade Ureteric Stenting
AVM	Arteriovenous Malformation
BP	Blood Pressure
canMEDS	Canadian Medical Education Directives for Specialists
CBD	Common Bile Duct / Case-based Discussion
CEAP score	Clinical severity Etiology Anatomy Pathophysiology
CIN	Contrast Induced Nephropathy
CME	Continuing Medical Education
CT	Computed Tomography
CTA	Computed Tomographic Angiography
CVA	Cerebro-Vascular Accident
CXR	Chest X-Ray
DSA	Digital Subtraction Angiography
DOPS	Direct Observation of Practice and Procedures
DOQI	Dialysis Outcomes Quality Initiative (US National Kidney Foundation)
DRE	Digital Rectal Examination
DRL	Diagnostics Reference Levels
DVT	Deep Vein Thrombosis
DWI	Diffusion Weighted Imaging
EBIR	European Board of Interventional Radiology
ERCP	Endoscopic Retrograde Cholangio-Pancreatography
ESIR	European School of Interventional Radiology
ESWL	Extracorporeal Shock Wave Lithotripsy
EU	European Union
EUS	Endoscopic Ultrasound
FDG	Fluorodeoxyglucose
FLR	Future Liver Remnant
Gd-BOPTA	Gadobenate dimeglumine (Contrast agent)
Gd-EOB	Gadolinium Ethoxybenzyl (Contrast agent)
GI	Gastro-Intestinal
GU	Genito-Urinary
HCC	Hepato Cellular Carcinoma
HIFU	High Intensity Focused Ultrasound
HPB	Hepato-Pancreatico-Biliary
IGA	Image-Guided Ablation
IVC	Inferior Vena Cava
IVCO	Inferior Vena Cava Obstruction
KAP	Kerma Area Product
MDT	Multi-Disciplinary Team
MELD score	Model for End-stage Liver Disease
MRA	Magnetic Resonance Angiography
MRCP	Magnetic Resonance Cholangio-Pancreatography
MRI	Magnetic Resonance Imaging
MRSA	Methicillin-Resistant Staphylococcus Aureus
NIHSS	National Institute of Health Stroke Scale
ODA	Operating Department Assistant
OSCE	Objective Structured Clinical Examination
PAD	Peripheral Arterial Disease

PAN	Polyarteritis Nodosa
PAT	Peer Assessment Tools
PBA	Procedural Based Assessment
PCNL	Percutaneous Nephrolithotomy
PET	Positron Emission Tomography
PICC	Peripherally Inserted Central Catheter
PSA	Prostate Specific Antigen
PV	Percutaneous Vertebroplasty
PVE	Portal Vein Embolisation
QA	Quality Assurance
RUS	Retrograde Ureteric Stenting
SFA	Superficial Femoral Artery
SOP	Standard Operating Procedure
ST	Soft Tissue
SVC	Superior Vena Cava
SVCO	Superior Vena Cava Obstruction
SVS/ISCS	Society of Vascular Surgery/International Society of Cardiovascular Surgery
TICI	Thrombolysis in Cerebral Infarction
TIPS	Transjugular Intrahepatic Portosystemic Shunt
TNM	Tumour Lymph Nodes Metastasis
TOS	Thoracic Outlet Syndrome
TRAS	Transplant Renal Artery Stenosis
TRUS	Transrectal Ultrasound
UAE	Uterine Artery Embolisation
UFE	Uterine Fibroid Embolisation
UICC-TNM	International Union Against Cancer Classification of Malignant Tumours
US	Ultrasound
VBCF	Vertebral Body Compression Fractures
VC	Vena Cava

