

# European Curriculum and Syllabus for Interventional Oncology

First Edition

Supplementary  
knowledge regarding  
Interventional Oncology  
for Interventional  
Radiologists



March 2019

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The European Curriculum and Syllabus for Interventional Oncology was created based on the foundation established in the European Curriculum and Syllabus for Interventional Radiology and is meant to be used as a supplementary companion document for specialisation in interventional oncology

### European Curriculum and Syllabus for Interventional Oncology

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

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# The European Curriculum and Syllabus for Interventional Oncology

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## European IR Societies

APRI – Portuguese Society of Interventional Radiology  
BSR – IR Section of the Belgian Society of Radiology  
BSIR – British Society of Interventional Radiology  
DeGIR – German Society of Interventional Radiology and Minimally-Invasive Therapy  
GSIR – Greek Society of Interventional Radiology  
HSCIR – Hungarian Society of Cardiovascular and Interventional Radiology  
IESIR – Italian European Society of Interventional Radiology  
NVIR – Dutch Society of Interventional Radiology  
NFIR – Norwegian Society of Interventional Radiology  
OEGIR – Austrian Society of Interventional Radiology  
SIRS – Serbian Society of Interventional Radiology  
SERVEI – Spanish Society of Vascular and Interventional Radiology  
SSVIR – Seldinger Society of Vascular and Interventional Radiology  
SSVIR – Swiss Society of Vascular and Interventional Radiology  
TGRD – Turkish Society of Interventional Radiology

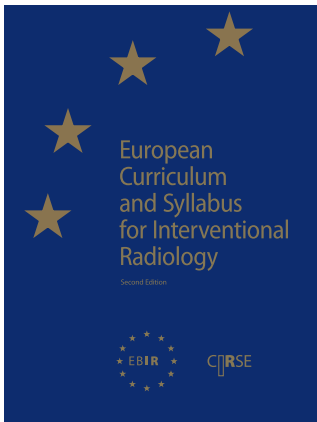
## IR Societies Outside of Europe

IRSA – Interventional Radiology Society of Australasia  
SoBRICE – Brazilian Society of Interventional Radiology and Endovascular Surgery  
CAIR – Canadian Association for Interventional Radiology  
GACIR – Georgian Association of Cardiovascular and Interventional Radiology  
ISVIR – Indian Society of Vascular and Interventional Radiology  
ESIR – IR Division of the Iranian Society of Radiology  
MYSIR – Malaysian Society of Interventional Radiology  
KSIR – Korean Society of Interventional Radiology  
SIDI – Sociedad Iberoamericana de Intervencionismo/Iberoamerican Society of Interventional Radiology

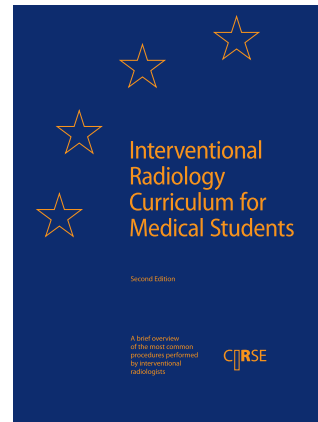
## Education | Knowledge | Certification

CIRSE is committed to furthering IR education by helping establish structured training guidelines and setting solid and reliable standards for those performing IR procedures. Find out about our other curricula in addition to this one, discover our learning resources to support continuing education and the option of certifying your IR expertise.

### Curricula



A standardised guideline for training that covers an array of general IR topics and safety concepts with which a well-trained interventional radiologist should be familiar.



A concise and structured overview of the most common clinical conditions in IR, raising awareness among medical students of the ever-increasing role of IR in hospital medicine.

### Learning Resources

## CIRSE library

Includes lectures and presentations from CIRSE live educational events that can be accessed individually or as part of topic packages put together by top experts in the field.

## CIRSE academy

Online courses that cover essential topics of IR. All courses are CME certified and include a combination of informative texts, graphics, videos and quizzes.

### Examination



The EBIR Examination allows physicians who have followed the objectives of the European curriculum and mastered the content of the syllabus to prove their professional competence.

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## Foreword

When the European Curriculum and Syllabus for Interventional Radiology first came out in 2013 it was instrumental in defining interventional radiology as a clinical discipline and to outline the appropriate training and training pathways. With the field of interventional radiology continuously evolving, the second edition was soon necessary in order to keep up with the trends and expansion of our medical field. In the second edition of the European Curriculum and Syllabus for Interventional Radiology published in 2017, new sections were introduced, among them – interventional oncology (IO).

The European Curriculum and Syllabus for Interventional Radiology remains the foundation underpinning training and education in interventional radiology. However, with the recent advancements in IO we felt that a supplementary training curriculum dedicated specifically to IO will accelerate its development. It will also offer a great opportunity for interventional radiologists to expand their knowledge in the clinical management of cancer patients.

The European Curriculum and Syllabus for Interventional Oncology is intended to reinforce and further bolster the reputation of IO as the fourth pillar in cancer care. As practitioners and health care providers, it is our responsibility to set standards for training and to provide guidance to interventional oncologists regarding the required competence for safe and effective practice.

The curriculum includes recommendations and guidelines for the knowledge, skills and competencies essential to attaining proficiency in IO. The syllabus consists of three sections that make up the critical foundations for providing optimal IO care to cancer patients: Fundamentals in Oncology, Fundamentals in Interventional Oncology and Organ Site-Specific Oncology. First, in order to evaluate the appropriate treatment route, it is necessary to have a reasonable working knowledge of cancer biology and available cancer treatments. The second section outlines general knowledge, as well as clinical and technical skills that form the basis of IO practice. The third section lays out important information regarding site-specific cancer, including genetic influences, incidence and aetiology; pathology, staging and common sites of metastases; available treatments; and the clinical and technical skills necessary for a highly qualified IO.

We would like to sincerely thank the members of our writing group, namely Andrés Cervantes, Marc Debled, Otto M. Van Delden, Martin Früh, Afshin Gangi, Lukas Hechelhammer, Guillaume Louvel, Franco Orsi, Julio Palmero, Jean Palussière, Sandra Petiot, Pramod Rao, Maxime Ronot, Bruno Sangro, Max Seidensticker, Georgia Tsoumakidou, Raman Uberoi, as well as Maria Weren, Mardis Karlsdottir and Megan Leahy from the CIRSE office for their invaluable help in producing this document. Our gratitude extends equally to all of our partner societies, which have supported the process and/or endorsed the final document.

Best regards,

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# 1 CURRICULUM



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# Introduction

Interventional radiology (IR) is a rapidly evolving field of medicine and over the past couple of decades it has made inroads into the field of cancer therapeutics. Over time, cancer care and treatment has evolved from surgical excision into the multidisciplinary approach of today. Interventional oncology (IO) is a part of IR dealing with cancer diagnostics and therapeutics. This curriculum is intended to give direction to all training centres on how to set up a basic programme which will help train future interventional oncologists (IOs). It is also intended to harmonise IO training across Europe. An IR curriculum published by the Cardiovascular and Interventional Radiological Society of Europe (CIRSE) [1] already exists, however, with the vast advances in IO, a curriculum dedicated specifically to IO is needed.

As IO is a rapidly growing specialty, the curriculum will need to evolve to keep up with the changes. Hence, the curriculum will be updated on a regular basis and will be re-evaluated every 5 years to keep up with the latest innovations.

## 1.1 Objectives

The objective of this curriculum is to ensure that all those trained in IO are competent and able to provide a high-quality service. This will enable them to take primary clinical responsibility for the patients they treat and fulfil their roles as caregiving physicians safely and effectively. It also aims to ensure that all IOs show medical professionalism and ethics in accordance with the Global Statement Defining Interventional Radiology [2].

In accordance with the European Commission (EC) directive 2005/36/EC, which aims to ensure that the member states mutually recognise the qualifications of doctors to facilitate the free movement of professionals within Europe [3], this curriculum intends to harmonise education standards across European Union (EU) states. Since 1996, when the EU states first agreed to mutually acknowledge each other's primary qualification, there have been regular updates to the law. Currently, specialist qualifications are also recognised whereby specialist doctors trained in one state can move to, and work in, any of the other EU member states. Considering that in each country the education varies depending on teaching curriculum and competence levels, this curriculum is created to support the harmonisation of the training in the field of IO across the EU states. This will in turn help the free mobility of professionals and also enable enhanced training opportunities across all EU member states.

The curriculum will provide guidelines for the education and experience essential to ensure competency in the roles mentioned below, as is expected of specialists employed as part of the expert working groups defined by CanMEDs 2015 [4].

### **MEDICAL EXPERT**

#### **Definition**

As Medical Experts, IOs integrate all of the CanMEDS Roles, applying medical knowledge, clinical skills and professional values in their provision of high-quality and safe patient-centred care. Medical Expert is the central physician Role in the CanMEDS Framework and defines the physician's clinical scope of practice.

**Role**

- Practice IO within their defined scope of practice and expertise
- Perform a patient-centred clinical assessment and establish a management plan
- Plan and perform IO procedures and therapies for the purpose of assessment and/or management
- Establish plans for ongoing care and, when appropriate, timely consultation
- Actively contribute, as an individual and as a member of a team providing care, to the continuous improvement of health care quality and patient safety

**COMMUNICATOR****Definition**

As Communicators, IOs form relationships with patients and their families that facilitate the gathering and sharing of essential information for effective health care.

**Role**

- Establish professional therapeutic relationships with patients and their families
- Elicit and synthesise accurate and relevant information, incorporating the perspectives of patients and their families
- Share health care information and plans with patients and their families
- Engage patients and their families in developing plans that reflect the patient's health care needs and goals
- Document and share written and electronic information about the medical encounter to optimise clinical decision-making, patient safety, confidentiality and privacy

**COLLABORATOR****Definition**

As Collaborators, IOs work effectively with other health care professionals to provide safe, high-quality, patient-centred care.

**Role**

- Work effectively with physicians and other colleagues in the health care professions
- Work with physicians and other colleagues in the health care professions to promote understanding, manage differences and resolve conflicts
- Hand over the care of a patient to another health care professional to facilitate continuity of safe patient care

**LEADER****Definition**

As Leaders, IOs engage with others to contribute to a vision of a high-quality health care system and take responsibility for the delivery of excellent patient care through their activities as clinicians, administrators, scholars or teachers.

**Role**

- Contribute to the improvement of health care delivery in teams, organisations and systems
- Engage in the stewardship of health care resources
- Demonstrate leadership in professional practice
- Manage career planning, finances and health human resources in a practice

## HEALTH ADVOCATE

### Definition

As Health Advocates, IOs contribute their expertise and influence as they work with communities or patient populations to improve health. They work with those they serve to determine and understand needs, speak on behalf of others when required and support the mobilisation of resources to effect change.

### Role

- Respond to an individual patient's health needs by advocating with the patient within and beyond the clinical environment
- Respond to the needs of the communities or populations they serve by advocating with them for system-level change in a socially accountable manner

## SCHOLAR

### Definition

As Scholars, IOs demonstrate a lifelong commitment to excellence in practice through continuous learning and by teaching others, evaluating evidence and contributing to scholarship.

### Role

- Engage in the continuous enhancement of their professional activities through ongoing learning
- Teach students, residents, the public and other health care professionals
- Integrate best available evidence into practice
- Contribute to the creation and dissemination of knowledge and practices applicable to health

## PROFESSIONAL

### Definition

As Professionals, IOs are committed to the health and well-being of individual patients and society through ethical practice, high personal standards of behaviour, accountability to the profession and society, physician-led regulation and maintenance of personal health.

### Role

- Demonstrate a commitment to patients by applying best practices and adhering to high ethical standards
- Demonstrate a commitment to society by recognising and responding to societal expectations in health care
- Demonstrate a commitment to the profession by adhering to standards and participating in physician-led regulation
- Demonstrate a commitment to physician health and well-being to foster optimal patient care

## 1.2 Recommendation for Training

It is recommended to enter an IO training programme after the completion of general training in IR. General IR training is mandatory as the core skills needed before IO training include sound knowledge of diagnostic radiology and general IR.

This curriculum will describe the knowledge, skills and competencies required for a comprehensive training in IO. It is advisable to have a minimum of one year training in IO at centres of good standing in the IO field.

### **General**

IOs should receive training in a multidisciplinary environment working together with surgical oncology, radiation oncology, medical oncology, pathology, anaesthesia and palliative care professionals. The programme should preferably also involve contact with cancer researchers (specifically in academic institutes).

### **Multidisciplinary**

IO trainees should attend, amongst other meetings, at least one multidisciplinary meeting per week, to help develop an attitude of complete and optimal patient care. It is important to understand that the treatment of cancer involves planning and a combination of therapies to obtain the best results. Priority should be placed on the best possible approach to treat the patient with the objective of best survival rates and good quality of life.

### **Clinics in IO**

IO trainees should gain exposure to supervised IO clinics at least once a week. It is essential to include patient confidence building along with the ability to discuss difficult situations with patients and their families. The first impression patients get of a clinician is of high importance and they should feel at ease to discuss and receive answers to their queries. Regular performance appraisals by programme heads are recommended.

### **Research**

IO trainees are encouraged to participate in research (clinical and preclinical) undertaken in their department, accompanied by collaborative research with other departments. Participation in multicentre studies should be highly encouraged. Research training and appraisal at the end of the programme is crucial.

### **Appraisal and Mentoring**

Trainees should have regular meetings with their mentors and/or programme directors (at least once every 3 months) which include an appraisal. It is vital to discuss the progress made and goals should be set for the next 3 months or for the rest of the programme.

### **Teaching and Education**

Regular teaching sessions, journal clubs, as well as mortality and morbidity meetings, should be included in the programme. Case review sessions on decision-making should be held regularly.

Trainees should have access to scientific journals via libraries or online access and any other electronic Continuing Medical Education (CME) resources. Access to teaching sessions in other centres of excellence in the vicinity should be made available.

Trainees should have access to the grand rounds of other departments and specialties to better understand the decision-making approaches of other specialties and to keep up-to-date with newer techniques and equipment in other specialties.

## 1.3 Educational Infrastructure and Organisation

All centres of training should comply with local and national requirements and EC guidelines to harmonise training across EU member states.

**Centres involved in training should:**

- Have a sufficient caseload for the number of trainees employed per year
- Be able to provide sufficient hands-on experience for training fellows and residents. After an initial period of training, it is important that the trainee starts performing procedures independently under supervision
- Perform a good mix of all types of procedures in IO in order to impart global competence in the field
- Have state-of-the-art equipment and materials and keep them updated on a regular basis as per requirement of local laws to provide training that is standard and up to date

The definition of the training programme should be delineated with regard to the complete spectrum of IO, including direct puncture and vascular access, treatments of various organs and different types of cancer.

A regular evaluation of trainees and trainers is essential. The trainees need to be evaluated by those training them. The training system should include an evaluation of the trainers in the department by the trainees, in order to keep up the standards of teaching. Continuous improvement in training methods is recommended and is the best way to evolve.

An end-of-programme evaluation is recommended for the trainee and it is also recommended that each trainee evaluates the programme.

## 1.4 Interventional Oncology Competence

### 1.4.1 Clinical Practice

IO is a clinical specialty.

**IOs should:**

- Act as the primary caretaking physicians of their patients once the patient is referred for treatment or consultation
- Evaluate patients prior to and after (immediate and longer-term follow-up) procedures
- Participate in multidisciplinary teams and meetings to discuss treatment options for patients
- Hold clinics to see patients before planning the procedure to discuss with the patients and their families the treatment being offered and the treatment options
- Ensure patients understand the procedures and give clear, informed, written consent about the procedure being performed

Clinical practice guidelines are available on the CIRSE website [5]. The Clinical Practice Manual contains details of a comprehensive approach to patient care.

## 1.4.2 Professionalism and Teamwork

IOs should show a high level of professionalism while interacting with patients, adults and children alike. Similar professionalism must be exhibited in interactions with other physicians and paramedical personnel. IOs should maintain a high level of personal integrity.

Teamwork is essential to the field of IO. Teamwork first and foremost consists of the IO team, which includes IOs, fellows, residents, technologists, nurses, anaesthetists, anaesthesia nurses and other paramedical and technical personnel. Secondly, teamwork consists of working in unison with physicians from other clinical specialties for the overall betterment of the patient and to achieve the highest level of care for that patient. Understanding the importance of teamwork and respecting everyone in the team and their opinions is an important part of becoming a good IO.

## 1.4.3 Ethics

It is a very competitive world and practice pressure can sometimes be immense. It is imperative that IOs work within the framework of medical ethics and local guidelines for ethics in practice.

For new techniques and materials, IOs should understand the importance of a local ethics committee. It is paramount to work together with the ethics committee to advance IO under optimal ethical conditions.

Working with the medical industry is a vital part of advancing IO by developing new equipment and materials; however, this should be carried out within medical ethics guidelines.

## 1.4.4 Decision-Making and Multidisciplinary Approach

It is an essential part of the IO training programme to teach the trainees the decision-making process and the importance of working with other specialties to achieve optimal patient care.

**IO trainees should:**

- Receive training in decision-making
- Have a sound understanding of decision-making approaches in IO as well as in a multidisciplinary setting
- Attend multidisciplinary meetings and be encouraged to have discussions with physicians from other specialties involved in patient care



## 1.5 Continuity of Education and Research

IO trainees should maintain the highest quality of clinical care and should follow CIRSE's quality assurance guidelines and standards ([www.cirse.org/education/guidelines](http://www.cirse.org/education/guidelines)).

### 1.5.1 Teaching Competency

It is important that, at the end of the programme, every IO trainee eventually understands and takes on the role of an educator and mentor.

**IO trainees should:**

- Teach residents, medical students and allied health staff, including nurses and radiographers
- Learn how to teach and understand the current basic teaching methodologies
- Create systems for constructive feedback for teaching
- Take part in, and where appropriate, lead journal clubs

### 1.5.2 Continued Medical Education

Cancer therapy and diagnostics are constantly changing with newer drugs, treatment options, radiotherapy techniques, surgical techniques and IO technologies. It is essential that the IO trainees and their mentors keep themselves up-to-date with the changes occurring and with the new technological advancements to ensure optimal outcomes for patients.

**IO trainees and mentors should:**

- Attend CME sessions in their hospital organised by their department or other departments
- Try to attend at least one external meeting or conference a year
- Have access to online resources in order to read relevant journals

### 1.5.3 Research Competency and Evidence Building

Departments should involve IO trainees in clinical and preclinical trials.

**IO trainees should:**

- Understand the principles of evidence-based medicine (see Appendix 1)
- Understand the different types of studies (see Appendix 1) and their role in the building of evidence for different procedures in IO
- Be able to review these different studies and understand their strengths and weaknesses
- Have dedicated time to participate in trials, especially those who intend to pursue a career at academic and research institutes
- Receive appropriate training in research methodologies and learn about the processes involved in setting up clinical trials, such as writing protocols, submitting to ethics committees, obtaining funding and conducting trials to the highest ethical standards

## 1.5.4 Preclinical Research

New devices and new drug delivery systems are introduced to IO on a regular basis. Most of the newer technologies or materials need to undergo preclinical research and evaluation before getting a CE approval for human use. These are tested in research facilities with access to research animals, or alternative simulations when possible, in an effort to protect the well-being of animals. IO trainees with an inclination towards research and academics should be encouraged to participate in preclinical research including:

- Undertaking animal experiment training courses approved by the EU or the national society
- Participating in preclinical and translational research
- Training in sound animal research practices, with an understanding of animal rights and safety

## 1.5.5 Log Book

IO trainees should maintain a logbook of all procedures performed during their training period, including the types of procedures, number of procedures and if it was conducted as a second operator, first operator under supervision or as an independent first operator.

Logbooks should also contain details of any research projects the trainee is involved in and their outcomes.

## 1.5.6 Recommended Links

The links below will give the trainee access to different IR societies. Recommendations for standards of practice can be found on the websites below.

**The links contain:**

- Technical considerations
- Oncology cases, CME presentations and expert presentations
- Clinical databases that give access to registered trials
- Information regarding newer anticancer drugs and treatments

<http://www.cirse.org/>

<http://www.sirweb.org/>

<http://www.bsir.org/>

<http://www.io-central.org/>

<https://library.cirse.org/>

<https://www.vumedi.com/accounts/login/>

<https://clinicaltrials.gov/>

<http://www.cancerresearchuk.org/>

<http://www.bacr.org.uk/>

<http://www.cebm.net>

<http://www.cancer.org/treatment/treatmentsandsideeffects/treatmenttypes/chemotherapy/chemotherapy-landing>



# 2 SYLLABUS

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## SECTION A

# 2.1 Fundamentals in Oncology

## 2.1.1 Epidemiology

Cancer epidemiology and its knowledge play an important role in cancer diagnosis and management. In today's world, where there is considerable free movement across borders and immigration, understanding cancer epidemiology becomes all the more significant.

**IO trainees should:**

- Know the rates of different tumours occurring in their region of practice, as well as those of different ethnic groups residing in their region of practice in order to improve early diagnosis and treatment, along with the goal to achieve longer survival rates

## 2.1.2 Biochemistry and Haematology

Knowledge of biochemistry and haematology is especially important in deciding when to intervene or when to avoid doing a procedure. Knowledge of coagulation profile, biology and haematology are equally critical to evaluate the general condition or function of various organs that will be part of the decision on whether to provide treatment or not, according to its potential risks and expected benefits.

**IO trainees should:**

- Be able to interpret biochemical analyses and haematology results and correlate them with the clinical condition
- Understand the clinical outcomes and risks linked with initial blood counts, liver function tests and renal function tests
- Understand post-treatment changes in blood counts, liver function tests and renal function tests

## 2.1.3 Tumour Biology and Pathology

Knowledge of tumour biology and pathology is fundamental in oncology. With the ever-changing diagnostic methods and tumour characterisations, it is essential to understand tumour pathology and different within-tumour microenvironments. IOs will be involved in tumour biopsies and a complete picture of tumour characteristics is key for better targeting. Knowledge of tumour biology is helpful in therapeutic procedures, especially with the advent of targeted therapies and immunotherapies.

**IO trainees should:**

- Understand tumour microenvironments and their importance
- Understand tumour proliferation and changes occurring in the genome, their significance, how they affect prognosis and how they are relevant to molecular targeting agents and immunotherapy
- Know the differences in tumour pathology and their effects on survival
- Know about tumour markers, the ones currently used in clinical practice (AFP, CEA, CA 19-9, etc.) and their significance in tumour detection and follow-up of patients

## 2.1.4 Radiation Physics and Dosage

Along their course of treatment, patients with cancer undergo a lot of examinations in the radiology department. These include computed tomography (CT) scans and radiographs, which can lead to a considerable number of cumulative doses of radiation, not to mention the additional doses for those receiving radiotherapy.

**IO trainees should:**

- Understand how to reduce doses to patients during procedures and follow good practice guidelines for dose reduction

For more information on dose reduction and management, please refer to the European Curriculum and Syllabus for Interventional Radiology Second Edition [1], published by CIRSE.

## 2.1.5 Anticancer Drugs

Anticancer drugs play a key role in the management of cancer.

**IO trainees should:**

- Know the terminology used with different drug regimens (induction, adjuvant, maintenance, etc.)
- Know the types of drugs available (chemotherapy, targeted therapies, hormone therapy and immunotherapy, etc.)
- Know the side effects and common toxicities for various systemic therapies generally and more detailed toxicity profiles for agents relative to their field of specialisation and action

### 2.1.5.1 Drug Regimen Terminology

**Adjuvant**

Administered post-surgical resection to treat residual or micro-metastatic disease. It is also given to reduce the risk of recurrence.

**Neoadjuvant**

Chemotherapy administered prior to surgical resection to help reduce the size of the primary tumour as well as an earlier treatment of micro-metastatic disease.

**Induction**

Usually the first treatment given for a disease accepted as the best treatment. The goal is to induce a major response.

**Conversion**

Involves the use of cytotoxic drugs that shrink the tumour to a level that can allow surgery in initially non-surgical candidates.

**Consolidation**

Therapy given to sustain remission once it is achieved.

**Maintenance**

Lower doses of chemotherapy given with certain cancers to prevent recurrence and maintain remission status.

**First-line Therapy**

Evidence-based standard therapy and the best possible chemotherapy regime for a given cancer, which has been proven with scientific studies and data.

**Second-line Therapy**

Chemotherapy that is proven to be effective by scientific evidence in case of failure of first line of therapy. Additionally, newer drugs not approved for the first line of therapy may be considered or approved specifically for the second line of therapy until there is enough data to support their use in first-line therapy.

**Third/Fourth-line or Salvage Therapy**

When no response or progression is seen after the first and second line of therapy, third or fourth lines may be offered, also known as salvage therapy. These generally include newer trial drugs that have not yet been approved. May involve off-label use under the framework of studies.

**Palliative Care**

Chemotherapy given with the purpose of reducing the patient's symptoms without any intent, cure or tumour response.

**Mode of Delivery**

Chemotherapy can be administered by different routes.

**Oral**

Examples of drugs that are given orally include capecitabine (Xeloda), imitinib (Gleevec), cyclophosphamide (Cytosan), idarubicin, methotrexate, tamoxifen and sorafenib (Nexavar).

**Intravenous**

Large percentages of chemotherapy drugs are given via intravenous route, either alone or in regimes like CHOP, FOLFOX, FOLFIRI, etc. Antiangiogenic drugs like bevacizumab (Avastin) are given intravenously.

**Intra-arterial Infusion**

Hepatic arterial perfusion (oxalipatin, 5FU, irinotecan).  
Isolated perfusion for limb, peritoneal, pelvic and hepatic (melphalan, etc.).

**Drug Delivery Systems**

Drug-eluting beads (DC Beads, HepaSphere, CeloNova Beads).  
Drug emulsions with Lipiodol for transcatheter arterial chemoembolisation (TACE; e.g. doxorubicin, cisplatin, epirubicin, idarubicin, etc.).  
Future drug delivery systems like liposomes (doxorubicin).

## 2.1.5.2 Chemotherapy

**General principles**

Tumours have a subpopulation of actively dividing cells termed the growth fraction, other cells will be in growth arrest or necrotic. The growth fraction cells tend to be the ones that are most sensitive to chemotherapy. Some agents act only in certain cell cycle phases whereas others may act at any cell cycle phase. Agents may act by a range of mechanisms to damage DNA, prevent DNA synthesis or arrest the cell cycle. Principles of combination chemotherapy to reduce the occurrence of drug resistance. Regime types by intent: induction, consolidation, adjuvant, neoadjuvant and maintenance [6].

Main drug classes in chemotherapy must be known:

- Alkylating agents: platinum agents (cisplatin, oxaliplatin and carboplatin), ifosfamide, cyclophosphamide, melphalan
- Antimetabolites: 5 fluorouracil, capecitabine, gemcitabine, methotrexate
- Cytotoxic antibiotics: bleomycin, doxorubicin, epirubicin, mitomycin C
- Mitotic inhibitors: taxanes, vinca alkaloids
- Topoisomerase inhibitors: etoposide, irinotecan

#### **Side effects**

Some chemotherapy drugs induce myelosuppression, it is important to know when to avoid performing procedures and which is the best window in which procedures can be performed on patients receiving this type of chemotherapy. In an effort to overcome these side effects knowledge of granulocyte colony stimulating factor and erythropoietin is needed.

### **2.1.5.3 Small Molecule Targeted Therapies**

Agents which directly target the regulatory mechanism of cells (broad range of targets) can penetrate the plasma membrane to interact directly with the cellular machinery. Includes tyrosine kinase inhibitors such as imatinib (chronic myeloid leukemia (CML)), gastrointestinal stromal tumour (GIST), sunitinib (GIST and renal cell cancer), gefitinib (non-small cell lung cancer (NSCLC) and erlotinib (NSCLC and pancreatic cancer). Awareness of the classes of agents, molecular mechanisms and new agents under trial (DNA demethylating agents, histone deacetylase inhibitors) [6].

#### **Monoclonal antibodies**

Classes of antibody (murine: -omab, chimeric: -ximab, humanised: -zumab and human: -umab) and implications for immunogenicity act by binding antigens on cell surface or growth factors. Aware of key targets and therapeutic examples, side effects, cost issues. E.g. trastuzumab for EGFR2 in breast cancer, rituximab for CD20 of B cell lymphoma, bevacizumab for vascular endothelial growth factor (VEGF) [6].

### **2.1.5.4 Immunotherapy of Cancer**

Anti-PD1 or anti-PDL1 antibodies such as pembrolizumab, atezolizumab, durvalumab, nivolumab, etc. are approved for use in many solid tumours due to its improvement in survival that have been consistently shown in randomised studies.

The use of immunotherapy is related to some immune-mediated secondary effects such as hepatitis, hypothyroidism or panhypopituitarism. Monitoring these potential toxic effects is of paramount importance.

Immunomodulators of tumours are blooming, namely with intra-tumoural injections including toll-like receptor (TLR) agonists, oncolytic peptide and modified viruses that have been demonstrated to re-programme the tumour microenvironment.



## 2.1.6 Endocrine Therapies

### **Breast cancer:**

- Tamoxifen and other SERMS (raloxifene): indications, contraindications, side effects and mode of action
- Aromatase inhibitors: indications, contraindications, side effects and mode of action
- Fulvestrant: indications, contraindications, side effects and mode of action

### **Neuroendocrine tumour (carcinoid):**

- Somatostatin analogues

### **Prostate cancer:**

- Oestrogens
- Luteinising hormone-releasing hormone (LHRH) partial agonists: goserelin, leuprolide
- Anti-androgens; new agents, e.g. abiraterone; immunotherapy: sipuleucel T

### **Thyroid cancer:**

- Thyroxine (for thyroid stimulating hormone (TSH) suppression)

## 2.1.7 Radiation Therapy

### **IO trainees should understand:**

- The different indications of radiation therapy (RT) (exclusive, adjuvant, palliative, etc.)
- The radiobiology of ionising radiations
- The basic physics of X-ray, electron beams and proton treatments
- The different modalities of RT (3D, intensity-modulated radiation therapy (IMRT), brachytherapy, etc.)
- The toxicities of RT (acute and late effects)
- The dose administration regimens (fractionation)

### 2.1.7.1 Mechanism of Action

#### **General principles**

RT is the use of ionising radiation to treat a tumour alone or in combination with other treatments modalities (surgery, anti-cancer drugs, etc.). RT can be used in a curative intent or in a palliative setting (analgesic effect, decompression, etc.).

RT is frequently used as an exclusive treatment (prostate cancer) but can be delivered in the tumour bed after surgery in an adjuvant setting to decrease the risk of recurrence (breast cancer), or before surgery in a neo-adjuvant setting to facilitate oncological surgery (rectal cancer).

#### **Direct DNA damage**

RT induces DNA damage: normal cells can repair sub-lethal DNA damage whereas tumour cells often have relatively impaired repair mechanisms. This differential effect is exploited in RT by fractionating the treatment in multiple sessions. Radiation damage to the DNA may be as double strand breaks, single strand breaks, base damage and DNA-DNA and DNA-protein cross-links [6].

**Oxygenation**

Oxygen stabilises radiation produced free radicals which then contribute to DNA strand breaks. Hypoxic areas of a cancer are therefore relatively radio-resistant. As a tumour shrinks during fractionated treatment, more areas become oxygenated and therefore sensitive to radiotherapy [6].

**Radio-resistance**

Certain molecular markers suggest relative radio-resistance: hypoxia, P21 and P53 mutations and a low proliferation rate. Absence of HPV- influence in head and neck cancer patients (HPV-positive head and neck squamous cell carcinoma (HNSCC) are more radiosensitive) [6].

## 2.1.7.2 Types of Radiotherapy

**3D Conformal radiotherapy**

May be delivered as electrons, photons or protons. Tumour targeting is achieved by beam collimation and image guidance, shielding and selection of the optimal type of radiation and energy which dictates the depth of penetration. Electrons are negatively charged subatomic particles which have a relatively low penetration depth (up to ~6cm). Photons (X-rays/gamma rays) are able to pass through the body (energy dependent) and can target tumours at any depth. Protons of a given energy have a certain range and very few protons penetrate beyond that distance. The dose delivered to tissue is maximum over the last few millimetres of the particle's range (Bragg peak) [6].

**Intensity-modulated radiation therapy**

Highly targeted RT using computer and CT controlled multiple beams with automatic collimation in linear accelerators (multi-leaf collimators). IMRT can be delivered with fixed beams, with arcs (volumetric modulated arc therapy, VMAT) or in a helical fashion (tomotherapy). IMRT is used to avoid radiation damage to critical structures and target dose escalation such as central nervous system sarcomas, parotid gland in head and neck cancers, bowel in prostate cancer etc. [6].

**Brachytherapy**

Direct placement of radioactive sources into the tumour or tumour bed. Able to deliver higher focal RT doses with relative sparing of normal tissue due to rapid dose fall-off around the sources (e.g. iridium-192 (Ir-192) after-loading for cervical and breast cancer, radioactive iodine seeds for prostate cancer). These produce mainly electrons and photons [6].

Increasing application of Ir-192 brachytherapy in afterloading technique for metastatic and primary liver tumours which are ineligible for thermal-based ablative techniques (with regard to location and size).

**Intra-operative**

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

**Stereotactic radiotherapy**

Refers to a highly precise treatment requiring: highly conformal delivery of the dose and highly precise positioning of the patient (by fixation of the target area or on-board imaging system integrated in the treatment room). Uses specific equipment as CyberKnife, tomotherapy, gamma knife or dedicated linear accelerator. Main indications are to the brain, liver and lung metastases and small primary tumours. Stereotactic radiosurgery (SRS) refers to high dose single fraction treatment in the brain. Stereotactic body radiotherapy (SBRT) or stereotactic ablative radiotherapy (SABR) refers to hypofractionated treatments in extracranial targets.

**Proton therapy**

Protons can be precisely targeted, with little side scatter, at a well-defined range and release most of their energy in the last few mm of this range. Protons are useful for specific indications (e.g. chordoma, ocular melanoma). Limited equipment availability [6].

**Radio-pharmaceuticals and peptide receptor radionuclide therapy (PRRT)**

Use of Iodine 131 bound either to thyroxine or meta-iodo-benzyl-guanidine (MIBG) to treat thyroid cancer or neuroendocrine tumours.

Use of 90Y-DOTATOC and 177Lu-DOTATATE in neuroendocrine tumours providing targeted radiotherapy to somatostatin analogue receptors.

Use of Radium-223 therapy for prostate cancer.

### 2.1.7.3 Side Effects

**Acute (within 3 months after treatment)**

- Mainly due to reversible inflammatory reactions: skin desquamation, nausea, diarrhoea, oedema. Specific side effects by disease site (proctitis in pelvic RT, dysphagia in head and neck RT, etc.)

**Chronic (more than 3 months after treatment) [6]**

- Mainly due to irreversible radiation fibrosis, vascular obliteration: complex cellular mechanism including myofibroblast activation and up-regulated fibrogenesis, fibrogenic cytokine release, hypoxia due to enhanced atherosclerosis and endarteritis obliterans
- Second cancer development: typically occurs with a rate of 1:1000, from 5 to 15 years and later after exposure. e.g. soft tissue and bone sarcoma, breast cancer
- Organ damage depending on total and fraction dose, volume and treatment time: pulmonary fibrosis, stricture, neuropathy, transverse myelitis, blindness, dementia, poor wound healing, joint contracture, infertility, lymphoedema

**Normal tissue complication probability**

A mathematical model aiming to correlate the dose delivered to the organ at risk with the risk of toxicity. Different organs have different thresholds.

### 2.1.7.4 Dosing and Administration

**Fractionation**

Radiotherapy is fractionated to allow time for normal cells to recover from damage whilst tumour cells have a reduced capacity to recover. Doses of 1.8-2.0 Gy by fraction, 5 times weekly are the standard fractionation. Total dose, dose/fraction and number of fractions/week can be manipulated in order to increase tumour cell killing, reducing acute and late morbidity.

The sensitivity of a tumour to radiotherapy can, in certain cases, be manipulated by sensitizers such as concurrent chemotherapy but will also affect normal tissue toxicity [6].

Catheter-based radiotherapy (high-dose rate (HDR) brachytherapy using an Ir-192 afterloading source) employs hypofractionated radiation techniques with application of the target dose in a single session (15-25Gy, depending on tumour entity).

**Hyperfractionation**

Refers to the use of multiple fractions during the same day.

**Accelerated fractionation**

Used to shorten the overall treatment time. This kind of treatment regimen will increase acute toxicities.

**Hypofractionation**

The delivery of more than 2 Gy per fraction in order to deliver less fractions. This kind of treatment regimen will increase late toxicities.

## 2.1.8 Surgical Oncology

Understanding of surgical oncology procedures is essential to a trainee in IO. Patients are often referred post-operatively for further management with tumour recurrence or residual tumours. Similarly, a large part of the IO practice involves providing services for post-operative patients.

**IO trainees should have:**

- Knowledge of different types of surgeries
- Knowledge of changes that are seen in the post-op period
- Knowledge of surgical pathophysiology
- An understanding of complications associated with surgical procedures
- A sound understanding of anatomic changes seen with regard to vascular and organ anatomy, taking these into account in order to plan procedures

**Knowledge of IO procedures:**

- Embolisation procedure for hypervascular tumours prior to surgery (materials and window for surgery)
- Understanding and knowledge of portal vein embolisation (PVE)
- Understanding and knowledge of biliary drainage and access for surgical resection patients
- Understanding of management of tumours and downstaging in patients awaiting transplants
- Understanding of surgical procedure (open, laparoscopic or robotic) and complications, e.g. post-operative drainage of abscess, embolisation of bleeding, repositioning of tubes or upsizing of tube

**Clinical skills:**

- Understanding the problem at hand
- Planning of biopsies in some cancers, discussing surgical plan prior
- Understanding when IO can help in presurgical planning (immediate presurgical or interval presurgical)
- Immediate presurgical: embolisation of hypervascular tumours, embolisation of renal tumours, etc.
- Interval presurgical: PVE to increase future liver remnant (FLR), biliary drainage to reduce bilirubin levels, TACE prior to transplant for downstaging
- Post-surgical IO help in the management of patients and surgical complications

**Technical skills:**

- How to approach keeping surgery in mind
- Where, when and how much to embolise (for immediate presurgical as well as interval presurgical)
- How to perform a procedure so as not to alter the surgical plan of the patient
- Post-procedure complication management, know post-surgical anatomic variations affecting IO procedure

**Breast**

- Know what modified radical mastectomy, mastectomy and lumpectomy are
- Know what axillary clearance or sentinel node biopsy involves
- Know the different types of surgical flaps, reconstructive surgeries and implants
- Understand imaging finding post-surgical reconstruction

**Lungs**

- Know the different possible surgeries for lung tumours
- Understand thoracoscopic excision of metastases and imaging changes after surgery
- Understand lobectomy and pneumonectomy (open or thoracoscopic)
- Know different thoracoscopic surgeries and mediastinoscopic procedures performed

**Liver**

- Know the different types of hepatic resections
- Know the difference between right, left, extended right or left and segmental hepatic resection
- Know laparoscopic hepatic resection
- Know different types of liver transplant and types of anastomoses
- Understand the type of choledochal or hepatic-intestinal (duodenum, jejunum) anastomoses

**Pancreas**

- Know the Whipple procedure
- Know pancreatectomy (partial and total) procedure

**Stomach**

- Know partial and complete gastrectomy (open and minimal access surgery)
- Know the types of bypass surgeries

**Duodenum and Small Intestine**

- Know about the different types of resection for the duodenum and the small intestine (jejunum and ileum)
- Know the different anastomoses possible

**Colon**

- Know the different types of colectomies: hemi (ascending, transverse and descending) and total colectomy
- Understand the surgical option for rectal tumours
- Understand colostomy
- Understand HIPEC (hyperthermic intraperitoneal chemotherapy)

**Retroperitoneum**

- Knowledge of surgery for retroperitoneal sarcoma and metastases

**Renal and Bladder**

- Know partial nephrectomy (open or laparoscopic)
- Know total nephrectomy and radical nephrectomy (open or laparoscopic)
- Know partial or total cystectomy (open or laparoscopic)

**Prostate**

- Know radical prostatectomy as a procedure

**Orthopaedic and Spine**

- Know surgery for primary and secondary bone tumours
- Know the different types of prostheses used in orthopaedic surgery
- Know the type of surgery offered for metastatic and primary tumours of the vertebrae
- Know the different types of stabilisation systems that are used
- Know the treatment for different types of soft tissue sarcomas

## 2.1.9 Palliative Care

The palliative care department plays an important role in the care of cancer patients. IO services are often required for cancer patients receiving palliative care. Palliative care consists of multiple levels up to end of life. The levels of consideration for an IO trainee are pain management, nutritional management, improvement of quality of life and emergency acute care.

### Pain Management in Palliative Care

Most often handled by anaesthetists in most centres but IOs can be approached for pain management in cases of painful metastases.

#### Knowledge of IO treatments:

- Knowledge of ablation of bone metastases
- Knowledge of ablation of painful soft tissue metastases
- Knowledge of sclerotherapy of different ganglia for pain management

#### Clinical skills:

- Understanding and localising the origin of the pain
- Understanding of how to approach pain in oncology
- Understanding area to address
- Decision of the approach to be used

#### Technical skills:

- Use of ablative therapies in pain management in a palliative setting
- Use of alcohol in pain management (when to use, where to inject)
- Approach to treatment of painful bone metastases
- Use of cement in painful bone metastases

### Nutritional Management

#### Knowledge of IO treatments:

- Knowledge of percutaneous gastrostomy and jejunostomy procedures along with indications and limitation in palliative setting
- Knowledge of intravenous tunnelled catheter placement in palliative setting

#### Clinical skills:

- Understanding the clinical problem of why the patient cannot be fed
- Being able to discuss and decide the best IO approach to add nutrition
- Understanding the benefits and risks associated with the approach being offered and the patient's condition

#### Technical skills:

- Competence in intravenous tunnelled catheter placement for nutritional purposes
- Competence of percutaneous gastrostomy or jejunostomy placements
- Understanding the limitations of each procedure in a palliative setting

## Emergencies in Palliative Care

### Knowledge of IO treatments:

- Knowledge of thrombolysis venous, pulmonary arterial if necessary
- Knowledge of venous stenting
- Knowledge of arterial embolisation of bleeding tumours (materials used)

### Clinical skills:

- Understanding do not resuscitate (DNR) status of the patients
- Being able to discuss with the patients and family about the benefits and risks in the setting of palliative care
- Decision making; when to and when not to treat

### Technical skills:

- How to manage a thrombolysis
- How to manage and stent for superior vena cava (SVC) syndrome
- How to embolise in case of tumour bleeds

## SECTION B

# 2.2 Fundamentals in Interventional Oncology

## 2.2.1 Anatomy

A perfect knowledge of anatomy is a crucial issue for the IR. It is essential not only for planning local treatments, but also for reducing the risk of complications and enhancing the outcome.

### IO trainees should understand:

- Normal vascular anatomy
- Organ anatomy and system anatomy
- Correlations between the real anatomy (surgical anatomy) and imaging anatomy (CT, magnetic resonance (MR), ultrasound (US), angiography and X-rays)
- Most common distortions and changes in anatomy occurring after surgery
- Most common anatomical variations

### Knowledge of IO treatments:

- Liver segmentation and its relationship with surrounding structures
- Liver parenchymal structure (the concept of “liver’s functional unit”)
- Liver vascular anatomy, including arterial, portal, and venous anatomy
- Biliary anatomy
- Most common liver anatomical variations in vascular and biliary anatomy
- Common post-operative modifications of liver anatomy and biliary route (e.g. biliary diversions)
- Renal anatomy and its relationship with surrounding structures
- Arterial and venous renal distribution
- Anatomy of the collecting system
- Most common anatomical variations of the vascular and collecting system
- Post-operative anatomical variations of the vascular and collecting system (e.g. urinary diversions)

- Anatomy of lungs (lobes/segments) and their relationships with surrounding structures
- Vascular anatomy of the lungs (pulmonary arteries and veins, bronchial arteries)
- Airways anatomy
- Most common post-surgical vascular anatomy and airways variations
- Anatomy, parenchymal structure, relationships with surrounding structures, vascular anatomy, most common anatomical variations and possible post-surgical changes of any other organs that might be involved in IO practice, including the pancreas, adrenal glands, thyroid, lymph nodes and bones

**Clinical skills:**

- Trainees should be able to properly investigate all the crucial anatomical aspects in order to plan the treatment. They should also be confident with other clinical information, useful for a comprehensive patient evaluation (such as patient's clinical story, labs, symptoms evaluation, imaging from other sources: endoscopy, nuclear medicine, etc.)
- According to the amount of anatomical and clinical information, the trainee should be able to define the clinical indication to a specific IO approach
- Trainees should also know the possible alternative options to the IO approach (surgery, endoscopy, RT, chemotherapy, etc.) when anatomy might represent a crucial issue
- Trainees should be able to actively attend the Tumour Board, which is an essential part of the decision-making process within the treatment planning. In the Tumour Board, discussion decisions are often based on the imaging evaluation performed by IOs

**Technical skills:**

- Trainees should be able to perform specific imaging evaluation and properly evaluate the findings in order to plan the IO procedure
- Trainees should know the imaging devices and technologies needed to carry out the image-guided IO interventions. They should also understand the main characteristics, advantages and limitations of the procedure, in order to evaluate the differences according to the patient's anatomy:
  - Needle for biopsy: size and tip characteristics
  - Ablation devices: different energies used for achieving tissue ablation in different organs and structures (microwave ablation (MWA), radiofrequency ablation (RFA), laser ablation, cryoablation (CRYO), high-intensity focussed ultrasound (HIFU))
  - Vascular and drainage catheter shapes and characteristics to be chosen according to the anatomical region

## 2.2.2 Management of Anticoagulants

**IO trainees should:**

- Have knowledge of current anticoagulants and their management. It is important to carefully understand the associated risks of using anticoagulants related to the specific IO procedure the patient has to be subjected to (primarily relating to continued use or discontinuation)
- Be able to handle the transition of one anticoagulant to another one, in order to reduce the risk of bleeding during IO procedures. They should also understand when to restore the original medications, once the procedure has been carried out
- Know and follow the guidelines for anticoagulants proposed by the Standards of Practice Committee in a joint consensus paper by CIRSE and the Society of Interventional Radiology (SIR) [7]



**Knowledge of IO treatments:**

- Tests of haemostasis (INR/PT, aPTT, platelet count, bleeding time)
- Most commonly used anticoagulants (warfarin, heparin)
- Most commonly used antiplatelet agents
- Haemostatic agents (fresh frozen plasma, platelets, protamine, vitamin K)

**Clinical skills:**

- Request the proper coagulation tests according to the bleeding risk of the scheduled procedure (according to CIRSE/SIR guidelines)
- Manage the altered values of coagulation tests, according to the specific IO procedure
- Manage the drug assumption of the patients according to the basic disease and the scheduled procedure
- Manage coagulation disorders or bleeding problems occurring during an IO procedure with the proper drugs on a case by case basis

## 2.2.3 Anaesthesia in IO

Trainees should be familiar with the different types of anaesthesia (local, regional, spinal, general), and be able to discuss with anaesthesiologists regarding the best anaesthesia for each specific IO procedure and according to the patient characteristics. They are also responsible for predisposing the IO suite with the essential facilities for the scheduled procedures.

**Knowledge of IO treatments:**

- According to the specific scheduled IO procedure, trainees have to be able to discuss the most appropriate anaesthesia with anaesthesiologist, according to the specific technical and clinical needs:
  - Reducing respiratory movements in some interventions (liver, kidney or lung ablations) might require some specific devices and/or manoeuvres
  - Understanding specific patient's positions for carrying out an IO procedure might need a specific anaesthesia regimen for safety reasons (e.g. prone position)
- For procedures that can be performed under different anaesthesia regimens, trainees must be able to discuss the advantages and disadvantages of the different options
- Trainees must be able to discuss the application of different local anaesthesia, according to each specific case (e.g. peri-hepatic injection of local anaesthetics before painful ablations, intra-arterial use of local anaesthetic agents in selected cases, when transarterial embolisation has to be performed)

**Clinical skills:**

- Trainees should be able to provide the patient with the essential information regarding the anaesthesia regimen chosen
- Trainees should be able to discuss the interaction with the most commonly used drugs, to provide indications to the patient regarding discontinuation of specific therapies (e.g. anti-hypertension drugs)
- Trainees should be aware of the possible side effects and common outcomes of different anaesthesia on the post-op course
- Trainees should be able to evaluate the principal vital monitored parameters, in order to carry out the procedure in the safest way

**Technical skills:**

- Trainees should collaborate with the anaesthesiologist to settle the IO suite, according to the anaesthesiologist's needs and the requirements for the procedure
- Trainees should know the various devices for anaesthesia that can be used during the interventional procedures

## Types of Anaesthesia

### Local anaesthesia

It consists of a direct injection of local anaesthetic in the region of interest. The injection concerns different structures: skin, fat, muscles, peritoneum, pleural, capsule of organ, etc.

Advantages:

- Excellent for very short procedures like biopsies, peripherally inserted central catheter (PICC line), Port-A-Cath, etc.
- Can be used in combination with conscious sedation
- Does not require detailed monitoring of patients
- No need for hospitalisation due to anaesthesia, patients need to be observed after the procedure depending only on the procedure performed and not the anaesthesia

Disadvantages:

- Short-acting
- Cannot be used for long procedures
- Patient comfort is limited to zone of anaesthesia
- Acts only in the region of injection and thus needs to be administered along the entire length of the needle tract
- Risk of arrhythmias if injected into the vascular space
- Can cause transient or permanent paralyses if injected in the arteries supplying the spine

### Regional anaesthesia

It consists of a peripheral nerve block (such as femoral nerve block). The injection around the nerve is guided by ultrasound (sometimes under fluoroscopy or CT scan). It allows anaesthesia of the anatomic region innervated by the targeted nerve. Patients can experience a motor and sensory block depending on the dose of the anaesthetic. The duration of the anaesthesia depends on the type of local anaesthetic used. It is also effective for management of post-operative analgesia. Several different nerve blocks can be offered according to the region of interest, type and duration required and indication (pre-procedure, post-procedure, etc.).

Advantages:

- Quick and easy to administer
- Good for short procedures which need a regional block of a nerve root zone
- Patients are awake during the procedure and can communicate with the operator and the team
- Can be used for ambulatory patients
- No hospitalisation needed
- Few side effects
- Good patient compliance
- Can be used to cover post-operative pain
- Can be used with conscious sedation
- Requires less monitoring than conscious sedation and general anaesthesia

Disadvantages:

- Limited duration of action, although longer acting drugs can be used
- May need more coverage of pain killers in post-operative period or need additional blocks during the post-operative period
- Cannot be used when complex positioning is required, can be very uncomfortable for the patient
- Cannot be used with long procedures as patient comfort and compliance decrease with time

### **Spinal anaesthesia**

It consists of an injection of local anaesthetic in the cerebrospinal liquid. Patients experience a motor and sensory block of the leg and the level of the block depends on the level of injection of the anaesthetic. Epidural anaesthesia consists of injecting the anaesthetic drug in the epidural space. Normal coagulation is a prerequisite for spinal anaesthesia unlike local and regional anaesthesia, which can be administered in patients with an abnormal coagulation profile.

Advantages:

- Quick to administer
- Effective for the lower limbs and lower pelvic region
- Zone of action can be chosen depending on the drug's region of injection
- Epidural catheter can be placed to give continued anaesthesia over a longer period of time
- Safe and effective
- Patient is conscious and can communicate during the procedure

Disadvantages:

- Generally limited to lower limbs and pelvis
- Cannot be used for long, complex procedures
- Requires post-op monitoring
- Depending on the position of the needle can be more effective on one side than the other
- Sometimes, if recovery speed is not simultaneous on both sides, it can be distressing for the patients
- Needs a good coagulation profile
- Always a risk of haematoma formation which can compress the spinal cord, especially in inexperienced hands

### **Local anaesthetic drugs**

The realisation of local, regional and spinal anaesthesia is safe if we respect the safety rules of injection such as the maximal dose of local anaesthetic (depends on the area and on the patient's weight). The principal risk is local anaesthetic toxicity, which can lead to patient death. Allergies exist but are rare.

#### **Short-acting (90-180 mins)**

mepivacaine, lidocaine, etc.

#### **Long-acting (4-18 hours)**

bupivacaine, ropivacaine, levobupivacaine, etc.

### **Conscious sedation**

It consists of an intravenous injection of a sedative drug (such as benzodiazepine, propofol, ketamine, etc.) with or without a morphinomimetic drug. The anaesthesia team can adapt the level of sedation from mild to deep sleep. The patient breathes spontaneously by him- or herself. It can be used along with local or regional anaesthesia.

**Advantages:**

- Good patient comfort and compliance
- Preferred by patients
- Procedures are pain-free
- Preferred for short procedures like vertebroplasties, embolisation, chemoembolisation, etc.

**Disadvantages:**

- Needs constant patient monitoring
- Patient breathing can become erratic and needs to be controlled
- Risk of apnoea with deep desaturation
- Needs additional local anaesthesia or regional block
- Studies requiring patients to hold their breath can be challenging if the patient is deeply sedated
- Procedure in prone position needs to be carefully monitored

**General anaesthesia**

It consists of an injection of a morphinomimetic drug associated with a hypnotic drug so that the patient is unconscious in apnoea and requires ventilation support. A curare for muscle relaxation can be added. To maintain the level of anaesthesia, a continuous intravenous infusion or gas inhalation can be used.

**Advantages:**

- Patients have no spontaneous motions, memories or pain
- Excellent for long, time-consuming and complex procedures (multiple lung RFA, CRYO, complex chemoembolisation, etc.)
- Good for procedures requiring apnoea
- Good for complex procedures with difficult access
- With muscle relaxants, patients can be carefully positioned without trauma to joints and tendons
- Patients are very comfortable and no hangover effect exists with the new drugs
- Can be quickly reversed with quick patient recovery
- Increases operator comfort during the procedure
- Excellent pain management can be achieved

**Disadvantages:**

- Can be time-consuming
- Not all patients can be administered general anaesthesia as some patients referred for IO procedures have multiple co-morbidities, making them higher risk patients
- Needs constant careful monitoring of patients
- Patients need to go to post-operative recovery after the procedure
- Patients need to be hospitalised
- Can be expensive
- Loss of nerve function cannot be easily and immediately monitored
- Requires a complete operating room set-up for patient monitoring and management with a ventilator, etc.
- Memory loss can be aggravated in elderly patients

**Hypnotic drugs**

The most frequently used are propofol, etomidate, hypnovel

**Morphinomimetic drugs**

sufentanil, remifentanil, alfentanil

**Curare**

Tracrium, Cisatracurium and Verocuronium. Allergy is the principal complication of curare.

## 2.2.4 Patient Positioning and Planning

Trainees should be familiar with the role of correct and safe patient positioning for various procedures and how different positions might affect the procedure outcome and its safety.

### **Knowledge of IO treatments:**

- Be able to discuss the different steps of planned procedure with the IO equip and how to manage and achieve the required patient position
- Know how to protect the patient from any trauma due to patient positioning and decubitus (e.g. the brachial plexus in patients whose arms will need to be extended over the head, in prone position, for an extended period of time)
- Be able to identify possible sensitive pressure points and know how to protect them from trauma during a procedure
- Know how to prevent trauma to joints and muscles during patient positioning and transferring to/from the IO bed

### **Clinical skills:**

- Be able to justify the clinical relevance of a specific patient position in relation to the specific technical needs for achieving a successful outcome of the procedure
- Require and manage all the necessary clinical parameters for right patient evaluation during the procedure, according to the different patient positions

### **Technical skills:**

- Be able to manage all the different devices usually employed for fixing the patient in a specific position for IO treatment:
  - vacuum pillows, head fixing device, etc.
- Have a good understanding of the patient position required for the procedures, which is an important part of the training. According to the scheduled procedure, the trainee should know which patient position has to be preferred in relationship with the organ to be approached and the tumour position

## 2.2.5 IO Materials and Usage

It is essential for the trainee to have good knowledge of all of the materials available on the market and those available within the IO department and their functions. It is essential to understand the do's and don'ts of all the devices.

### **Knowledge of IO treatments:**

- Be aware of the available materials for tumour ablations (MWA, RFA, CRYO, laser ablation, HIFU)
- Keep up-to-date with newer and evolving technology for ablation
- Understand the differences between available technologies and which ones to use for different kinds of tumours
- Know the current available options for intravascular drug delivery and the expected benefits and limitations
- Be aware of available embolic materials and the advantages and disadvantages of each
- Be confident in the use of the different devices and material available in the department

**Clinical skills:**

- Be able to offer the patient the best technique for percutaneous ablation according to any specific case
- Clearly define the procedural steps and share it with the whole IO team (nurses, anaesthetists and technicians)
- Choose the device to use, according to its specific technical characteristics on a case by case basis
- Be able to establish which kind of embolic material to use, according to patient, disease and intended procedure

**Technical skills:**

- Know how to handle all the different thermal ablation systems available in the department
- Be able to deal with different embolic materials to be used on a case by case basis
- Be familiar with catheters, guidewires and all systems for a safe and effective intravascular procedure
- Know when and how to use microcatheters and embolisation materials: coils, iodinated oil, glue and different beads
- Be confident with some basic manual skills, which are mandatory for all trainees to know from the beginning of training:
  - US-guided biopsies (liver, kidney, etc.) or fluid collection drainage
  - CT-guided biopsy (lung, retroperitoneal lymph nodes and masses, bones, etc.)
  - catheter/guide-wire handling

## 2.2.6 Biopsy

IO trainees should acquire clinical, pathological and radiological understanding of diseases and conditions requiring biopsy.

**Knowledge of IO treatments:**

- Normal relevant anatomy of different organs that may require biopsy
- Typical anatomy and variants
- Different types of material used for biopsy (advantages and limitations to each)
- Indications of different organ biopsy (diagnostic, prognostication, treatment planning or follow-up, research protocol) and the requirement of each situation
- Contra-indications to biopsies depending on the clinical setting and target organ, and ways of correcting or managing them
- Know the different kind of samples that may be obtained (cytology, tissue sampling, liquid biopsy, etc.) and their associated suitable conditioning techniques (fixation, frozen section, etc.)
- Know the specifics of biopsy performed before molecular diagnosis
- Know the specifics of liquid biopsy in oncology patients (circulating tumour cells, cell-free tumour DNA)
- Understand the changes that will occur in different organs parenchyma after biopsy
- Know the concept and use of post-ablation biopsy

**Clinical skills:**

- Know how to perform and handle imaging workup before, during and after biopsy
- Prioritise patients
- Clinical assessment of patients before and after biopsy
- Understand specific conditions that may require particular precautions (paediatrics, tumour characteristics – sarcoma, atypical locations, etc.)
- Recognition and management of complications
- Accurately report key findings and procedure steps

**Technical skills:**

- Perform basic and advanced percutaneous biopsy in different organs
- Perform cytology
- Plan optimal biopsy access, patient positioning and relevant/optional image guidance methods
- Demonstrate competence in using the current technologies
- Understand the material used for biopsy and know which one to use with reference to the indication

## 2.2.7 Vascular Treatments

IO trainees should acquire clinical, pathological and radiological understanding of diseases and conditions requiring vascular treatments.

**Knowledge of IO treatments:**

- Vascular anatomy of different organs and peripheral circulation that may require vascular treatment
- Typical anatomy and variants
- Clinical presentations of different diseases (acute or elective)
- Other treatment options (surgical, medical, observational) and understand when one should be preferred over the others

**Clinical skills:**

- Perform vascular treatments in emergency or elective settings
- Know how to perform and handle imaging workup before and after vascular treatments
- Understand the changes that will occur in different organs parenchyma after vascular treatments
- Know different agents that may be injected (delivery, side effects)
- Clinical assessment of patients before and after the treatment
- Recognition and management of complications
- Accurately report key findings and treatment steps

**Technical skills:**

- Plan the vascular procedure depending on the indication
- Understand the material used for procedures, and know which one to use with reference to the indication
- Know basic and advanced guidance techniques (digital subtraction angiography (DSA), 3D imaging)
- Perform diagnostic angiography
- Perform angioplasty and stent placement
- Perform embolisation (arterial and venous)
- Perform basic and advanced chemoembolisation
- Perform radioembolisation
- Perform arterial or venous thrombolysis and thrombectomy
- Place access lines
- Place and retrieve superior and inferior vena cava filters
- Perform dialysis fistula interventions
- Perform foreign body retrieval
- Place closure devices

## 2.2.8 Non-Vascular Treatments

IO trainees should acquire clinical, pathological and radiological understanding of diseases and conditions requiring non-vascular treatments.

### Knowledge in IO treatments:

- Normal relevant anatomy of different organs that may require non-vascular treatment
- Typical anatomy and variants
- Clinical presentations of different diseases (acute or elective)
- Other treatment options (surgical, medical, observational) and understand when one should be preferred over the others

### Clinical skills:

- Perform non-vascular treatments in emergency or elective settings
- Know how to perform and handle imaging workup before and after non-vascular treatments
- Understand the changes that will occur in different organs parenchyma after non-vascular treatments
- Know different agents that may be injected (delivery, side effects)
- Clinical assessment of patients before and after the treatment
- Recognition and management of complications
- Accurately report key findings and treatment steps

### Technical skills:

- Plan optimal procedural access, patient positioning and relevant/optional image guidance methods
- Demonstrate competence in using the current technologies
- Plan the procedure depending on the indication
- Understand the material used for procedures (balloons, stents, drains, etc.) and know which one to use with reference to the indication
- Be able to use adjunctive procedures such as hydro-dissection, CO<sub>2</sub> dissection, ureteral stenting, etc. in order to optimise the procedural outcome
- Know basic and advanced guidance techniques
- Perform drainage (collection, bile, urinary, etc.)
- Perform nutritional procedures (gastro and jejunostomies)
- Perform conversion from drain to stent (urinary and biliary)

## 2.2.9 Emergency IR Treatments

IOs, like in other clinical branches and in IR, will need to be on-call for emergency procedures.

### Emergency procedures in IO include:

- Embolisation for gastrointestinal (GI) bleeding, tumour bleeding (liver, etc.), bronchial artery bleeding, head and neck tumour bleeds, etc.
- Biliary drainage with patients in sepsis or cholangitis
- Nephrostomy for patients with urinary sepsis
- Superior vena cava stenting for SVC syndrome
- Inferior vena cava stenting
- Inferior vena cava filter placement



**IO trainees should:**

- Have exposure to these procedures and have a sound understanding of the management of patients who are referred for these procedures
- Have competence in decision-making in situations requiring a quick response such as in cases of embolisation for bleeds

For training recommendations with regards to these procedures, please refer to the CIRSE Curriculum and Syllabus for IR [1].

## 2.2.10 Imaging

**Pre- and post-treatment, post-surgical changes, post-chemo and antiangiogenics**

Oncology patients undergo a significant amount of imaging throughout their course of treatment. They also undergo a variety of different imaging protocols and types.

**IO trainees should:**

- Have an understanding of the different imaging modalities such as US, CT scan, MR imaging, positron emission tomography (PET), PET-CT, bone scans and other radionuclide scans
- Be able to interpret pre-treatment images
- Be able to stage disease with reference to images
- Be able to interpret post-treatment images and follow-up images with reference to post-treatment sequelae
- Be able to identify local post-treatment recurrences
- Be able to interpret imaging changes in post-operative patients
- Be able to interpret imaging changes in patients on antiangiogenics

**Imaging Machines****IO trainees should:**

- Develop an understanding of the imaging machines used in the department, especially the functioning of the interventional module to help in the planning of procedures
- Know how to use technologies such as needle tracking, US fusion, interventional CT or interventional MR

**Medication**

IO involves using many medications (local anaesthetics, antibiotics, iodinated non-ionic contrast, Lipiodol, etc.) and devices (liquid embolics, internal radiation therapy spheres, etc.). Knowledge of these medications and their interactions with other drugs (namely anticancer drugs), doses, contraindications and management of toxicities is an essential part of IO training.

**IO trainees should:**

- Know how to handle these drugs
- Know how to manage the complications and toxicities of these drugs
- Know what interactions could occur
- Know what drugs can be substituted and with which drug
- Have an understanding of all medications that are made available in the department and others which may be essential in patient management

## SECTION C

# 2.3 Organ Site-Specific Oncology

## 2.3.1 Breast

### Knowledge in breast cancer:

Genetics, incidence and aetiology:

- Know worldwide incidence of breast cancer, with nearly 1.7 million new cases diagnosed each year; rare for men (~ 1% of all cases)
- Know the five-year survival rate of early stage breast cancer is 80–90%, falling to approximately 25% for metastatic disease
- Know breast cancer subtypes, hormone-related or not
- Know predisposing factors, including exposure to oestrogen and progesterone, early menarche, late menopause, not bearing children, first pregnancy over the age of 30 and ionising radiation exposure, particularly during puberty
- Know heredity of breast cancers, and association with mutations in two genes: BRCA1 (breast cancer gene one) or BRCA2 (breast cancer gene two)

Pathology, staging and common sites of metastases:

- Know rate of in situ breast neoplasia with mainly ductal carcinoma in situ (DCIS)
- Know different intrinsic subtypes of breast cancer identified with gene expression profiling techniques: the presence of oestrogen and/or progesterone hormone receptors and the level of human epidermal growth factor receptor 2 (Her2)
- Know poorer short-term prognosis of triple negative (ER-, PR-, Her2-)
- Know that overexpression of an oncogenic protein or an amplification of the Her2 gene is an independent predictor of poor prognosis and less sensitivity to endocrine therapy of Her2-enriched cancers
- Know hormone receptor-positive tumours have been shown to have a greater propensity to develop bone metastases

Systemic therapies:

- Adjuvant systemic therapy:
  - Know that adjuvant endocrine therapy reduces the relative risk of relapse and death by breast cancer in hormone receptor-positive tumours. Tamoxifen is the standard of care for premenopausal women
  - Know that for Her2-enriched cancers, trastuzumab (a monoclonal antibody against Her2 receptor) highly decreases the relative risk of relapse
  - Know that adjuvant polychemotherapy reduces the risk of early systemic relapse and the risk of death from breast cancer
  - Know that bisphosphonates also reduce the risk of relapse, but for post-menopausal women only
- Neoadjuvant treatment:
  - Know that for large tumours not suitable for conservative surgery, administration of adjuvant systemic treatment (chemotherapy +/- trastuzumab, or endocrine treatment) before surgery downstages tumour and allows breast-conserving surgery for half of the patients
- Metastatic disease:
  - Know poor median survival of triple-negative tumours versus luminal and Her2 tumours

**Surgical treatment:**

- Know basic principle of surgical management that aims to excise invasive and non-invasive cancer with clear margins
- Know that breast conserving surgery followed by radiotherapy has equivalent survival to mastectomy. Mastectomy being reserved for when breast conserving surgery is not possible (tumour size, multifocal disease, large DCIS, contra-indication to radiotherapy). Radiotherapy following mastectomy is prescribed according to nodal status and pathological tumour size
- Know that pathological axillary staging is usually achieved with sentinel lymph node biopsy guided by radionuclide or blue dye injection near the tumour and then removed to check for the presence of cancer cells
- Benefits of breast surgery are debatable in case of metastatic disease

**Knowledge of IO treatments of primary breast cancer:**

- Breast conserving surgery remains the standard of care, until now percutaneous thermal ablation has been especially proposed as a substitute to surgery for non-surgical patients, mainly elderly patients who are not suitable candidates for surgery or patients who refuse surgery

**Clinical skills:**

- Be able to acquire 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
- Understand the different classifications and staging of breast cancers and its relevance to therapy
- Understand the concept of hormone receptors (positive, negative and triple negative) and their impact on therapy
- Determine radiological staging by mammography (understand ACR BI-RADS), 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 breast cancer including chemotherapy, radiotherapy (brachytherapy), the relevance of surgical resection according to staging and the role of image-guided ablation (IGA)
- Discuss with the anaesthetist the need for sedation versus general anaesthesia and understand the advantages of each technique
- Assess the patient during and following IGA and other cancer therapies
- Be able to determine patient fitness for discharge and recognise 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 imaging before and after IGA therapy of breast malignancy
- Understand how to interpret post-ablative imaging in the breast of patients treated

**Technical skills:**

- Breast ablation is an uncommon procedure in IO as not all departments perform it and therefore the IO trainee may need to know basic knowledge of understanding and feasibility
- 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 the tumour and neighbouring vital structures such as internal mammary vessels, the anterior chest wall, the intercostal nerves, skin, etc. The skin needs to be particularly monitored and protected during the intervention
- Be able to decide which kind of ablative technology (RFA, CRYO, MWA) to use for treatment depending on the type and size of the tumour, its imaging, pathology characteristics and adjacent structures. Know HIFU which is a non-invasive and in-progress technique

- Plan the correct positioning of the electrodes/antennas/probes in the tumour to achieve optimal results
- Plan the size of the electrode/antenna/probe to use to acquire effective ablation
- Know the difference between ablation of the breast gland and other organs like lung, liver etc. to adapt the protocol for optimal breast ablation

## 2.3.2 Lung: Primary and Metastatic

### Knowledge in primary lung cancer:

Genetics, incidence and aetiology:

- Know epidemiology and evolution of lung carcinoma (small cell and non-small cell)
- Know basic figures about incidence and relevance of primary lung cancer

Pathology and staging:

- Understand the incidence and prevalence of the various types of primary lung carcinoma
- Understand the World Health Organization (WHO) classification of the different subtypes with reference to local therapies (adenocarcinomas in situ (AIS), minimally invasive adenocarcinomas (MIA), lepidic (LEP), etc.)
- Understand the relevance of imaging and pathological staging on subsequent therapeutical options

Systemic therapies:

- Know principal systemic treatment indication according to tumour stage (i.e. adjuvant therapy in early stage, multimodal therapy in stage III and palliative treatment in stage IV lung cancer)
- Know principal systemic treatment options in stage IV lung cancer including chemotherapy, targeted therapy with tyrosine kinase inhibitors and immunotherapy

Surgical treatment:

- Know the differences of the surgical options for operable lung cancer treatment (pneumectomy, anatomical and non-anatomical resections)
- Know the required cardio-pulmonary function to undergo surgery

Stereotactic radiotherapy:

- Know the relevance of SBRT in the treatment of primary lung cancer
- Know the treatment-related toxicities associated with SBRT

### Knowledge in lung metastases:

Genetics, incidence and aetiology:

- Understand the prevalence, incidence and prognostic significance of common lung metastases such as breast, kidney, thyroid, testis, colorectal, sarcoma and lung

Systemic therapies:

- Know general systemic treatment options according to origin of the primary tumour

Pathology and staging:

- See primary cancer responsible for the lung metastases
- Understand the importance of PET staging
- Know the difference between diffuse lung metastases and the emerging concept of oligometastatic diseases

**Surgical treatment:**

- Know the differences of the surgical options for metastasectomy (thoracoscopic, open)
- Know the required cardio-pulmonary function to undergo surgery
- Know the relevance of SBRT in the treatment of lung metastases
- Know the treatment related toxicities associated with SBRT

**Knowledge of IO treatments in primary lung cancer and lung metastases:**

- Understand lobar and fissure 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 relevance of any proposed IGA in primary end metastatic lung cancer in the context of survival, local recurrences, etc.
- Understand how interstitial lung disease can affect ablation or have higher risks associated with treatment
- Select and interpret appropriate laboratory and imaging investigation in order to decide for image-guided ablation therapy options relevant to patients with lung malignancy prior to intervention

**Clinical skills:**

- Be able to acquire 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 or therapy abortion
- Determine cardiorespiratory reserve and performance status with regard 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 Union for International Cancer Control (UICC) tumour, node, metastasis (TNM) staging classification of lung carcinoma and its relevance to therapy
- Determine radiological staging by CT, PET and MR where necessary
- Be able to explain the appropriateness of an 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 IGA
- Be able to decide whether a patient can undergo the intervention using local or general anaesthesia; discuss with the anaesthetist the need for general anaesthesia
- Assess the patient during and following IGA and other cancer therapies
- Be able to determine patient fitness for discharge and elicit complications following intervention and initiate relevant treatments or appropriate follow-up
- 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 therapy of lung malignancy
- Understand how to interpret post-ablative imaging in lungs of patients treated

**Technical skills:**

- Plan optimal procedural access, patient positioning and relevant/optional image guidance methods in accordance to the ALARA principle
- Be able to use separation techniques to help create a buffer zone between the tumour and neighbouring vital structures such as pleura, mediastinum and diaphragm (e.g. artificial pneumothorax/hydrothorax, pneumomediastinum)

- Be able to decide which kind of ablative technology (MWA, RFA, CRYO, IRE) to use for treatment depending on the type and location of tumour, its size and its imaging, pathology characteristics and adjacent structures (vascular, bronchi, mediastinal structures, nerves and heart)
- Plan the correct positioning of the electrodes in the tumour to achieve optimal results with the least possible complications
- Plan the size of the electrode to use and the number required to receive acquired ablation effect
- Know when and how to avoid pleural burns
- Know when to do a prophylactic infiltration of long acting local anaesthetic to prevent pain due to pleural burns
- Decide when to treat bilateral disease in the same setting or in a second setting
- Recognise the differences between the lung and parenchymal organs such as liver and kidney in terms of thermal and electrical conductivity which result in differences in ablation times and protocols
- Be able to recognise intra-procedural pneumothorax or haemorrhage as soon as possible and be able to establish appropriate management by aspiration, placement of a chest tube, embolisation or consultation of surgical colleague for adequate treatment

### 2.3.3 Upper GI: Stomach and Oesophagus

#### Knowledge in upper GI cancer:

##### Stomach

##### Genetics, incidence and aetiology:

- Have knowledge about the various types of gastric cancer (see below) and be able to discriminate between cancers of the oesophagus, including cancer of the esophagogastric (EG) junction
- Have knowledge about the incidence and prevalence of the various types and the regional variations thereof
- Have knowledge about the main causes and risk factors for gastric cancer, such as helicobacter pylori for the distal stomach cancer, as well as age, low social/economic status, smoking, alcohol abuse, hereditary factors, history of stomach surgery, pernicious anaemia, living in a high-risk population, nutritional and environmental factors. Although hereditary factors do play a role as a risk factor (and peak with the hereditary diffuse gastric carcinoma and Lynch syndrome), the contribution of genetic risk factors is believed to be low compared to the acquired risk factors as listed above.
- Have knowledge about screening and prevention programmes and the role of H.pylori eradication as prevention
- Understand the role of endoscopy in the detection of gastric cancer
- Realise that gastric cancer is frequently diagnosed in an advanced stage of disease without the option for curative resection
- Realise that gastric cancer shows a high rate of disease relapse (local, lympho-nodal, organ metastases) after curative intended resection
- Realise that the prognosis is low with a 5-year survival rate of approximately 30% over all stages

##### Pathology and staging:

- Know the different histopathologic types of gastric cancer: adenocarcinoma (~70%), undifferentiated carcinoma (~20%), signet cell carcinoma (~10%), in rare cases adenosquamous, or squamous carcinoma and other entities (neuroendocrine or GIST); know the Lauren classification (dividing the gastric carcinoma into the intestinal type - circumscribed tumour growth) and the diffuse type (diffuse tumour growth) and the implication on the prognosis
- Have knowledge of the tumour classification/staging according to the TNM classification of UICC
- Have knowledge of the diagnostic work up, including endoscopy/endoscopic ultra-sonography (EUS), US of the liver, thoracoabdominal CT ± abdominal magnetic resonance imaging (MRI) and the need for diagnostic biopsy in case of suspected metastases

- Have knowledge of prognostic factors such as tumour location, tumour type, infiltration depth, locoregional lymph node metastases, resection margin, vascular invasion and Her2/neu expression

#### Systemic therapies:

- To understand which patient qualifies for a neoadjuvant chemotherapy (locally advanced and irresectable cases to reach for resectability and in T3 and T4a to increase efficacy) and palliative chemotherapy (in case of locally advanced/irresectable gastric cancer and in case of metastases) and to know that there is no evidence for an adjuvant chemotherapy
- To understand the role of Her2/neu status
- To understand the role of chemoradiotherapy in case of irresectable but locally confined gastric cancer

#### Surgical treatment:

- To understand that resection is the only curative option for T1 – T4a gastric cancers aiming on R0 resection (mainly through gastrectomy), including regional lymph node resection. Secondary resection after neoadjuvant treatment of initially non-resectable gastric cancers is under evaluation
- To understand the role of endoscopic resection in superficial gastric cancer which is confined to the mucosa
- To understand that palliative resection (except for otherwise non-treatable tumour bleeding) is not indicated; stent implantation, palliative radiotherapy and bypass operation is preferred in symptomatic patients
- To understand that metastasectomy (except for regional lymph node resection) is not validated
- Know that interventional tumour ablation of metastatic disease is not validated and that, based on the dynamics of metastatic gastric cancer, local ablation is usually not effective. Understand the role of multidisciplinary cooperation in order to identify eligible (oligometastatic) patients

## Oesophagus

#### Genetics, incidence and aetiology:

- Have knowledge about the types of oesophageal cancer (squamous cell carcinoma and adenocarcinoma) and realise that cancer of the esophagogastric junction belongs to oesophagus cancer
- Have knowledge about the incidence and prevalence of the various types and the regional variations thereof
- Have knowledge about the main causes and risk factors for oesophageal cancer with respect to the histopathologic subtype:
  - smoking, alcohol abuse, previous head and neck cancer, previous cervico-thoracic radiotherapy, achalasia and acid/base injury to the oesophagus for squamous cell carcinoma
  - achalasia, smoking, history of acid/base injury to the oesophagus, adiposity, reflux, hiatal hernia, and Barrett oesophagus for adenocarcinoma
- Understand the role of endoscopy in the detection of oesophageal cancer
- Realise that oesophageal cancer is frequently diagnosed in an advanced stage of disease

#### Pathology and staging:

- Have knowledge on different histopathologic types of oesophagus cancer (adeno-carcinoma vs squamous cell carcinoma vs rare entities) and the association of histopathologic type and location (adenocarcinoma distal, squamous cell carcinoma proximal/mid oesophagus)
- Have knowledge on the most recent tumour classification/staging according to the TNM classification of UICC and the high prognostic value of the TNM
- Have knowledge on the diagnostic work up, including endoscopy/EUS, thoracoabdominal CT ± cervical CT (depending on tumour location), FDG PET CT (in patients with >T2 tumours) and bronchoscopy in patients with tumours adjacent to the tracheobronchial tree
- Have knowledge on the prognostic value of Her2/neu expression in adenocarcinoma of the oesophagus



#### Systemic therapies:

- Know that weight loss (mainly due to dysphagia) is associated with low tolerability/adherence to systemic therapy, thus facilitation of nutrition via percutaneous endoscopic gastrostomy (PEG) (via endoscopy or via image guidance) is important
- Know the prognostic value and therapeutic implications of Her2/neu expression
- Know that in non-metastatic disease systemic chemotherapy is usually accompanied by radiotherapy of the primary, for example:
  - as neoadjuvant treatment of resectable (T2 optional) T3 and T4 oesophageal carcinoma (with the exception of adenocarcinomas where chemotherapy alone can be recommended as well)
  - for the treatment of local recurrences after resection or
  - as adjuvant chemoradiotherapy after resection of adenocarcinomas of the EG junction in patients without neoadjuvant treatment or
  - as definitive chemoradiotherapy in patients with non-resectable tumours (technical and/or functional) without distant metastases
- Further on, it should be realised that chemoradiotherapy can serve as a valuable alternative to resection as
  - definitive chemoradiotherapy in patients with resectable T3/T4 squamous cell carcinomas without distant metastases
  - definitive chemoradiotherapy in patients with squamous cell carcinomas of the cervical oesophagus
- Know that palliative chemotherapy is indicated in the metastatic stage of disease as well as in the otherwise non-controllable local tumour progression

#### Surgical treatment:

- Realise that besides definitive chemoradiotherapy of squamous cell carcinomas and endoscopic resection of high-grade intraepithelial neoplasia and mucosal carcinomas, resection is the only curative treatment option
- Know that the aim of surgical resection is a complete resection of the primary, as well as a regional lymphadenectomy
- Realise that T4a tumours (infiltration of pleura, diaphragm, pericard) are deemed resectable, whereas T4b tumours (infiltration of aorta, vertebra or trachea) are deemed non-resectable. If metastases are present a resection cannot be recommended
- Know that guidelines recommend that oesophageal resections are only to be performed in high turnover centres
- Realise that pre-operative weight loss/low body mass index (BMI) is associated with post-operative complications and mortality
- Have knowledge on the possible types of reconstruction after oesophageal resection and know about the surgical approach (based on the location, a transthoracic or transhiatal resection)
- Realise that cervical oesophagus resection is associated with a high morbidity/complication rate, thus definitive chemoradiotherapy should be preferred (see above)
- Understand that after R1 resection post-operative chemoradiotherapy is usually indicated
- Know that pre-operative chemotherapy or chemoradiotherapy in  $\geq$  (optional) and  $>$  (mandatory) T2 adenocarcinomas is recommended
- Know that pre-operative chemoradiotherapy in  $\geq$  (optional) and  $>$  (mandatory) T2 squamous cell carcinomas is recommended
- Understand that a restaging after neoadjuvant treatment, and prior to resection, is mandatory
- Know that irresectable tumour stenting and intraluminal brachytherapy are efficient to alleviate dysphagia
- Know that interventional tumour ablation of metastatic disease is not validated and that based on the dynamics of metastatic oesophageal cancer, local ablation is usually not effective.
- Understand the role of multidisciplinary cooperation in order to identify eligible (oligometastatic) patients



**Clinical skills:**

- Demonstrate skill in history taking and physical examination with reference to upper GI cancers
- Describe the signs and symptoms of these disease processes
- Perform a directed history and physical examination in patients with suspected upper GI tract tumour
- Understand available surgical and medical treatment options in patients with upper GI cancer
- Work within a multidisciplinary team to optimise patient care in this population, especially with regard to identification of the small subset of patients eligible for an interventional therapy
- Consult with patients and their families regarding treatment options, risks and benefits of interventional oncologic therapies and other interventional techniques (bleeding embolisation, gastrostomy)
- Understand how previous visceral surgery will bear upon proposed interventions in terms of altered anatomy
- Have knowledge on the risk of significant tumour bleeding of advanced gastric cancer and understand that origin of bleeding might derive either from vessel erosion/pseudoaneurysms or from direct diffuse tumour bleeding. Understand the role of CT angiography to identify the source of bleeding
- Understand the role of tumour embolisation of gastric cancer for bleeding control
- Understand the importance of facilitation of nutrition through gastrostomy (via endoscopy or through image guidance) in order to optimise treatment results of both systemic and surgical therapy in patients with oesophageal cancer

**Technical skills:**

- Have knowledge on the vascular anatomy and the various anastomoses in the upper GI tract
- Know the use of microcatheters and micro-guidewires for superselective embolisation
- Know which size of particles can be used for tumour embolisation to diffuse gastric cancer bleeding in order to optimise bleeding control and to minimise ischemic complications
- Know how to embolise macroscopic bleedings in the upper GI tract (due to vessel erosion, pseudoaneurysms) with the use of microcoils. Have knowledge on the importance to embolise distal and proximal to the bleeding due to possible retrograde distal perfusion through collaterals
- Be familiar with techniques of image-guided gastrostomy and be familiar with the different available systems
- Be able to place a gastrostomy with and without assistance of a nasogastric tube
- Understand the role of peri-interventional antibiotics in gastrostomy placement

## 2.3.4 Hepatic: Primary and Metastatic

**Knowledge in primary liver cancer:**

## Genetics, incidence and aetiology:

- Learn the main causes of primary liver cancer (including hepatocellular carcinoma (HCC), intrahepatic cholangiocarcinoma) and the difference in their incidence across geographical regions
- Know the causes of cirrhosis and implications for therapy in patients with co-existing hepatic malignancy

## Pathology and staging:

- 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
- Have thorough knowledge of the clinical staging systems of HCC and cirrhosis (e.g. Barcelona Clinic Liver Cancer (BCLC) system, Child-Pugh class, MELD score and LI-RADS classification)

**Systemic therapies:**

- Know the indication and main toxicities of systemic therapies for HCC (sorafenib, lenvatinib, regorafenib, cabozantinib and nivolumab) and intrahepatic cholangiocarcinoma (cisplatin, gemcitabine)

**Surgical treatment:**

- Understand the role of liver transplantation in the management of HCC, including the Milan criteria
- Understand the role of liver resection in the management of HCC and intrahepatic cholangiocarcinoma and the impact of portal hypertension and liver functional reserve in tumour resectability

**Knowledge in liver metastases:****Genetics, incidence and aetiology:**

- Learn which primary tumours tend to produce liver metastasis including colorectal, breast and renal cell carcinoma and neuroendocrine tumours

**Pathology and staging:**

- Understand the therapeutic implications of the main genetic alterations observed in colorectal carcinoma and breast cancer (see specific section)
- Understand the TNM staging system in patients presenting with metastatic liver disease in terms of indications for treatment
- Understand the histological grading of neuroendocrine tumours

**Systemic therapies:**

- Learn the main chemotherapeutic regimes, targeted agents and hormonal interventions used for the treatment of colorectal, breast and renal cell carcinoma and neuroendocrine tumours
- Learn the mode of action and indications of PRRT radioactive somatostatin analogues

**Surgical treatment:**

- Understand the place of surgical management of liver disease by traditional resection or in combination with ablative therapies
- Understand the impact of liver resection on the prognosis of patients with liver metastasis
- Understand the liver volumetry and functionality that impact the possibility of liver resection in healthy liver and steatosis liver
- Know potential toxicity of chemotherapy in liver function

**Knowledge of IO treatments in primary and metastatic cancer of the liver:**

- Know hepatic, fore- and midgut vascular anatomy. Understand variant hepatic vascular anatomy and intrahepatic segmental anatomy relevant to liver disease from the viewpoint of intra-arterial therapy and surgical resection
- Understand and look for parasitisation of blood supply to hepatic tumours prior to or as a consequence of intra-arterial therapy
- Understand the alterations of hepatic anatomy caused by Budd Chiari syndrome, cirrhotic disease and large volume, indolent intrahepatic malignant disease
- Understand how the malignant process within the liver can alter hepatic blood supply and the bearing this will have on vascular and non-vascular interventions
- Understand the relations between the liver and other structures (such as extrahepatic bile ducts, gallbladder, bowel, diaphragm and body wall) and their bearing on any proposed intervention
- Understand the process of development of metastatic malignancy in the liver with particular reference to tumour vascularisation and its bearing on appropriate therapies, both vascular and non-vascular
- Demonstrate skill in history taking and physical examination with reference to metastatic and primary malignant liver disease

- 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
- 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 including the role of PET-CT and contrast agents used in imaging hepatic malignancy
- Be able to describe strategies for imaging of patients with hepatic malignancy including algorithms for metastatic colorectal disease and metastatic neuroendocrine tumours (including gut carcinoid)
- Have an understanding of assessment for anaesthetic risk and patient performance status to independently determine patient fitness with regard to undertaking interventions and thereby to determine the appropriateness of any such intervention
- Be able to balance the relative merits of various oncologic interventions in the setting of metastatic colorectal disease, neuroendocrine disease and primary hepatic malignancy besides other metastatic disease processes
- Have an understanding of the relative merits of adjunctive treatments such as embolisation and chemoembolisation prior to IGA therapy
- 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
- Identify tumour types that respond well to chemoembolisation and/or radioembolisation
- Identify tumours that will respond to intra-arterial chemoperfusion
- Identify patients at high risk for infectious complications following chemo/radioembolisations and/or chemo/radioablations and strategies to prevent them
- Understand pre- and post-procedure care for chemo/radioembolisation, intra-arterial perfusion and ablation patients
- Understand the role of various imaging studies (CT, MRI, PET and US) in the post-operative follow-up period and be able to interpret responses to therapy

### **Technical skills:**

#### **Technical skills in vascular hepatic interventions:**

- Know the indications and absolute and relative contraindications to chemo/radioembolisation
- Demonstrate technical competence in performing lobar, segmental and targeted embolisation therapy
- Know the different types of catheters, guidewires and sheaths available to make access easier
- Know the use of microcatheters and micro-guidewires for superselective treatments (especially chemoembolisation)
- Know when to use TACE and when to use drug-eluting microsphere (DEM) TACE
- Know how to protect adjacent structures (duodenum, stomach, skin, etc.) during radioembolisation
- Know the differences between radioembolic microsphere in terms of size, materials and isotope
- Understand how to plan a dose for radioembolisation
- Know when a single lobar treatment needs to be done and when both lobes can be treated simultaneously
- Understand the concept of radiation segmentectomy
- Know which size of beads to use in which size of tumours
- Know which chemotherapy to charge the beads with depending upon the tumour
- Understand the difference between conventional TACE (cTACE) and DEM TACE
- Understand the concept of bland embolisation for neuroendocrine metastases
- Be able to manage tumour bleeds (intra- and extratumoural)

**Technical skills in non-vascular hepatic interventions:**

- Demonstrate competence in the current technologies available in IGA therapy including ethanol, radiofrequency and MWA
- Understand the evolving technologies in this area including cryotherapy and irreversible electroporation (IRE)
- 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 therapy in specific locations may cause injury to non-target areas such as the diaphragm, bowel, stomach and major bile ducts and know strategies to reduce these risks and to perform IGA therapy 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 CO<sub>2</sub>)
- Be able to recognise intraoperative and post-operative complications of IGA therapy and undertake the appropriate investigation and management of complications such as haemorrhage, infection and GI perforation

### 2.3.4.1 Pre-Operative Portal Vein Embolisation

**Knowledge in pre-operative portal vein embolisation:**

- 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 PVE followed by liver surgery
- Understand the concept of anticipated FLR volumes prior to major hepatectomy and the concept of flow redistribution related hypertrophy of the liver
- Understand the changes in liver post-chemotherapy and its relevance to PVE

**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 tests and other parameters useful in classifying neoplastic liver disease
- Demonstrate a fundamental knowledge of the surgical strategies in the management of liver tumours and indications for PVE 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, previous systemic chemotherapy, concomitant extrahepatic disease)
- Know how to calculate the need for larger FLR in patients who have undergone multiple chemotherapy regimens and/or radiotherapy
- 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 subscapular haematoma, haemoperitoneum, haemobilia, arteriovenous fistula formation and sepsis
- Demonstrate knowledge of clinical post-procedural management of patients undergoing PVE

## 2.3.5 Biliary Cancer

### Knowledge in biliary cancer:

#### Genetics, incidence and aetiology:

- Realise that cholangiocellular carcinoma is rare contributing to 0.5-1% of all neoplasia
- Know that risk factors for a cholangiocellular carcinoma are: cholangitis, PSC, hepatolithiasis, high BMI, Caroli disease, as well as chronic inflammation of the biliary tree due to parasites
- Know the most common cause of biliary obstruction linked with cancer

#### Pathology, staging and common sites of metastases:

- Know that >90% of cholangiocellular carcinomas are adenocarcinomas
- Understand that cholangiocellular carcinomas are categorised into intrahepatic (usually mass forming) and extrahepatic tumours, the latter being further categorised into proximal/perihilar (Klatskin tumours) and distal tumours
- Understand the classification of cholangiocellular carcinomas with Bismuth classification valid for extrahepatic proximal (Klatskin) tumours and TNM classification valid for the other tumour locations
- Have knowledge on the diagnostic work-up, including endoscopy/endoscopic retrograde cholangiography (ERC), EUS (in distal extrahepatic tumours), MRI/magnetic resonance cholangiopancreatography (MRCP), thoracoabdominal CT and FDG PET-CT
- Have knowledge on common sites of metastases such as liver metastases (with satellite metastases in the mass for cholangiocellular carcinoma), regional lymph node metastases in the liver hilum, mediastinal and retroperitoneal lymph node metastases, bone metastases, and peritoneal seeding
- Know the current classification for cholangiocarcinoma and biliary obstruction (TNM, Bismut)
- Understand the concept of biliary drainage and biliary stenting: indications, limitations and complications
- Have knowledge of when to perform an internal-external drainage and when to limit it to external drainage alone

#### Systemic therapies:

- Understand that options for palliative/systemic treatment are very limited in cholangiocarcinoma with only one validated chemotherapeutic regimen (gemcitabine/cisplatin)
- Understand that adjuvant therapy with oral fluoropyrimidine is an option in cholangiocarcinoma

#### Surgical treatment:

- Understand that complete resection is the only curative treatment option
- Realise that only a minor proportion of patients are eligible for resection (~ 25%)
- Realise that the 5-year survival rate after resection is low with 20-40%, indicating a high a rate of disease relapse

**Clinical skills:**

- Demonstrate skill in history taking and physical examination with reference to cholangiocarcinoma and metastatic biliary obstruction
- Describe signs and symptoms of malignant biliary obstruction
- Demonstrate skill to identify biliary sepsis and know when to intervene effectively to avoid severe morbidity and mortality
- Know how to identify acute cholangitis secondary infection in an obstructed (completely or partially) or non-dilated biliary system
- Know how to identify cholangitis and cholestasis on serum biochemistry results
- Be able to discuss with patients and their family members the approach to management of the situation and the long-term plan (e.g., stenting, etc.)
- Know how to interpret MRCP, MRI, CT scans and US for biliary structures
- Knowledge of biliary anatomy and the variations with relation to portal vein and hepatic artery variations
- Understand biliary obstruction secondary to primary disease, metastases, pancreatic head tumours and surgical resection and anastomoses
- Know how to identify metastatic disease
- Know how the procedure will affect future therapies (chemotherapy, surgery, ablation or chemoembolisation/radioembolisation, etc.)
- Know how the effects of previous therapies (surgical resection, PVE, chemoembolisation, recent chemotherapy, etc.) will affect the outcome of the procedure

**Technical skills:**

- Demonstrate knowledge and understanding of safe biliary puncture
- Show competence in decision-making in which lobar duct to access in order to achieve the best drainage
- Be competent at ultrasound-guided puncture of intrahepatic biliary radicals (dilated or non-dilated)
- Know how to access an intrahepatic biliary radical under fluoroscopic guidance
- Have an understanding and knowledge of sheaths, guidewires, catheters, endobiliary biopsy forceps (cardiotomy or punch biopsy forceps), different types of internal-external drains and/or external drains
- Understand the concept of a rendezvous with ERC through biliary drainage
- Have knowledge of the types of stents available and when to use covered, partially covered, uncovered or removable stents
- Recognise trauma to the adjacent vascular structure (portal vein or hepatic artery branch) with haemobilia
- Demonstrate knowledge of how to manage complications secondary to biliary interventions

## 2.3.6 Renal Cancer

**Knowledge in renal cancer:**

Genetics, incidence and aetiology:

- Know that familial renal cancer incidence represents 2-3% of all cancer and accounts for only a small percentage of overall renal cancer cases. It is likely that other undiscovered genes along with background genetic and non-genetic factors contribute to the development of familial renal cell cancer
- Know the peak incidence of renal cancer is between 60 and 70 years of age
- Have knowledge of syndrome diseases such as von Hippel-Lindau syndrome (VHL) and other hereditary renal cancers where ongoing renal cancer management is an issue
- Understand the aetiology and clinical manifestations of renal cancer

Pathology, staging and common sites of metastases:

- Know WHO and TNM classification of renal cancer comprises a wide spectrum of histopathological entities with the three main renal cell cancers: clear cell (nearly 75% of cases), papillary (~ 15%) and chromophobe (~ 5%). Collecting duct carcinoma (urothelial cancers) (<1% of cases) are a separate identity and are not amenable to IR treatments
- Know the anatomical classification systems (PADUA, RENAL nephrometry score, ABLATE, etc.) assessing the tumour size, localisation (endophytic/exophytic, pole location) and proximity to the renal sinus and collecting system that are further used to predict morbidity of surgical and percutaneous ablation treatments
- Know renal cell cancer metastasises in two basic patterns: haematogenous and lymphatic. Common sites of metastasis include lung, bone, lymph node, adrenal gland, liver, contralateral kidney, brain and thyroid

Systemic therapies:

- To know systemic therapies are proposed for metastatic/advanced renal cell cancer (immunotherapy, anti-angiogenesis agents, etc.)

Surgical treatment:

- Understand surgical techniques such as radical nephrectomies, partial nephrectomies, laparoscopic minimal access guided surgeries and their outcomes, complications and how they are seen on imaging (CT, MR or ultrasonography)

#### **Knowledge of IO treatments of renal cancer:**

- 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
- 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 therapy to cause vascular, pelvicalyceal, urethral or collateral organ injury
- Understand ablative technologies available (RFA, CRYO, MWA) in order to define the optimal one for the given tumour with reference to complete ablation and low complication rate
- Devise a plan with the referring clinician for patient follow-up with imaging, laboratory tests and clinical evaluation in order to assess treatment success and detect disease recurrence or new lesions

#### **Clinical skills:**

- Be able to acquire a clinical history and physical examination relevant to renal cancer and carry out an assessment of patient fitness for the proposed intervention
- Be able to discuss with the patients and the relatives the procedure and the associated risks (short-term, mid-term and long-term) involved with the procedure
- Be able to evaluate the risk of renal failure in patients with unique kidneys
- Have an understanding of assessment for anaesthetic risk and patient performance status
- Be able to assess imaging and staging investigations performed for renal cancer (MRI, CT, US)
- Understand the radiological features relevant to renal cancer and its differential diagnosis and recognise the features which would influence proposed resection

#### **Technical skills:**

##### **Technical skills in renal cancer ablation:**

- Demonstrate competence in the available ablation technologies including CRYO, RFA and MWA
- Plan optimal procedural access to the tumour, patient positioning and relevant/optional image-guidance methods



- Plan the size and number of radiofrequency electrodes, cryo-probes or microwave antennas that are necessary to achieve a satisfactory ablation zone according to the tumour size, location and vascularity
- Discuss with the anaesthetist the need/advantages of general anaesthesia/sedation and the utility of jet ventilation
- Understand associated interventions (e.g. embolisation) that can be performed to improve the outcome of IGA
- Recognise that energy-based image-guided ablation therapy in specific locations may cause injury to non-target areas (bowel, duodenum, pancreas, adrenal glands, ureter, etc.)
- Be able to use the different thermal insulation (hydro-, CO<sub>2</sub>- and balloon-dissection, as well as pyeloperfusion) in order to protect the surrounding structures at risk
- Be able to recognise intra-operative and post-operative complications of IGA therapy and undertake the appropriate investigation and management of complications such as haemorrhage, infection, urinomas, ureteral strictures and digestive fistulas

**Technical skills in vascular renal cancer:**

- Know the indications of palliative embolisation and arterial embolisation in combination with thermal ablation techniques
- Demonstrate technical competence in performing targeted selective embolisation
- Know the different types of catheters, guidewires, microcatheters and sheaths available to make access easier
- Know the different embolic agents that can be used

## 2.3.7 Prostate Cancer

**Knowledge in prostate cancer:**

Genetics, incidence and aetiology:

- Know the incidence of prostate cancer and that it is the second most common cancer diagnosed in men, accounting for approximately 15% of all cancers diagnosed
- Know that even if a genetic predisposition of the disease is suspected, true hereditary forms of the disease are rare

Pathology, staging and common sites of metastases:

- Know that approximately 95% of prostate tumours are adenocarcinoma originating from the glands. The remaining 5% are made up of other types originating from the transitional cells of the urethra, support tissue (sarcomas) or lymphoid tissue (lymphoma)
- Know the TNM classification and staging system
- Know prostate cancer metastasises distally in two basic ways: haematogenous and lymphatic. Distant metastases often affect the skeleton (spine, flat bones, humerus and femur)
- Know the role of active surveillance in patients with clinically localised prostate cancer in order to avoid or delay the side effects of treatment without compromising survival

Systemic therapies:

- Know hormonal therapy

Surgical treatment:

- Know indication and side effects of radical prostatectomy (open, laparoscopic or robot-assisted)

Non-surgical local treatments:

- Know the potential of curative treatment of localised prostate cancer with radiation therapy with external beam radiation therapy or brachytherapy
- Know the potential of curative treatment with cryotherapy under transrectal ultrasound (TRUS) or MR guidance
- Know the potential of curative treatment with HIFU



**Knowledge of IO treatments in prostate cancer:**

- Understand zonal and vascular anatomy of the prostate gland
- Understand the pathophysiological processes affecting the prostate
- Understand the incidence and aetiology of prostate cancer
- Understand the spread and evolution of prostate cancer
- Understand metastatic prostate cancer disease
- Be familiar with the different probes and needles/biopsy devices used for biopsies (TRUS-guided and MRI guided)
- Understand the concept of multiple zones sampling during biopsies for malignancy and mapping of the prostate gland

**Clinical skills:**

- Understand the clinical presentation of prostate cancer and the importance of prostate specific antigen (PSA), digital rectal examination (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 TRUS
- 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 multidisciplinary team meetings
- Be familiar with the set-up and role of IR in brachytherapy
- Understand the indications and limitations of brachytherapy
- Understand and list the complications of brachytherapy
- Be familiar with the role of cryotherapy in percutaneous transperineal ablation of the prostate gland
- Understand the indications, limitations and complications of cryotherapy of the prostate gland
- Be familiar with the setup and role of IR in HIFU
- Understand the indications and limitations of HIFU
- Understand and list the complications of HIFU
- Have a good knowledge of the follow-up protocols
- Be familiar with and understand other minimally invasive treatment modalities like laser ablation and IRE
- 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
- Competence in guidance for brachytherapy implants
- Know how to plan for cryotherapy of prostate gland
- Be able to plan the number and type of electrodes needed and where to position them
- Know how to create a separation plane between the rectum and the prostate to avoid rectal complications
- Understand how to protect the urinary bladder during ablation procedures
- Know how to monitor the progress of the ice ball and when to stop
- Understanding of planning for HIFU and how to place the probe for tumour ablation
- Understanding and planning for laser ablation
- Know how many laser fibres will be needed and where to place them to achieve an effective and complete ablation

## 2.3.8 Musculoskeletal Cancer

### Knowledge in musculoskeletal cancer:

- Know the anatomy of long bones, pelvic bones and the spine and their relation to surrounding muscles, soft tissues, vascular structures, nerves, spinal cord 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 therapy
- Know benign bone tumours, especially those that can be treated with ablation
- 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 therapy in these cases
- Recognise the progressive features of bone metastases in the appropriate clinical setting, depending on the type and stage of primary tumour
- Understand the pathophysiology of osteoporosis, haemangioma benign tumours and neoplastic disease as it relates to the spine
- Understand bone repair and changes post-radiotherapy of vertebrae
- Understand how to approach soft tissue extensions of bone lesions

### Clinical skills:

- Be able to acquire 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, including non-invasive testing (imaging, physical findings and past surgical history) to identify symptomatic levels in vertebral pain
- Appropriately identify patients with symptomatic vertebral body compression fracture (VBCF)
- Know the classification of benign and malignant bone tumours
- 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, contraindications and risks of IGA therapy, cementoplasty and percutaneous osteosynthesis according to the location, type and extent of bone disease
- 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
- Know the indications for percutaneous vertebroplasty 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, in an effort to identify patients who may benefit from vertebroplasty
- Identify patients who might benefit from ablation (MWA, RFA, CRYO or laser) with or without vertebroplasty
- Know when an embolisation is indicated before ablation or surgery
- 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 contraindications
- 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 and refer the patient to the anaesthesia clinic for pre-procedure assessment
- Be able to place oncologic and palliative interventions for metastatic disease in their appropriate clinical place alongside medical treatment, radiotherapy and surgical interventions
- Know which patients with metastatic disease need to be addressed for radiotherapy before or after the procedure. Discuss with the radiotherapy team prior to treatment for better planning
- Understand when the patient may need a surgical intervention immediately after treatment (such as laminectomy post sclerotherapy for vertebral haemangiomas)
- Be familiar with interventional equipment used including cements and cement delivery systems, needles, vertebroplasty-vertebral height enhancing devices (stents, peek cages, etc.) and X-ray screening facilities
- 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 visual analogue scale (VAS) score in evaluating the response of pain to IGA therapy of bone lesions

**Technical skills:**

- Plan optimal procedural access to vertebra and other bones, 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 anaesthesia according to the type of procedure planned, the site and extent of the disease
- Be able to use separation techniques to help create a buffer zone between tumour and neighbouring vital structures (e.g. hydrodissection or dissection with CO<sub>2</sub>)
- Recognise the need to place thermocouples to monitor the temperature of sensitive structures during ablative procedures
- Recognise bone lesions at risk of fracture and understand when to perform IGA therapy with cementoplasty in order to provide additional structural support
- Know the type of ablation (laser, MWA, RFA and CRYO) technique optimal for the bone lesion with reference to the position of the lesion, the size of the lesion and the adjacent sensitive structures
- Know how to place osteosyntheses in the pelvic bones, neck of femur, sacrum and scapula
- Plan the placement of screws in optimal positions and be able to decide on the number of screws required
- Know the type and size of screws to place
- Be able to decide if there is a need to inject cement along with the screws
- Be able to recognise intra-procedural and post-procedural complications and arrange interventional radiological management if appropriate
- Be able to monitor motor and sensory functions of the extremities in order to rule out neural damage after ablation of lesions close to major nerve bundles
- Be familiar with all measures to protect and monitor sensitive neural structures in the spine (including active and passive thermoprotection by means of air or CO<sub>2</sub> injection, thermocouples, evoked potentials, etc.)
- Be familiar with sclerotherapy for vertebral haemangioma, how to use sclerogel
- To know how to monitor the patient for need of emergency decompression, or plan for simultaneous decompression procedure after the sclerotherapy
- Be aware of when to plan a vertebroplasty after a sclerotherapy procedure

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

Soft tissue tumours such as desmoids, sarcomas and lymph node metastases are not often treated at all centres but a basic knowledge of these and their management is important.

### Desmoid Tumours

#### Knowledge of desmoid tumours:

- Know and understand the anatomy of structures around desmoid tumours
- Know how desmoid tumours grow and the types
- Know the gene mutations and the risk of recurrence associated with them
- Know when to treat lesions

#### Clinical skills:

- Be able to acquire an appropriate clinical history and perform relevant clinical examinations prior to intervention
- Identify patients who will benefit from treatment (symptomatic patients, patients with growing lesions, etc.)
- Know the correct imaging technique to use (MR, CT, etc.)
- Identify mutations in the patient
- Identify Gardner syndrome
- Discuss with the oncologist the best possible option for the patient and possible outcomes
- Know how to protect the adjacent sensitive structures such as nerves, vessels and hollow viscera
- Know how to explain to the patient and their family about the type of treatment and the possible risks for the patient

#### Technical skills:

- Know which ablation technique to use (CRYO, RFA)
- Know how to use hydrodissection or dissection with CO<sub>2</sub> to protect adjacent structures
- Know and explain to the patient what to expect after the treatment, including how long the pain will last
- Know how and where to correctly place the needles to get optimal ablation
- Define if the treatment is with curative intent or to treat symptoms
- Know how to manage the post-treatment period

### Lymph Nodes

#### Knowledge of lymph nodes:

- Know the type of primary tumour
- Know how to triage the indications for treatment of metastatic lymph nodes with regard to which patients will benefit from this treatment, from either symptomatic relief or curative intent
- Demonstrate knowledge of how to avoid adjacent structures and isolate the lymph node

#### Clinical skills:

- Know in which cases patients will benefit from treatment
- Know where a curative therapy can be attempted and in which case a symptomatic response will be the best result
- Discuss the best possible option with the rest of the cancer-treating group (surgeon, oncologist, radiotherapist, etc.)
- Know the best imaging option for follow-up scans (MR, CT, PET, etc.)

**Technical skills:**

- Know which ablative technique to use
- Know where to place the needles
- Know how many needles to place
- Know when and where hydrodissection or CO<sub>2</sub> dissection is essential and effective

## 2.3.10 Endocrine Malignancies (Thyroid, Adrenal and Pancreatic)

### Thyroid

**Knowledge in the thyroid gland:**

- Understand the anatomy of the thyroid gland along with the anatomic variants
- Understand the anatomy of the arterial, venous and recurrent laryngeal nerve
- Understand the anatomy of sensitive structures adjacent to the thyroid gland
- Understand the incidence and prevalence of the various types of thyroid cancer
- Understand the effect of thermal ablation on the adjacent structure and the adverse effects of thermal ablation
- Understand the patient risk groups for thyroid cancers

**Clinical skills:**

- Be able to acquire 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
- Understand the TNM, WHO and histology-based staging classification of thyroid carcinoma and its relevance to therapy
- Determine radiological staging by radioactive isotope scan, 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 thyroid carcinoma including radioactive isotope therapy, radiotherapy, the relevance of surgical resection according to TNM staging and the role of IGA
- Discuss with the anaesthetist the need for sedation versus general anaesthesia and understand the advantages of each technique
- Assess the patient during and following IGA and other cancer therapies
- Be able to determine patient fitness for discharge and recognise 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 imaging before and after IGA therapy of thyroid malignancy
- Understand how to interpret post-ablative imaging of the thyroid and neck of patients

**Technical skills:**

- Thyroid ablation is an uncommon procedure in IO as not all departments perform it and therefore the IO trainee may need to have basic knowledge of understanding and feasibility
- 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 the tumour and neighbouring vital structures such as the recurrent laryngeal nerve, carotid artery, internal jugular vein, pleura, trachea and mediastinum in the case of large tumours

- Be able to decide which kind of ablative technology (RFA, CRYO) to use for treatment depending on the type and size of tumour, as well as its imaging, pathology characteristics and adjacent structures (vascular, bronchi, mediastinal structures, nerves and heart)
- Plan the correct positioning of the electrodes in the tumour to achieve optimal results
- Plan the size of the electrode to use to acquire effective ablation
- Know the specificities of ablation of the thyroid gland to adapt the protocol for optimal thyroid ablation

## Adrenal

### Knowledge in the adrenal gland:

- Understand the anatomy of the adrenal gland
- Understand the anatomy of the arterial and venous systems
- Understand the incidence and prevalence of the various types of adrenal tumours depending on the histology and secretory nature
- Understand the effect of thermal ablation on the adjacent structure and the adverse effects of thermal ablation
- Understand the effect of treatment of metastases to the liver

### Clinical skills:

- Be able to acquire 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
- Understand importance of genetic testing in patients with MEN 1, MEN 2, von Hippel-Lindau (VHL) and familial paragangliomas type of syndromes
- Understand the TNM classification, the staging according to the European Network for Study of Adrenal Tumours (ENSAT) and European Society for Medical Oncology (ESMO) guidelines
- Determine radiological staging by CT, PET and MR where necessary
- Understand the adrenal cancer workup chart recommended by ENSAT and ESMO
- Understand the genetic markers and the mutations seen in malignant pheochromocytomas
- 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 adenoid cystic carcinoma (ACC) including the relevance of surgical resection according to TNM staging and the role of image-guided ablation (if any in debulking or metastatic disease), role of medical therapy in symptomatic patients and those with metastases
- Understand the role of medical therapy such as mitotane, glucocorticoids and mineralocorticoids depending on the type of tumour
- Discuss with the anaesthetist the need for sedation versus general anaesthesia and understand the advantages of each technique
- Discuss with the oncologist and anaesthetist the need for therapy to control blood pressure prior to procedure and follow guidelines of when to start
- Assess the patient during and following image-guided ablation or intra-arterial therapies and other cancer therapies
- Be able to determine patient fitness for discharge and recognise 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 imaging before and after IGA or percutaneous intra-arterial therapy of liver metastases
- Understand how to interpret therapy changes in the liver or adrenal gland

**Technical skills:**

- Adrenal ablation is an uncommon procedure in IO as not all departments perform it and therefore the IO trainee may need to have basic knowledge of understanding and feasibility
- 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 the tumour and neighbouring vital structures such as the pleura, kidney, IVC, liver and diaphragm
- Be able to decide which kind of ablative technology (RFA, CRYO) to use for treatment depending on the size and type of tumour and its imaging, pathology characteristics and adjacent structures
- Plan the correct positioning of the electrodes in the tumour to achieve optimal results
- Plan the size of the electrode to use to acquire effective ablation
- Know the difference between ablation of the pancreas and other organs such as lung, liver, etc. to adapt the protocol for optimal pancreatic tumour ablation
- For liver metastases from ACC please follow skills of ablation and intra-arterial therapy for liver metastases

**Gastro-entero-pancreatic neuroendocrine tumour (GEP-NET)****Knowledge in GEP-NET:**

- Understand the anatomy of the stomach, small bowel, rectum and pancreas, along with the variation in anatomy
- Understand the anatomy of the arterial and venous systems, as well as ductal (pancreas) anatomy
- Understand the anatomy of mesentery and the omentum and the relationship of the portal vein and biliary ducts
- Understand the incidence and prevalence of the various types of GEP-NET
- Understand the effect of thermal ablation on the adjacent structure and the adverse effects of thermal ablation
- Understand the effect of treatment of metastases to the liver or lymph nodes

**Clinical skills:**

- Be able to acquire 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
- Understand the importance of genetic testing in patients with MEN 1 type of syndrome
- Understand the TNM according to the European Neuroendocrine Tumour Society, WHO histology and Ki-67 based staging of GEP-NET
- Determine radiological staging by radioactive isotope scan, CT, PET and MR where necessary
- Understanding the different relevance of different types of isotope PET scans along with its limitations
- Determine the tumour markers to look for e.g. chromogranin A, urine 5-HIAA, serotonin etc.
- 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 GEP-NET including the relevance of surgical resection according to TNM staging and the role of image-guided ablation, the role of medical therapy in symptomatic patients and those with bulky metastases
- Understand role of medical therapy such as somatostatin analogues and interferon
- Understand role of chemotherapy in GEP-NET, along with the role of peptide receptor targeted therapy
- Discuss with the anaesthetist the need for sedation versus general anaesthesia and understand the advantages of each technique
- Discuss with the oncologist and anaesthetist the need for somatostatin analogues during therapy to avoid carcinoid crisis



- Assess the patient during and following image-guided ablation, intra-arterial therapies and other cancer therapies
- Be able to determine patient fitness for discharge and recognise 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 when to treat again with regard to recurrence of symptoms
- Understand the role of imaging before and after IGA or percutaneous intra-arterial therapy of liver metastases
- Understand how to interpret therapy changes in the liver or pancreas
- Understand the risks following a Whipple procedure for locoregional therapies

**Technical skills:**

- Pancreatic ablation is an uncommon procedure in IO as not all departments perform it and therefore the IO trainee may need to have basic knowledge of understanding and feasibility
- 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 the tumour and neighbouring vital structures such as the normal pancreatic tissue, pancreatic duct and bowel
- Be able to decide which kind of ablative technology (IRE, CRYO) to use for treatment depending on the size and type of tumour and its imaging, pathology characteristics and adjacent structures (stomach, bowel, pancreatic duct and splenic vein)
- Plan the correct positioning of the electrodes in the tumour to achieve optimal results
- Plan the size of the electrode to use to acquire effective ablation
- Know the difference between ablation of the pancreas and other organs such as lung, liver, etc. to adapt the protocol for optimal pancreatic tumour ablation
- For liver metastases from neuroendocrine cancer please follow skills of ablation and intra-arterial therapy for liver metastases. One should however keep in mind the need to use somatostatin analogues during therapy





## Acronyms

<b>ABLATE</b>	Axial Tumour Diameter, Bowel Proximity, Location within Kidney, Adjacency to Ureter, Touching Renal Sinus Fat, Endo/Exophytic
<b>ACC</b>	Adenoid Cystic Carcinoma
<b>ACR</b>	American College of Radiology
<b>AFP</b>	Alpha-Fetoprotein
<b>ALARA</b>	As Low as Reasonably Achievable
<b>aPTT</b>	Activated Partial Thromboplastin Time
<b>BCLC</b>	Barcelona Clinic Liver Cancer
<b>BI-RADS</b>	Breast Imaging Reporting and Data System
<b>BMI</b>	Body Mass Index
<b>CA 19-9</b>	Cancer Antigen 19-9
<b>CEA</b>	Carcinoembryonic Antigen
<b>CME</b>	Continued Medical Education
<b>CML</b>	Chronic Myeloid Leukemia
<b>CHOP</b>	Cyclophosphamide, Hydroxydaunorubicin, Oncovin, Prednisone
<b>CIRSE</b>	Cardiovascular and Interventional Radiological Society of Europe
<b>CO<sub>2</sub></b>	Carbon Dioxide
<b>CRYO</b>	Cryoablation
<b>CT</b>	Computed Tomography
<b>cTACE</b>	Conventional Transcatheter Arterial Chemoembolisation
<b>DCIS</b>	Ductal Carcinoma In Situ
<b>DEM TACE</b>	Drug-Eluting Microsphere Transcatheter Arterial Chemoembolisation
<b>EC</b>	European Commission
<b>ENSAT</b>	European Network for Study of Adrenal Tumours
<b>ER</b>	Oestrogen Receptor
<b>ERC</b>	Endoscopic Retrograde Cholangiography
<b>ESMO</b>	European Society for Medical Oncology
<b>EU</b>	European Union
<b>EUS</b>	Endoscopic Ultrasonography
<b>FDG</b>	Fluorodeoxyglucose
<b>FLR</b>	Future Liver Remnant
<b>FOLFOX</b>	Folinic Acid, Fluorouracil, Oxaliplatin
<b>FOLFIRI</b>	Folinic Acid, Fluorouracil, Irinotecan Hydrochloride
<b>GEP-NET</b>	Gastroenteropancreatic Neuroendocrine Tumours
<b>GI</b>	Gastrointestinal
<b>GIST</b>	Gastrointestinal Stromal Tumour
<b>HCC</b>	Hepatocellular Carcinoma
<b>HIAA</b>	Hydroxyindoleacetic Acid
<b>HIFU</b>	High-Intensity Focussed Ultrasound
<b>IGA</b>	Image-Guided Ablation

<b>IMRT</b>	Intensity-Modulated Radiation Therapy
<b>INR/PT</b>	International Normalized Ratio/Prothrombin Time
<b>IO</b>	Interventional Oncology or Interventional Oncologist
<b>IR</b>	Interventional Radiology or Interventional Radiologist
<b>IRE</b>	Irreversible Electroporation
<b>LHRH</b>	Luteinising Hormone-Releasing Hormone
<b>LI-RADS</b>	Liver Imaging Reporting and Data System
<b>MELD</b>	Model for End-Stage Liver Disease
<b>MEN</b>	Multiple Endocrine Neoplasia
<b>MR</b>	Magnetic Resonance
<b>MRCP</b>	Magnetic Resonance Cholangiopancreatography
<b>MRI</b>	Magnetic Resonance Imaging
<b>MWA</b>	Microwave Ablation
<b>NSCLC</b>	Non-Small Cell Lung Cancer
<b>PADUA</b>	Preoperative Aspects and Dimensions Used for an Anatomical
<b>PET</b>	Positron Emission Tomography
<b>PR</b>	Progesterone Receptor
<b>PRRT</b>	Peptide Receptor Radionuclide Therapy
<b>PSA</b>	Prostate Specific Antigen
<b>PVE</b>	Portal Vein Embolisation
<b>RCTs</b>	Randomised Controlled Trials
<b>RENAL</b>	Radius, Exophytic Extent, Nearness to the Renal Sinus, Anterior/Posterior Location, Location Relative to the Polar Lines
<b>RFA</b>	Radiofrequency Ablation
<b>RT</b>	Radiation Therapy
<b>SIR</b>	Society of Interventional Radiology
<b>SBRT</b>	Stereotactic Body Radiotherapy
<b>SVC</b>	Superior Vena Cava
<b>TACE</b>	Transcatheter Arterial Chemoembolisation
<b>TLR</b>	Toll-Like Receptor
<b>TNM</b>	Tumour, Node, Metastasis
<b>TRUS</b>	Transrectal Ultrasound
<b>TSH</b>	Thyroid Stimulating Hormone
<b>UICC</b>	Union for International Cancer Control
<b>US</b>	Ultrasound
<b>VBCF</b>	Vertebral Body Compression Fracture
<b>VEGF</b>	Vascular Endothelial Growth Factor
<b>VMAT</b>	Volumetric Modulated Arc Therapy
<b>WHO</b>	World Health Organization

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# Appendix 1

## Different Types of Studies and Trials

### **Randomised controlled trials (RCT)**

A clinical trial to study the effect of a type of therapy. It is used to determine whether a cause-effect relationship exists between a treatment and the outcome. Can be blinded (less bias) or un-blinded. It is a planned experiment providing sound evidence and is considered the gold standard for clinical trials.

### **Systematic reviews**

A review aimed at summarising previous literature in order to address a specific clinical issue. After an extensive and comprehensive literature search using a set of specific criteria, all relevant studies with sound methodology on the topic are collected. These studies are then reviewed, evaluated and the findings summarised.

### **Meta-analyses**

A statistical analysis that can be used as part of a systematic review. Following a comprehensive literature search, all valid studies that meet predefined criteria are combined into a single large dataset which can then be analysed. Meta-analyses have a much higher statistical power than any individual study and can be used to contrast the results from different studies and uncover patterns.

### **Observational Studies:**

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

A case study is a detailed and in-depth observation report of a single subject (the case) within its real-life context. A case report is a comprehensive medical narrative of a single patient, typically describing an unusual phenomenon. A case series is a descriptive observation tracking multiple subjects that have the same known exposure or treatment and recording the outcome. Although the methodological limitations inherent in these studies mean that the findings are not generalisable, they can form the basis or stepping stones for future research.

**Case control studies**

A case-control study is an observational study where an outcome of interest is chosen (e.g. a specific disease) and two groups are identified according to whether they are positive (case group) or negative (control group) for the outcome. The two groups are then observed and compared for suspected risk factors or exposures. They are relatively inexpensive and don't require a large time investment, however they are not very statistically robust and do not provide evidence for causality. These studies are retrospective.

**Cohort studies**

Cohort studies are longitudinal observations where a group of subjects, or cohort, are examined and repeated measurements are taken over a period of time. There is no treatment or exposure given and there is no predetermined control group. The incidence rate of the outcome of interest is recorded and hypothesised risk factors are examined using statistical analysis. Cohort studies are expensive and require a long follow-up time but can be vital in uncovering risk/protective factors for diseases.

**Cross sectional studies**

A descriptive study that examines the relationship between diseases (or other health-related characteristics) and other variables of interest as they exist in a defined population at one particular time (i.e. exposure and outcomes are both measured at the same time). Can be used to determine prevalence, absolute risks and relative risks of an outcome.

## Appendix 2

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

#### Levels of Evidence

##### A Level Therapy/Prevention, Aetiology / Harm

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

##### B

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

##### C

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

##### D

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

#### Grades of Recommendation

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

Source: Oxford Centre for Evidence-Based Medicine. Levels of evidence, 2009 [8].









