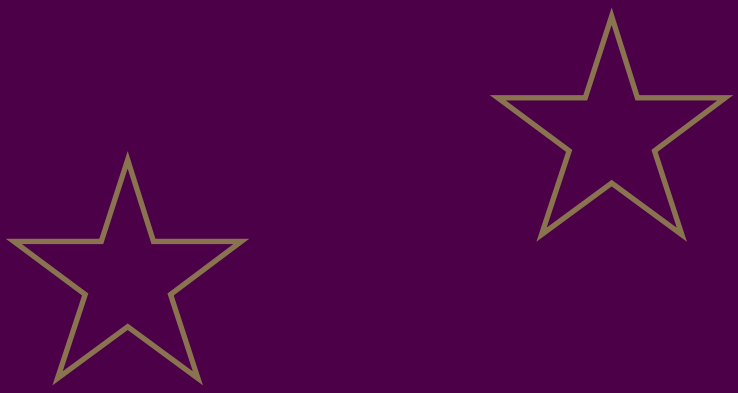

European Curriculum and Syllabus for Interventional Oncology

Second Edition

Supplementary knowledge regarding Interventional Oncology for Interventional Radiologists

CIRSE

July 2025

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 specialization 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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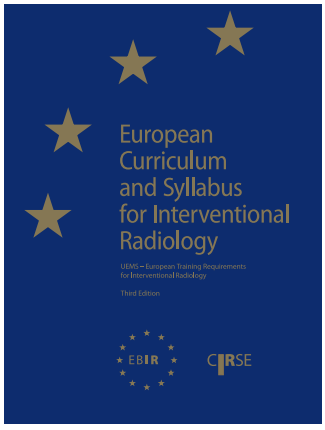
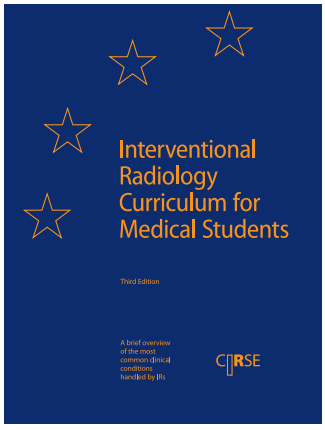
Education | Knowledge | Certification

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 full range of curricula, support your continuing education with our curated learning resources, and explore options to certify your IR expertise.

Curricula



A standardized 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 medicine.

Learning resources

CIRSE library

Includes lectures and presentations from CIRSE's 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 accredited and include a combination of informative texts, graphics, videos, and quizzes.

Examination

EBIR **European Board of Interventional Radiology**

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

Specialist certifications

This evidence-based specialist certificate allows IRs who have been EBIR holders for at least two years to prove their expert knowledge in endovascular therapy.

This specialized, documented-experience certification is tailored for EBIR-holders seeking acknowledgement of their proficiency and extensive involvement in IO.

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 document has been further revised in 2023 where it was also accepted as an ETR (European Training Requirements)[1] document for IR by the UEMS.

The European Curriculum and Syllabus for Interventional Radiology remains the foundation underpinning training and education in interventional radiology. However, with the recent advances 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 healthcare 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 necessary 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.

The European Certification for Interventional Oncology Specialists (EBIR-IO) and the International Accreditation System for Interventional Oncology (IASIOS) are pivotal tools in ensuring optimized and high-quality cancer care. EBIR-IO provides a standardized benchmark of clinical and technical competence for interventional radiologists specializing in oncology, fostering consistent expertise across institutions. Complementing this, IASIOS offers a rigorous accreditation framework that promotes continuous quality improvement and patient safety, focusing on ensuring that patient pathways within interventional oncology are delivered in a structured, standardized, and clinically sound manner. Together, these systems not only enhance clinical outcomes but also build trust among patients and healthcare providers, making them essential components of a comprehensive, multidisciplinary cancer care strategy.

We would like to sincerely thank the members of our writing group, namely Irene Bargellini, Colin Cantwell, Laura Crocetti, Antonia Digklia, Jérôme Durand-Labrunie, Thomas Helmberger, Rüdiger Hoffmann, Shazad Ilyas, Uwe Martens, Franco Orsi, Jean Palussière, Pramod Rao, Steffan Stättner, as well as Cornelia Schuöcker, Maria Weren and Kit Schofield from the CIRSE office for their invaluable help in producing this document. Our gratitude extends to the Editor-in-Chief of the first edition, Thierry de Baère, who also provided valuable guidance in this revision process. Finally, we appreciate all our partner societies, which have supported the project and/or endorsed the final document.

Best regards,

Afshin Gangi
Oncology Alliance Subcommittee Chairperson

Laura Crocetti
IO Curriculum Task Force Chairperson

Philippe L. Pereira
CIRSE President

[1] *https://www.uems.eu/european-training-requirements*

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1 CURRICULUM

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. Interventional oncology (IO) has effectively established itself as an important treatment speciality within multidisciplinary oncologic care, together with medical, surgical and radiation oncology. IO is now considered the fourth pillar of modern cancer care. This curriculum is intended to give direction to all training centres on how to set up a basic programme which will train future interventional oncologists (IOs). It is also intended to harmonize IO training across Europe. An IR curriculum published by the Cardiovascular and Interventional Radiological Society of Europe (CIRSE)[2] already exists, however, with the vast advances of IR in this field, a curriculum dedicated specifically to IO is needed.

As an increasingly prominent subspecialty within interventional radiology (IR), IO is characterized by rapid advancements and an expanding body of knowledge. To ensure that the curriculum remains aligned with the latest developments and best practices, it will undergo regular updates and be subject to comprehensive review at a minimum of every five years.

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[3].

In accordance with the European Commission (EC) directive 2005/36/EC, (amended in 2024), which aims to ensure that the member states mutually recognize the qualifications of doctors to facilitate the free movement of professionals within Europe[4], this curriculum intends to harmonize education standards across European Union (EU) states. Since 1996, when the EU states first agreed to mutually acknowledge each other's formal qualification, there have been regular updates to the legislative act. Currently, specialist qualifications are also recognized allowing specialist doctors trained in one state to 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 harmonization 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[5].

[2] *European Curriculum and Syllabus for Interventional Radiology, 3rd ed., Vienna: Cardiovascular and Interventional Radiological Society of Europe (CIRSE), 2023.*
[3] *Morgan, R.A., Patel, P.J., Binkert, C. et al. Global Statement Defining Interventional Radiology – Have We Reached the Tipping Point? CardioVascular and Interventional Radiology 47, 1433-1438, 2024.*
[4] *Directive 2005/36/EC of the European Parliament and of the Council of 7 September 2005 on the recognition of professional qualifications. Version: 20.06.2024.*
[5] *J. R. Frank, L. Snell and J. Sherbino, CanMEDS 2015 Physician Competency Framework, Ottawa: Royal College of Physicians and Surgeons of Canada, 2015.*

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 safe, high-quality, 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
- Discuss, plan and perform IO treatments and take part in multidisciplinary therapies
- Establish plans for ongoing care and, when appropriate, timely consultation and longitudinal care
- Actively contribute, as an individual and as a member of a team providing care, to the continuous improvement of healthcare 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 healthcare.

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

COLLABORATOR

Definition
As collaborators, IOs work effectively with other healthcare professionals to deliver safe, high-quality, patient-centred care. IOs must also develop the knowledge and judgment necessary to recognize when referral to other specialties is appropriate, (thereby ensuring that patients receive the most comprehensive and coordinated care possible).

Role
- Work effectively with physicians and other colleagues in healthcare professions
- Work with physicians and other colleagues in healthcare professions to promote understanding, manage differences and resolve conflicts
- Hand over the care of a patient to another healthcare 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 healthcare 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 healthcare delivery in teams, organizations and systems
- Engage in the stewardship of healthcare resources
- Demonstrate leadership in professional practice
- Manage their practice and career

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 mobilization 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 healthcare professionals
- Integrate the best available evidence into their 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 recognizing and responding to societal expectations in healthcare
- 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. IOs should participate in relevant educational programmes for continuous advancement of skills and knowledge (e.g. CIRSE Academy, ESIR courses, CIRSE webinars, CIRSE conferences such as ECIO, and CIRSE Annual Scientific meetings).

This curriculum will describe the knowledge, skills and competencies required for 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, nuclear medicine, 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 tumour board 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 treatments 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 least at the end of the programme is crucial.

Appraisal and mentoring
IO 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 their programme. Case review sessions on decision-making should be held regularly.

IO 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.

IO 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 organization

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

Centres involved in training should

- Have a sufficient caseload for the number of IO 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 IO 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 the 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 IO trainees and trainers is essential. The IO trainees need to be evaluated by those training them. The training system should include an evaluation of the trainers in the department by the IO 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 IO trainee, and it is also recommended that each IO 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) treatment
- Participate in multidisciplinary teams and meetings to discuss optimal therapy options for patients
- Hold clinics to see patients before planning the procedure to discuss with the patients and their families the treatment being offered, explaining procedures, risks, benefits, and alternatives
- Be able to communicate with patients and their relatives: understanding patients and their relatives' needs and expectations

- Ensure patients understand the goal of local treatments, and give clear, informed, written consent about the procedure being performed and potential complications
- Provide immediate post-procedural care and manage the follow-up

Standard of practice documents are available on the CIRSE website:
https://www.cirse.org/publications/standards-of-practice/cirse-documents/.
The Clinical Practice Manual[6] 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, radiographers, 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.

New devices and new drug delivery systems are introduced to IO on a regular basis, provided that they are CE marked and approved by hospitals' internal regulations.
All prospective and retrospective clinical trials should be submitted for approval to the ethics committee (local or national according to national rules).

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 IO trainees the decision-making process and the importance of working with other specialties to achieve optimal patient care.[7]

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

[6] *Mahnken, A.H., Boullosa Seoane, E., Cannavale, A. et al. CIRSE Clinical Practice Manual. Cardiovascular Interventional Radiology 44, 1323-1353, 2021.*
[7] *Pereira, P.L. Multidisciplinarity is Key on the Road to Improving Quality Cancer Care Throughout Europe. Cardiovascular and Interventional Radiology 43, 1261-1262, 2020.*

1.5 Continuity of education and research

IO is a dynamic field and continuous learning and research are essential for staying up to date with advances and improving patient outcomes. IO trainees should maintain the highest quality of clinical care and should follow CIRSE's quality assurance guidelines and standards (https://www.cirse.org/publications/standards-of-practice/cirse-documents/).

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

- Be a scholar. Prepare for and obtain certification by completing the European Board of Interventional Radiology (EBIR) examination
- Learn how to teach and understand the current basic teaching methodologies. Specific additional training in clinical education skills is highly desirable and attendance at "train the trainers" or "teach the teachers" meetings should be undertaken. Local responsible bodies for training should set up these meetings for IO trainees to advise on learning theory and techniques focused on conceptual learning and behaviour
- Clearly communicate learning goals during teaching based on this IO Curriculum. Understand the process of blueprinting teaching content and methods to the curriculum
- Teach residents, medical students and allied health staff, including nurses and radiographers. Take part in, and where appropriate, lead journal clubs
- Understand systems for constructive feedback for teaching. Understand the role of 360-degree feedback
- Be familiar with formative and summative assessment tools
- Understand the role of competency-based teaching and training
- The educational work of IO trainees should be appraised annually within their department/institution with the use of an objective, validated tool. The results of these appraisals may be used as part of re-accreditation of the workplace for training

1.5.2 Continuing medical education

Cancer therapy and diagnostics are constantly changing with newer drugs, treatment options, radiotherapy (RT) 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 new technological advances to ensure optimal outcomes for patients.

IO trainees and mentors should

- Decide on patient treatment plans using evidence-based medicine or in accordance with national and international guidelines, when available

IO trainees should maintain the highest quality of clinical care and should

- Follow CIRSE's quality assurance guidelines and standards (https://www.cirse.org/publications/standards-of-practice/cirse-documents/)
- Attend CME sessions in their hospital organized by their department or other departments
- Try to attend at least one external meeting or conference a year
- Be involved in research and audit
- Be involved in scientific journal peer review
- Have access to online resources in order to read relevant journals

1.5.3 Research competency and evidence building

It is crucial to conduct well-designed research projects to further consolidate the position of IO in the field of oncology. This will ensure that IO continues to evolve and meet the needs of cancer patients worldwide.[8] IO trainees should be encouraged to develop an understanding of research methodology. All IO trainees should be able to assess and understand published work. Ideally, the opportunity for performing clinical and/or basic research should be available to the IO trainee with appropriate faculty supervision. Appropriate qualified faculty should supervise specific research projects as applicable. Protected time should be available so that an IO trainee can participate in research.

IO trainees should

- 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
- Obtain certification in good clinical practice (GCP)
- Understand the different types of studies and their role in the building of evidence for different procedures in IO
- Understand the principles of evidence-based medicine. Understand how to find the best evidence for making patient care decisions using PICO (population, intervention, comparison, outcome) questions, e.g. at https://www.cebm.ox.ac.uk/.
- All IO trainees should be able to appraise published work
- Perform journal peer review, be able to review original research studies and understand their strengths and weaknesses
- Take part in, and where appropriate, lead journal clubs

1.5.4 Preclinical research

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 Logbook

IO trainees should maintain a logbook of all procedures performed during their training period, including the types of procedures, number of procedures and if they were 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 IO trainee is involved in and their outcomes.
Regular appraisal with review of logbooks and constructive feedback by the IR responsible for training is not only pivotal to demonstrate up-to-date competence but is also important for a continuous learning process.

[8] *Kaufmann, N.C., Zeka, B. and Pereira, P.L. Research in interventional oncology: How sound is the evidence base? Journal of Medical Imaging and Radiation Oncology 67, 903-914, 2023.*

1.5.6 Assessment and qualification

EBIR and EBIR-IO:
There is no homogenous training pathway for IR and further specialization throughout Europe and the world. In an attempt to offer an international, standardized assessment for IR knowledge and an experience-based specialization programme, CIRSE created the European Board of Interventional Radiology (EBIR) in 2010. Ever since, it has served over 1.700 IRs to certify their expertise and demonstrate their experience in their fields.
After completion of national radiology training and at least 2 years of dedicated IR training, physicians can sit the EBIR examination. IRs who have successfully passed the EBIR exam can apply for the specialist certification EBIR-IO, after a minimum of two years to obtain proof of their IO practice.

EBIR practice requirements:
Case volume should comply with the logbook requirements to sit the EBIR. The applicant must verify that they have experience as the first operator, performing at least 250 IR procedures, 150 of which have to be interventions according to chapter 2.2.1 Vascular diagnosis and intervention and/or chapter 2.2.5.2 Vascular interventional oncology of the European Curriculum and Syllabus for IR/ETR.

EBIR-IO practice requirements:
Case volume for specialist certification should comply with logbook requirements to apply for the EBIR-IO i.e. a minimum number of 250 procedures as first operator since successfully passing the EBIR examination, covering procedures as outlined in the following chapters:

- Tumour ablation [2.3.1-2.3.8]
- Chemoembolization [2.2.7, 2.3.1]
- Radioembolization [2.3.1.1-2.3.1.5]
- Hepatic arterial infusion/Bland embolization [2.1.5, 2.1.8, 2.3.1, 2.3.3.1, 2.3.4.1]
- Neurolysis [2.1.9]
- Bone and spine augmentation techniques for malignancies [2.1.9, 2.3.4.1-2.3.4.2]

Biopsies and drainages are not accepted.

1.5.7 Recommended links

The links below will give the IO trainee access to different IR and IO-specific content. 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

www.cebm.ox.ac.uk
www.cirse.org
www.cirse.org/online/academy
www.clinicaltrials.gov
www.cirse.org/publications/standards-of-practice/cirse-documents
www.ecio.org
www.iasios.org
www.library.cirse.org

2 SYLLABUS

SECTION A

2.1 Fundamentals in oncology

2.1.1 Epidemiology

Knowledge of cancer epidemiology is paramount for cancer prevention, detection and treatment. In today's world, where there is considerable free movement across borders and increased immigration, understanding cancer epidemiology becomes even more significant.

IO trainees should
Know the incidence rates of different tumours by sex occurring in their geographic region of practice, as well as those of different ethnic groups residing in their region of practice to improve early diagnosis and treatment, along with the goal to achieve longer survival rates.

2.1.2 Biochemistry and haematology

Knowledge of biochemical and haematologic tests in clinical practice is crucial especially in association with specific disease disorders. For example, knowledge of coagulation profile, biology and haematology are equally critical to evaluate the general condition or function of various organs. These tests will be part of the decision-making whether to provide treatment, according to its potential risks and expected benefits.

IO trainees should
- Be able to interpret biochemical and haematologic tests and correlate them with the patient's clinical condition
- Know the impact of chemotherapy, immunotherapy and targeted therapies on biochemical and haematologic tests
- 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 characterizations, it is essential to understand the dynamic tumour microenvironment, 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
- Understand the changes occurring in the tumour genome, how they affect prognosis, and how they are relevant to molecular targeting agents and immunotherapy as well as how they contribute to anti-cancer drug resistance
- Know the differences in type of tumour pathology, grade and their impact on survival and metastatic potential
- 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 cancer patients under treatment

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 Third Edition[2], 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 specialization and action

2.1.5.1 Drug regimen terminology

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

Neoadjuvant
Systemic therapy administered prior to surgical resection in patients with tumours suitable for curative therapies, to help reduce the size of the primary tumour as well as allowing for 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 using systemic treatments to shrink tumours to a size that makes curative options, such as resection, transplantation, or ablation, feasible in patients who were not initially eligible for them.

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 systemic therapy regime for a given cancer, which has been proven with scientific studies and data.

Second-line therapy
Systemic therapy that is proven to be effective by scientific evidence in case of failure of first-line therapy. Additionally, newer drugs not approved for first-line therapy may be considered or approved specifically for second-line 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 first- and second-line 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 of cure or tumour response.

Mode of delivery
Systemic therapy can be administered by different routes.

Oral
Examples of drugs that are given orally include capecitabine (Xeloda), imitanib mesylate (Gleevec), cyclophosphamide (Cytoxan), idarubicin, methotrexate, tamoxifen and sorafenib (Nexavar).

Intravenous
Large percentages of systemic therapy 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 (oxaliplatin, 5FU, irinotecan, etc.).
Isolated perfusion for limb, peritoneal, pelvic and hepatic (melphalan, etc.).

Drug delivery systems
Drug-eluting microspheres (DEM) to be loaded with doxorubicin, oxaliplatin, irinotecan, epirubicin, idarubicin) for DEM-TACE (transcatheter arterial chemoembolization)
Drug emulsions with Lipiodol for conventional transcatheter arterial chemoembolization (TACE; e.g. doxorubicin, cisplatin, epirubicin, idarubicin, etc.).

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[9].

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, pemetrexed
- Cytotoxic antibiotics: bleomycin, doxorubicin, epirubicin, mitomycin C
- Mitotic inhibitors: taxanes, vinca alkaloids
- Topoisomerase inhibitors: etoposide, irinotecan[9]

Side effects
The most common side effects of relevance to chemotherapy are myelosuppression with susceptibility to infection, polyneuropathy and mucosal toxicity, in particular diarrhea.
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 about the application of granulocyte colony stimulating factors and (prophylactic) diarrhoea management 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 leukaemia (CML)), gastrointestinal stromal tumour (GIST), sunitinib (GIST and renal cell carcinoma (RCC)), erlotinib (NSCLC and pancreatic cancer)[9], osimertinib (NSCLC), cabozantinib (RCC, hepatocellular carcinoma (HCC), thyroid cancer), lenvatinib (thyroid cancer, RCC, HCC, endometrial cancer), and dabrafenib (melanoma, NSCLC, thyroid cancer, agnostic in combination with trametinib for BRAF-V600E mutation).
Agents which inhibit poly (ADP-ribose) polymerase (PARP) enzymes such as olaparib (ovarian cancer, breast cancer, pancreatic cancer, prostate cancer), rucaparib (ovarian cancer, prostate cancer), and talazoparib (breast cancer, prostate cancer).
Agents which inhibit cyclin-dependent kinase (CDK) 4 and 6 in combination with endocrine therapies in breast cancer such as palbociclib, ribociclib and abemaciclib.

Monoclonal antibodies
Classes of antibodies (murine: -omab, chimeric: -ximab, humanized: -zumab and human: -umab) differ in their immunogenicity and act by binding to antigens on cell surfaces or to growth factors. Be aware of key targets and therapeutic examples, side effects, cost issues, e.g. trastuzumab for HER2 in breast cancer, EGFR (epidermal growth factor receptor) targeting with cetuximab and panitumumab for RAS wild type colorectal cancer, and rituximab for CD20 of B cell lymphoma, bevacizumab for vascular endothelial growth factor (VEGF)[9].

Antibody-drug conjugates (ADCs) as a new class of targeted therapeutic agents composed of a monoclonal antibody (mAB) backbone covalently attached to a cytotoxic chemotherapy through a chemical linker such as trastuzumab-deruxtecan (Enhertu) for HER2-low breast cancer and Sacituzumab-govitecan (Trodelvy) for triple-negative breast cancer.

[9] *The European Society of Surgical Oncology, ESSO Core Curriculum, Brussels: EJSO – Journal of Cancer Surgery, 2013.*

2.1.5.4 Immunotherapy of cancer

Immune checkpoint inhibitors (ICI) targeting PD-1, PD-L1 or CTLA-4 have revolutionized cancer therapy by enhancing the immune system's ability to recognize and attack cancer cells. Anti-PD1 or anti-PDL1 antibodies such as pembrolizumab, atezolizumab, durvalumab, nivolumab, etc. or CTL-4 Inhibitors such as ipilimumab or tremelimumab are approved for use in many solid tumours due to their improvement in survival that has been consistently shown in randomized studies. They are used alone, in combination (dual inhibition) or in context with other therapies like chemotherapy or radiotherapy.

The use of immunotherapy is related to specific immune related adverse events (irAEs) which can affect virtually any organ system. These effects range from manageable conditions such as hepatitis, hypothyroidism, colitis, arthritis, etc. up to severe complications such as myocarditis or encephalitis. Monitoring these potential toxic effects is of paramount importance.

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

2.1.5.5 Metastatic state terminology

Oligometastatic disease (OMD): metastatic disease confined to a limited number of sites (often described as up to three or five sites) and can be synchronous or metachronous with the primary tumour presentation.

Oligoresistant disease: mixed response of polymetastatic disease after systemic therapy (often molecular targeted therapies).

Oligopersistant disease: persistent sites of polymetastatic disease after initial response (often molecular targeted therapies).

Oligoprogressive disease (OPD): OPD develops on a background of polymetastatic disease. OPD occurs following an initial response to systemic treatment where disease progression only occurs in a limited number of sites. OPD is increasingly encountered in clinical practice due to the widespread use of first- and second-generation molecular targeted treatments with the potential for the development of sub-clones of drug resistance.

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, enzalutamide, darolutamide; immunotherapy: sipuleucel

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

2.1.7.1 Indications of radiation therapy

RT is the use of ionizing radiation to treat a tumour alone or in combination with other treatment modalities (surgery, systemic treatments, etc.). RT can be used in a curative intent or in a palliative setting (analgesic effect, decompression, haemostatic, etc.):

- **Neoadjuvant RT:** Used before surgery to shrink tumours in order to facilitate surgical removal and increase chances of complete resection (e.g. rectal cancer, oesophageal cancer, and some sarcomas)
- **Exclusive RT:** Used as the primary treatment to eradicate cancer, most of the time with concomitant chemotherapy (e.g. head and neck cancers, oesophageal cancer, anal cancer, prostate cancer)
- **Adjuvant RT:** Administered after surgery to eliminate residual cancer cells and reduce the risk of recurrence (e.g. breast cancer, head and neck cancers)
- **Palliative RT:** Aims to relieve symptoms and improve quality of life in advanced cancer stages (e.g. bone metastases, spinal cord compression, tumour haemorrhage)

Radiobiology of ionizing radiations

- Ionization and DNA damage: Ionizing radiation, such as photons (X-rays), electrons, protons and heavy ions, can remove tightly bound electrons from atoms, leading to ionization. Ionization causes direct damage to DNA and generates reactive oxygen species (ROS) that indirectly damage DNA
- Cellular responses: Cells respond to radiation-induced DNA damage through different mechanisms like DNA repair, cell cycle arrest, or cell death. Mitotic death is the most common type of cell death induced by radiotherapy. It occurs when cells damaged by radiation are unable to successfully divide during mitosis. This often happens several divisions after the initial radiation exposure explaining the delay between radiotherapy and tumour shrinkage
- Radiation sensitivity: Different cells and tissues have varying sensitivity to radiation. Rapidly dividing cells (e.g. cancer cells, bone marrow, intestinal lining) are generally more sensitive, whereas non-dividing cells (e.g. neurons) are more resistant. Radiation sensitivity is influenced by other factors than cell type, like tissue hypoxia
- Radiation dose-response relationship: The biological effect of radiation is influenced by the dose and dose rate. Higher doses typically result in more significant damage. The relationship can be linear or nonlinear depending on the type of radiation and biological context

Basic physics of X-ray, electron beams and proton treatments

- X-Ray therapy: X-rays have an exponential attenuation, depositing energy along their path with more dose delivered to deeper tissues. They have no sharp endpoint, which can affect both the tumour and surrounding healthy tissues. It is by far the most commonly used ionizing radiation in radiotherapy

- Electron beam therapy: Electrons have a limited penetration range and deposit most of their energy near the surface of the tissue, making them suitable for treating superficial tumours (e.g. skin carcinomas)
- Proton therapy: Protons deposit minimal energy as they travel through tissue but release a large burst of energy at the end of their range (Bragg peak), causing maximal DNA damage at a specific depth. The Bragg peak allows precise targeting of tumours with minimal damage to surrounding healthy tissue, making proton therapy ideal for treating deep-seated tumours (e.g. intramedullary, choroidal or paediatric tumours)

2.1.7.2 Types of radiotherapy

3D conformal radiation therapy (3D-CRT)
3D-CRT uses 3D imaging, typically CT scans, to create a detailed map of the tumour and surrounding anatomy. This allows for precise targeting of the tumour with shaped radiation beams from multiple angles, conforming to the tumour's shape. While 3D-CRT was a significant advancement over earlier methods and is still useful in certain cases, particularly in settings with limited access to more advanced technology, its use is declining as more sophisticated and effective treatment options become widely available and preferred.

Intensity-modulated radiation therapy (IMRT)
IMRT is an advanced form of 3D-CRT. It modulates the intensity of each radiation beam and multiplies the number of radiation beam angles. Compared to 3D-CRT it allows more complex treatment plans that can better spare critical structures and reduce side effects. This has led to a preference for this technique in clinical practice.

Stereotactic radiosurgery (SRS) and stereotactic body radiation therapy (SBRT)
Delivers highly focused radiation in one (SRS) or a few (SBRT) sessions. Advances in dose shaping (IMRT) and on-board imaging have made it possible to deliver very high doses of radiation per session with precise targeting that protects nearby organs. SRS/SBRT delivers a higher dose at the centre of the tumour and a lower dose at the edges. This is an ablative technique like radiofrequency or cryotherapy (e.g. lungs, liver, and brain tumours).

Brachytherapy
Places temporary (e.g. cervical cancer) or permanent (e.g. prostate cancer) radioactive sources directly inside or near the tumour. It delivers high doses directly to the tumour with minimal exposure to surrounding tissues.

2.1.7.3 The toxicities of radiotherapy

- Acute toxicities (within 3 months after treatment): Acute toxicities arise from the immediate inflammatory reactions to radiation exposure. These effects generally resolve after the treatment ends, but they can significantly affect the patient's quality of life during this period. It depends on radiation anatomical localization (e.g. skin desquamation, nausea, diarrhoea, oedema, proctitis or dysphagia)
- Chronic toxicities (more than 3 months after treatment): Chronic toxicities develop over time and often result from long-term damage to tissues and organs. These effects are typically due to irreversible changes caused by radiation, including fibrosis and vascular damage. The risk of chronic organ damage depends on factors such as the total radiation dose, the fractionation, the volume of the organ exposed, and the duration of treatment. It also depends on radiation anatomical localization (e.g. second cancer, pulmonary fibrosis, stricture, infertility)

2.1.7.4 The dose administration regimens

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

Hyperfractionation
Refers to the use of multiple fractions during the same day (e.g. bifractionation refers to two fractions per 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 an IO trainee. IO treatments are often offered as an alternative to surgical treatment, therefore knowing fundamentals of surgery is needed for an optimal multidisciplinary tumour board (MTDB) discussion. Moreover, 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 the main types of surgeries for different cancers
- Have knowledge of different approaches for surgery (open, laparoscopic, robot-assisted, etc.)
- Have knowledge of changes that are seen in the post-op period
- Have knowledge of surgical pathophysiology
- Have an understanding of complications associated with surgical procedures
- Have a sound understanding of anatomic changes seen with regard to vascular and organ anatomy, taking these into account in order to plan procedures

Clinical skills
- Planning of biopsies or re-biopsies in some cancers, discussing the surgical plan prior to resection
- Understanding when IO can help in presurgical planning (immediate presurgical or interval presurgical)
- Immediate presurgical: embolization of hypervascular tumours, embolization of renal tumours, etc.
- Interval presurgical: liver regeneration techniques prior to major hepatectomies (see 2.3.1.6), biliary drainage to reduce bilirubin levels and/or reduce postoperative liver failure, TACE prior to transplant for downstaging
- Post-surgical IO help in the management of patients having surgical complications (e.g. biloma, pancreatic fistula with abscess)

Technical skills
- How to approach keeping surgery in mind
- Where, when and how much to embolize (for immediate presurgical as well as interval presurgical)
- How to perform a procedure so as not to alter the surgical plan of the patient e.g. keep vascular stump free of embolization materials for safe vascular transection
- 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 anatomical and non-anatomical open or thoracoscopic resection of metastases and imaging changes after surgery (e.g. staple lines)
- Understand lobectomy and pneumonectomy (open or thoracoscopic)
- Know the different thoracoscopic surgeries and mediastinoscopic procedures performed

Liver
- Know the different types of hepatic resections (according to Brisbane classification[10])
- Know the difference between right, left, extended right or left and segmental hepatic resection
- Know minimally invasive hepatic resections (laparoscopic or robotic)
- Know the different types of liver transplant and types of anastomotic vascular and biliary reconstructions
- Understand the different types of bilio-enteric reconstructions (duodenum, jejunum, Y-Roux)

Pancreas
- Know the variations in pancreatic head resections (classical Whipple procedure vs pylorus-preserving procedures)
- Know the variations of left sides pancreatectomy procedures (radical antegrade modular pancreatosplenectomy -RAMPS- procedure, parenchymal sparing technique and spleen preserving e.g. in neuroendocrine tumours) and total duodeno-pancreatectomy

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

Duodenum and small intestine
- Know about the different types of resections for the duodenum and the small intestine (jejunum and ileum) and resection of mesentery (e.g. different technique used in neuroendocrine tumours)
- Know the different reconstruction types (e.g. end to end, side to side)

[10] *Belghiti J, Clavien PA, Gadzijev, et al. The Brisbane 2000 terminology of liver anatomy and resections. HPB 2000; 2:333-9*

Colon
- Know the different types of colectomies: hemi (ascending, transverse and descending) and total colectomy
- Understand the surgical option for rectal tumours
- Understand colostomy types (e.g. protective loop with aim to reverse)
- Understand HIPEC (hyperthermic intraperitoneal chemotherapy) procedures

Retroperitoneum
- Knowledge of surgery for retroperitoneal sarcoma and metastases

Renal and bladder
- Know partial nephrectomy (open or minimally invasive)
- Know total nephrectomy and radical nephrectomy (open or minimally invasive)
- Know partial or total cystectomy (open or minimally invasive)

Prostate
- Know radical prostatectomy as a procedure (including levels of lymph node and reconstruction)

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
- Know the different types of stabilization 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. It is important to understand quality of life parameters in palliative medicine.

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 or cancer related pain.
Role of IO in pain management: Involves predominantly ablation, cementoplasty or stabilization with screw fixation, but may also involve neurolysis (the application of physical or chemical agents to a nerve in order to cause a temporary or permanent degeneration of targeted nerve fibres).

IO trainees should
- Have knowledge of pathophysiology of pain in different cancer types
- Have knowledge of different medical approaches for pain in cancer patients
- Have knowledge of the role of radiation therapy in cancer pain
- Knowledge of ablation of bone metastases
- Have knowledge of which patients will benefit from cementoplasty or stabilization by screw fixation
- Have knowledge of ablation of painful soft tissue metastases
- Have knowledge of principles of neurolysis and different techniques: radiofrequency (heat), chemoneurolysis (chemical), or cryoablation

Clinical skills
- Understanding and localizing the origin of the pain
- Clinical examination of patient to localize 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 different techniques for neurolysis
- Approach to treatment of painful bone metastases
- Use of cement in painful bone metastases
- Use of internal screw fixation with or without cement injection (when, where and how)

Nutritional management

IO trainees should
- Have knowledge of basic principles of nutrition assessment in patients with cancer
- Have knowledge of tumour-induced and therapy-induced effects on nutrition status
- Have knowledge of the indications and different approaches for nutrition support (enteral and parenteral nutrition)
- Have knowledge of percutaneous gastrostomy and jejunostomy procedures along with indications and limitations in a palliative setting
- Have knowledge of gastrojejunostomy for relief of gastric outlet obstruction and nutrition via jejunostomy
- Have knowledge of intravenous tunnelled catheter placement in a 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
- Understanding of the use of gastrojejunostomy in gastric outlet obstruction
- Understanding of the best venous access for tunnelled catheters

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

Emergencies in cancer care

Knowledge
- Clinical, pathological and radiological understanding of conditions in oncologic patients that require emergency treatment
- Clinical presentations of patients in (haemorrhagic) shock
- Legal and ethical aspects
- Interventional treatment options
- Alternative treatment options
- Tumour-induced and therapy-induced complications and adverse events that may require emergency interventions
- Supporting interventional imaging options
- Embolization materials of emergency treatment procedure (coils, plugs, stent-grafts, liquid embolics, particles) incl. advantages and disadvantages

Clinical skills
- Know how to handle and interpret pre-interventional imaging
- Interpretation of relevant laboratory results
- Interpretation of the coagulation status and initiation of appropriate measures
- Competence in decision-making regarding treatment and request for anaesthesiologic support
- Provide recommendations for post-interventional monitoring and further measures
- Understand changes of blood flow after embolization
- Understanding do not resuscitate (DNR) and do not intubate (DNI) 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
- Embolization for gastrointestinal (GI) bleeding, tumour bleeding (liver, etc.), bronchial artery bleeding, head and neck tumour bleeding, etc.
- Biliary drainage with patients in sepsis or cholangitis
- Nephrostomy for patients with urinary sepsis or hydronephrosis
- Superior vena cava (SVC) stenting for SVC syndrome
- Inferior vena cava stenting
- Inferior vena cava filter placement
- Thrombolysis of venous or arterial systems
- Management of massive pulmonary artery thrombosis
- How to manage bleeds from varices around ileostomies or colostomies or from varices secondary to portal hypertension

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.

Knowledge
- Normal human anatomy (vascular, organ and system) and the most common native variations
- Correlations between the real anatomy (surgical anatomy) and imaging anatomy (CT, MR, US, angiography and X-rays)
- Most common distortions and changes in anatomy occurring after surgery
- Liver segmentation and its relationship with surrounding structures
- Liver functional structure (the concept of “liver’s functional unit”)
- Liver vascular anatomy, including arterial, portal, and venous anatomy
- Biliary anatomy
- Most common native variations in vascular and biliary anatomy
- Common post-surgical modifications of liver anatomy and the biliary route (e.g. hemihepatectomy, biliary diversions, etc.)
- Renal anatomy and its relationship with surrounding structures
- Arterial and venous renal distribution
- Anatomy of the collecting system

- Most common native and post-surgical anatomical variations of the vascular and collecting system (e.g. duplicated collecting system, urinary diversions, etc.)
- Anatomy of lungs (lobes/segments) and mediastinum with 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, the most common anatomical variations and the 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

- IO trainees should be able to properly investigate all the crucial anatomical aspects, correlating with clinical specific information, to plan the treatment. They should also be confident with other general clinical information, useful for a comprehensive patient evaluation (such as the 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 IO trainee should be able to define the clinical indication to a specific IO approach
- IO trainees should also know the possible alternative options to the IO approach (surgery, endoscopy, RT, chemotherapy and their combinations) when anatomy might represent a crucial issue (e.g. laparoscopic liver ablation)
- IO 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

- IO trainees should be able to choose and perform a specific imaging modality (CT, US, MR, fluoroscopy), according to the specific anatomical region and properly evaluate the findings to plan the IO procedure
- IO trainees should know how to deal with 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, to evaluate the differences according to the patient's anatomy:
  - Needles 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 focused ultrasound (HIFU), irreversible electroporation (IRE), electro chemotherapy (ECT) and histotripsy
  - Vascular and drainage catheter shapes and characteristics to be chosen according to the anatomical region

2.2.2 Peri-procedural management of anticoagulants and antiplatelet agents

Peri-procedural management of anticoagulants and antiplatelets is complex. Two opposing risks decide the peri-procedural management of these patients: the risk of bleeding from the procedure versus the risk of thromboembolic events from stopping therapy. It is important to carefully understand the management of anticoagulants and antiplatelets related to the specific planned IO procedure (basically relating to continued use or discontinuation).

Knowledge

- IO trainees should be familiar with the coagulation tests (international normalized ratio (INR)/ prothrombin time (PT), activated partial thromboplastin time (aPTT), platelet count, and bleeding time)
- Have general knowledge of current anticoagulants and antiplatelets and their management
- Know the most commonly used anticoagulants and their mechanisms of actions
- Know the most commonly used antiplatelet agents
- Be able to handle the transition of one medication to another one, in order to reduce the risk of bleeding during IO procedures
- Know when to restore the original medications, once the procedure has been carried out
- Know and follow the guidelines for anticoagulants proposed by the CIRSE Standards of Practice Committee[11]
- Know the most common coagulation disorders (haemophilia, thrombophilia, etc.)
- Handle reversal of anticoagulation for anticoagulated patients requiring emergency procedures or with life-threatening bleeding

Clinical skills

- IO trainees need to know when to request the proper coagulation tests, according to the bleeding risk of the scheduled procedure (according to CIRSE 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

IO trainees should be familiar with the different types of anaesthesia (local, regional, spinal and 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

- IO trainees should know the principles of local anaesthesia, regional anaesthesia (i.e. peripheral blocks), and spinal/epidural anaesthesia
- IO trainees should know the difference among the most common local anaesthetic drugs, in terms of efficacy, safety and duration (short-acting vs long-acting)
- Be familiar with the differences in terms of advantages, disadvantages and limitations among the spinal and epidural anaesthesia
- Know the principles of intravenous sedation and general anaesthesia and their respective advantages and limitations
- Know the differences in terms of advantages, disadvantages and limitations among the inhalational and injectable general anaesthesia
- Know the main drugs used for intravenous sedation and general anaesthesia
- Know the different modalities of patient ventilation during general anaesthesia (tracheal tube ventilation, jet ventilation, one-lung ventilation, laryngeal mask ventilation) and their specific advantages and limitations, according to the most common IO procedures
- IO trainees should know the various devices for anaesthesia that can be used during the interventional procedures
- Know the important advantages and limitations in using muscle relaxant drugs during general anaesthesia
- Be familiar with the most common analgesic profiles used during general anaesthesia

[11] *Hadi, M., Walker, C., Desborough, M. et al. CIRSE Standards of Practice on Peri-operative Anticoagulation Management During Interventional Radiology Procedures. Cardiovascular Interventional Radiology 44, 523-536, 2021.*

Clinical skills

- According to the specific scheduled IO procedure, IO trainees have to be able to discuss the most appropriate anaesthesia with anaesthesiologist, according to the specific technical and clinical needs:
  - For mitigating patient movements (e.g. as a pain reaction) during a specific intervention
  - For reducing respiratory movements in some interventions (liver, kidney or lung ablations)
  - Understanding specific patient 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, IO trainees must be able to discuss the advantages and disadvantages of the different options
- IO trainees must be able to discuss the application of different local anaesthesia, according to each specific case (e.g. short-acting vs long-acting local anaesthesia for percutaneous biopsy vs percutaneous ablation)
- IO trainees should be able to provide the patient with the essential information regarding the anaesthesia regimen chosen
- IO 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)
- IO trainees should be aware of the possible side effects and common outcomes of different anaesthesia on the post-op course
- IO trainees should be able to evaluate the principal vital monitored parameters, in order to carry out the procedure in the safest way (sphygmomanometer, pulse-oximeter, capnometer, bispectral index-BIS, etc.)

Technical skills

- IO trainees should collaborate with the anaesthesiologist to settle the IO suite, according to the anaesthesiologist's needs and the requirements for the any specific procedure
- IO trainees should know how to deal with the common devices for anaesthesia, that can be used during the interventional procedures, to facilitate their usage by the anaesthesiologist

2.2.4 Patient positioning and planning

Knowledge

- Understand the importance of correct and safe patient positioning for various IO procedures
- Familiarity with guidelines and best practices for patient positioning on the operating bed
- Knowledge of specific patient positioning requirements for common procedures (e.g. prone, supine, lateral) and their indications
- Understand how different positions might affect the procedure planning as well as outcome and safety
- Knowledge of anatomical considerations relevant to patient positioning and any potential complications (i.e. nerve plexus stretching),related to improper positioning
- Awareness of the role of patient positioning in pain management and patient comfort
- Understand the impact of patient positioning on imaging quality and accuracy
- Understand the principles of patient transfer and handling to prevent injury
- Knowledge of the roles and responsibilities of the healthcare team in ensuring correct patient positioning (physicians, anaesthesiologists, nurses, radiographers, orderlies)
- Understand the role of patient positioning in respiratory management during procedures (local anaesthesia vs sedation vs general anaesthesia)
- Familiarity with protocols for emergency repositioning of patients (Basic Life Support Defibrillation – BLSD)
- Awareness of training and education programs for healthcare providers on patient positioning techniques, including the use of AI tools

- Familiarity with the integration of navigation systems with imaging modalities like CT, magnetic resonance imaging (MRI), and US
- Knowledge of different navigation technologies, including electromagnetic, optical, and hybrid systems and their role in interventional oncology for enhancing procedural accuracy
- Awareness of the latest advances in technology and equipment for patient positioning and treatment planning, such as AI-driven and robotic systems, and fusion imaging softwares
- Familiarity with advances in artificial intelligence and its application in navigation and confirmation for interventional oncology
- Understanding the ethical considerations in patient positioning, including patient dignity and consent

Clinical skills

- Ability to discuss the different steps of the planned procedure with the IO team and how to manage and achieve the required patient position, using AI-based tools for simulation and planning
- Understanding the importance of the essential actions sequence in IO (planning, targeting, guiding, confirming) in relation with patient position
- Ability to identify possible sensitive pressure points in particular along nerve trajectories and know how to protect them from trauma during a procedure
- Knowledge of how to protect the patient from trauma due to patient positioning and decubitus, such as the brachial plexus in prone positions
- Familiarity with the clinical relevance of specific patient positions in relation to technical needs in specific interventions
- Ability to manage all the necessary clinical parameters for proper patient evaluation during the procedure according to different patient positions (blood pressure cuff, pulse oximeter, BIS, etc.)
- Understanding of the preferred patient position for various procedures, considering the organ to be approached, the tumour position and image-guidance
- Ability to justify patient positioning decisions based on clinical and procedural requirements
- Awareness of potential complications specific to interventional oncology procedures related to patient positioning (e.g. a critical hypertensive event during adrenal ablation in a prone patient)
- Understanding the role of patient positioning in optimizing the effectiveness of a specific intervention (e.g. percutaneous lung ablation vs TACE)
- Knowledge of how to integrate imaging guidance with patient positioning to enhance procedural accuracy
- Ability to recognize and mitigate risks associated with prolonged procedures and patient immobility
- Familiarity with strategies for repositioning patients safely during multi-step or prolonged interventions and reducing the effect on the whole procedure outcome
- Proficiency in coordinating with the healthcare team to ensure correct patient positioning
- Understanding of how to tailor patient positioning to individual patient needs and procedural requirements, utilizing AI-based device for planning (robotic systems)

Technical skills

- Ability to justify the clinical relevance of a specific patient position in relation to the technical needs using different imaging modalities for guiding the procedures (CT vs cone-beam CT (CBCT) vs US vs MRI)
- Capability to manage all necessary clinical parameters for proper patient evaluation during procedures according to different patient positions
- Competence in managing devices used for fixing patients in specific positions for IO treatments, such as vacuum pillows and head-fixing devices, to achieve optimal procedural access and visualization
- Knowledge of the preferred patient position based on the scheduled procedure and the organ

to be approached
- Ability to prevent trauma to joints and muscles during patient positioning and transferring to/from the IO table
- Skill in using imaging guidance to verify and adjust patient positioning during procedures
- Competence in integrating patient positioning considerations into procedural planning and execution utilizing AI tools
- Awareness of the benefits of using navigation systems for complex and minimally invasive procedures
- Understanding the setup and calibration of navigation systems prior to procedures
- Knowledge of patient safety protocols and radiation protection measures when using navigation systems
- Understanding the role of navigation systems in enhancing the accuracy of biopsies and ablative procedures
- Familiarity with the workflow integration of navigation systems in interventional oncology suites
- Knowledge of the limitations and challenges associated with the use of navigation systems
- Awareness of the cost-benefit analysis of implementing navigation systems in clinical practice

2.2.5 IO materials and usage

It is essential for the IO trainee to have good knowledge of all the materials and devices available on the market and those available within their IO department and their functions. It is also essential to understand the proper usage and limitations of all the devices.

Knowledge
- Be aware of the available materials for tumour ablations (MWA, RFA, CRYO, laser, HIFU, IRE and ECT)
- Stay updated on new and evolving ablation technologies
- Understand the fundamental physics behind the various ablation technologies
- Understand which technology is best suited for different types 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
- Know the current available options for intravascular radioactive microparticles delivery (Y90 resin and glass, Ho166) and their features
- Be confident in the use of the different devices and material available in the IO department

Clinical skills
- Be able to offer the patient the best technique for percutaneous ablation according to any specific case
- Choose the device to use, according to its specific technical characteristics on a case-by-case basis
- Be able to establish which kind of intra-arterial treatment to use, according to patient, disease and intended aim of the procedure (TACE vs transarterial radioembolization (TARE))
- Be able to establish which kind of intra-arterial embolic or radioactive particles to use, according to patient, disease and intended aim of the procedure
- Clearly define the procedural steps and share them with the whole IO team (nurses, anaesthetists and technicians)

Technical skills
- Know how to handle all the different ablation systems available in the IO department
- Be able to deal with different embolic and radioactive particles 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 embolization materials
- Master basic manual skills, which are essential for all IO trainees to learn at the beginning of their training:
  - US-guided percutaneous biopsies (liver, kidney, etc.) and fluid collection drainage
  - CT-guided percutaneous biopsy (lung, retroperitoneal masses, bones, etc.)
  - Catheter/micro-catheter and guide-wire handling

2.2.6 Biopsy

Knowledge
- Normal relevant anatomy of different organs that may require biopsy
- Typical anatomical variants
- Appropriate patient information before biopsy procedures
- Different types of material used for biopsy in different organs (advantages and limitations to each)
- Typical device diameters for different biopsy techniques and target organs
- 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
- Specific complications and complication rates
- Different kind of samples that may be obtained (cytology, tissue sampling, liquid biopsy, etc.) and their associated suitable conditioning techniques (fixation, frozen section, etc.)
- Specifics of liquid biopsy in oncology patients (circulating tumour cells, cell-free tumour DNA)
- Different imaging modalities for biopsy procedures
- Knowledge of alternatives to percutaneous biopsy (transbronchial, open, etc.)

Clinical skills
- Know how to perform and handle imaging workup before, during and after biopsy
- Peri-interventional anticoagulation management
- Options for conscious sedation and local anaesthesia and requirements
- 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
- Recommendations for follow-up after the biopsy procedure
- Reasons for a negative biopsy results and recommendations in case of a negative biopsy result
- Indications for transjugular liver biopsy

Technical skills
- Perform basic and advanced percutaneous biopsy in different organs
- 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
- Be able to perform a transjugular liver biopsy

2.2.7 Endovascular treatments

Knowledge
- Clinical, pathological and radiological understanding of diseases and conditions requiring endovascular treatments
- Endovascular anatomy of different organs and peripheral circulation that may require endovascular treatment
- Typical endovascular anatomical variants
- Appropriate patient information
- Indications and contraindications
- Alternative treatment options (surgical, medical, observational) and understand when one should be preferred over the other
- Specific complications and complication rates
- Relevant studies concerning endovascular interventions in oncology

Clinical skills
- Perform endovascular treatments in emergency or elective settings in oncologic patients
- Know how to perform and handle an imaging workup before and after endovascular treatments
- Understand the changes that will occur in different organs parenchyma after endovascular 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
- Give recommendations for post-treatment follow-up

Technical skills
- Plan the endovascular 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, navigation softwares)
- Perform diagnostic angiography
- Perform angioplasty and stent placement
- Perform embolization (arterial and venous)
- Perform basic and advanced chemoembolization
- Perform radioembolization
- Perform arterial or venous thrombolysis and thrombectomy
- Place access lines
- Place and retrieve superior and inferior vena cava filters
- Place closure devices

2.2.8 Non-vascular treatments

Knowledge
- Clinical, pathological and radiological understanding of diseases and conditions requiring non-vascular treatments
- Normal relevant anatomy of different organs that may require non-vascular treatment
- Typical anatomical variants
- Indications and contraindications

- Alternative treatment options (surgical, medical, observational) and understand when one should be preferred over the others
- Specific complications and complication rates
- Relevant studies concerning non-vascular interventions in oncology

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 materials
- Clinical assessment of patients before and after the treatment
- Recognition and management of complications
- Accurately report key findings and treatment steps
- Give recommendations for follow-up

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 and know which one to use with reference to the indication
- Be able to use adjunctive procedures (such as hydro-dissection, CO2 dissection, etc.) in order to optimize safety and the procedural outcome
- Know basic and advanced guidance techniques, including navigation and robotics
- Perform drainage (collection, bile, urinary, etc.)
- Perform nutritional procedures (gastro and jejunostomies)
- Perform conversion from drain to stent (urinary and biliary)

2.2.9 Imaging

Knowledge:
- Understanding of the different imaging modalities such as US, contrast US, CT, MRI, PET-CT, single-photon emission computed tomography (SPECT-CT)
- Contraindications and alternatives of imaging modalities
- Criteria for categorizing lesions and standardized reports (liver imaging reporting and data system (LI-RADS); prostate imaging reporting and data system (PI-RADS); European Association for the Study of the Liver (EASL) criteria for HCC, etc.)
- Common staging systems (TNM (Tumour, Node, Metastasis), Barcelona Clinic Liver Cancer (BCLC), UNOS, etc.)
- Criteria for evaluation of tumour response (Response evaluation criteria in solid tumours (RECIST), LI-RADS treatment response algorithm (TRA LI-RADS), modified RECIST (mRECIST), etc.)
- Staging with reference to images
- Interpretation of immediate post-treatment images
- Terminology in assessment of treatment results
- Opportunities of artificial intelligence concerning tumour segmentation/detection
- Opportunities of accelerated MR imaging using artificial intelligence
- Knowledge of post-interventional follow-up imaging intervals
- Opportunities of US-fusion, CT- and MR-fluoroscopy
- Principles of radiation protection

Clinical skills
- Knowledge of regular post-interventional changes during follow-up
- Recognition of local post-treatment recurrences
- To give recommendations for imaging follow-up after interventional procedures (imaging modality and interval)
- Detecting complications in intra- and post-interventional imaging
- Post-treatment evaluation criteria (TRA-LIRADS, World Health Organization (WHO), EASL, RECIST)
- Typical imaging findings after surgery, interventional oncology, and systemic therapy (including immune therapy)

Technical skills
- To be familiar with the common imaging modalities such as fluoroscopy, DSA, CBCT, US, contrast US, CT, MRI, PET-CT, SPECT-CT.

SECTION C

2.3 Organ site-specific oncology

2.3.1 Liver malignancies

2.3.1.1 Hepatocellular carcinoma

Knowledge
- Learn the main risk factors for hepatocellular carcinoma and its incidence across geographical regions
- Know the causes of liver cirrhosis and the implications for therapy in patients with co-existing hepatic malignancy
- Understand the pattern of evolution of a nodule from pre-malignant lesion to fully developed HCC and understand vascular recruitment and tumour angiogenesis
- Have thorough knowledge of the main clinical staging systems of HCC and cirrhosis (e.g. BCLC system, Eastern Cooperative Oncology Group (ECOG) Performance Status, Child-Pugh class, model for end-stage liver disease (MELD score), albumin-bilirubin (ALBI) score and LI-RADS classification)
- Understand the role of liver transplantation in the management of HCC, including the Milan criteria, extended criteria and the role of downstaging
- Understand the role of liver resection in the management of HCC and the impact of portal hypertension and liver functional reserve in tumour resectability
- Have basic knowledge of the later advances in surgical techniques for resection and transplantation
- Know the indications and main toxicities of systemic therapies for HCC, including first line (atezolizumab + bevacizumab, tremelimumab + durvalumab, ipilimumab + nivolumab, sorafenib, lenvatinib), second line and third line options (such as regorafenib, ramucirumab, cabozantinib)
- Know the imaging criteria for non-invasive HCC diagnosis
- Have knowledge of the imaging criteria to evaluate HCC response to treatment

Clinical skills
- Demonstrate skill in history taking and physical examination
- Evaluate laboratory data with a specific understanding of liver function tests and their impact on treatment decision-making

- Consult with patients and their families regarding risks and benefits of various surgical, medical and interventional oncologic therapeutic options
- Work within a multidisciplinary team to optimize patient care
- Have an understanding of assessment for anaesthetic risk and patient performance status to independently determine patient fitness with regard to undertaking interventions
- Be able to describe strategies for imaging of HCC patients, understanding the mechanisms, complementary roles and limitations of US, contrast-enhanced US, MR, CT +/- angiography
- Know the abdominal vascular anatomy. Understand variant hepatic vascular anatomy and intrahepatic segmental anatomy relevant to liver disease from the viewpoint of intra-arterial and ablative 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
- Identify tumour types that will respond well to ablative and intra-arterial therapies, such as chemoembolization and radioembolization
- Identify patients at high risk for procedural complications and have knowledge of the strategies to prevent them
- Understand how previous liver and visceral surgery will bear upon proposed interventions in terms of altered anatomy, hypertrophic change, vascular insufficiency, etc.
- Understand pre- and post-procedure patient care for chemo/radioembolization, intra-arterial perfusion and ablation (including prevention of infection, post-ablation/post-embolization syndrome and post-procedural pain management)
- Plan optimal patient follow-up with imaging, laboratory tests and clinical evaluation to assess treatment success and to detect complications and disease recurrence or progression
- 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

Vascular hepatic interventions

- Know the indications and absolute and relative contraindications to chemo/radioembolization
- Demonstrate technical competence in performing lobar, segmental and targeted embolization 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 and flow-modulated procedures
- Understand the differences between microspheres (bland, drug eluting, resorbable)
- Understand the differences between conventional TACE (cTACE) and drug eluting microspheres (DEM) TACE
- Know how to protect adjacent structures (duodenum, stomach, skin, etc.) during radioembolization
- Know the differences between radioembolic microsphere in terms of size, materials and isotopes
- Understand how to plan a dose for radioembolization and the concepts of radiation lobectomy and segmentectomy
- Be able to recognize and manage procedural complications, such as arterial spasms, tumour bleeds and non-target embolization

Non-vascular hepatic interventions:
- Know the indications and absolute and relative contraindications to percutaneous ablation
- Demonstrate competence in the current ablation technologies including ethanol, RF, MW, IRE and ECT, their preferential indications and specific mechanisms of action
- Recognize 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)
- Understand how specific tumour locations can be associated with increased risks of injuries of non-target areas (such as diaphragm, bowel, stomach and major bile ducts) and know strategies to reduce these risks (e.g. technique of artificial ascites, bile duct cooling, artificial pneumothorax and separation of organs with CO2)
- Be able to recognize and manage intraoperative and post-operative complications of ablation therapies, such as haemorrhage, infection and GI perforation

2.3.1.2 Intrahepatic cholangiocarcinoma

Knowledge
- Know the main risk factors for cholangiocarcinoma and the incidence across geographical regions
- Know the anatomical, macroscopic and histologic classifications of cholangiocarcinoma and, more specifically, of intrahepatic cholangiocarcinoma (ICC), and their prognostic and therapeutic implications
- Have knowledge of the staging system of ICC and of the common sites of metastases
- Have knowledge of the role of different imaging modalities in the diagnosis and staging of ICC
- Understand the role of biopsy of ICC
- Know the role of next generation sequencing and molecular characterization in ICC and the impact on prognosis and treatment
- Understand the role of resection in the management of ICC as the only curative treatment modality and know the available options able to increase tumour resectability
- Understand the role of liver transplantation in patients with ICC
- Know the indications and main toxicities of first and second lines systemic therapies for ICC, and the impact of modern systemic therapies on the treatment algorithm and the clinical outcomes
- Know the anatomical classification of biliary obstruction associated with ICC and the role of biliary drainage and biliary stenting

Clinical skills
- Demonstrate skill in history taking and physical examination
- Evaluate laboratory data with a specific understanding of liver function tests and their impact on treatment decision-making
- Consult with patients and their families regarding risks and benefits of various surgical, medical and interventional oncologic therapeutic options
- Work within a multidisciplinary team to optimize patient care
- Be able to assess patient fitness with regard to the different possible interventions
- Understand imaging features of ICC indicative of technical feasibility and likelihood of response to percutaneous ablation and transarterial treatments
- Identify patients at high risk for complications and strategies to prevent them
- Understand how previous liver and visceral surgery will bear upon proposed interventions in terms of altered anatomy, hypertrophic change, vascular insufficiency, etc.
- Understand pre- and post-procedure patient care for chemo/radioembolization, intra-arterial perfusion therapy and percutaneous ablation (including prevention of infection, post-ablation/ post-embolization sydrome and post-procedural pain management)

- Plan optimal patient follow-up with imaging, laboratory tests and clinical evaluation to assess treatment success and detect disease recurrence or new lesions
- 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
- Understand the biliary anatomy and be able to identify biliary obstructions related to ICC

Technical skills

Vascular hepatic interventions
- Know the indications and absolute and relative contraindications to chemo/radioembolization
- Demonstrate technical competence in performing lobar, segmental and targeted embolization 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 and flow-modulated procedures
- Know when a single lobar treatment needs to be done and when both lobes can be treated simultaneously
- Understand the differences between microspheres (bland, drug eluting, resorbable)
- Understand the differences between conventional TACE (cTACE) and drug eluting microspheres – (DEM) TACE
- Know how to protect adjacent structures (duodenum, stomach, skin, etc.) during radioembolization
- Know the differences between radioembolic microsphere in terms of size, materials and isotopes
- Understand how to plan a dose for radioembolization and the concepts of radiation lobectomy and segmentectomy
- Be able to recognize and manage procedural complications, such as arterial spasms, tumour bleeds and non-target embolization
- Know the indications and absolute and relative contraindications to percutaneous ablation
- Demonstrate competence in the current ablation technologies including ethanol, radiofrequency, microwave and electroporation, their preferential indications and specific mechanisms of action
- Recognize 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)
- Understand how specific tumour locations can be associated with increased risks of injuries of non-target areas (such as diaphragm, bowel, stomach and major bile ducts) and know strategies to reduce these risks (e.g. technique of artificial ascites, bile duct cooling, artificial pneumothorax and separation of organs with CO2)
- Be able to recognize and manage intraoperative and post-operative complications of ablation therapies, such as haemorrhage, infection and gastrointestinal (GI) perforation

Biliary interventions
- 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 endoscopic retrograde cholangiography (ERC) through biliary drainage
- Have knowledge of the types of stents available and when to use covered, partially covered, uncovered or removable stents

- Recognize 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

2.3.1.3 Colorectal cancer liver metastases

Knowledge

- Incidence and epidemiology of colorectal cancer liver metastases
- Diagnostic techniques (imaging modalities (e.g. CT scan, PET/CT scan, MRI), tissue biopsy methods (e.g. percutaneous needle biopsy, surgical biopsy)
- Biomarkers testing (Mismatch repair (MMR) status, KRAS, NRAS exon 2, 3 and 4, BRAF mutations, RAS testing, Mismatch repair deficient (dMMR)/ Microsatellites instability (MSI), etc.)
- Differential diagnosis (differentiating liver metastases from primary liver cancer, recognizing benign conditions, such as cysts, haemangiomas, focal nodular hyperplasias, etc.)
- Staging and risk assessment
- Knowing the concepts of oligometastatic disease, oligo-progression, oligo-persistence and oligo-recurrence
- Treatment options (systemic therapies (e.g. chemotherapy, targeted therapy, immunotherapy), indications for local treatments (e.g. surgical resection, stereotactic body radiotherapy, ablation, intra-arterial treatments) in metastatic disease
- Follow-up (surveillance strategies for detecting progression or response to treatment, adjusting treatment plans based on disease progression and patient condition)
- Current guidelines (staying updated with guidelines from major oncology societies, e.g. European Society for Medical Oncology (ESMO), American Society of Clinical Oncology (ASCO), National Comprehensive Cancer Network (NCCN)

Clinical skills

- Patient evaluation (comprehensive assessment of patient's medical history, fitness, comorbidities, and overall health status)
- Evaluating the extent of metastatic disease and suitability for local treatments; recognizing detailed history, including prior treatments, response to therapy, and potential impacts on local treatments (e.g. prior surgery, SBRT, extensive chemotherapy)
- Procedure selection: identifying appropriate local treatment options (e.g. RFA, MWA, cryoablation, IRE, ECT, TACE, TARE, surgery plus ablation) based on tumour type, size, location, and patient factors; understanding the specific indications, contraindications, and risk profile of each treatment modality
- Post-procedural care (monitoring patients for immediate and delayed complications following the procedure; providing detailed post-procedural instructions and managing follow-up care; recognizing and managing post-ablation syndrome and other common post-procedural issues)

Technical skills

- Diagnostic imaging: interpreting various imaging modalities (e.g. US, CT, MRI, PET) for accurate localization of liver tumours; application of imaging techniques (e.g. US, fluoroscopy, DSA, CBCT, CT, CTA) during interventions to guide treatment; identifying immediate procedure related outcome and complications
- Percutaneous biopsy: techniques for obtaining tissue samples (e.g. fine-needle aspiration, core needle biopsy); management of biopsy-related complications (e.g. bleeding)
- Thermal ablation: knowledge of mode of action, equipment, and technique of various ablative modalities (RFA, MWA, cryo-ablation); experience in setting up specific ablation equipment, placing probes, delivering energy, assessing the progress of the ablative procedure, considering safety margins, recognizing and managing early complications and systemic effects

- Non-thermal ablation: knowledge of mode of action, equipment, and technique of IRE and ECT; know specific indications and contraindications for the use of non-thermal modalities; know how to place the electrodes, when to infuse cytotoxic drug in ECT, and specificities for anaesthesia protocols
- Intra-arterial treatments: knowledge of mode of action, drugs (irinotecan, oxaliplatin), and technique for TACE; knowledge of mode of action, technique and dosimetry for TARE in colorectal liver metastases
- Complication management: recognition and management of procedural complications (e.g. bleeding, infection, damage to the biliary tree); awareness of immediate peri- and post-procedural complications to minimize the risk of delayed complications; (training in basic life support)

2.3.1.4 Neuroendocrine liver metastases

Knowledge

- Definition and overview: liver metastases from neuroendocrine neoplasms (NENs) that originates most frequently in the digestive system (small intestine and pancreas) followed by the lung; NENs includes well differentiated neuroendocrine tumours (NETs) and poorly differentiated neuroendocrine carcinomas (NECs)
- Incidence and epidemiology: small intestine NETs (Si-NETs) vs pancreatic NETs (Pan-NETs) vs lung NETs; sporadic vs hereditary settings (multiple endocrine neoplasia type 1 - MEN1-syndrome, von Hippel-Lindau -VHL- disease, tuberous sclerosis -TSC- and neurofibromatosis)
- Key features for diagnostic and therapeutic decisions: proliferative activity, somatostatin receptors (SSTR) expression, tumour growth rate and extent of the disease
- Histomorphology and genetics: proliferation rate, immunohistochemistry (synaptophysin, chromogranin A) and biomarkers (Ki-67, SSTR, DAXX/ATRX, p53/pRb, O6-methylguanine-DNA methyltransferase (MGMT))
- Clinical presentation of functioning tumours and carcinoid syndrome
- Knowledge of WHO classification of NENs (G1, G2, G3)
- Knowledge of staging and risk assessment
- Diagnostic techniques: imaging modalities (e.g. CT scan, 68Ga-SSA-PET/CT, MRI), tissue biopsy methods (e.g. percutaneous needle biopsy, surgical biopsy) and SSA=somastostatin analogues
- Different PET tracers (68Ga-DOTATOC, 68Ga-DOTATATE and 68Ga-DOTANOC) and the role of SSTR imaging in diagnostic work-up and staging selection of patients for peptide receptor radionuclide therapy (PRRT) and therapy monitoring in selected scenarios
- Understand the role of 18FDG-PET/CT for risk stratification and prior to PRRT in patients with NET G2/ G3
- Treatment options (SSA, everolimus, IFNα, chemotherapy, surgery, PRRT, ablation, intra-arterial treatments) in metastatic disease to the liver
- Management of symptoms and complications: carcinoid syndrome, common side effects of treatments, management of treatment-related complications
- Follow-up and monitoring: surveillance strategies for detecting progression or response to treatment, adjusting treatment plans based on disease progression and patient condition
- Current guidelines: staying updated with guidelines from major oncology societies, e.g. European Neuroendocrine Tumour Society (ENETS), ESMO, ASCO, NCCN

Clinical skills

- Patient evaluation: comprehensive assessment of the patient's medical history, fitness, comorbidities, and overall health status
- Evaluating the extent of metastatic disease and suitability for local treatments
- Procedure selection: identifying appropriate local treatment options (e.g. ablation, TAE, TACE and TARE) based on tumour size, number, location, and patient factors; understanding the specific indications, contraindications, and risk profiles of each local treatment modality

- Post-procedural care: monitoring patients for immediate and delayed complications following the procedure, providing detailed post-procedural instructions and managing follow-up care, recognizing and managing post-ablation syndrome and other common post-procedural issues

Technical skills

- Diagnostic imaging: interpreting various imaging modalities (e.g. US, CT, MRI, PET) for accurate localization of liver tumours, application of imaging techniques (e.g. US, fluoroscopy, DSA, CBCT, CT, CTA) during interventions to guide treatment, identifying immediate procedure related outcomes and complications
- Percutaneous biopsy: techniques for obtaining tissue samples (e.g. fine-needle aspiration, core needle biopsy), management of biopsy-related complications (e.g. pneumothorax, bleeding)
- Thermal ablation: knowledge of mode of action, equipment, and technique of various ablative modalities (RFA, MWA, cryo-ablation), experience in setting up specific ablation equipment, placing probes, delivering energy, assessing the progress of the ablative procedure, considering safety margins, recognizing and managing early complications and systemic effects (e.g. cryo-shock)
- Non-thermal ablation: knowledge of mode of action, equipment, and technique of IRE, ECT, knowledge of specific indications and contraindication for the use of non-thermal modalities, knowledge of how to place the electrodes, when to infuse cytotoxic drug in ECT, and specificities for anaesthesia protocols
- Intra-arterial treatments: knowledge of better safety profile of conventional TACE vs DEM-TACE in the treatment of liver neuroendocrine metastases, knowledge of mode of action, technique and dosimetry for TARE in neuroendocrine liver metastases
- PPRT: knowledge of patient selection, mode of action, and way of administration of PRRT with 177Lu-DOTATATE
- Complication management: recognition and management of procedural complications (e.g. bleeding, infection damage to the biliary tree), awareness of immediate peri- and post-procedural complications to minimize the risk of delayed complications, training in basic life support

2.3.1.5 Metastases from other primaries

Knowledge

- Definition and overview: liver metastases originating from primary cancers elsewhere in the body (e.g. breast, colon, prostate, kidney, lung, melanoma)
- Pathophysiology: mechanisms of metastatic spread (e.g. hematogenous, lymphatic routes), molecular and genetic factors influencing metastatic potential
- Diagnostic techniques: imaging modalities (e.g. CT scan, PET scan, MRI), tissue biopsy methods (e.g. percutaneous needle biopsy, surgical biopsy)
- Biomarkers testing according to the primary tumour
- Differential diagnosis: differentiating liver metastases from primary liver cancer, recognizing benign conditions, such as haemangiomas, focal nodular hyperplasias, etc.
- Staging and prognosis: understanding the impact of liver metastases in the staging of primary cancers, prognostic factors influencing outcomes
- Knowing the concepts of oligometastatic disease, oligo-progression, oligo-persistence and oligo-recurrence
- Treatment options: systemic therapies (e.g. chemotherapy, targeted therapy, immunotherapy), indications for local treatments (e.g. surgical resection, stereotactic body radiotherapy, ablation, intra-arterial treatments) in metastatic disease
- Management of symptoms and complications: common side effects of treatments (e.g. nausea, pain, fatigue, neutropenia), management of treatment-related complications (e.g. bleeding, abscess, liver failure)
- Follow-up and monitoring: surveillance strategies for detecting progression or response to treatment, adjusting treatment plans based on disease progression and patient condition

- Current guidelines: staying updated with guidelines from major oncology societies (e.g. ESMO, ASCO, NCCN)
- Patient selection: indications and contraindications for palliative and curative local treatments, criteria for the definition of oligometastatic disease, state of the primary tumour, assessment of the patient's overall health status and comorbidities

Clinical skills

- Patient evaluation: comprehensive assessment of the patient's medical history, fitness, comorbidities, and overall health status
- Evaluating the extent of metastatic disease and suitability for local treatments, recognizing detailed history, including prior treatments, response to therapy, and potential impacts on local treatments (e.g. prior surgery, SBRT, extensive chemotherapy)
- Procedure selection: identifying appropriate local treatment options (e.g. RFA, MWA, cryoablation, IRE, ECT, TACE, TARE) based on tumour type, size, location, and patient factors, understanding the specific indications, contraindications, and risk profiles of each local treatment modality
- Post-procedural care: monitoring patients for immediate and delayed complications following the procedure, providing detailed post-procedural instructions and managing follow-up care, recognizing and managing post-ablation syndrome and other common post-procedural issues

Technical skills

- Diagnostic imaging interpreting various imaging modalities (e.g. US, CT, MRI, PET) for accurate localization of liver tumours, application of imaging techniques (e.g. US, fluoroscopy, DSA, CBCT, CT, CTA) during interventions to guide treatment, identifying immediate procedure related outcome and complications
- Percutaneous biopsy: techniques for obtaining tissue samples (e.g. fine-needle aspiration, core needle biopsy), management of biopsy-related complications (e.g. bleeding)
- Thermal ablation: knowledge of mode of action, equipment, and technique of various ablative modalities (RFA, MWA, cryo-ablation), experience in setting up specific ablation equipment, placing probes, delivering energy, assessing the progress of the ablative procedure, considering safety margins, recognizing and managing early complications and systemic effects (e.g. cryo-shock)
- Non thermal ablation: knowledge of mode of action, equipment, and technique of IRE, ECT, knowledge of specific indications and contraindication for the use of non-thermal modalities, knowledge of how to place the electrodes, when to infuse cytotoxic drug in ECT, and specificities for anaesthesia protocols
- Intra-arterial treatments: knowledge of mode of action, drugs (irinotecan, oxaliplatin), and technique for TACE, knowledge of mode of action, technique and dosimetry for TARE in liver metastases
- Complication management: recognition and management of procedural complications (e.g. bleeding, infection damage to the biliary tree), awareness of immediate peri- and post-procedural complications to minimize the risk of delayed complications, training in basic life support

2.3.1.6 Liver regeneration procedures prior to major hepatectomies

Knowledge

- Definitions in liver surgery: anatomical vs non-anatomical; major vs minor hepatectomy
- Definition, incidence and risk factors for post-hepatectomy liver failure (PHLF)
- Definition of sufficient future liver remnant (FLR) according to underlying liver status such as post-chemotherapy liver injury or chronic liver disease such as cirrhosis or chronic cholestasis
- Know the epidemiology and pathophysiology of neoplastic diseases involving the liver which may benefit from strategies to increase FLR

- Understand the concept of flow redistribution related to hypertrophy of the liver
- Know the definitions of portal vein embolization (PVE), sequential PVE followed by hepatic vein embolization (HVE), double vein embolization (DVE or biembolization or PVE/HVE), liver venous deprivation (LVD)
- Know the definition of associated liver partition and portal vein ligation for staged hepatectomy (ALPPS)

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
- Demonstrate a fundamental knowledge of the surgical strategies in the management of liver tumours and indications for liver regeneration techniques 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)
- Know how to calculate FLR volume on CT images and how to adjust it to individual patient size
- Know the role of mebrofenin scintigraphy-CT or MRI using hepatospecific contrast agent in evaluating liver function
- Know the role of mebrofenin scintigraphy-CT or MRI using hepatospecific contrast agent in evaluating liver function
- Know the absolute and relative contraindications for liver regeneration techniques prior to major hepatectomies
- Multidisciplinary management: importance of a multidisciplinary team with respect to the individual patient's performance status, tumour resectability and vascular invasion, FLR volume and function, type of tumour and underlying liver disease
- Outline a strategy for FLR hypertrophy surveillance using imaging studies and software assisted volumetric evaluation
- Participate in the decision of the correct timing for surgery

Technical skills

- Be able to perform volumetric and functional liver assessment with CT/MR and scintigraphy pre-intervention
- Recognize the anatomy of intrahepatic portal vein branches and their relationships with tumour bearing liver segments
- Know the differences between and indications for ipsilateral and contralateral transhepatic approaches in PVE
- Be competent at US-guided transhepatic puncture of intrahepatic portal vein branches
- Be familiar with the equipment used in PVE including guidewires, sheaths, catheters, embolic materials and transhepatic cannulation kits
- Recognize the anatomy of hepatic vein branches and their relationships with tumour bearing liver segments
- Be competent at US-guided transhepatic puncture of hepatic vein branches
- Be competent at a transjugular or transfemoral approach of hepatic veins
- Be familiar with the equipment used in HVE/LVD including guidewires, sheaths, catheters, embolic materials (including plugs)
- Be able to embolize all transhepatic paths (gelfoam, coils, glue)
- Recognize 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/DVE/LVD
- Be able to perform volumetric and functional liver assessment with CT/MR and scintigraphy 14-28 days after intervention

2.3.2 Lung malignancies

2.3.2.1 NSCLC (non-small cell lung cancer)

Knowledge

- Definitions and types of NSCLC: primary cancer of the lung; adenocarcinoma, squamous cell carcinoma, large cell carcinoma
- Epidemiology: incidence, prevalence, and key risk factors (e.g. smoking, environmental exposures, genetic predispositions) of primary lung cancer
- Pathophysiology: common genetic mutations and molecular markers (e.g. EGFR, anaplastic lymphoma kinase (ALK), KRAS, ROS1), types of tumour growth and microenvironment
- Clinical presentation: typical symptoms (e.g. persistent cough, chest pain, haemoptysis, shortness of breath), signs of advanced disease (e.g. weight loss, bone pain, neurological symptoms), and paraneoplastic syndromes
- Diagnostic techniques: imaging studies (e.g. chest X-ray, CT scan, PET scan, MRI), tissue biopsy methods (e.g. bronchoscopy, percutaneous needle biopsy, surgical biopsy), and molecular and genetic testing (e.g. polymerase chain reaction (PCR), fluorescence in situ hybridization (FISH), next-generation sequencing)
- Staging: TNM classification system staging workup (e.g. mediastinoscopy, endobronchial ultrasound (EBUS), bone scan), and prognostic implications of different stages
- Treatment options: surgery (e.g. lobectomy, pneumonectomy, segmentectomy, atypical resection), radiation therapy (e.g. stereotactic body radiotherapy, intensity-modulated radiation therapy), systemic therapy protocols (e.g. platinum-based chemotherapy), targeted therapies (e.g. EGFR inhibitors, ALK inhibitors, ROS1 inhibitors), immunotherapy (e.g. PD-1/PD-L1 inhibitors, CTLA-4 inhibitors), percutaneous ablative therapies (e.g. RFA, MWA, Cryo-ablation)
- Management of side effects and complications: common side effects of treatments (e.g. nausea, fatigue, neutropenia), management of treatment-related toxicities, and supportive and palliative care
- Follow-up and survivorship care: surveillance strategies post-treatment, monitoring for recurrence or secondary cancers, long-term management of treatment sequelae
- Advances and guidelines: updates from major oncology societies (e.g. ESMO, ASCO, NCCN) implications of latest advances in personalized medicine for clinical practice
- Patient selection: indications and contraindications for diagnostic procedures and for palliative and curative intended local treatments (e.g. tumour size, location, number of lesions), criteria for oligometastatic disease versus locally advanced disease, assessment of patient's overall health status and comorbidities
- Diagnostic and therapeutic techniques: understanding the indications/contraindications for biopsy, bronchial artery embolization, SBRT, and for local ablative interventional techniques based on tumour stage, symptoms, and therapeutic goal
- Post-procedural care: awareness and monitoring for immediate and delayed complications (e.g. pneumothorax, infection, bleeding), recognition, management, and patient education of potential post-ablation syndrome, managing follow-up imaging to assess treatment efficacy and detect recurrence

Clinical skills

- Patient evaluation: comprehensive assessment of patient's medical history, comorbidities, and overall health status, evaluation of lung cancer staging and assessment of suitability for local interventions

- Procedure selection: identifying appropriate local treatment options (e.g. RFA, MWA, cryoablation) based on tumour type, size, location, and patient factors, understanding the specific indications, contraindications, and risk profiles of each local treatment modality
- Post-procedural care: monitoring patients for immediate and delayed complications following the procedure, providing detailed post-procedural instructions and managing follow-up care, recognizing and managing post-ablation syndrome and other common post-procedural issues

Technical skills

- Diagnostic imaging and interventional monitoring: interpreting various imaging modalities (e.g. CT, MRI, PET) for accurate localization of lung tumours; application of real-time imaging techniques (e.g. fluoroscopy, CT-fluoroscopy, angiography) during interventions to guide precise needle placement, identifying immediate procedure related outcome and complications
- Interventional techniques
- Percutaneous biopsy: techniques for obtaining tissue samples (e.g. fine-needle aspiration, core needle biopsy), management of biopsy-related complications (e.g. pneumothorax, bleeding)
- Bronchial artery embolization in haemoptysis: knowledge in catheterizing bronchial arteries and selecting appropriate embolic materials (e.g. coils, particles), techniques for minimizing non-target embolization risks
- Thermal ablation: knowledge of mode of action, equipment, and technique of various ablative modalities (RFA, MWA, cryo-ablation), experience in setting up specific ablation equipment, placing probes, delivering energy, assessing the progress of the ablative procedure, considering safety margins, recognizing and managing early complications and systemic effects (e.g. cryo-shock)
- Stereotactic Body Radiotherapy (SBRT): understanding the potential need of interventional radiology in placement of fiducial markers
- Complication management: recognition and management of procedural complications (e.g. pneumothorax, bleeding, infection); awareness of immediate peri- and post-procedural complications to minimize the risk of delayed complications, training in basic life support

2.3.2.2 Lung metastases

Knowledge

- Definition and overview: secondary pulmonary tumours originating from primary cancers elsewhere in the body; typical primary cancers (e.g. breast, colon, prostate, kidney, melanoma)
- Pathophysiology: mechanisms of metastatic spread (e.g. hematogenous, lymphatic routes), molecular and genetic factors influencing metastatic potential
- Clinical presentation: lung metastases often asymptomatic and discovered incidentally, symptomatic in advanced metastatic spread (e.g. persistent cough, haemoptysis, dyspnoea, chest pain), systemic symptoms usually related to the primary cancer
- Diagnostic techniques: imaging modalities (e.g. chest X-ray, CT scan, PET scan, MRI), tissue biopsy methods (e.g. bronchoscopy, percutaneous needle biopsy, surgical biopsy), and molecular and genetic testing (e.g. PCR, FISH, next-generation sequencing)
- Differential diagnosis: differentiating lung metastases from primary lung cancer, recognizing benign conditions mimicking metastases (e.g. granulomas, infections)
- Staging and prognosis: understanding the impact of lung metastases in staging of primary cancers, prognostic factors influencing outcomes (e.g. number and size of metastases, e.g. oligometastases), primary cancer type, patient performance status
- Treatment options: systemic therapies (e.g. chemotherapy, targeted therapy, immunotherapy) based on primary cancer type, indications for local treatments (e.g. surgical resection, stereotactic body radiotherapy, RFA, MWA, Cryo- ablation) in the oligometastatic disease, considerations for radiation therapy in certain scenarios

- Management of symptoms and complications: common side effects of treatments (e.g. nausea, fatigue, neutropenia), management of treatment-related complications (e.g. pleural effusion, pneumothorax, and haemoptysis)
- Follow-up and monitoring: surveillance strategies for detecting progression or response to treatment, adjusting treatment plans based on disease progression and patient condition
- Current guidelines: staying updated with guidelines from major oncology societies (e.g. ASCO, NCCN, ESMO, ECO (European Cancer Organization))
- Patient selection: indications and contraindications for diagnostic procedures and for palliative and curative intended local treatments (e.g. tumour size, location, number of lesions), criteria for oligometastatic disease versus locally advanced disease, control of the primary tumour, assessment of patient's overall health status and comorbidities
- Diagnostic and therapeutic techniques: understanding the indications/contraindications for biopsy, surgical options, SBRT, and for local ablative interventional techniques based on tumour stage, symptoms, and therapeutic goal
- Post-procedural care: awareness and monitoring for immediate and delayed complications (e.g. pneumothorax, infection, bleeding), recognition, management, and patient education of potential post-ablation syndrome, managing follow-up imaging to assess treatment efficacy and detect recurrence

Clinical skills

- Patient evaluation: comprehensive assessment of patient's medical history, comorbidities, and overall health status
- Evaluating the extent of metastatic disease and suitability for local treatments, recognizing detailed history, including prior treatments, response to therapy, and potential impacts on local treatments (e.g. prior surgery, SBRT, extensive chemotherapy)
- Procedure selection: identifying appropriate local treatment options (e.g. RFA, MWA, cryoablation) based on tumour type, size, location, and patient factors, understanding the specific indications, contraindications, and risk profiles of each local treatment modality
- Post-procedural care: monitoring patients for immediate and delayed complications following the procedure; providing detailed post-procedural instructions and managing follow-up care, recognizing and managing post-ablation syndrome and other common post-procedural issues (e.g. subsequent systemic therapies)

Technical skills

- Diagnostic imaging and interventional monitoring: interpreting various imaging modalities (e.g. CT, MRI, PET) for accurate localization of lung tumours; application of real-time imaging techniques (e.g. fluoroscopy, CT-fluoroscopy, angiography) during interventions to guide precise needle placement, identifying immediate procedure related outcomes and complications
- Interventional techniques
- Percutaneous biopsy: techniques for obtaining tissue samples (e.g. fine-needle aspiration, core needle biopsy), management of biopsy-related complications (e.g. pneumothorax, bleeding)
- Thermal ablation: knowledge of mode of action, equipment, and technique of various ablative modalities (RFA, MWA, cryo-ablation), experience in setting up specific ablation equipment, placing probes, delivering energy, assessing the progress of the ablative procedure, considering safety margins, recognizing and managing early complications and systemic effects (e.g. cryo-shock)
- Stereotactic Body Radiotherapy (SBRT): understanding the potential need of interventional radiology in placement of fiducial markers
- Complication management: recognition and management of procedural complications (e.g. pneumothorax, bleeding, infection), awareness of immediate peri- and post-procedural complications to minimize the risk of delayed complications, training in basic life support

2.3.3 Kidney and adrenal cancer

2.3.3.1 Kidney

Knowledge

- Definitions and types of kidney cancer: clear cell carcinoma, papillary carcinoma, chromophobe carcinoma
- Epidemiology: incidence, prevalence, and key risk factors (e.g. smoking, obesity, hypertension and chemical exposures
- Know that familial renal cancer incidence represents 2-3% of all cancers
- Know autosomal dominant syndromes such as von Hippel-Lindau syndrome (VHL) and other hereditary renal cancers where ongoing renal cancer management is an issue
- Know that the initial presentation of RCC, classically based on flank pain, gross haematuria and palpable abdominal mass, has been largely replaced by incidental detection
- Know WHO and TNM classification of renal cancer (clear cell, papillary, and chromophobe)
- Know that sarcomatoid or rhabdoid differentiation is strongly associated with prognosis and therapy
- Know the anatomical classification systems (PADUA, RENAL nephrometry score, ABLATE, etc.) assessing the tumour size, localization (endophytic/exophytic, pole location) and proximity to the renal sinus and collecting system
- Know renal cell cancer metastases in two basic patterns: haematogenous and lymphatic; common sites of metastasis include lung, bone, lymph node, adrenal gland, liver, contralateral kidney, brain and thyroid
- Know the IMDC score (International Metastatic RCC Database Consortium) for stratifying patients with advanced RCC

Technical skills

Non-vascular renal interventions

- 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. embolization) that can be performed to improve the outcome of ablation
- Recognize 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 techniques (hydro-, CO2- and balloon-dissection, as well as pyeloperfusion) in order to protect the surrounding structures at risk
- Be able to recognize intra-operative and post-operative complications of ablation therapy and undertake the appropriate investigation and management of complications such as haemorrhage, infection, urinomas, ureteral strictures and digestive fistulas

Endovascular renal interventions

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

2.3.3.2 Adrenal

Knowledge

- 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 primary adrenal tumours depending on the histology and secretory nature
- Understand the incidence and epidemiology of adrenal metastases
- Understand the effect of thermal ablation on the adjacent structure and the adverse effects of thermal ablation
- Understand the effect of treatment of metastases on the liver

Clinical skills

- Be able to acquire an appropriate clinical history and perform a relevant clinical examination prior to intervention
- Recognize features of progressive and metastatic disease which would guide appropriate therapy
- Understand the importance of genetic testing in patients with MEN 1, MEN 2, 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 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), and the 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 oncologist and anaesthetist the need for therapy to control blood pressure prior to procedure and follow guidelines of when to start
- Discuss with the anaesthetist the need for general anaesthesia for adrenal ablation in view of the risk of severe hypertension
- Assess the patient during and following image-guided ablation
- Be able to determine patient fitness for discharge and recognize 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 how to interpret therapy changes in the adrenal gland

Technical skills

- Plan optimal procedural access, patient positioning and relevant/optional image-guidance methods.
- Be able to use separation techniques to help create a buffer zone between the tumour and neighbouring vital structures such as the pleura, kidney, IVC, liver and diaphragm
- Be able to decide which kind of ablative technology 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 devices in the tumour to achieve optimal results
- Plan the size of the electrode to use to acquire effective ablation
- Know the specific complications during adrenal ablation with the risk of severe hypertension or takotsubo cardiomyopathy, which requires close coordination with anaesthetists before or during the intervention
- Know the risk of adrenal insufficiency after the thermal ablation
- For liver metastases from ACC please follow skills of ablation and intra-arterial therapy for liver metastases

2.3.4 Muscoloskeletal cancer

2.3.4.1 Bone metastases

Knowledge

- Knowledge of different types of bone metastases depending on the type of primary tumours
- Knowledge and understanding of the types of IO treatments that can be offered with regards to location, number, type and symptoms of the patient
- Knowledge of different non- IO treatment options for bone metastases (radiotherapy, systemic therapy)
- Understanding of how to optimize treatment options, either IO, other or combined
- Knowledge of anatomy of bones and neurovascular structures in proximity to the involved bones
- Understanding when to combine treatments (ablation, embolization, consolidation, screw fixation)
- Knowledge of oligometastatic and multi metastatic bone disease

Clinical skills

- Be able to elicit an appropriate clinical history and perform relevant clinical examinations prior to intervention
- Recognize 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
- Devise, with the referring clinician, a plan for patient follow-up with imaging, laboratory tests and clinical evaluation. Understand the role of a VAS (Visual Analogue Score) in evaluating the response of pain after ablation of bone lesions
- List the absolute and relative contra-indications for IO treatment of bone metastases
- Understand pre-procedural, intra-procedural and post-procedural pharmacological management for patients undergoing IO techniques including constant sedation, narcotic and non-narcotic allergies
- Ability to decide treatment depending on the oligometastatic or multimetastatic status

Technical skills

- Plan optimal procedural access, patient positioning and relevant/optional image guidance methods
- Understand adjunctive interventions e.g. embolization, 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 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 CO2)
- Recognize the need to place thermocouples to monitor the temperature of sensitive structures during ablative procedures
- Recognize bone lesions at risk of fracture and understand when to combine ablation with cementoplasty in order to provide additional structural support
- Know the type of ablation (MWA, RFA, CRYO, ECT) technique optimal for the bone lesion with reference to the position of the lesion, size of the lesion and sensitive adjacent structures
- Know how to insert osteosyntheses in the pelvic bones, neck of femur, sacrum and scapula, clavicle

- Plan the placement of screws in optimal position and be able to decide on the number of screws required
- Know the type and size of screws to place
- Be able to decide if there is a need to inject cement along with the screws
- Be able to recognize intraprocedural and postprocedural complications and arrange interventional radiological management if appropriate
- Be able to monitor motor and sensory functions of the extremities to rule out neural damage after ablation of lesions close to major nerve bundles

2.3.4.2 Primary bone tumours

Knowledge

- Knowledge of primary malignant and benign bone tumours and their imaging findings
- Knowledge of IO treatment approaches to malignant or benign bone tumours
- Knowledge of other (surgical, medical and radiation oncology) treatment for malignant bone tumours
- Understanding when to combine treatments (ablation, embolization, consolidation, fixation, etc.)
- Understanding of complications that can arise after treating young patients with benign bone tumours in sensitive regions

Clinical skills

- Be able to elicit an appropriate clinical history and perform relevant clinical examinations prior to intervention
- Ability to explain the treatment to the patient and obtain consent from the patient or guardians (in the case of minor patients)
- Understanding how to localize the pain (benign tumours) and how to do a thorough clinical examination
- Interpretation and corroboration of clinical findings along with imaging findings
- Understanding which treatment option is best depending on the clinical and imaging findings
- Discussing the case in a multi-disciplinary team meeting (MDT) and optimizing the approach
- Devise, with the referring clinician, a plan for patient follow-up with imaging, laboratory tests and clinical evaluation. Understand the role of a VAS score in evaluating the response of pain after ablation of bone lesions
- Know when not to touch and when patient will benefit from other treatments

Technical skills

- Planning of the procedure, type of imaging guidance to use depending on the type of treatment offered
- Planning with the anaesthetists the best possible analgesic and anaesthetic technique for every case
- Planning protection techniques to protect the nerves, skin, etc. from trauma during treatment
- Deciding when and where to place thermocouples and dissection needles
- What kind of ablative technique and how many needles (cryo, MWA, RFA, bipolar RFA, ECT)
- Planning combined therapy (ablation plus cement injection, or cement plus screw fixation, etc.)
- Be familiar with sclerotherapy for vertebral haemangiomas, how to use sclerogel as well as how to monitor the patient for need of emergency decompression, if need be, or plan as simultaneous decompression procedure after the sclerotherapy
- Be aware of when to plan a vertebroplasty after a sclerotherapy procedure

2.3.4.3 Soft tissue tumours (including desmoids)

Knowledge

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

Lymph nodes and soft tissue metastases
- 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 either through symptomatic relief or curative intent
- Knowledge of how to avoid adjacent structures and isolate the lymph node

Clinical skills

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

Lymph nodes and soft tissue metastases
- Know in which cases the 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 with the rest of the cancer treating group (surgeon, oncologist, radiotherapist, etc.) which will be the best option
- Know the best imaging option for follow-up scans (MR, CT, PET, etc.)
- Know when to apply ablation or vascular stenting or both

Technical skills

Desmoid tumours
- Know which technique of ablation to use (cryo, RFA)
- Know how to use hydrodissection or gas dissection (with air or CO2) to protect adjacent structures
- Know and explain to the patient what to expect after the treatment, 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 node and soft tissue metastases
- Know which ablative technique to use
- Know where to place the needles
- Know how many needles to place
- Know when and where hydro dissection or CO2 dissection is essential and effective
- Know when and if there is need for vascular stenting (venous) to relieve symptoms

2.3.5 Thyroid cancer

2.3.5.1 Primary thyroid cancer

Knowledge
- Know epidemiology and incidence trends of differentiated thyroid cancer (DTC)
- Know the appropriate laboratory and imaging evaluation for patients with clinically or incidentally discovered thyroid nodules
- Know the recommendations for diagnostic fine-needle aspiration (FNA) of a thyroid nodule based on sonographic pattern (high, intermediate, low, very low sonographic pattern of suspicion)
- Understand the incidence and prevalence of the various types of DTC
- Understand how to interpret results of cytopathology (Bethesda System for Reporting Thyroid Cytopathology) with reference to local therapies
- Understand the relevance of preoperative imaging and laboratory tests for staging
- Know the surgical options for DTC (thyroid lobectomy, near total or total thyroidectomy, lymph node dissection)
- Know when active surveillance or local ablative treatments can be considered as an alternative to immediate surgery
- Know when radioactive iodine (RAI) postoperative therapy is to be considered

Clinical skills
- Know the criteria for the selection of patients who are candidates for minimally invasive treatment (papillary thyroid microcarcinomas (PTMCs) - unresectable thyroid cancer)
- Select and interpret appropriate laboratory and imaging investigation to decide for image-guided ablation therapy
- Be able to explain the appropriateness of intervention to the patient in light of the features of the disease
- Discuss with the anaesthetist the best regimen for the treatment (sedation versus general anaesthesia)
- Assess the patient during and following local ablative therapy
- Be able to determine patient fitness for discharge and recognize complications following the intervention
- Devise, with the referring clinician, a plan for patient follow-up with imaging, laboratory tests and clinical evaluation to assess treatment success and detect disease recurrence or new lesions

Technical skills
- Understand neck anatomy with particular reference to nerve anatomy
- Be able to perform US-guided interventions
- Plan optimal procedural access and patient positioning
- Know about different ablative modalities for treating primary thyroid cancer (laser, radiofrequency, microwave, cryoablation)
- Be able to use hydro-dissection techniques to protect neighbouring vital structures (such as nerves, airways and skin) and to avoid relevant heat sink effect from major vessels

- Be able to decide which kind of ablative technology (laser, radiofrequency, microwave, cryoablation) to use for treatment depending on the type and size of the tumour, its imaging, pathology characteristics and adjacent structures

2.3.5.2 Neck recurrence of thyroid cancer

Knowledge
- Know the incidence and pattern of neck persistence and recurrence after initial treatment
- Understand the relevance of post-operative staging (AJCC 7th Edition/TNM Classification System for DTC)[12] for post-operative risk of recurrence
- Know the American Thyroid Association (ATA) Initial Risk Stratification System that estimates the risk of persistent/recurrent disease in patients treated with thyroidectomy
- Know the role of surgery and its pros and cons in the treatment of structured neck recurrence
- Know when active surveillance or local ablative treatments can be considered as an alternative to immediate surgery
- Know when radioactive iodine (RAI) postoperative therapy is to be considered

Clinical skills
- Know the criteria for the selection of patients who are candidates for minimally invasive treatment or a multimodal approach
- Select and interpret appropriate laboratory and imaging investigation to decide for image-guided ablation therapy
- Be able to acquire an appropriate clinical history and perform a relevant clinical and imaging examination prior to intervention
- Be able to explain the appropriateness of intervention to the patient in light of the features of the disease
- Discuss with the anaesthetist the best regimen for the treatment (sedation versus general anaesthesia)
- Assess the patient during and following local ablative therapy
- Be able to determine patient fitness for discharge and recognize complications following the intervention
- Devise, with the referring clinician, a plan for patient follow-up with imaging, laboratory tests and clinical evaluation to assess treatment success and detect disease recurrence or new lesions

Technical skills
- Understand neck anatomy with particular reference to nerve anatomy
- Be able to perform US- and CT- guided interventions
- Plan optimal procedural access and patient positioning and relevant/optional image guidance methods
- Know about different ablative modalities for treating neck recurrences (laser, radiofrequency, microwave, cryoablation, electrochemotherapy or irreversible electroporation)
- Be able to use hydro-dissection techniques to protect neighbouring vital structures (such as nerves, airways and skin) and to avoid relevant heat sink effect from major vessels (if heat or cold based methods are used)
- Be able to decide which kind of ablative technology (laser, radiofrequency, microwave, cryoablation, electrochemotherapy or irreversible electroporation) to use for treatment depending on the type and size of the tumour, its imaging, pathology characteristics and adjacent structures

[12] *Edge SB, Byrd DR, Compton CC, Fritz AG, Greene FL, Trotti A, editors. AJCC cancer staging manual (7th ed). New York, NY: Springer; 2010.*

2.3.6 Breast cancer

Knowledge

- Know worldwide incidences 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 long exposure to hormones (early menarche, late menopause, not bearing children, first pregnancy over the age of 30), lifestyle factors (obesity, overweight, smoking, etc.) previous chest radiotherapy and environment
- Know the heredity of breast cancers, and association with mutations in two genes: BRCA1 (breast cancer gene one) or BRCA2 (breast cancer gene two)
- Know that adenocarcinomas constitute more than 95% of breast cancers, invasive ductal carcinoma (IDC) being the most common form of invasive breast cancer adenocarcinoma (80% of breast cancers)
- Know rate of in situ breast neoplasia with mainly ductal carcinoma in situ (DCIS)
- Know the difference between the four 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): luminal A, B, HER 2+, triple negative
- Be aware of the 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
- Know the indications for surgery in breast cancer and how to manage the axilla according to patient age
- Understand the indications for local ablation of breast tumours
- Know the indications, according to hormone receptor expression, for systemic therapies in the adjuvant and neo-adjuvant setting
- Metastatic disease: know the indication for the treatment of distant metastases, taking into account the molecular profile of breast tumours

Clinical skills

- Be able to acquire an appropriate clinical history and perform a relevant clinical examination prior to intervention
- Recognize 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 American College of Radiology (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 recognize 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

- 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 the lungs, liver, etc. to adapt the protocol for optimal breast ablation

For breast metastatic cancer please refer to the chapters on bone, liver and lung metastases.

2.3.7 Pancreatic cancer

Knowledge

- The classification of pancreatic tumours based on function (exocrine, endocrine, nonepithelial)
- Understand the anatomy of the arterial and venous systems, as well as ductal (pancreas) anatomy
- Understand the anatomy of the mesentery and the omentum and the relationship of the portal vein and biliary ducts
- Understand the effect of thermal ablation on adjacent structures and potential associated complications
- Know the difference between the ablation of the pancreas and other organs such as lung, liver, etc. to adapt the protocol for optimal pancreatic tumour ablation
- Understand the importance of genetic testing in patients with multiple endocrine neoplasia, type 1 (MEN 1) type syndrome
- Understand the TNM according to the European Neuroendocrine Tumour Society, WHO histology and Ki-67 based staging of neuroendocrine tumours
- Understand the relevance of different types of isotope PET scans along with their limitations
- Determine the tumour markers to look for (e.g. chromogranin A, urine 5-HIAA, serotonin, etc.)
- Understand the range of treatment strategies for pancreatic tumours including the relevance of surgical resection according to TNM staging and the role of image-guided ablation, and the role of medical therapy in symptomatic patients and those with bulky metastases
- Understand the role of medical therapy such as somatostatin analogues and interferon
- Understand the role of chemotherapy in treating neuroendocrine tumours, along with the role of peptide receptor targeted therapy

Clinical skills
- Be able to acquire an appropriate clinical history and perform a relevant clinical examination prior to intervention
- Recognize features of progressive and metastatic disease which would guide appropriate 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
- 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 recognize complications following intervention
- Devise, with the referring clinician, a plan for patient follow-up with imaging, laboratory tests and clinical evaluation to assess treatment success and detect disease recurrence or new lesions
- Understand when to repeat treatment for recurrent disease
- 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
- 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, electrochemotherapy) 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 devices in the tumour to achieve optimal results
- Plan the size of the electrode to use to acquire effective 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

2.3.8 Digestive tract tumours

Knowledge

Oesophagus
- Have knowledge about the types of oesophageal cancer (squamous cell carcinoma and adenocarcinoma) and realize 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-thoracal 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
- Realize that oesophageal cancer is frequently diagnosed in an advanced stage
- Have knowledge of 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 of the most recent tumour classification/staging according to the TNM classification of UICC and the high prognostic value of the TNM
- Have knowledge of 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 of the prognostic value of Her2/neu expression in adenocarcinoma of the oesophagus
- 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 that in non-metastatic disease, systemic chemotherapy is usually accompanied by radiotherapy of the primary, either in the neoadjuvant or adjuvant setting, or as a definitive therapy
- Realize 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
- Realize 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
- Realize that T4a tumours (infiltration of pleura, diaphragm, pericardium) 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
- Realize that pre-operative weight loss/low body mass index (BMI) is associated with post-operative complications and mortality
- Have knowledge of the possible types of reconstruction after oesophageal resection and know about the surgical approach (based on the location, a transthoracic or trans-hiatal resection)
- Realize 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 ≥ (optional) and > (mandatory) T2 adenocarcinomas is recommended
- Know that pre-operative chemoradiotherapy in ≥ (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 dysphagi

Stomach

- 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
- Realize that gastric cancer is frequently diagnosed in an advanced stage of disease without the option for curative resection
- Realize that gastric cancer shows a high rate of disease relapse (local, lympho-nodal, organ metastases) after curative intended resection
- Realize that the prognosis is low with a 5-year survival rate of approximately 30% over all stages
- 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 the Union for International Cancer Control (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, 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
- Understand the role of the Her2/neu status
- Understand the role of chemoradiotherapy in case of irresectable but locally confined gastric cancer
- Understand that resection is the only curative option for T1-T4a gastric cancers aiming for R0 resection (mainly through gastrectomy), including regional lymph node resection. Secondary resection after neoadjuvant treatment of initially non-resectable gastric cancers is under evaluation
- Understand the role of endoscopic resection in superficial gastric cancer which is confined to the mucosa
- 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
- Understand that metastasectomy (except for regional lymph node resection) is not validated

Clinical skills

- Know that interventional tumour ablation of stomach and oesophagus 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 to identify eligible (oligometastatic) patients
- 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 a suspected upper GI tract tumour
- Understand available surgical and medical treatment options in patients with upper GI cancer
- Work within a multidisciplinary team to optimize patient care in this population, especially with regard to the 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 embolization, gastrostomy)
- Understand how previous visceral surgery will bear upon proposed interventions in terms of altered anatomy
- Have knowledge of the risk of significant tumour bleeding of advanced gastric cancer and understand that the origin of bleeding might derive either from vessel erosion/pseudoaneurysms or from direct diffuse tumour bleeding. Understand the role of CT angiography in identifying the source of bleeding
- Understand the role of tumour embolization of gastric cancer for bleeding control
- Understand the importance of facilitation of nutrition through gastrostomy (via endoscopy or through image guidance) to optimize treatment results of both systemic and surgical therapy in patients with oesophageal cancer

Technical skills

- Have knowledge of the vascular anatomy and the various anastomoses in the upper GI tract
- Know the use of microcatheters and micro-guidewires for superselective embolization
- Know which size of particles can be used for tumour embolization to diffuse gastric cancer bleeding to optimize bleeding control and to minimize ischaemic complications
- Know how to embolize macroscopic bleedings in the upper GI tract (due to vessel erosion, pseudoaneurysms) with the use of micro coils. Have knowledge of the importance to embolize 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

Acronyms

ABLATE	Axial Tumour Diameter, Bowel Proximity, Location within Kidney, Adjacency to Ureter, Touching Renal Sinus Fat, Endo/Exophytic
ACC	Adenoid Cystic Carcinoma
ACR	American College of Radiology
AFP	Alpha-Fetoprotein
ALBI	Albumin-Bilirubin
ALK	Anaplastic Lymphoma Kinase
ALPPS	Associated Liver Partition and Portal Vein Ligation for Staged Hepatectomy
aPTT	Activated Partial Thromboplastin Time
ASCO	American Society of Clinical Oncology
ATA	American Thyroid Association
BCLC	Barcelona Clinic Liver Cancer
BI-RADS	Breast Imaging Reporting and Data System
BLSD	Basic Life Support Defibrillation
BMI	Body Mass Index
CA 19-9	Cancer Antigen 19-9
CBCT	Cone-Beam CT
CEA	Carcinoembryonic Antigen
CME	Continued Medical Education
CML	Chronic Myeloid Leukaemia
CHOP	Cyclophosphamide, Hydroxydaunorubicin, Oncovin, Prednisone
CIRSE	Cardiovascular and Interventional Radiological Society of Europe
CO2	Carbon Dioxide
CRYO	Cryoablation
CT	Computed Tomography
cTACE	Conventional Transcatheter Arterial Chemoembolization
DCIS	Ductal Carcinoma in Situ
dMMR	Mismatch Repair Deficient
DNR	Do Not Resuscitate
DNI	Do Not Intubate
DSA	Digital Subtraction Angiography
DTC	Differentiated Thyroid Cancer
DVE	Double Vein Embolization
EASL	European Association for the Study of the Liver
EBIR	European Board of Interventional Radiology
EBUS	Endobronchial Ultrasound
EC	European Commission
ECO	European Cancer Organization
ECOG	Eastern Cooperative Oncology Group
ECT	Electro Chemotherapy
EG	Esophagogastric
EGFR	Epidermal Growth Factor Receptor
ENETS	European Neuroendocrine Tumour Society
ENSAT	European Network for Study of Adrenal Tumours
ERC	Endoscopic Retrograde Cholangiography
ESMO	European Society for Medical Oncology

EU	European Union
EUS	Endoscopic Ultrasonography
FDG	Fluorodeoxyglucose
FLR	Future Liver Remnant
FNA	Fine Needle Aspiration
FISH	Fluorescence In Situ Hybridization
FOLFOX	Folinic Acid, Fluorouracil, Oxaliplatin
FOLFIRI	Folinic Acid, Fluorouracil, Irinotecan Hydrochloride
GCP	Good Clinical Practice
GI	Gastrointestinal
GIST	Gastrointestinal Stromal Tumour
HCC	Hepatocellular Carcinoma
HIAA	Hydroxyindoleacetic Acid
HIFU	High-Intensity Focussed Ultrasound
HIPEC	Hyperthermic Intraperitoneal Chemotherapy
HVE	Hepatic Vein Embolization
ICI	Immune Checkpoint Inhibitors
IDC	Invasive Ductal Carcinoma
IGA	Image-Guided Ablation
IMDC	International Metastatic RCC Database Consortium
IMRT	Intensity-Modulated Radiation Therapy
INR/PT	International Normalized Ratio/Prothrombin Time
IO	Interventional Oncology or Interventional Oncologist
IR	Interventional Radiology or Interventional Radiologist
irAEs	Immune Related Adverse Events
IRE	Irreversible Electroporation
IVC	Inferior Vena Cava
LHRH	Luteinising Hormone-Releasing Hormone
LI-RADS	Liver Imaging Reporting and Data System
LVD	Liver Venous Deprivation
MDT	Multi-disciplinary Team Meeting
MGMT	O6-Methylguanine-DNA Methyltransferase
MELD	Model for End-Stage Liver Disease
MEN	Multiple Endocrine Neoplasia
MMR	Mismatch Repair
MR	Magnetic Resonance
MRI	Magnetic Resonance Imaging
MSI	Microsatellites Instability
MTBD	Multisciplinary Tumour Board Discussion
MWA	Microwave Ablation
NCCN	National Comprehensive Cancer Network
NECs	Neuroendocrine Carcinomas
NENs	Neuroendocrine Neoplasms
NETs	Neuroendocrine Tumours
NSCLC	Non-Small Cell Lung Cancer
PADUA	Preoperative Aspects and Dimensions Used for an Anatomical

PCR	Polymerase Chain Reaction
PET	Positron Emission Tomography
PEG	Percutaneous Endoscopic Gastrostomy
PHLF	Post-Hepatectomy Liver Failure
PI-RADS	Prostate Imaging Reporting and Data System
PRRT	Peptide Receptor Radionuclide Therapy
PT	Prothrombin Time
PTMC	Papillary Thyroid Microcarcinoma
PVE	Portal Vein Embolization
RAMPS	Radical Antegrade Modular Pancreatosplenectomy
RAI	Radioactive Iodine
RCC	Renal Cell Carcinoma
RCTs	Randomized Controlled Trials
RENAL	Radius, Exophytic Extent, Nearness to the Renal Sinus, Anterior/Posterior Location, Location Relative to the Polar Lines
RECIST	Response Evaluation Criteria in Solid Tumours
RFA	Radiofrequency Ablation
RT	Radiation Therapy
SBRT	Stereotactic Body Radiotherapy
SPECT-CT	Single-Photon Emission Computed Tomography
SSA	Somastostatin Analogues
SSTR	Somatostatin Receptors
SVC	Superior Vena Cava
TACE	Transcatheter Arterial Chemoembolization
TARE	Transarterial Radioembolization
TLR	Toll-Like Receptor
TNM	Tumour, Node, Metastasis
TRA	Treatment Response Algorithm
TSH	Thyroid Stimulating Hormone
UICC	Union for International Cancer Control
VAS	Visual Analogue Score
VEGF	Vascular Endothelial Growth Factor
VHL	Hippel-Lindau Syndrome
WHO	World Health Organization

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[13] Oxford Centre for Evidence-Based Medicine, The Oxford Levels of Evidence, 2011.

Appendix 1

Different types of studies and trials

Randomized 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 summarizing 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 summarized.

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 analyzed. 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 generalizable, 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 hypothesized 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[13]

Question	**Step 1** (Level 1*)	**Step 2** (Level 2*)
How common is the problem?	Local and current random sample surveys (or censuses)	Systematic review of surveys that allow matching to local circumstances**
Is this diagnostic or monitoring test accurate? (Diagnosis)	Systematic review of cross sectional studies with consistently applied reference standard and blinding	Individual cross sectional studies with consistently applied reference standard and blinding
What will happen if we do not add a therapy? (Prognosis)	Systematic review of inception cohort studies	Inception cohort studies
Does this intervention help? (Treatment benefits)	Systematic review of randomized trials or *n*-of-1 trials	Randomized trial or observational study with dramatic effect
What are the COMMON harms? (Treatment harms)	Systematic review of randomized trials, systematic review of nested case-control studies, *n*-of-1 trial with the patient you are raising the question about, or observational study with dramatic effect	Individual randomized trial or (exceptionally) observational study with dramatic effect
What are the RARE harms? (Treatment harms)	Systematic review of randomized trials or *n*-of-1 trial	Randomized trial or (exceptionally) observational study with dramatic effect
Is this (early detection) test worthwhile? (Screening)	Systematic review of randomized trials	Randomized trial

[13] *Oxford Centre for Evidence-Based Medicine, The Oxford Levels of Evidence, 2011.*

Step 3 (Level 3*)	**Step 4** (Level 4*)	**Step 5** (Level 5)
Local non-random sample**	Case-series**	n/a
Non-consecutive studies, or studies without consistently applied reference standards**	Case-control studies, or "poor or non-independent reference standard**	Mechanism-based reasoning
Cohort study or control arm of randomized trial*	Case-series or case control studies, or poor quality prognostic cohort study**	n/a
Non-randomized controlled cohort/follow-up study**	Case-series, case-control studies, or historically controlled studies**	Mechanism-based reasoning
Non-randomized controlled cohort/follow-up study (post-marketing surveillance) provided there are sufficient numbers to rule out a common harm. (For long-term harms the duration of follow-up must be sufficient.)**	Case-series, case-control, or historically controlled studies**	Mechanism-based reasoning
Non-randomized controlled cohort/follow-up study**	Case-series, case-control, or historically controlled studies**	Mechanism-based reasoning

* *Level may be graded down on the basis of study quality, imprecision, indirectness (study PICO does not match questions PICO), because of inconsistency between studies, or because the absolute effect size is very small; Level may be graded up if there is a large or very large effect size.*

** *As always, a systematic review is generally better than an individual study.*