Core Curriculum for Percutaneous Cardiovascular Interventions (2020)

Committee for Education and Training

European Association of Percutaneous Cardiovascular Interventions (EAPCI)

A branch of the European Society of Cardiology

Co-authors

Eric Van Belle*[1], Rui C. Teles*[2], Stylianos A. Pyxaras*[3], Oliver Kalpak*[4], Thomas Johnson*[5], Israel Moshe Barbash*[6] , Giuseppe De Luca*[7], Jorgo Kostov*[4], Radoslaw Parma*[8], Flavien Vincent*[1], Salvatore Brugaletta*[9], Nicolas Debry*[1], Gabor G Toth*[10], Ziyad Ghazzal*[11], Pierre Deharo*[12], Dejan Milasinovic*[13], Klaus Kaspar*[14], Francesco Saia*[15], Josepa Mauri[16], Jürgen Kammler[17], Douglas Muir[18], Stephen O'Connor[19], Julinda Mehilli[20], Holger Thiele[21], Daniel Weilenmann[22], Nils Witt[23], Francis Joshi[24], Kharbanda Rajesh[25], Zsolt Piroth[26], Wojciech Wojakowski[8], Alexander Geppert[27], Giuseppe Di Gioia[28], Gustavo Pires-Morais[29], Anna Sonia Petronio[30], Rodrigo Estévez-Loureiro[31], Zoltan Ruzsa[32], Joelle Kefer[33], Vijay Kunadian[34], Nicolas Van Mieghem[35], Stephan Windecker[36], Andreas Baumbach[37], Michael Haude[38], Dariusz Dudek*[39]

[1] CHU Lille, Institut Coeur-Poumon, Department of Cardiology, and INSERM U1011, Lille, F-59000, France
[2] Hospital de Santa Cruz CHLO, Carnaxide, Portugal; CEDOC, Nova Medical School, Lisboa, Portugal
[3] Medizinische Klinik I, Landshut-Achdorf Hospital, Landshut, Germany
[4] University Cardiology Clinic, Majka Tereza 17, 1000 Skopje, Macedonia
[5] Bristol Heart Institute, Bristol, United Kingdom
[6] Leviev Heart Center, Sheba Medical Center, Sackler Faculty of Medicine, Tel Aviv University, Israel
[7] AOU Maggiore della Carità, Eastern Piedmont University, Novara - Italy
[8] Department of Cardiology and Structural Heart Diseases, Medical University of Silesia, Katowice, Poland
[9] Hospital Clinic, Cardiovascular Clinic Institute, Institut d'Investigacions Biomèdiques August Pi i Sunyer (IDIBAPS), Barcelona, Spain
[10] University Heart Center Graz, Medical University Graz, Graz, Austria
[11] American University of Beirut Faculty of Medicine and Medical Center, Lebanon
[12] Hopital la Timone, Marseille, 13005 France
[13] Clinical Center of Serbia, Department of Cardiology, Belgrade, Serbia
[14] LKH Hochsteiermark/Bruck, Tragösserstrasse 1, 8600 Bruck / Mur, Austria

[15] Cardio-Thoraco-Vascular Department University Hospital of Bologna, Policlinico S. Orsola - Malpighi (Pav. 23), Bologna, Italy
[16] Hospital Universitari Germans Trias i Pujol. Badalona. Spain
[17] Med Campus III., Kepler University Hospital Linz, Faculty of Medicine, Johannes Kepler University Linz, A-4021 Linz, Krankenhausstraße 9, Austria
[18] The James Cook University Hospital, Middlesbrough, United Kingdom
[19] St. James's Hospital, Dublin, Ireland
[20] Med. Klinik und Poliklinik I, Klinikum der Universitaet, Ludwig-Maximilian University, Munich Heart Alliance at DZHK, Marchioninistr. 15, D-81377 Munich
[21]Heart Center Leipzig at University of Leipzig, Department of Internal Medicine/Cardiology and Leipzig Heart Institute, Leipzig, Germany
[22]Department of Cardiology, Kantonsspital St. Gallen, Rorschacherstrasse 95, 9007 St. Gallen, Switzerland
[23]Department of clinical science and education, Karolinska Institute, division of cardiology Södersjukhuset, Stockholm, Sweden
[24]Department of Cardiology, Rigshospitalet, Copenhagen, Denmark
[25] Oxford University Hospitals NHS Trust and Oxford NIHR Biomedical Centre
[26] Hungarian Institute of Cardiology, Haller street, 1096 Budapest, Hungary
[27] Wilhelminenhospital Vienna, Montleartstrasse 37, A-1160 Vienna, Austria
[28] Cardiovascular Center OLV Hospital, Aalst, Belgium
[29] Cardiovascular Intervention Unit, Department of Cardiology, Centro Hospitalar de Vila Nova de Gaia, Vila Nova de Gaia, Portugal
[30] Cardiothoracic and Vascular Dpt. AOUP,University of Pisa, Italy
[31] University Hospital Puerta de Hierro-Majadahonda, Madrid Spain
[32] Semmelweis University, Heart and Vascular Center, Budapest, Hungary
[33] Cliniques universitaires Saint-Luc, 10, avenue Hippocrate, 1200 Bruxelles, Belgium
[34] Translational and Clinical Research Institute, Faculty of Medical Sciences, Newcastle University and Freeman Hospital, Newcastle upon Tyne Hospitals NHS Foundation Trust, United Kingdom
[35] Department of Cardiology, Thoraxcenter, Erasmus Medical Center, Rotterdam, the Netherlands.
[36] Department of Cardiology, Swiss Cardiovascular Center, University Hospital Bern, Bern, Switzerland
[37] Queen Mary University of London, Barts Heart Centre, London, United Kingdom
[38] Med. Klinik I, Städtische Kliniken Neuss, Lukaskrankenhaus GmbH, Preußenstr. 84, 41464 Neuss, Germany
[39] Jagiellonian University Medical College in Poland, 17 Kopernika St., 31-501 Krakow, Poland

*: these authors equally contributed to the manuscript

Corresponding author:
Eric Van Belle, ericvanbelle@aol.com, Institut Cœur Poumon (Heart and Lung Institute), Bd du Pr Leclercq, CHU Lille, 59000 Lille, France
Dariusz Dudek, mcdudek@cyfronet.pl, Department of Interventional Cardiology, Institute of Cardiology, Jagiellonian University Medical College, Krakow, Pradnicka 80, Poland

Summary

The proposed 2020 Core Curriculum for Percutaneous Cardiovascular Interventions aims to provide an updated European consensus that defines the level of experience and knowledge in the field of Percutaneous Cardiovascular Intervention (PCI). It promotes homogenous education and training programmes among countries, and is the cornerstone of the new EAPCI certification, designed to support the recognition of competencies at the European level and the free movement of certified specialists in the European Community.

It is based on a thorough review of the ESC guidelines and of the EAPCI Textbook in Percutaneous Interventional Cardiovascular Medicine. The structure of the current Core Curriculum evolved from previous EAPCI Core Curriuclum and from the "2013 core curriculum of the general cardiologist" to follow the current ESC recommendations for Core Curriculums. In most subject areas, there was a wide - if not unanimous - consensus among the task force members on the training required for the interventional cardiologist of the future. The document recommends that acquisition of competence in Interventional Cardiology requires at least 2 years of postgraduate training, in addition to 4 years devoted to cardiology.

The first part of the curriculum covers general aspects of training and is followed by a comprehensive description of the specific components in 54 chapters. Each of the chapters includes statements of the objectives, and is further subdivided into the required knowledge, skills, behaviours, and attitudes.

List of Abbreviations and Acronyms

ACC	American College of Cardiology
ACE inhibitors	Angiotensin-Converting Enzyme inhibitors
ACS	Acute Coronary Syndrome
AF	Atrial Fibrillation
AHA	American Heart Association
AMI	Acute Myocardial Infarction
AMU	Acute Medical Unit
ARC	Academic Research Consortium
ASD	Atrial Septal Defect
BARC	Bleeding Academic Research Consortium
BMC	Balloon Mitral Commissurotomy
BMS	Bare Metal Stent
BPA	Balloon Pulmonary angioplasty
BTHC	Butyryl-Tri-Hexyl Citrate
CABG	Coronary Artery Bypass Graft
CAD	Coronary Artery Disease
CARDS	CARDS (Cardiology Audits and Registration Data Standards)
CAS	Carotid Artery Stenting
CCU	Coronary Care Unit
CEC	Clinical Event Committee
CHD	Congenital Heart Disease
CIHF	Chronic Ischemic Heart Failure
CIN	Contrast-Induced Nephropathy
CKD	Chronic Kidney Disease

COPD	Chronic Obstructive Pulmonary DiseaseChronic Obstructive Pulmonary Disease
CTO	Chronic Total Occlusion
CTEPH	Chronic Thromboembolic Pulmonary Hypertension
DAPT	Dual Antiplatelet Therapy
DCM	Dilated Cardiomyopathy
DEB	Drug Eluting Balloon
DSA	Digital Subtraction Angiography
EAPCI	European Association of Percutaneous Cardiovascular Interventions
EAS	European Atherosclerosis Society
EBSC	European Board for the Specialty of Cardiology
ECG	Electrocardiogram
EMB	Endomyocardial Biopsy
ESC	European Society of Cardiology
ESH	European Society of Hypertension
ETC	Education and Training Committee
EVAR	Endovascular Aneurysm Repair (or Endovascular Aortic Repair)
F	French (size)
FFR	Fractional Flow Reserve
GUCH	Grown-Up Congenital Heart
HCM	Hypertrophic CardiomyopathyHypertrophic Cardiomyopathy
HF	Heart Failure
IC	Interventional Cardiologist
ICH	Intra Cerebral Haemorrhage
iFR	instantaneous Instantaneous Wave-Free Ratio
IMR	IndexIndex of Microcirculatory ResistanceResistance
ISR	In-Stent Restenosis

IVUS	Intra-Vascular Ultrasound
LAAO	Left Atrial Appendage Occlusion
LM	Left Main
MCE	Myocardial Contrast Echocardiography
MRA	Magnetic Resonance Angiography
MSCD	Myocardial Stem Cell Delivery
MSCT	Multi Slice Cardiac Tomography
MTC	Mitral and Tricuspid Disease
MVARC	Modified Valve Academic Research Consortium
NARC	Non-Adherence Academic Research Consortium
NIRS-IVUS	Near-Infrared Spectroscopy-IVUS
NSTE-ACS	Non-ST-Segment Elevation Acute Coronary Syndrome
NSTEMI	Non-ST-Segment Elevation Myocardial Infarction
OCT	Optical Coherence Tomography
OFDI	Optical Frequency Domain Imaging
OHCA	Out of Hospital Cardiac Arrest
OTW	Over the Wire
PCI	Percutaneous Coronary Intervention
PCR	Paris Course on Revascularization
PE	Pulmonary Embolism
PFO	Patent foramen ovale
POBA	Plain Old Balloon Angioplasty
POT	Proximal Optimization Technique
PPI	Proton Pump Inhibitor
PPVI	Percutaneous Pulmonary Valve Implantation
PTA	Percutaneous Transluminal Angiography

PVD	Peripheral Vascular Disease
PVL	Paravalvular Leaks
QA/QI	Quality Assessment and Quality Improvement
QCA	Quantitative Coronary Angiography
RA	Refractory Angina
RASS	Renin-Angiotensin-Aldosterone System
RBBB	Right Bundle Branch Block
RFC	Renal Frame Count
RFR	Relative Flow Reserve
RVOT	Right Ventricular Outflow Tract
STEMI	ST-segment Elevation Myocardial Elevation Myocardial Infarction
SVG	Saphenous Vein Graft
SYNTAX	Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery
TASH	Transcoronary Ablation of Septal Hypertrophy
TAVI	Transcatheter Aortic Valve Implantation
TEE	Trans-Esophageal Echocardiography
TEVAR	Thoracic Endovascular Aortic/Aneurysm Repair
TIMI	Thrombolysis In Myocardial Infarction
TMTCI	Transcatheter or Mixed Interventions
TMVI	Transcatheter Mitral Valve Intervention
TMVR	Transcatheter Mitral Valve Replacement
VARC 2	Valve Academic Research Consortium 2
VHD	Valvular Heart Disease
VSD	Ventricular Septal Defect

Preface

The present version of the Core Curriculum for Percutaneous Cardiovascular Interventions was organized and developed by the Education and Training Committee (ETC) of the EAPCI, under the leadership of EAPCI Presidents Michael Haude and Andreas Baumbach.

In most countries, the prevalence of coronary artery disease (CAD), valvular heart disease (VHD), peripheral vascular disease (PVD) and heart failure (HF) is increasing. This relates both to the progressive ageing of the population and to a better identification of these diseases. To date, cardiovascular disease remains the leading cause of death worldwide. In Europe, ischaemic heart disease now accounts for almost 1.8 million annual deaths while VHD is becoming a pressing clinical issue (1, 2).

The main areas of the percutaneous cardiovascular interventional field, as covered by the interventional cardiologist (IC), are percutaneous coronary interventions (PCI), transcatheter valvular interventions, percutaneous interventions for PVD (including those for ischaemic stroke), and percutaneous interventions for HF (including those for cardiogenic shock).

The broad use of these interventions is supported by paramount scientific evidences and has been associated with durable benefits for both individuals and populations (3-11). In that context, ensuring quality of patient care, and clinical excellence in percutaneous cardiovascular interventions are of the utmost importance. The completion of a dedicated curriculum provides the IC with the knowledge, skills, behaviours and attitudes to act as an expert in the invasive physiological and anatomic assessment, diagnosis, and management of coronary and structural heart diseases as well as in the invasive management of HF and PVD.

The first and only “Curriculum and syllabus for Interventional Cardiology subspecialty training in Europe “ was published in 2006 by di Mario on behalf of the “Working Group 10 of the ESC” (which later transformed into the EAPCI) and a panel of experts in education including the chairmen of the national interventional societies, coordinated by the European Board for the Specialty of Cardiology (EBSC) (9). This document was very ambitious and addressed the need of a certified, uniform, training programme, before cardiologists engage in interventional procedures that carry a potential risk. It was divided in several parts: Rationale and aims of this curriculum, structure of the training programme, assessment methods, organization of the training and, importantly, a syllabus specific programme content with several chapters (Basic Science, Pharmacology, Imaging, Indication for Treatment and Patient selection, Procedural techniques, Management of complications of percutaneous intervention and Miscellaneous). Some procedures were not considered to be part of the core curriculum but as an “optional” part of the training.

The 2006 visionary document set the European standards although those were not broadly adopted. The present approach intends to overcome the main limitations identified in the previous document, namely its endorsement and promotion by the interventional and general cardiology societies. The proposed Core Curriculum aims to support the educational requirements and to fill the gap of an updated European consensus that defines the level of competences in the field of Percutaneous Cardiovascular Intervention. It promotes homogenous education and training programmes in interventional cardiology among countries, and is the cornerstone of the new EAPCI certification,

designed to support the recognition of knowledge, skills, behaviours and attitudes of newly trained interventional cardiologists.

Considering the distinct realities among European or other countries and because numbers are not sufficient *per se* to describe the proficiency of an IC, the present document is not recommending minimal procedural volume for trainees or for training centers. It is rather providing guidance on the "achievements" and on the "levels of competence" which have to be acquired by the trainees (Tables 1-3). We also provide detailed information on how a training center will have to be organized, including the need to involve at least two ICs with more than five years' experience dedicated to the percutaneous cardiovascular interventional field (Table 4).

The EAPCI has designed a new two-part certification process: Part A (theoretical) and Part B (practical). The part A is a multiple choice question (MCQ) exam held twice a year, based on the present Core Curriculum, as well as the EAPCI Textbook of Interventional Cardiology, the ESC General Cardiology Core Curriculum and the content of the Fellows Course of the EAPCI. The exam was successfully launched at EuroPCR 2018 in Paris. The Part B, which is currently under final development, is based on the recognition of acquisition of the competencies listed in the table 4 of the present document. To prevent duplication, and simplify the process, it will be preferably conducted through a very strong interaction with national certification programmes when such programmes are existing (i.e. mutual recognition process) and/or a direct interaction with training centres. The model of the present EAPCI certification, in which a full certification requires to acquire the two parts, is very similar to those developed by the other sub-specialty associations of the ESC.

The EAPCI ETC Committee launched the project under the auspices of Professors Michael Haude and Andreas Baumbach. A total of 10 groups consisting of 2 to 3 interventional cardiologists each, developed, circulated and improved the document under the direction of the successive Chair and co-chair of the ETC, Professors Dariusz Dudek, Eric Van Belle and Doctor Rui Campante Teles. The document was revised by the Chair and Co-Chair of the ETC, Prof Eric Van Belle and Doctor Rui Campante Teles as well as the current EAPCI President, Professor Andreas Baumbach and President Elect, Professor Dariuz Dudek.

The 2020 Core Curriculum underwent a thorough review process based on the template of the review of the ESC guidelines and of the EAPCI Textbook in Percutaneous Interventional Cardiovascular Medicine. The document does not include minimum or optimal numbers of procedures to be undertaken, and does not address periodic evaluation or revalidation. It defines the clinical, patient-oriented, training of the IC. The structure of the current Core Curriculum has been drastically modified as compared to the previous version and evolved from the "2013 Core Curriculum of the general cardiologist" to follow the current ESC recommendations for Core Curriculums. In most subject areas, there was a wide if not unanimous consensus among the task force members on the training required for the IC of the future. The document recommends that acquisition of competence requires at least 2 years of training in interventional cardiology, in addition to 4 years devoted to cardiology.

The first part of the curriculum covers general aspects of training and is followed by a comprehensive description of the specific components in 54 chapters. Each of the chapters includes statements of

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PART A: THE CORE CURRICULUM FOR THE INTERVENTIONAL CARDIOLOGIST

A.1 The clinical field of interventional cardiology

The clinical specialty of interventional cardiology aims to deliver expert interventional care for patients presenting with disorders of the heart, the systemic, and the pulmonary circulations. This Core Curriculum provides the standards for training in interventional cardiology, as well as a template for the maintenance of competence for qualified cardiologists.

The interventional cardiologist (IC) is the subspecialist that performs percutaneous interventional cardiovascular procedures. He/she is a primarily a medical specialist with a thorough basic training in internal medicine that completed an approved Cardiology Fellowship program incorporating the knowledge demanded by the European Society of Cardiology (ESC) Core Curriculum for the general cardiologist (3). Interventional cardiologists perform general cardiac investigation and management of patients with suspected or established cardiovascular disease using non-invasive methods and are involved in the comprehensive management of the patient and treatment of the underlying disease, not only focused on procedural considerations. They have the ability to consider and apply interventional techniques to the global care of patients. They are team-workers who interact closely with other cardiologists and other medical specialties, nurses, paramedics and other healthcare professionals.

In order to master the invasive techniques, there are several general fields whose skills are important for the IC and require special differentiation that complements basic general cardiology skills. It is recommended that an operator is able to interpret the most advanced cardiology imaging techniques required for peri-procedural assessment, especially echocardiography, computed tomography and endovascular studies. A high level of cardiac intensive care experience is requested with a special emphasis on acute heart failure and arrhythmias management (13).

As simulators have shown benefit in the progress of novice operators, they are progressively incorporated into training programs and courses (14, 15). While the exact role of those simulators in most advanced technical skills still needs to be clarified, with their progressive sophistication their use in the training of ICs will continue to increase.

A key role of the IC is to perform emergency procedures for reperfusion of acute myocardial infarction in 24/7 PCI-capable centre. Regarding PCI, any operator is expected to be fully competent regarding all the spectrum of the patient evaluation, information, techniques and follow-up, namely including all advanced techniques from imaging, physiology, adverse clinical presentations and anatomies and adverse lesion scenarios, including calcification, degenerated grafts, simple chronic total occlusions (CTOs) and bifurcations in general. An IC is expected to be fully skilled in the management of any procedural complications.

Concerning the increasing importance of transcatheter aortic valve implantation (TAVI) any operator should be prepared to conduct complete pre-procedural evaluation of TAVI candidates and collaborate with a Valvular Heart Team to select the most suitable treatment.

Concomitantly these fields are continuously expanding and, in certain cases, a very specific training to master a procedure or technique is required. Help from a proctor is recognized as advantageous or an appropriate referral for a more skilled centre might be advisable, especially in certain areas that, depending on the individual and centre, require a particular expertise, namely complex coronary interventions, stroke, PVD, grown-up congenital heart (GUCH) disease, mitral or tricuspid valve disease, left atrial appendage occlusion (LAAO), etc.

The spectrum of expertise is broad, and, on top of the procedures, it includes a comprehensive patient risk assessment that is fundamental for patient information and integrates medical decision-making. A multidisciplinary management strategy is essential including a heart-failure specialist, imaging specialist, surgeons, geriatrician, anaesthetist and cardiac rhythm specialists (16).

Because these interventions are applied to a very large population of patients, their economic impact has become significant. The IC must be conscious of this economic burden and responsible for the appropriate utilization of the devices and therapies.

The process for medical decision-making and patient information is guided by the 'four principles' approach to healthcare ethics: autonomy, beneficence, non-maleficence and justice. The IC represents the patient's best interest and therefore the medical decision process must be independent and be performed according to the best available evidence, in order to deliver optimal patient-centred care. Moreover, because this is a very technological and continuously demanding evolving medical area, it requires a lifelong learning and continuous update of his/her knowledge. The IC is expected to be engaged in structured clinical investigation programs and to collaborate actively in patient follow up.

A.2 General aspects of training in the specialty

Candidates for interventional training should be physicians licensed to practice in the country of training. The trainee must have the necessary linguistic ability to communicate with patients and colleagues in the country of training and later in the country of practice. The trainee should have completed a minimum of 4 years of full-time training in general cardiology.

The recommended minimum duration of dedicated sub-speciality training should be 2 years of full-time and exclusive training in interventional cardiology.

To gain sufficient experience, the trainee should gain exposure to all aspects of interventional cardiology, with an appropriate mix of in-patient/out-patient and emergency/elective care, including the elements described below and summarized in Table 1:

- Participation in the clinical management of in-patients, with an emphasis on patients presenting acutely to the coronary care unit (CCU) and acute medical unit (AMU) with acute coronary syndromes (ACS).

- Regular on-call commitment providing a primary PCI service for patients presenting with ST-elevation myocardial infarction (STEMI) and/or out of hospital cardiac arrest (OHCA).

- Regular attendance and/or coordination of heart team meetings.

- Bedside patient care including pre- and post-procedural assessment.

- Structured learning, under the direct supervision of educational supervisors/nominated trainers, which may include (a minimum of 2 hours/day is suggested):

    - explicit learning: journal club, postgraduate teaching, exercises in evidence-based medicine, discussion of guidelines for clinical practice, national/international symposia/congresses attendance.
    - implicit learning: ward rounds, case-based discussions, supervised acquisition of diagnostic and interventional skills.

- Interventional training should include a mix of acute and elective cases with direct supervision, progressing from second, to first and ultimately independent operator status by the end of the training period.

- Interventional training should guarantee experience with arterial access (femoral and radial), and with the most frequent of the complex techniques, including bifurcation strategies, treatment of calcified vessels, intravascular imaging, and functional assessment of coronary stenoses (FFR, iFR, etc).

- Exposure to chronic total occlusion (CTO) strategies, with both antegrade and retrograde approach, atherectomy tecniques including rotablation, haemodynamic support/mechanical circulatory support, is required.

- Exposure to structural intervention including TAVI, mitral and tricuspid valve treatment, atrial septal defect/patent *foramen ovale*/left atrial appendage closure, and paravalvular leak/ventricular septal defect closure is strongly recommended.

- The training programme should be clearly defined for each individual, with regular review/appraisal of their progress and formal assessment of their knowledge and procedural competencies.

- Participation in clinical/translational research in interventional cardiology is recommended to enhance critical appraisal of evidence.

Table 1: Summary of the General aspects of training in Interventional cardiology

Area of training	General aspects of training
Continuous medical education	Structured learning, under supervision including explicit learning and implicit learning.
Supervision and mentoring	Acute and elective cases with direct supervision, progressing from second, to first and ultimately independent operator status.
Research	Participation in clinical/translational research to enhance critical appraisal of evidence.
Evaluation	Clearly defined for each individual, with regular review/appraisal of their progress and formal.
Outpatient care	Pre and post-procedural assessment.
Acute Coronary Syndrome, STEMI	Appropriate mix of in-patient/emergency and out-patient/elective care, including patients with "Acute Coronary Syndrome" and "Out of Hospital Cardiac Arrest".
Percutaneous coronary interventions	Experience with different arterial accesses and exposure to several complex techniques.
Structural interventions	Exposure to structural intervention is strongly recommended.
Heart Team	Regular participation in the Heart Team meetings.

Learning objectives should be clearly defined and are preferred to recommendations based solely on the time spent in a particular department or on the number of procedures performed. The objectives should include knowledge, and specific and generic skills including communication and appropriate behaviours, competences and attitudes that will further be reinforced during ongoing training.

A.3 Learning objectives

These are specific aims which demonstrate skills acquired by the trainee at the end of the course. They are based on trainee's capabilities in certain tasks. Specific objectives are classified according to *knowledge, skills, and behaviours and attitudes*.

- *Knowledge*: Describes requirements for trainees. The subject matter is defined by the EAPCI Core Curriculum chapters. This knowledge includes pathology of diseases as the rational basis for long-term learning.
- *Skills*: A practical application of knowledge acquired from experience and training to solve practical problems, make clinical decisions and perform specific procedures.
- *Behaviours and attitudes*: Refer to those attitudes and behaviours that lead to optimal clinical performance .

A.4 Categories and levels of competence

First-hand exposure and practical experience are crucial in learning of techniques. However, the number of procedures performed by trainees is not considered as an exclusive measure of performance. The authors acknowledge the variability of the learning curve among individuals and the impact of the training centre volumes on the learning process. Thus, this document focuses on the acquisition of competences rather than on procedural volume.

This section describes the levels to translate competencies into investigational or procedural skills. Their ascending order is defined as follows and summarized in Table 2 and has been adapted from the description of Entrustable Professional Activities (EPA) (17):

- Levels I and II*: The trainee must have acquired the experience in selecting an appropriate diagnosis or therapy and in interpreting results or choosing an appropriate treatment for a referred patient.
    - Level I does not require any procedural skills, yet participation in related procedures during training may be valuable.
    - Level II of competency indicates acquisition of some procedural skills as operator, usually as assistant/second operator, obtained in the primary or external training centres.
- Level III: The trainee must be able to interpret clinical data, recognise treatment indications, and perform the technique or procedure and manage related complications, as first operator, but still requiring working under direct supervision of a senior IC operator.
- Level IV: The trainee must be independent in the ability to interpret clinical data, recognise treatment indications, perform the technique or procedure and manage related complications, as first operator without direct supervision of a senior IC operator. Post-hoc supervision including case review with more senior colleagues is possible.
- Level V**: Same as level IV. In addition it includes the ability to teach and supervise the technique or procedure to more junior colleagues.

Table 2: Description of levels translating competence into investigational or procedural skills adapted from EPA

Technique	Description of competence
Level I*	No performance, even with direct supervision. Observation is recommended
Level II*	Performance as second operator and/or with direct, proactive supervision
Level III	Performance as first operator with reactive supervision, i.e., on request and quickly available
Level IV	Performance as first operator without supervision. Possibility to post-hoc supervision.
Level V**	Performance as first operator without supervision and ability to teach/supervisemore junior colleagues

* Levels I and II intervention skills may be acquired outside the primary training centre, as a part of a cooperation program. **: Level V intervention skills are not expected in all areas at the end of the 2 years of training in interventional cardiology.

Table 3 summarises the level of competence translating into interventional cardiology skills that the EAPCI considers desirable for a trainee in interventional cardiology to achieve at the end of his 2 years of training. Although organisation of cardiac services and resources for training are not uniform across Europe and ESC member countries, the Core Curriculum aspires to an optimal, rather than a minimal standard. In countries or centres that are currently unable to deliver training in all aspects required, the Core Curriculum should be used as a benchmark to promote policies for improvement. Also, rotation of trainees between different centres may provide an adequate solution.

Table 3: Level of competence translating into interventional cardiology skills

Technique	Description of competence	Level of competence
Peripheral venous access	Performance as first operator and teaching/supervision to more junior colleagues	V
Radial access	Performance as first operator and teaching/supervision to more junior colleagues	V
Femoral access <10F	Performance as first operator and teaching/supervision to more junior colleagues	V
Femoral access ≥10F	Performance with reactive supervision, i.e., on request and quickly available	III
Closure devices <9F	Performance as first operator and teaching/supervision to more junior colleagues	V
Closure devices ≥9F	Performance with reactive supervision, i.e., on request and quickly available	III
Pericardiocentesis	Performance as first operator without supervision	IV
Right and left hemodynamic assessment	Performance as first operator and teaching/supervision to more junior colleagues	V
Coronary angiography	Performance as first operator and teaching/supervision to more junior colleagues	V
Ventricular angiography	Performance as first operator and teaching/supervision to more junior colleagues	V
Peripheral angiography	Performance with reactive supervision, i.e., on request and quickly available	III
Cerebral angiography	No performance, even with direct supervision. Observation is recommended	I

PCI in simple lesions	Performance as first operator without supervision	IV
PCI in STEMI	Performance as first operator without supervision	IV
PCI in NSTE-ACS	Performance as first operator without supervision	IV
PCI in multivessel disease	Performance as first operator without supervision	IV
PCI in bypass grafts	Performance as first operator without supervision	IV
PCI in bifurcation lesions	Performance as first operator without supervision	IV
PCI in LM	Performance as first operator without supervision	IV
PCI in CTO	Performance as second operator and/or with direct, proactive supervision	II
PCI with rotablator	Performance as second operator and/or with direct, proactive supervision	II
Invasive physiology (FFR, iFR, RFR and others)	Performance as first operator without supervision	IV
OCT/OFDI	Supervision at a distance and/or *post hoc*	IV
IVUS	Supervision at a distance and/or *post hoc*	IV
Endomyocardial biopsy	No performance, even with direct supervision. Observation is recommended	I
Use of percutaneous mechanical haemodynamic support	Performance with reactive supervision, i.e., on request and quickly available	III
Balloon aortic valvuloplasty	Performance as second operator and/or with direct, proactive supervision	II
TAVI	Performance as second operator and/or with direct, proactive supervision	II
Balloon mitral valvuloplasty	Performance as second operator and/or with direct, proactive supervision	II
Transcatheter mitral valve repair	No performance, even with direct supervision. Observation is recommended	I
Transcatheter mitral valve implantation	No performance, even with direct supervision. Observation is recommended	I
Transcoronary ablation of septal hypertrophy	No performance, even with direct supervision. Observation is recommended	I

Transcatheter pulmonary valve interventions	No performance, even with direct supervision. Observation is recommended	I
Left atrial appendage occlusion	Performance as second operator and/or with direct, proactive supervision	II
Atrial septal defect closure or patent *foramen ovale* closure	Performance as second operator and/or with direct, proactive supervision	II
Closure of ventricular septal defect	No performance, even with direct supervision. Observation is recommended	I
Percutaneous treatment of paravalvular leaks	No performance, even with direct supervision. Observation is recommended	I
Transcatheter myocardial stem cell therapy	No performance, even with direct supervision. Observation is recommended	I
Cardiac catheterisation in "Grown Up Congenital Heart" patients	Performance as second operator and/or with direct, proactive supervision	II
Supra-aortic interventions including acute ischemic stroke treatment	No performance, even with direct supervision. Observation is recommended	I
Aortic disease interventions (Thoracic Endovascular Repair of Aorta/ Endovascular Repair of Aortic Aneurysm)	No performance, even with direct supervision. Observation is recommended	I
Infra-aortic arterial disease interventions	No performance, even with direct supervision. Observation is recommended	I
Renovascular interventions for arterial hypertension	No performance, even with direct supervision. Observation is recommended	I
Transseptal puncture	Performance as second operator and/or with direct, proactive supervision	II
Interpretation of Multi-Slice CT for TAVI	Performance as second operator and/or with direct, proactive supervision	II
Interpretation of transoesophageal echocardiography for mitral procedure	Performance as second operator and/or with direct, proactive supervision	II
Percutaneous direct treatment for Acute Pulmonary Embolism	No performance, even with direct supervision. Observation is recommended	I
Balloon pulmonary angioplasty for "Chronic Thrombo embolic Pulmonary Hypertension"	No performance, even with direct supervision. Observation is recommended	I

A.5 Requirements for training institutions and trainers

A.5.1 Requirements for training institutions

- General aspects

We believe that training institution profile and performance are as important as trainers' profile and expertise in order to provide objective and quality interventional training. In order to comply to EAPCI standards, the institutions must be standardized using procedural volume reports and performance measures.

Training Institution/centre for interventional cardiology should include cardiac catheterization laboratory with on-call 24-hour PCI availability and dedicated cardiology unit, department or ward, in order to manage patients throughout hospitalization. The trainee should be able to be educated to manage patients from their admission, through the invasive procedure and to discharge from the ward. Institutional workflow allowing the interventional cardiology program attendees to follow the patient throughout their hospitalization is mandatory.

The training centre should have an independent interventional cardiology unit, allowing the trainee to follow the patient from the beginning to the completion of Interventional treatment. Units not integrated in a cardiology department (run as a service without dedicated beds) can be exceptionally considered if they demonstrate a well-developed structured co-operation with cardiology wards where the patients are admitted allowing the interventional cardiology programme attendees to follow the patient throughout their hospitalisation.

Training centres should be encouraged to incorporate on-site interventional cardiology simulators or to provide simulation sessions during the IC training, especially during the early phases of training of the trainee and/or the techniques.

Training centers should have the following basic characteristics (Summarized in Table 4):

1) Active clinical research program and/or involvement in clinical trials is mandatory for both types of centres.
2) Number of trainees per Institution should not exceed number of faculty members/trainers.
3) Heart-Team meetings, including participation by clinical cardiologists, interventional operators, and cardiothoracic surgeons should be planned regularly (i.e. weekly or bimonthly).
4) Regular database - electronic database of diagnostic and interventional procedures regularly audited by the National Interventional Society is recommended to ensure centre quality.
5) Performance measures report of institution (periodic at least annual): In hospital mortality in acute, elective PCI and diagnostic catheterisation.
6) Regular "quality assessment and quality improvement" (QA/QI) program including radiation safety program.

We further define 2 types of training centers: **standard** and **advanced** training center (Table 4).

- Standard center: Must have (mandatory) programme of 24 hours a day, availability of PCI on call with STEMI/NSTEMI patients and working hours regular program for all kinds of patients. Availability of IVUS and/or OCT and assessment of intracoronary pressure based physiology indices such as FFR/iFR is mandatory. It is strongly recommended that these centres are involved in complex PCI, including left main and multivessel disease. Availability of left ventricular assist devices such as IABP/Impella is desirable but not mandatory as well as CTO programme, rotational atherectomy and similar procedures. Institutional coronary and structural Heart Teams are also encouraged, even if the center does not perform TAVI.
- Advanced centres: These have similar requirements as standard centres and should have a structural heart programme including at least TAVI according to national regulation, transseptal procedures and a structured CTO programme. Other structural procedures (stroke, carotid, peripheral, GUCH, septal ablation, left atrial appendage occlusion, paravalvular leak closure, etc) are recommended. The presence of a Heart team is mandatory.
- A center may develop other programmes for peripheral interventions (stroke, carotid stenting, aorta, peripheral limb), treatment of adult congenital heart disease, performance of septal ablation for hypertrophic cardiomyopathy, etc.

Table 4: Characteristics and Requirements of Training Centers

Basic Characteristics (mandatory)	Number of trainees should not exceed number of trainers; Catheterization laboratory conferences, at least monthly; Regular electronic database, audited by the national Interventional association/working group; Research program Performance measures at least annually Quality program Radiation safety program Compliance with local standards according to national regulation bodies, including minimal procedural volumes.
Standard center	PCI including complex procedures (mandatory) Intra-coronary imaging (IVUS and/or OCT, others) and Invasive physiological assessment (FFR, iFR, RFR and others) mandatory) CTO programme (recommended) Rotational Atherectomy (recommended) Percutaneous mechanical circulatory support devices (encouraged)

	TAVI (encouraged)
Advanced center	PCI including complex procedures (mandatory) Intra-coronary imaging (IVUS and/or OCT, others) and Invasive physiological assessment (FFR, iFR, RFR and others) (mandatory) CTO programme (mandatory) Rotational Atherectomy and Lithotripsy (mandatory) Percutaneous mechanical circulatory support device program (recommended) TAVI (mandatory) Transseptal procedures (mandatory) Other structural procedures (recommended)

- Procedural Volumes and Public metric reporting

It has been established that the procedural volumes of centres has a significant impact on the availability of training opportunities and on performance measures and intervention outcomes, but numbers are insufficient to define the quality of a centre and their ability to train interventional fellows. Public reporting of centre training program, procedural volumes and clinical outcomes are advisable to guide trainee choice of the training centre. While the present document does not make recommendations on specific procedural volumes, training centres should comply with local standards according to national regulation bodies, including minimal procedural volumes.

A.5.2 Requirements for trainers

- General aspects and levels of competence

Trainers should be graded as trainers in standard institutions (standard trainers) and trainers in advanced institutions (advanced trainers). Trainers should be experts for level of competence III, IV and V (Table 2 and 3). It is not required that every trainer be expert in those techniques for which a level of competence I or II (Table 2 and 3) is required, provided trainees can rotate to train with IC (in the same or different institution) with the necessary expertise.

Ideally the number of trainers (full-time equivalent) should match or exceed the number of trainees. Delivery of the curriculum may be facilitated by a structure that includes a Director of Training (National/Regional), a Cath lab Director (or Supervisor) a Training Mentor (or educational Mentor), and multiple Clinical Trainers (or clinical Mentors).

The training Mentor (or someone else involved in the organization of training) should be responsible for organizing the training programme in interventional cardiology, coordinating external rotations to referral centres, attendance at courses and congresses, and organizing structured learning. It is necessary that both trainee and training Mentors are subject to periodic assessment.

- Number of Trainers and their expertise

At least two trainers (supervisors) must be available, with more than five years' experience dedicated to interventional cardiology as main clinical activity. These trainers should be members of the permanent staff and should be able to deliver the procedural skills associated with level of competence III, IV and V in the learning objectives (Table 2 and 3).

In advanced centres, trainers should have an experience of more than five years performing advanced heart interventions.

Trainers without personal expertise for these additional skills described in the learning objective (level competence I and II, Table 2 and 3), should make them available to trainees through cooperation program with other trainers (or other institutions) who will deliver the formal training on these techniques. A similar 5 years of experience is required for the trainers delivering training each one of those additional procedural skills.

The Cath lab Director must be responsible for the interventional unit and should ensure that the trainee fulfils his/her learning objectives. The training Mentor must also ensure that the trainee attends the formal training courses and is involved in the research and educational activities of the department.

PART B: THE CORE CURRICULUM PER TOPIC

Part I - Coronary Track - Invasive diagnostic assessment

1.1 - Natural history of coronary artery disease

ESC topic list:

- *12.1 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Coronary Artery Disease – Pathophysiology and Mechanisms*

Essential reading:

- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- *Chapter 12, 16 and 17 of the ESC Textbook of Cardiovascular Medicine*

- **Objectives**
  To understand the pathophysiological basis for chronic and acute coronary disease

Knowledge

- The coronary circulation with reference to the functional subdivisions of the coronary arterial system
- The pathophysiology of macro and microvascular atherosclerotic disease
- The epidemiology of chronic coronary syndromes
- The epidemiology of acute coronary syndromes

Skills

The ability to:

- Use the clinical history and examination to assess suspected coronary artery disease
- Use appropriate non-invasive and invasive diagnostic techniques to assess coronary artery disease
- Advise on the pharmacological, non-pharmacological and revascularisation options for coronary artery disease based on knowledge of its natural history.

Behaviours and attitudes

- Commitment to keep updated with new knowledge about the changing patterns of coronary heart disease
- Provision of a balanced discussion about the natural history of coronary disease and its management

1.2 - Vascular access and closure

ESC topic list:

- *12.3.2 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Coronary Artery Disease: Angiography, Invasive Imaging, FFR*
- *25.1. Interventional Cardiology and Cardiovascular Surgery: Invasive Imaging and Functional Assessment*
- *25.2.1 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Vascular Access*

Essential reading:

- *EAPCI Textbook Part I; Chapters "Vascular access" and "Vascular closure"*

Objectives

- To gain an understanding of the various access routes for catheterization and PCI
- To understand the advantages and disadvantages of each access route
- To understand the methods available to achieve haemostasis after catheterization or PCI

Knowledge

- Principles of arterial cannulation by Seldinger, modified Seldinger or cut down techniques
- Specific knowledge of the common arterial access routes and the relevant surface anatomy:
    - Transradial including distal and proximal radial
    - Transfemoral
    - Transulnar
- Principles of brachial arterial cutdown and percutaneous access
- Venous anatomy for access to the right heart
- Anatomical variants which may affect the procedure
- Anti-thrombotic and other pharmacological therapy for each approach
- Mechanisms of action of various vascular closure devices
- Access site complications, assessment and management

Skills

The ability to:

- Use patient and procedure characteristics to determine the optimal access route
- Gain safe and accurate arterial access by using standard anatomical landmarks
- Use adjunctive techniques such as fluoroscopy and ultrasound to assist safe access – selectively or routinely
- Use appropriate antithrombotic agents where required by procedure
- Select and use an appropriate method of vascular closure and haemostasis
- Determine when further assessment for possible complications is required

Behaviours and attitudes

- Provide the patient with an overview of vascular access options and related complications as part of informed consent for procedure
- Be prepared to use more than one access site and individualise choice according to patient needs and procedural demands
- Recognise the risk of vascular access, assess complications promptly and provide information on management to other members of the multi-disciplinary team

1.3 – Invasive Coronary Angiography

ESC topic list:

- *12.3.2 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Coronary Artery Disease: Angiography, Invasive Imaging, FFR*
- *25.1.2 Interventional Cardiology and Cardiovascular Surgery: Coronary Angiography*

Essential reading:

- *EAPCI Textbook Part II; Chapter "Invasive diagnostic coronary angiography"*

Objectives

- Understand the indications for coronary angiography with reference to international guidelines including the EAPCI.
- Thorough understanding of the coronary anatomy and congenital anomalies
- Independent at undertaking coronary angiography
- Acquisition of appropriate angiographic images with accurate classification of the degree, character and location of luminal stenoses.
- To demonstrate effective decision making on the appropriate therapeutic strategy based on the angiographic findings

Knowledge

- Principles of fluoroscopic imaging, radiation physics, exposure, and safety regulations
- Nephrotoxic effects of contrast agents, their prevention, and management
- Catheterization laboratory equipment (physiological monitoring, transducers, blood gas analysers, power injector);
- Radiological anatomy of the heart, aorta, large vessels, and coronary arteries, as well as that of the femoral, radial, and brachial arteries used for vascular access during catheterization;
- Principles of catheter selection and familiarity with the various diagnostic catheters and guidewires
- Thorough knowledge of coronary anatomy, anomalous coronary circulation and venous/arterial bypass grafts.
- Optimal coronary projections to accurately delineate specific coronary segments.
- Familiarity with the AHA classification of coronary segments.
- Degree of coronary stenosis by visual estimate, quantitative coronary angiography (QCA) and intravascular imaging.
- Morphology of coronary stenosis - AHA/ACC classification system.
- Myocardial perfusion – TIMI classification.
- SYNTAX I and II scores and the background trial data.
- Complications of angiography and their on-table management including, coronary spasm, acute coronary dissection, air and thrombotic embolus, coronary perforation, ventricular fibrillation, retroperitoneal haematoma, catheter kinking, acute stroke, vasovagal and acute contrast reaction.

Skills

The ability to:

- Consent a patient for coronary angiography
- Gain safe and accurate arterial access by using standard anatomical landmarks
- Ability to select appropriate catheters to achieve optimal opacification and support.
- Ability to perform safe and efficient catheter manipulation and pressure monitoring.
- Ability to perform a comprehensive coronary angiogram with adequate and optimal radiological projections with low dose radiation.
- Select and use an appropriate method of vascular closure and haemostasis
- To be able to interpret acquired images and accurately perform a report of a patient's coronary anatomy and coronary disease.

Behaviours and attitudes

- Strict adherence to the principle of maintaining patient comfort at all times and avoiding inflicting pain.
- Fastidious and systematic approach to performing a high-quality coronary angiogram in a safe manner for both the patient and the cath lab team.
- Ability to adapt to the challenge that anatomical variation brings and accordingly adapting radiological projection angles to accurately delineate the anatomy of all coronary segments.

- Be able to classify a patient's coronary disease with various scoring methods (SYNTAX, AHA, TIMI, etc.) and make appropriate therapeutic decisions based on current EAPCI guidelines for chronic or unstable CAD.
- Understand the collegial/heart team approach with respect to therapeutic decision-making based on the results of a coronary angiogram.

1.4 - Invasive haemodynamic assessment

ESC topic list:

- *12.3.2 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Coronary Artery Disease: Angiography, Invasive Imaging, FFR*
- *25.1.1 Interventional Cardiology and Cardiovascular Surgery: Invasive Hemodynamic Assessment/Right Heart Catheterization*

Essential reading:

- EAPCI Textbook Part I, Chapter "Right and left heart catheterisation" and "Cardiac catheterisation in children and adults with grown-up congenital heart disease"
- EAPCI Textbook Part II, Chapter "Invasive haemodynamic assessment"

Objectives

- To understand the pathophysiological basis for congenital and acquired valve disease;
- To perform and analyse:
    - coronary and LV angiography,
    - cardiac catheterization and haemodynamic;
- To obtain fully informed patient consent for the procedure.

Knowledge

- Principles of fluoroscopic imaging, radiation physics, exposure, and safety regulations;
- Nephrotoxic effects of contrast agents, their prevention, and management;
- Catheterization laboratory equipment (physiological monitoring, transducers, blood gas analysers, power injector);
- Radiological interpretation of the anatomy of the heart, aorta, large vessels, and coronary arteries, as well as that of the femoral, radial, and brachial arteries used for vascular access during catheterization;
- Basic hemodynamics: normal pressure curves, normal left and right atrial and ventricular hemodynamics;
- Intra-cardiac shunt calculations;
- Valve disease hemodynamics;
- Diastolic dysfunction hemodynamics;
- Epidemiology of valve diseases.

Skills

The ability to:

- Use the clinical history and examination to assess suspected valve disease, intracardiac shunts and cardiac tamponade;
- Use appropriate non-invasive and invasive diagnostic techniques to assess valve disease, cardiac tamponade;
- Optimize use of the equipment to minimize exposure to radiation in order to protect the patient and the catheterization team, and to minimize the use of nephrotoxic contrast agents;
- Carry out left and right heart catheterization;
- Interpret haemodynamic and oxymetric data;
- Manage life-threatening complications in the catheterization laboratory and bedside;
- Advise of the pharmacological, non-pharmacological and interventional / surgical options for valve disease, intracardiac shunts and cardiac tamponade.

Behaviours and attitudes

- Assumption of responsibility for the appropriate communication and performance of invasive tests, while carefully balancing the risks and benefits of these procedures;
- Cooperation with members of the Heart Team, nurses, technicians, and other medical professionals;
- Commitment to keep updated with contemporary data on the changing patterns of coronary heart disease;
- Provision of a balanced discussion about the natural history of coronary heart disease and its management.

1.5 - Invasive physiological assessment of coronary artery disease

ESC topic list:

- *12.3.2 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Coronary Artery Disease: Angiography, Invasive Imaging, FFR*
- *12.1.2 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Coronary Circulation, Flow, and Flow Reserve*
- *25.1.6 Interventional Cardiology and Cardiovascular Surgery: Fractional Flow Reserve*

Essential reading:

- *EAPCI Textbook Part II; Chapters "Invasive physiological assessment of coronary disease: non-hyperaemic indices (iFR)", "Invasive physiological assessment of coronary disease (FFR)" and "Assessment of coronary vasoreactivity and the microcirculation"*

Objectives

- To appreciate the importance of physiological assessment of coronary artery disease in patient management
- To understand the methods of assessing coronary physiology in the catheter lab
- To understand the integration of these physiological data into clinical decision making

Knowledge

- Benefits and limitations of common non-invasive tests
- Limitations of coronary angiography in assessing functional significance of coronary artery disease
- Principles and practice of obtaining physiological measurements in the catheter lab – FFR, iFR, IMR, etc.
- Normal physiology and pathological cut-offs
  Knowledge of main outcomes of relevant clinical trials
- Interpretation in specific lesion subsets: multi-vessel disease, left main stem, serial lesions, diffuse disease
- Potential pitfalls and limitations of functional assessment in practice

Skills

The ability to:

- determine when invasive physiological assessment is required
- safely perform and interpret invasive coronary physiological studies
- use the data generated from invasive physiological studies and integrate this into clinical decision making
- recognize the limitations of physiological assessments and where other adjunctive assessment techniques may be preferred

Behaviours and attitudes

- Appropriately use physiological assessment rather than purely anatomical measures to aid decision making
- Commitment to follow the evolving literature on adaptations to established physiological assessment techniques

1.6 - Invasive imaging: cardiac catheterization and angiography

ESC topic list:

- *25.1. Interventional Cardiology and Cardiovascular Surgery: Invasive Imaging and Functional Assessment*

Essential reading:

- EAPCI Textbook Part I, Chapter "Right and left heart catheterisation" and "Cardiac catheterisation in children and adults with grown-up congenital heart disease"
- EAPCI Textbook Part II, Chapter "Invasive haemodynamic assessment"

Objectives

To perform and analyse:

- coronary and LV angiography;
- cardiac catheterization and haemodynamic evaluation

Knowledge

- Principles of fluoroscopic imaging
- Risks associated with radiation & methods to minimize patient and staff exposure
- Catheterization laboratory equipment (physiological monitoring, transducers, blood gas analysers, power injector);
- Radiological anatomy of the heart, aorta, large vessels, and coronary arteries, as well as that of the femoral, radial, and brachial arteries used for vascular access during catheterization;
- Collection of haemodynamic and oximetric data, and how to use the measurements to calculate cardiac output, vascular resistance, valve areas, and shunts;
    - Interpretation of pressure waveforms, haemodynamic and oximetric data;
    - Techniques and sites of vascular access;
    - Type of catheters used in cardiac catheterization and coronary angiography;
    - Basic principles and indications for intravascular ultrasound (IVUS), Doppler, coronary artery pressure measurements (FFR and other), and optical coherence tomography (OCT);
- Complications of cardiac catheterization and angiography and their management.

Skills

The ability to:

- obtain arterial (femoral, radial, brachial) and venous (femoral/jugular/subclavian) access and achieve haemostasis after catheterization;
- carry out left heart catheterization including coronary angiography, ventriculography, aortography, and angiography of coronary bypass grafts, including mammary artery grafts;
- carry out right heart catheterization in the catheterization laboratory and at the bedside, and measure & interpret cardiac output, intravascular pressure, and oxygen saturation;
- manage life-threatening arrhythmias and other emergencies in the catheter laboratory;
- assess normal, aberrant and pathological coronary angiograms, ventriculograms, aortograms, and pulmonary angiograms;
- interpret haemodynamic and oximetric data;
- use adjunctive pharmacological therapy safely and when appropriate.

Behaviours and attitudes

- A consistent analytical approach to selecting the appropriate treatment modality (medical, percutaneous, or surgical) based on the clinical context as well as the data generated by cardiac catheterization;
- Assumption of responsibility for the appropriate communication and performance of invasive tests, while carefully balancing the risks and benefits of these procedures.
- Cooperation with members of the Heart Team, nurses, technicians, and other medical professionals;

1.7 - Intravascular Imaging

ESC topic list:

- *12.3.2 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Coronary Artery Disease: Angiography, Invasive Imaging, FFR*
- *25.1 Interventional Cardiology and Cardiovascular Surgery: Invasive Imaging and Functional Assessment*
- *25.1.4 Interventional Cardiology and Cardiovascular Surgery: Intracoronary Ultrasound*
- *25.1.5. Interventional Cardiology and Cardiovascular Surgery: Optical Coherence Tomography*

Essential reading:

- EAPCI Textbook Part II; chapters "Intravascular ultrasound", "Optical coherence tomography" and "Near-infrared spectroscopy"
- Clinical Use of Intracoronary Imaging. Part 1. Eur Heart J 2018 (18)
- Clinical Use of Intracoronary Imaging. Part 2. Eur Heart J 2019 (19)

Objectives

- To understand the appropriate application and interpretation of intravascular imaging in diagnostic and interventional coronary procedures

Knowledge

- Limitations of coronary angiography and the role of intravascular imaging
- Basic principles of the clinically available imaging modalities; IVUS, OCT, optical frequency domain imaging (OFDI) and where available near-infrared spectroscopy-IVUS (NIRS-IVUS)
- To understand the advantages, disadvantages & limitations of individual imaging modalities, aiding appropriate selection of adjunctive tools during diagnostic angiography and PCI
- Role of intravascular imaging to delineate the etiology of stent failure & guide treatment and optimization

Skills

The ability to:

- Obtain experience in the use of clinically available imaging modalities, including IVUS, OCT/OFDI and NIRS-IVUS combined imaging
- Gain confidence in the interpretation of images and the subsequent decision-making in diagnostic evaluation and PCI guidance/optimisation

Behaviours and attitudes

- To acknowledge the limitations of angiographic coronary assessment and consider adjunctive invasive imaging to overcome diagnostic uncertainty
- To select the most appropriate imaging modality according to the clinical need
- To work in collaboration with the multi-disciplinary cathlab team (nurses, radiographers & cardiac physiologists)

1.8 - Intravascular Ultrasound

ESC topic list:

- *12.3.2 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Coronary Artery Disease: Angiography, Invasive Imaging, FFR*
- *25.1.4 Interventional Cardiology and Cardiovascular Surgery: Intracoronary Ultrasound*

Essential reading:

- ESC core curriculum for general cardiologists (2013): Chapters Coronary artery disease and Acute Cardiac Care
- EAPCI Textbook Part II; chapters “Intravascular ultrasound”
- Clinical Use of Intracoronary Imaging. Part 1. Eur Heart J 2018 (18)
- Clinical Use of Intracoronary Imaging. Part 2. Eur Heart J 2019 (19)

Objectives

- To integrate the use and interpretation of intravascular ultrasound (IVUS) imaging in the management of patients undergoing percutaneous coronary intervention (PCI)

Knowledge

- Indications for the use of intravascular ultrasound in the diagnostic assessment and guidance/optimization of PCI
- IVUS-characteristics of plaque components and the limitations of virtual histology-IVUS
- Role and limitations of IVUS-based lesion severity assessment
- Role of IVUS in assessing and treating left main stem disease
- Role of IVUS in determining appropriate stent selection & parameters used to guide stent optimization

- Role of IVUS in delineating the etiology of stent failure
- Role of IVUS in specific situations such as identification of guidewire position in coronary dissections and during CTO procedures.
- Awareness of the research applications and ongoing developments of IVUS imaging technology

Skills

The ability to:

- Understand how to set up and safely undertake IVUS evaluation of the coronary arteries
- Gain confidence in the interpretation of IVUS imaging and recognise common artefacts

Behaviours and attitudes

- To work collaboratively with the multi-disciplinary cath lab team, including nurses, radiographers and cardiac physiologists
- To provide patients with optimal treatment results, particularly in the setting of stent failure
- To obtain sufficient experience in coronary imaging to undertake and interpret images safely

1.9 - Optical Coherence Tomography

ESC topic list:

- *12.3.2 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Coronary Artery Disease: Angiography, Invasive Imaging, FFR*
- *25.1.5 Interventional Cardiology and Cardiovascular Surgery: Optical Coherence Tomography*

Essential reading:

- ESC core curriculum for general cardiologists (2013): Chapters Coronary artery disease and Acute Cardiac Care.
- EAPCI Textbook Part II; chapter “Optical coherence tomography”
- Clinical Use of Intracoronary Imaging. Part 1. Eur Heart J 2018 (18)
- Clinical Use of Intracoronary Imaging. Part 2. Eur Heart J 2019 (19)

Objectives

- To integrate the use and interpretation of optical coherence tomography/optical frequency domain imaging (OCT/OFDI) in the management of patients undergoing percutaneous coronary intervention (PCI)

Knowledge

- Indications for the use of OCT/OFDI in the diagnostic assessment and guidance/optimization of PCI
- Advantages and limitations of OCT/OFDI imaging compared with IVUS
- OCT characteristics of plaque components

- Role of OCT in determining appropriate stent selection & the parameters used to guide stent optimization
- Role of OCT in delineating the etiology of stent failure
- Awareness of the research applications and ongoing developments of OCT imaging technology

Skills

The ability to:

- Safely set-up and acquire optimal OCT imaging, avoiding/dealing with associated complications
- Develop skills of interpretation of plaque composition and an awareness of imaging artefacts
- Gain familiarity with OCT software to undertake quantitative lesion assessment, stent planning and subsequent optimisation
- Understand the potential role of 3D OCT assessment in the treatment of bifurcation disease

Behaviours and attitudes

- To work collaboratively with the multi-disciplinary cath lab team, including nurses, radiographers and cardiac physiologists
- To provide patients with optimal treatment results, particularly in the setting of stent failure
- To obtain sufficient experience in coronary imaging to undertake and interpret images safely

1.10 - Endomyocardial biopsy

ESC topic list:

- *25.3.99 Interventional Cardiology and Cardiovascular Surgery: Non-Coronary Cardiac Intervention, Other*
- *17.3 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Myocardial Disease – Diagnostic Methods*

Essential reading:

- EAPCI Textbook Part I; chapter “Endomyocardial biopsy”

Objectives

- to understand the clinical indications for endomyocardial biopsy (EMB)
- to safely perform EMB and manage complications with appropriate post-intervention patient surveillance

Knowledge

- Indications of EMB

- Required preparation for the procedure
- Choice of vascular access site
- Techniques of right and left ventricle biopsy
- Selection of bioptome
- How to safely take biopsy specimens
- Handling and fixation of biopsy specimens for different diagnostic techniques (histopathology, molecular biology)
- Post-intervention patient surveillance
- Potential peri- and post-intervention complications

Skills

The ability to:

- Identify appropriateness of indication to EMB
- Obtain a safe vascular access
- Perform a safe EMB
- Recognize and manage peri- and post-procedural complications

Behaviours and attitudes

- To collaborate with heart failure and heart transplant teams
- To collaborate with doctors from other specialties, such as haematologists
- To provide correct clinical indication for EMB.

1.11 - Radiation protection

ESC topic list:

- *25.2 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention*

Essential reading:

- EAPCI Textbook Part I, Chapter “Radiation protection”

Objectives

- To be aware of the hazard of radiation injury to patients and cath lab personnel
- To know how to optimize X-ray use for patients’ and staff’s protection
- To plan the follow-up and care of the patients who received increased doses of radiation during complex procedures

Knowledge

- Physical and biological basis of radiation damage
- Deterministic effects for patients and cath lab staff: skin injuries and cataracts
- Stochastic risk for patients and cath lab staff: cancer

- Regulatory requirements for formal training in radiation protection
- How to minimize patient risk in the catheterisation lab
- How to maximize protection for cath lab staff
- Annual recommended limits of the absorbed doses
- Health effects of prenatal radiation exposure and dose limits for the pregnant worker and patient

Skills

The ability to:

- Optimize use of the equipment (X-ray tube, image receptor, and shield) to minimize exposure to radiation to protect the patient and the catheterization team and obtain best quality images
- Recognise and treat deterministic effects of patients, such as skin injuries
- Identify patients and procedures associated with increased exposition
- Know the occupational annual dosing limits

Behaviours and attitudes

- Recognition of the risk of radiation to patient and personnel
- Participation in radiation audit, compliance with cath lab protocols, use of protective shields, aprons, thyroid shields and eyewear and appropriately placed dosimeters
- Optimization of the X-ray procedure (fluoroscopy time, frame rate, last image hold, collimation, change of projections, distance to intensifier) to minimize radiation exposure to patients and cath lab staff
- Cooperation with other professionals in the treatment of X-ray related tissue injuries of patients and patient follow-up

1.12 - Contrast agents and renal protection

ESC topic list:

- *25.2 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention*

Essential reading:

- EAPCI Textbook Part I, chapter “Contrast agents and renal protection”

Objectives

- To recognize risk factors and mechanisms of contrast-induced nephropathy (CIN)
- To prevent, diagnose and treat an allergic reaction to contrast agents
- To prevent, diagnose and treat CIN

Knowledge

- Types and properties of contrast agents
- Definition and risk factors for CIN
- Renal protection measures to prevent and to treat CIN
- Prevention and treatment of allergic reactions to contrast agents
- Adverse effect of contrast agents in specific conditions (elderly, diabetes)

Skills

The ability to:

- Identify patients at risk of CIN
- Prevent and treat CIN
- Prevent and treat allergic reaction to contrast agents
- Minimize use of nephrotoxic contrast agents

Behaviours and attitudes

- Awareness of the side-effects of contrast agents
- Monitor the hydration status and use of nephrotoxic medications
- Limit the use of contrast
- Plan the staged elective procedures based on the risk of CIN
- Follow-up the renal function after hospital discharge
- Collaborate with other professionals, such as nephrologists, to minimize risk of contrast-induced nephropathy

Part II – Coronary Track: Percutaneous interventions - Devices and Tools

2.1 - Guide catheters and wires for PCI (except CTOs)

ESC topic list:

- *25.2.2 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Devices*

Essential reading:

- ESC core curriculum for the general cardiology: Content of Chapters Coronary artery disease and Acute Cardiac Care
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapter “Guide catheters and wires”

Objectives

- To be familiar with the purpose and clinical use of diagnostic and guide catheters
- To understand construction, design features and performance characteristics of diagnostic and guiding catheters
- To be able to select and use catheters appropriately to the planned type of diagnosis or intervention, the vascular access site and patient anatomy
- To be familiar with the purpose and clinical use of guidewires
- To understand construction, design features and performance characteristics of guidewires
- To be able to select and use guidewires appropriately to the planned type of diagnosis or intervention

Knowledge

Diagnostic and guiding catheters

- Construction and basic components of diagnostic and guiding catheters
- The influence of catheter design features on their properties in clinical use
- The difference between diagnostic and guiding catheters
- Definition of sizes in French units
- The difference between outer and inner catheter diameters
- Consideration factors for catheter coaxial alignment and support
- The clinical application, benefit and disadvantages of catheters based on their outer sizes
- The clinical application of catheters based on their shape design features (over bent vs. under bent)
- Accommodating capacity of catheters for PCI devices
- Standard lengths of catheters relative to the length of equipment used for diagnosis and intervention
- The application, benefits and disadvantages of catheters with side holes
- The application of sheathless guide catheters
- The difference between an active and passive catheter support and methods of their enhancement
    a. Anchoring technique
    b. Mother and child technique/Guide extension catheters (GuideLiner etc..)

Guidewires

- Guidewire structure and design
- Definitions of guidewire main characteristics based on their
    a. Flexibility
    b. Tip style
    c. Tip tapering
    d. Core construction
    e. Target lesion type
- Specific guidewires (pressure, marker, rotablator, wiggle wires)
- Definition of a tip load and penetration force
- Guidewire classification according to the planned intervention and lesion

f. workhorse
g. extra support
h. access, crossing and chronic total occlusion (CTO) guidewires

- Techniques of using CTO guidewires (controlled drilling, penetration, knuckle and sliding strategy)
- Shaping the wire tip
- Complications of guidewire manipulation
- The relative length of catheters / guidewires and interventional equipment and methods of solving their length incompatibility

Skills

The ability to:

- Appropriately select diagnostic and guide catheters to the type of diagnosis, intervention, the vascular access site and patient anatomy
    - In transfemoral interventions
    - In transradial interventions
    - In native coronary arteries
    - In coronary bypass grafts
    - In challenging peripheral or aortic anatomy
    - To select the catheter providing increased support for a difficult lesion (distal, calcified or located in a tortuous anatomy)
- Successfully perform diagnostic and interventional procedures with a range of diagnostic and guide catheters
- Successfully use microcatheters and/or use dual lumen catheters to facilitate wiring of very tortuous vessels and complex lesions
- Solve the problem of pressure dampening during coronary intervention based on catheter selection and wire support
- Solve the problem of catheter/guidewire/interventional equipment length incompatibility
- Successfully apply methods for enhancing guide catheter support using the anchoring or “mother and child” /Guide extension techniques.
- Select guidewires appropriately to planned interventions and lesions
    - Radial artery crossing
    - Catheter backup support
    - FFR, IVUS, OCT
    - Coronary procedures
    - Rotablation
    - Crossing very tight lesions
    - Crossing dissections
    - CTO wiring
- Effectively use techniques of guiding catheter stabilisation and device advancement support.
- Apply techniques of guidewire insertion and removal in catheter/guidewire/device length incompatibility
    - Using extension wire
    - Saline flush in OTW balloons

- Wire trapping
- Anticipate and solve complications of guiding catheters manipulation
  - Catheter kinking or rupture
  - Aortic, arterial and coronary dissection
  - Distal embolization
  - Arterial vasospasm
- Anticipate and solve complications of guidewire manipulation
  - Plaque embolization
  - Arterial dissection
  - Vasospasm
  - Subintimal wire entry
  - Wire fracture
  - Wire entrapment

Behaviours and attitudes

- The attitude to understanding, evaluation, planning and discussing an individualised approach to PCI, according to the type of procedure
- Prediction of possible challenges in catheter crossing, manipulation and their stability
- Develop pre-procedural and intraprocedural steps in catheter and guidewire choice, and their manoeuvring techniques.
- Presentation of the plans as well as step-up strategies to the patient and the team involved in the procedure
- Anticipation of complications and their treatment based on the planned catheter and guidewire use

2.2 - Balloon angioplasty technology

ESC topic list:

- *25.2.4 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Technique*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapter “Balloon angioplasty technology”

Objectives

- To be able to safely and effectively perform balloon angioplasty in all its applications (plain

old balloon angioplasty, predilatation, postdilatation, focused force balloons, kissing balloon, balloon expandable stents)
- To be aware of common and uncommon complications of balloon angioplasty and to be able to apply measures to prevent and/or treat such occurrences.

Knowledge

- Coronary artery disease and indication to coronary angiography and angioplasty.
- Design, materials and technology used in balloon catheters, and their biological interactions with tissue and blood fluids.
- Equipment needed to perform balloon angioplasty (guiding catheters, guidewires, connector, indeflator, docking extension).
- Balloon catheter systems (monorail, over the wire, high pressure balloons, balloon expandable stents, drug coated balloons, porous balloons, bifurcation balloons, focused force balloons).
- Difference between semi-compliant and non-compliant balloons and concepts of nominal pressure and rated burst pressure.
- Procedural steps needed to perform balloon angioplasty (balloon preparation, insertion and lesion crossing, inflation, deflation, balloon exchange).
- Techniques to improve the rate of lesion crossability (buddy-wire, change guidewire in favour of a more supporting one, predilate with a smaller balloon, mother and child catheters, use of larger guiding catheters, deep guiding catheter engagement, anchoring technique, use of extension catheters (Guideliner, etc,…).
- Performance characteristics of balloon catheters (trackability, pushability, crossability).
- Dimension parameters of balloon catheters (diameter, length, usable catheter length, proximal and distal shaft diameter, primary and secondary crossing profile, catheter entry profile).
- Advantageous applications of over-the-wire balloon catheters (total occlusion or tortuosity, distal wire exchange, distal drug or contrast medium injection, rotablation, septal ablation).
- Interpretation of coronary imaging techniques (IVUS, OCT)
- Interpretation of haemodynamic relevance of coronary stenosis (FFR, iFR), especially in case of multiple tandem stenosis
- Complications related to balloon angioplasty (dissection, stent loss, vessel occlusion, balloon rupture, balloon trapping, balloon shearing off, coronary embolization, systemic embolization).

Skills

The ability to:
- Perform all the steps necessary to perform balloon angioplasty.
- Elaborate an interventional strategy based on lesion morphology and characteristics (selecting the right balloon in terms of diameter/length and inflation pressures).
- Recognize the reason of failure to cross a stenosis and adapt the interventional strategy accordingly.

- Deal with fibrotic, calcified and sometimes undilatable lesions, acknowledging the possibility to use scoring balloons or rotational atherectomy.
- Be familiar with the use of over-the-wire balloons and docking extension, and in case of necessity acknowledge the possibility to use alternative methods for catheter exchange, such as the "saline flush" and the "trapping balloon" methods.
- Prevent and/or treat common and uncommon complications.

Behaviour and attitudes

- Ensure, before starting any PCI, that the diagnosis, indication, and informed consent, as well as all other prerequisites, are satisfactory.
- Cooperation and appropriate communication with the second operator, nurses and technician.
- Careful study of coronary anatomy and stenosis characteristics before balloon insertion, in order to plan the strategy for PCI in relation to material selection and procedural sequence.
- Awareness of possible complications derived from balloon angioplasty, and application of measures to prevent and/or treat adverse events.

2.3 - Coronary artery stents (including DES)

ESC topic list:

- *25.2.3 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Stents*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
  EAPCI textbook Part III, Chapter "Coronary artery stents"

Objectives

- To be able to safely and effectively perform coronary stent implantation, especially in complex settings
- To be able to select the most appropriate stent and stent implantation technique according to patients and lesion characteristics
- To be aware of common and uncommon complications of coronary stent implantation and to be able to apply measures to prevent and/or treat such occurrences.

Knowledge

- Acute and long-term results of coronary stent implantation

- Results in selected subsets (elective, ACS, STEMI, diabetes, chronic kidney disease, high bleeding risk) and lesions (left main, bifurcation, long-lesion, calcified lesion, small vessels, SVG, thrombus-containing lesions, ostial lesions).
- Stent types and components (metal composition, stent delivery – balloon-expandable or self-expandable- profile, size and length available, strut thickness and design (open, closed cells), coating, antiproliferative drug.
- Techniques to improve the rate of lesion crossability in tortuous and calcified vessels, diffuse disease (buddy-wire, mother and child catheters, use of larger guiding catheters, deep guiding catheter engagement, anchoring technique, use of extension catheters (Guideliners,…).
- Optimal lesion preparation (predilatation with non-compliant or high-pressure balloon, cutting balloon or angiosculp, rotablation, lithotripsy balloon, excimer laser, cutting-wire technique, cutting balloon, scoring balloon, manual and mechanical thrombectomy)
- Techniques to treat bifurcations lesions (provisional stenting, culotte, T-stenting, TAP, minicrush, crush, reverse or inverted crush)
- Interpretation of coronary imaging techniques (IVUS, OCT)
- Interpretation of haemodynamic relevance of coronary stenosis (FFR, iFR), especially in case of multiple tandem stenosis
- Optimal type, time of administration and duration of DAPT according to the type of stent and patient characteristics
- Complications and its resolutions (stent dislodgement, struts damage, stent fracture, acute stent thrombosis, vessel rupture, distal embolization, no-reflow, side-branch occlusion)

Skills

The ability to:

- Perform all the steps necessary to perform stent implantation
- Select the best technical approach according the lesion characteristics (distal lesions, tortuous and calcified vessels, bifurcation, ostial lesions, CTO).
- Recognize the reason of failure to cross the lesion with the stent and identify a solution
- Recognize the reason of suboptimal stent expansion and the approach to solve it
- Prevent and/or treat common and uncommon complications.

Behaviours and attitudes

- Commitment to use of scores (especially the Syntax Score) and to work in a heart team for the identification of optimal revascularization strategy in complex patients
- Commitment to follow the evolving field of percutaneous coronary intervention (new stent technology, intravascular imaging, balloon technology, new potential adjunctive devices, new potential tips and tricks).
- Provision of appropriate information to the patients concerning the therapeutic choice (explanation of pros and cons of each therapeutic approach), and the optimal duration of DAPT.

2.4 - Bioresorbable scaffolds

ESC topic list:

- *25.2.3 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Stents*
- *25.2.2 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Devices*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
  EAPCI textbook Part III, Chapter "Bioresorbable scaffolds"
- Report of an ESC-EAPCI Task Force on the evaluation and use of bioresorbable scaffolds for percutaneous coronary intervention: executive summary (2018). (20)

Objectives

- To understand the potential theoretical advantages of BRS
- To know that BRS should not be used in clinical practice (except in clinical trials)
- The evidence regarding BRS therapy
- To know the patient and lesion selection
- To know the recommended BRS implantation technique
- To be aware of common and uncommon complications of BRS and to be able to apply measures to prevent and/or treat such occurrences.

Knowledge

- BRS technology principles
- Most studied BRS devices
- Acute and long-term results of BRS implantation
- Results in selected subsets (elective, ACS, STEMI, diabetes) and lesions (Left main, bifurcation, long-lesion, calcified lesion, small vessels, SVG, thrombus-containing lesions, ostial lesions).
- Acute and long-term complications, including the risk of Scaffold thrombosis
- Optimal BRS implantation technique
- Interpretation of coronary imaging techniques (IVUS, OCT)
- Optimal DAPT duration after BRS

Skills

The ability to:

- Select the patient and lesion suitable for BRS

- Use appropriate intracoronary imaging
- Prevent and/or treat common and uncommon complications.

Behaviours and attitudes

- Appropriate selection of patient and lesion for BRS
- Systematic use of intracoronary imaging for BRS implantation
- Patient follow up after BRS and DAPT adaptation
- Awareness of BRS technology and its rapid evolution

2.5 - Drug-coated balloons

ESC topic list:

- *25.2.2 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Devices*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapter "Drug-coated balloons"

Objectives

- To fully understand the rationale behind the use of drug-coated balloons and their mechanism of action.
- To be able to recognize clinical situations in which drug-coated balloon angioplasty is indicated and/or potentially beneficial.
- To safely and effectively perform drug-coated balloon angioplasty, with adequate lesion preparation and attention to potential complications that might require bailout stenting.

Knowledge

- Pitfalls of drug-eluting stents drug release mechanism (delayed and incomplete endothelialisation due to low levels of antiproliferative drug in vessel wall not covered by struts; polymeric matrix induced inflammation and thrombosis, leading to neoatherosclerosis)
- Concept of "leaving nothing behind" in order to promote endothelialisation, avoid permanent implants and lead to the reestablishment of normal vascular function (vascular restoration).

- Potential advantages of drug-coated balloons (homogenous drug delivery to the vessel wall, immediate drug release without the use of a polymer, can be used alone or in combination with a stent, no foreign object left behind, potential shorter dual antiplatelet therapy).
- Common drug used in coatings (paclitaxel), its dose (2-3 µg/mm2) and mechanism of action.
- Common coating excipients (iopromide, shellac, BTHC, urea, others) and their role in drug release.
- Absence of a class effect due to the different excipients and designs.
- Current drug-coated balloons indications (in stent restenosis, superficial femoral artery disease) and potential advantageous applications (small vessel disease, bifurcation lesions, long and distal lesions, very angulated segments).
- Importance of lesion preparation before drug-coated balloon inflation.
- Importance of inflation time (at least two minutes, in one or multiple inflations) after achievement of optimal "stent like" by balloon predilatation.
- Angiographic parameters (late lumen loss, acute lumen gain, binary restenosis).

Skills

The ability to:

- Adequate lesion preparation and optimal "stent like" results, with semi-compliant or non-compliant balloon and if necessary, with scoring balloons, before using drug-coated balloons.
- Appropriately handle the device and avoid geographical mismatch.
- Recognize the need for bailout stenting (coronary dissection type C or higher)

Behaviours and attitudes

- Ensure, before performing drug-coated balloon angioplasty, that the diagnosis, indication, and informed consent, as well as all other prerequisites, are satisfactory.
- Careful weighing of pros and cons of drug-coated balloons when dealing with lesions representing a possible indication for use.
- Pay particular attention before and during balloon inflation to avoid geographical miss and respect nominal pressure and minimal inflation time.
- Awareness of possible complications, especially coronary dissection (type C or higher), which might require bailout stenting, and balloon rupture.

LESION SUBSETS

2.6 - Lesion subsets: General aspects

ESC topic list:

- *25.2.4 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Technique*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*

Objectives

- To be able to identify and interpret correctly coronary artery lesions (i.e. morphological characteristics) based on angiogram and eventually based on additional invasive imaging tools.

Knowledge

- Clinical and procedural relevance of different lesion characteristics (i.e. myocardial bridging, thrombus, calcification, dissection flap, involvement of bifurcation, etc.)
- Advantages and limitations of coronary angiography in terms of correct visualization of different coronary artery lesions.
- Indications, advantages and limitations of different additional imaging tools besides coronary angiography.

Skills

The ability to:

- Evaluate and interpret appropriately the coronary angiogram and identify normal, anomalous and pathological findings.
- Understand the clinical and interventional consequences of various normal, anomalous and pathological findings.
- Use different risk-stratification tools when deciding on revascularization strategies of different lesion subsets (left main, bifurcations, CTO, resistant and calcified lesions, saphenous vein grafts).

Behaviours and attitudes

- Correct evaluation and interpretation of coronary angiogram and;
- Identification of normal, anomalous and pathological findings should result in (i) appropriate decisions about therapeutic approaches, (ii) interventional strategies when indicated and (iii) allocation of medical resources.

2.7 - Bifurcation lesions

ESC topic list:

- *25.2.4 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Technique*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapter "Bifurcation lesions"

Objectives

- To assess, diagnose and treat patients with bifurcation lesions.

Knowledge

- Fundamental anatomical and pathophysiological aspects of bifurcation lesions (three diameters, flow pattern, plaque distribution), Medina classification and the role of quantitative coronary angiography (QCA), intracoronary imaging and invasive physiological assessment in assessing bifurcation lesions.
- Description of the main steps of provisional SB stenting strategy (wiring, stenting of the main branch, proximal optimization technique (POT), guidewire exchange, kissing balloon inflation) and different two-stent techniques.
- Of the type of bifurcation stenting technique for the type of lesion.
- Evidence from main randomized trials regarding the acute and long-term results of provisional single-stent vs. complex bifurcation stenting, the choice of two-stent technique and the use of final kissing balloon inflation in bifurcation stenting.
- The role of dedicated stents in bifurcation PCI.

Skills

The ability to:

- Use appropriate non-invasive and invasive diagnostic techniques.
- Evaluate bifurcation anatomy and decide on the optimal bifurcation PCI technique for each individual patient (provisional single-stent strategy vs. planned two-stent strategy).
- Conduct bifurcation PCI using provisional single-stent strategy.

- Conduct bifurcation PCI using different complex stenting strategies. It is required to know the principle of all complex stenting techniques, while being familiar in practice with at least two (i.e. T-stenting and DKCrush).

Behaviours and attitudes

- Commitment to follow and critically appraise new evidence in this evolving field, as well as to adopt new techniques.
- Provision of balanced, readily understood and individually appropriate information regarding the specific bifurcation stenting technique used in an individual patient.

2.8 - Calcified and Resistant lesions (including Rotational atherectomy)

ESC topic list:

- *25.2.4 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Technique*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapter “Calcified coronary lesions”

Objectives

- To be able to identify and successfully treat potentially ‘undilatable’ coronary artery lesions (heavily calcified or severely fibrotic lesions) with good acute and long-term outcomes.

Knowledge

- Complex evaluation and risk stratification of a patient with coronary artery disease including calcified coronary stenosis regarding best treatment strategy (percutaneous revascularization vs. surgical revascularization vs. conservative therapy)
- Assessment of the coronary pathology and evaluation of the degree of calcification of coronary arteries, including angiographic assessment and intravascular imaging (OCT and IVUS), to predict the difficulty of a potential PCI procedure.
- Equipment and expertise, needed for PCI procedures of calcified stenosis (i.e. high-pressure balloons, scoring/cutting balloons, rotational atherectomy, litothripsy, etc).
- Rules and essential steps of a safe usage of rotational atherectomy.

- Potential complications and management during different PCI of calcified stenosis, including rotational atherectomy.

Skills

The ability to:

- Recognize lesions potentially requiring specific technique for plaque modification.
- Be familiar with intracoronary imaging techniques for the identification of underlying fibrotic or calcified plaque burden.
- Appropriately define interventional strategy to manage 'undilatable' lesions.
- Appropriately evaluate interventional strategies, incl. rotational atherectomy to manage 'undilatable' lesions.
- Recognize and manage complications, potentially occurring during PCI of resistant lesions

Behaviours and attitudes

- Applying evidence-based medicine and current guidelines in complex PCI
- Commitment to dedicate sufficient time for a well-structured learning curve, optimally guided by proctor.
- Proper informed consent regarding the risk, clinical presentation and possible treatment of calcified and resistant stenosis.

2.9 - Left main coronary artery disease

ESC topic list:

- *25.2.4 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Technique*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapter "Left main coronary artery disease"

Objectives

- To assess, diagnose and treat patients with left main (LM) coronary artery disease, including the identification of patients amenable for percutaneous vs. surgical revascularization.

Knowledge

- Short- and long-term outcomes after percutaneous vs. surgical revascularization for LMCA disease, including unprotected LM PCI in the setting of ACS.
- Role of risk stratification in deciding between PCI and CABG, and the differentiation between anatomical (e.g. SYNTAX score), clinical (e.g. EuroScore) and combined risk scores (e.g. Clinical SYNTAX score, Logistic Clinical SYNTAX score, etc).
- Anatomy and pathophysiology of LM disease (ostium, mid and distal LM portion, plaque distribution, three diameters and bifurcation angle of distal LM bifurcation).
- Main technical steps of PCI of aorto-ostial and mid vessel LM lesions.
- General treatment algorithm to guide one- or two-stent strategy in PCI for distal LM bifurcation lesions.
- Description of the main steps of provisional single-stent strategy and different double-stenting techniques for distal LM bifurcation treatment.
- Role of intracoronary imaging (IVUS, OCT) and FFR/iFR in assessing angiographically intermediate lesions and optimization of the LM stenting.

Skills

The ability to:

- Use appropriate non-invasive and invasive diagnostic techniques.
- Apply risk scores to identify patients amenable for percutaneous vs. surgical revascularization.
- Evaluate the LM anatomy and potential complexity of PCI for LMCA disease in an individual patient.
- Perform and interpret intracoronary imaging and physiology measurements.
- Conduct PCI of distal LM bifurcation using provisional single-stent and different double-stenting strategies. It is required to know the principle of all complex stenting techniques, while being familiar in practice with at least two (i.e. T-stenting and DKCrush).

Behaviours and attitudes

- Commitment to work in a Heart Team with cardiovascular surgeons, anaesthetists and non-invasive cardiologists.
- Commitment to follow and critically appraise new evidence in this evolving field.
- Explanation of pros and cons of percutaneous vs. surgical treatment options for patients with LMCA disease.
- Provision of balanced, readably understood and individually appropriate information to the patients with LM disease regarding the technique and the expected outcomes

2.10 - Chronic total occlusions (including specific guides and wires)

ESC topic list:

- *25.2.7 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: CTO*
- *25.2.2 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Devices*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapter "chronic total occlusions"
- Guiding Principles for Chronic Total Occlusion Percutaneous Coronary Intervention. Circulation. 2019 (21)

Objectives

- To assess, diagnose and treat patients with chronic total coronary occlusions (CTO), including the identification of patients in whom revascularization of a CTO is clinically indicated and reasonable.

Knowledge

- Indications for revascularization of a CTO and diagnostic methods for the evaluation of regional myocardial viability, to accept or to reject a case for CTO PCI.
- Complex evaluation and risk stratification of a patient with coronary artery disease including a CTO, regarding best treatment strategy (percutaneous revascularization vs. surgical revascularization vs. conservative therapy)
- Assessment and classification of CTO pathology to predict the difficulty of a potential CTO PCI procedure.
- Equipment and expertise, needed for basic and more advanced CTO PCI procedures, including antegrade and retrograde approaches.
- Main steps of different PCI techniques for antegrade and retrograde approaches to CTO PCI.
- Potential complications and their management during different CTO PCI techniques, including antegrade and retrograde approaches.

Skills

The ability to:

- Evaluate indication, feasibility and potential complexity of CTO PCI for individual cases.
- Create reasonable CTO PCI strategy for individual cases of various complexities.
- Conduct CTO PCI procedures through antegrade approach. Retrograde approach can be resorted to when necessary
- Make the necessary decisions about changing technique, changing approach or even to stop the procedure.

Behaviours and attitudes

- Commitment to dedicate sufficient time to appropriately move up the learning curve, optimally guided by a proctor.
- Commitment to follow and eventually apply new techniques and new devices of this evolving field.
- Commitment to dedicate sufficient time for planning and performing CTO PCI, while working together with specifically trained CTO operators.
- Importance to explain the pros and cons of different treatment modalities of patients with coronary artery disease, including a CTO (i.e. percutaneous revascularization vs. surgical revascularization vs. conservative therapy)
- Understanding balanced and individually appropriate information regarding the specific CTO technique used in an individual patient

2.11 - Bypass graft disease

ESC topic list:

- *26.1 Interventional Cardiology and Cardiovascular Surgery: Cardiovascular Surgery – Coronary Arteries*
- *25.2. Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention*
- *25.1.4 Interventional Cardiology and Cardiovascular Surgery: Intracoronary Ultrasound*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapter “Saphenous vein graft disease”

Objectives

- To have acquired knowledge of the content in Chapters Coronary artery disease and Acute Cardiac Care of the ESC core curriculum for general cardiologists regarding non-invasive imaging, invasive imaging and chronic ischemic heart disease.
- To assess, diagnose and treat patients after CABG surgery and de novo significant atherosclerosis of the graft

Knowledge

- Equipment, including different distal protection devices, specific techniques and expertise, needed for bypass PCI.
- To recognize anatomies and lesions, where the application of distal protection devices is needed and feasible.

- Complex evaluation and risk stratification of a patient with significant coronary bypass sclerosis, regarding best treatment strategy: clinical benefit of bypass intervention versus native vessel intervention versus medical management alone.
- Potential periprocedural complications and their management during graft PCI (i.e. dissection, no-reflow, etc.)
- Evidence from main randomized trials on bypass versus PCI, regarding different stent types and treatment strategies
- Acute and long-term expected outcomes of native bypass grafts and stented bypass grafts.

Skills

The ability to:

- Appropriately analyse the angiogram of the native coronary and of the graft anatomy, including the evaluation of potential risk of graft versus native coronary intervention.
- Be familiar with the main procedural steps of applying one type of embolic distal protection device.
- Be familiar with safe performance of graft PCI and the management of potential complications.

Behaviours and attitudes

- Appropriate clinical judgment taking into consideration the clinical presentation and the patient's comorbidities in the assessment of the benefit-to-risk ratio of graft vs. native coronary intervention vs. conservative therapy.
- Be able to refer the patient to a CTO-dedicated team to consider PCI of the native artery.
- Understanding balanced and individually appropriate information regarding the specific graft failure technique used in an individual patient

2.12 Device failure (stent thrombosis and in-stent restenosis)

ESC topic list:

- *25.2.10 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Restenosis*
- *25.2.11 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Stent Thrombosis*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapters "Stent thrombosis" and "In-stent restenosis"

Objectives

- To have acquired knowledge of the content in Chapter "Acute Cardiac Care" of the ESC core curriculum for general cardiologists, and of chapters "Peri- and post-procedural antithrombotic pharmacotherapy", "Intravascular imaging" and "Devices and tools" of the EAPCI core curriculum for interventional cardiologists.
- To assess, diagnose and treat patients with stent thrombosis (ST) and in-stent restenosis (ISR), including the understanding and the identification of different mechanisms leading to stent failure.

Knowledge

- Predictors, rate of occurrence and standardized definitions of thrombosis after coronary stent implantation according to the Academic Research Consortium criteria (definite/probable/possible and early/late/very late stent thrombosis).
- Predictors and rate of occurrence of in-stent restenosis after coronary stent implantation.
- Differentiation between the factors related to 1) stent/scaffold technology, 2) procedure of stent implantation and 3) biology of the patient and the lesion, that have been associated with the occurrence of stent thrombosis and/or ISR.
- Evidence from main randomized trials regarding the acute and long-term results after coronary intervention with various devices (DEB vs. POBA vs. BMS vs. DES vs. BRS).
- Evidence from main randomized trials regarding the acute and long-term results of different interventional treatments of ISR (DES vs. DEB).
- Evidence from main randomized trials regarding risks and benefits of prolonged vs. shorter dual antiplatelet therapy (DAPT) regimens with different antiplatelet drugs.
- Role of intravascular imaging in elucidating different mechanisms of stent failure.

Skills

The ability to:

- Assess in advance the potential risk of stent failure in an individual patient and undertake necessary precautions to minimize the stent- and procedure-related factors that contribute to the occurrence of stent thrombosis and/or ISR.
- In case of stent failure, use appropriate invasive diagnostic techniques, including performing and interpreting intracoronary imaging measurements (IVUS and OCT).
- In case of stent failure, to conduct invasive treatment of stent failure (ST or ISR) using the best fitting interventional strategy (i.e. DES implantation, balloon angioplasty, drug-eluting balloon angioplasty, pharmacotherapy).
- Assess individual risks and benefits of prolonged vs. shorter DAPT in all patients undergoing PCI with stent implantation.

Behaviours and attitudes

- Commitment to follow and critically appraise new evidence, with an emphasis on emerging stent/scaffold technology and data on the optimal duration of DAPT following stent implantation.
- Provision of balanced, readily understood and individualized information regarding the risk, clinical presentation and possible treatment of stent failure.
- Understanding balanced and appropriate information regarding the specific stent failure technique used in an individual patient

PATIENT SUBSETS

2.13 - Interventions for chronic coronary syndromes

ESC topic list:

- *25.2 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention*
- *12.4.4.1. Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Percutaneous Coronary Intervention*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapters “Risk stratification and risk models in revascularization” and “Interventions for stable coronary disease (chronic coronary syndromes)

Objectives

- Making the right decision in treating patients with chronic CAD between PCI, medical therapy, and CABG.
- Finding the best way to treat with comparison of outcome data

Knowledge

- Predicting overall risk of ischemic events (e.g. Calcium scoring, Framingham Risk Score)
- Typical assessment of severity of chronic CAD
- Differences in the outcome of patients treated with optimal medical therapy and PCI (COURAGE and ISCHEMIA trials)
- Evaluation of the clinical benefit of the revascularisation in the absence of ischemia
- Knowing the proven benefits of PCI in patients with chronic CAD
- PCI versus CABG in patients with chronic multivessel CAD
- CAD and heart failure

Skills

The ability to:

- Perform clinical evaluation of CAD
- FFR for decision making
- Association of the anatomy, clinical symptoms, and ischemic burden, several other factors with prognosis in patients with chronic CAD
- Treat chronic CAD in elderly patients (anticoagulant therapy, renal failure, LV dysfunction)

Behaviours and attitudes

- Finding the best strategy for the patient in the treatment of chronic CAD: optimal medical therapy (OMT), CABG and PCI

2.14 - Interventions for patients with multi-vessel CAD (including hybrid approach)

ESC topic list:

- *25.2 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention*
- *26.1 Interventional Cardiology and Cardiovascular Surgery: Cardiovascular Surgery – Coronary Arteries*
- *12.4.4.1. Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Percutaneous Coronary Intervention*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapter “Risk stratification and risk models in revascularization”, “secondary revascularization”, “hybrid Interventions” and “Interventions for stable coronary disease (chronic coronary syndromes)

Objectives

- Understanding of the different factors (coronary anatomy as well as comorbidities) of importance for appropriate selection of revascularization mode
- Understanding the advantages of the combination of minimal invasive CABG and PCI in treatment of patients with multivessel disease

Knowledge

- Understand the advantages and limitations of the various techniques
- Combination of PCI and a minimally invasive valvular procedure
- Appropriate use of FFR for selection of lesions to be revascularized

Skills

The ability to:

- Find correct indication for a minimally invasive hybrid strategy
- Timing and sequence performing a hybrid approach
- Combined PCI and TAVI
- Combination of a PCI and port access endoscopic mitral valve repair

Behaviours and attitudes

- Select the right patients with coronary artery disease or with combined valvular and coronary disease which can realistically be offered minimally invasive treatment strategies
- Knowing about the need for a Heart Team multidisciplinary decision approach

2.15 - Interventions for ST-segment elevation acute myocardial infarction (including thrombectomy)

ESC topic list:

- *25.2.6 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Primary and Acute PCI*
- *13.6.3 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: ST-Elevation Myocardial Infarction (STEMI)*
- *25.2 6 Interventional Cardiology and Cardiovascular Surgery Y: Coronary Intervention*
- *13.4.3.1 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Acute Coronary Syndromes: Treatment, Revascularization: Coronary Intervention*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapters “Interventions for ST-segment elevation acute myocardial infarction” and “Distal protection and thrombectomy”

Objectives

- Learning how to diagnose and treat ST-segment elevation myocardial infarction in an optimal fashion
- Learning how to select optimal adjunctive pharmacotherapy during interventions for ST-segment elevation myocardial infarction
- Acquiring the knowledge on the access site selection, use of adjunctive devices, and stent selection during interventions for ST-segment elevation myocardial infarction
- Understanding the role of reperfusion quality assessment

Knowledge

- Pathophysiology of ST-segment elevation myocardial infarction and the role of delay to reperfusion
- Role of networking for the treatment of ST-segment elevation myocardial infarction
- The role of thrombolysis in the treatment of ST-segment elevation myocardial infarction
- Interventions after thrombolysis (routine vs. rescue angiography/percutaneous coronary interventions)
- Access site selection
- Catheter and guidewire selection
- Treatment strategy in patients with multivessel disease
- Prevention of no-reflow and distal embolization - thrombectomy, proximal and distal protection devices, delayed versus immediate stenting
- Adjunctive antiplatelet therapy - timing and drug selection
- Adjunctive antithrombotic therapy - timing and drug selection
- Assessment of reperfusion - impact and available techniques
- Principal trials in ST-segment elevation myocardial infarction and gap of knowledge

Skills

- Awareness of the impact of time delay to reperfusion
- Selection of the optimal strategy for the treatment of ST-segment elevation myocardial infarction including the selection of access site, adjunctive devices, stent, and pharmacotherapy
- Angiographic and electrocardiographic assessment of reperfusion

Behaviours and Attitudes

- Make the right selection of access site, adjunctive devices, stent and pharmacotherapy adjusted to patient risk-profile (tailored approach)
- Acting rapidly to diagnose and treat ST-segment elevation myocardial infarction in an optimal and timely fashion

2.16 - Interventions in patients with NSTE-ACS

ESC topic list:

- *25.2.6 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Primary and Acute PCI*
- *13.6.2 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Non-ST-Elevation Myocardial Infarction (NSTEMI)*
- *25.2.6 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention*
- *13.4.3.1 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Acute Coronary Syndromes: Treatment, Revascularization: Coronary Intervention*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
  EAPCI textbook Part III, Chapter "Interventions for non-ST-segment elevation acute coronary syndromes"

Objectives

- Learning diagnostic measures, risk stratification, and different therapeutic options in patients with NSTE-ACS

Knowledge

- Pathophysiology of acute coronary syndromes
- Differential diagnoses
- Electrocardiogram (ECG) in the acute phase of NSTE-ACS
- Assessment of cardiac biomarkers, including use of high- or ultrasensitive troponin assays
- Risk stratification using recommended ischemic risk and bleeding scores
- Invasive vs. conservative approach
- Timing of angiography and intervention
- Antithrombotic medications in the acute phase
- Oral antiplatelet medications, including type, timing of administration and recommendations for the post-acute phase
- Specific clinical considerations in special populations such as the elderly, patients with concomitant oral anticoagulation, women and diabetic patients

Skills

- Accurate diagnosis of NSTE-ACS
- Applying guidelines for coronary revascularization, including the heart team approach

- Pharmacologic and technical approach to perform PCI in a high-thrombotic milieu
- Identification of the culprit lesion
- Use of FFR in the setting of ACS
- Application of bleeding-risk reduction strategies

Behaviours and Attitudes

- Implementation of algorithms of pharmacologic and interventional treatments based on accurate risk stratification, both in the acute and post-acute phases

2.17 - Interventions for patients with diabetes mellitus

ESC topic list:

- *28.7.4 Preventive Cardiology: Diabetes and the Heart: PCI and Surgery*
- *25.2 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention*
- *12.4.4.1. Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Percutaneous Coronary Intervention*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapter “Interventions for patients with diabetes mellitus”

Objectives

- Choose the right revascularisation mode in diabetic patients

Knowledge

- Understanding the pathophysiologic mechanism of the prothrombotic state in patients with diabetes
- Involved mechanism in the restenosis process
- Contemporary data and recommendations regarding efficacy of CABG versus PCI in diabetic patients
- BMS, DES and Bioresorbable scaffolds in patients with diabetes
- Potential complications in diabetic patients undergoing CABG

Skills

- Antiplatelet therapy in diabetes mellitus
- Treatment options to tackle antiplatelet resistance

- Renal complication after contrast administration in diabetic patients

Behaviours and Attitudes

- Decision making in patients with diabetes: CABG vs. PCI; single vessel vs. Multi vessel disease

2.18 - Interventions for patients with chronic kidney disease

ESC topic list:

- *25.2 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention*
- *12.4.4.1. Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Percutaneous Coronary Intervention*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapters "Lesion and patient subsets: chronic kidney disease"

Objectives

- Understand the cardio-renal unit
- Take consideration between PCI treatment and CABG in patients with Chronic Kidney disease (CKD)

Knowledge

- Definition and measurement classification of CKD
- Metabolic milieu in patients with CKD
- Discrimination between patients with multivessel disease vs. single or double vessel disease and mild to moderate CKD
- Bleeding risk and antiplatelet strategies
- Contrast induced nephropathy: definition, risk factors,

Skills

The ability to:

- Apply Syntax Score and guidelines based-heart team decisions on revascularization strategy
- Prepare patient to reduce the risk of contrast induced nephropathy
- Choose and amount of contrast media in patients with CKD
- Undertake post procedure treatment and monitoring

Behaviours and Attitudes

- Make the right selection of the vascular access depending on the stage of CKD
- Post treatment monitoring of the renal function

2.19 - Interventions for cardiogenic shock

ESC topic list:

- *25.2.9 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Mechanical Circulatory Support*
- *14.4 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: Acute Cardiac Care – Cardiogenic Shock*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part I Chapter "Percutaneous ventricular assistance" and Part III "Cardiogenic shock"

Objectives

- Learning how to diagnose cardiogenic shock complicating acute myocardial infarction and to recognise the underlying causes, in order to be able to choose the best treatment for each patient among different available drugs, devices and therapeutic strategies
- Acquiring basic knowledge on mechanical assist devices and their physiologic effects

Knowledge

- Epidemiology of cardiogenic shock
- Pathophysiology of cardiogenic shock and differential diagnosis
- Mechanical complications of myocardial infarction
- Stages of cardiogenic shock and therapeutic implications
- Drugs used in cardiogenic shock
- Revascularization and cardiac surgery in patients with cardiogenic shock
- Devices for mechanical cardiac support and current evidence in clinical trials
- Principal trials in cardiogenic shock and gap of knowledge
- Features and specific therapies for mechanical causes of cardiogenic shock (e.g. free wall or septal rupture, acute mitral regurgitation)

Skills

The ability to:

- Promptly recognise cardiogenic shock or pre-shock conditions
- Develop the ability to identify the causes of cardiogenic shock in order to tailor treatment for each patient
- Learning principles of functioning and technical skills to use mechanical cardiac support devices

Behaviours and Attitudes

- Ability to act and re-act rapidly and intelligently in a highly-demanding, rapidly-evolving clinical setting where every choice must be fast but at the same time well targeted because potentially discriminating between life and death for the patient

2.20 - Complications and Management

- Cardiac complications (including low flow, slow flow, dissection, tamponade; …)
- Non-cardiac complications (including vascular access, aortic complications and stroke)

ESC topic list:

- *25.2.5 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Complications*
- *13.1.8 Coronary Artery Disease, Acute Coronary Syndromes, Acute Cardiac Care: No Reflow*
- *24.6.3.99 Aortic Disease, Peripheral Vascular Disease, Stroke: Stroke: Cardiogenic Embolism, Other*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
  EAPCI textbook Part III, Chapters "Risk stratification and risk models in revascularization" and "The prevention and management of complications during percutaneous coronary intervention"

Objectives

- To learn the importance of pre-procedural planning and the use of adequate methodology and techniques to minimize risks
- To recognize, assess, diagnose and treat patients suffering from complications resulting from coronary interventions

- To understand the application of adjunctive invasive imaging tools such as IVUS or OCT as well as non-invasive imaging such as CT scan in the diagnosis, procedural guidance and follow-up of patients with PCI complications
- To properly follow-up patients who suffer PCI complications

Knowledge

- Prior to procedure
    a. Identification of patient-related characteristics that can increase the risk of complications: advanced age, urgent or unscheduled intervention, heart failure and hemodynamic instability, renal insufficiency, diabetes mellitus, electrolyte disturbance, arrhythmia, coagulation or platelet disturbances
    b. Identification of lesion-related characteristics that can increase the risk of complications: lesion type; calcium burden; type of bifurcation anatomy; presence of dissection or vessel ectasia; thrombus burden; unidentified angiographic findings
    c. Establishment of patient/lesion risk scores based on the above findings and consultation with the Heart Team if appropriate.
    d. Choice of radiocontrast agent taking into consideration risk of nephropathy, volume status and anaphylactic reaction
    e. Choice of vascular access and documentation of pulses at baseline
- Procedural complications
    a. Vascular access:
        i. Predictors of complications relating to vascular access; adequate choice of vascular access balancing access site, bleeding risk and risk of vascular damage
        ii. Recognition and management of radial access complications (vasospasm, pseudoaneurysm, dissection, perforation, forearm or chest wall hematoma, compartment syndrome)
        iii. Recognition and management of femoral access complications (Retroperitoneal haemorrhage, pseudoaneurysm, AV firstula, infection, hematoma, neuropraxia, lower limb ischaemia, artery dissection)
    b. Coronary complications / threatened myocardial perfusion / hemodynamic compromise:
        i. Threatened or acute coronary vessel closure:
            - 1. Coronary dissection (including ostial dissection, left main dissection)
            - 2. Iatrogenic occlusion of relevant side branch leading to ischemia
            - 3. Iatrogenic thrombotic vessel occlusion
            - 4. Coronary spasm
            - 5. Perforation and potential cardiac tamponade
            - 6. No reflow, distal embolization
            - 7. Air embolism
            - 8. Papillary muscle ischemia
            - 9. Emergency coronary artery bypass surgery
            - 10. Emergency surgery for structural and vessel complications
        ii. Aortic dissection
            - 1. Aortic dissection related to aorto-ostial PCI

        - 2. Aortic dissection related to access sheaths, catheters and other interventional devices
      iii. Chamber perforation
    c. Myocardial reperfusion injury
    d. Retained equipment
    e. Arrhythmia
- Post-procedural complications
    i. Recurrent chest discomfort
    ii. Acute vessel closure
    iii. Stent thrombosis
    iv. Myocardial infarction
    v. Hemodynamic instability, heart failure
    vi. Stroke
    vii. Infection
    viii. Bleeding

Skills

The ability to:

- Correct establishment of a vascular access
- Recognition and appropriate management of impaired coronary blood flow during PCI
- Diagnosis and management of vessel perforation during PCI: balloon occlusion and deployment of covered stent when indicated
- Performance of emergency pericardiocentesis for relief of hemodynamic compromise
- Use of invasive imaging techniques to assess vessel-related complications during PCI, namely intravascular ultrasound (IVUS) and optical coherence tomography (OCT)
- Management of retained intervention equipment in coronary arteries or the peripheral arterial system (wires, balloons or stents): knowledge of different techniques and expected results
- Diagnosis and management of arrhythmias during PCI
- Pharmacological management for hemodynamic instability
- Adequate use of mechanical haemodynamic support devices, either before the start of procedure to reduce risk, or following the identification of a complication
- Adequate use of different types and dosages of anti-thrombotic and anti-platelet agents
- Diagnosis and management of vascular access complications, including the need for percutaneous or surgical correction
- Diagnosis and management of stroke (as complication of the procedure)

Behaviours and Attitudes

- Commitment to evaluate every case in advance, anticipating possible complications and how to address them
- Commitment to work in a multidisciplinary team with cardiac surgeons, vascular surgeons, intensive care doctors and anaesthesiologists

- Obtain informed consent from patients after clear explanation of the procedure, benefits as well as related risks and possible complications

2.21 - Peri-Procedural and Post-Procedural Antithrombotic Pharmacotherapy

ESC topic list

- *25.2.8 Interventional Cardiology and Cardiovascular Surgery: Coronary Intervention: Adjunctive Pharmacotherapy*
- *31.1.4 Cardiovascular Pharmacology: Anticoagulants*
- *31.1.5 Cardiovascular Pharmacology: Antiplatelet Drugs*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapters "Peri-procedural and post-procedural antithrombotic pharmacotherapy" and "The high bleeding risk patient" and Part IV "Secondary prevention of atherothrombotic cardiovascular disease"

Objectives

- To be able to select the appropriate type of drug (and their combination), dosing, timing for initiation and duration of the antithrombotic treatments, regarding the clinical presentation of the disease (STEMI, NSTEMI, chronic CAD)
- To conduct follow-up of patients after initiation of antithrombotic therapy

Knowledge

- Mechanisms of action and indications for usage of intravenous anticoagulant therapy, including unfractionated heparin, low molecular weight heparin, fondaparinux and the direct thrombin inhibitor bivalirudin
- Mechanisms of action and indications for usage of antiplatelet agents including the irreversible cyclo-oxygenase inhibitor acetylsalicylic acid, and the ADP receptor blockers
- Mechanisms of action and indications for usage of glycoprotein IIb/IIIa receptor inhibitors
- Up to date knowledge on randomized clinical trials and guidelines applicable to antithrombotic pharmacotherapy in the catheterization laboratory
- Choice of antithrombotic therapy prior to, during and after intervention for
  a. chronic elective patients
  b. Non-ST elevation acute coronary syndrome
  c. ST elevation myocardial infarction

- Duration of anticoagulation and antiplatelet agents after intervention according to clinical presentation, type and complexity of the procedure, and patient subset
- Antiplatelet therapy: loading, re-loading and switching methodology between agents whenever indicated
- Triple therapy (dual antiplatelet and oral anticoagulant): risks versus benefits
- Antithrombotic therapy and drug-drug interaction
- Bridging to cardiac or non-cardiac surgery in patients on antithrombotic pharmacotherapy.
- Reversal of anticoagulation therapy when appropriate

Skills

The ability to:

- Select the most appropriate antithrombotic therapy for each individual clinical scenario
  a. Selection of type of antiplatelet therapy, dosage and duration
  b. Selection of type of anticoagulant therapy, dosage and duration
- Establish an appropriate antithrombotic therapy considering the clinical scenario: chronic elective coronary syndromes, unstable angina, non-ST elevation acute coronary syndrome, ST elevation myocardial infarction
- Adequately evaluate bleeding risk and use of appropriate risk scores when applicable.
  a. Management of the available treatment strategies considering the thrombotic and bleeding risk of each particular case
  b. Selection of long-term dual antiplatelet therapy relevant to the clinical presentation, type of stent and thrombotic/bleeding risk of patients
- Prevent bleeding complications, including the use of pump proton inhibitot (PPI), in patients receiving antithrombotic therapy
- Manage antithrombotic therapy in patients requiring chronic oral anticoagulation and receiving a coronary stent
- Manage antithrombotic therapy in patients requiring cardiac or non-cardiac surgery

Behaviours and Attitudes

- Commitment to evaluate every case in advance, anticipating possible complications in order to select the best therapeutic combination
- Commitment to work in a multidisciplinary team with intensive care doctors and ward doctors in order to select the best therapeutic strategy
- Informing patients of possible complications and solutions prior to initiation of antithrombotic therapy

2.22 - Secondary prevention and follow-up

ESC topic list

- *28.3 Preventive Cardiology: Secondary Prevention*
- *29.2 Preventive Cardiology: Cardiovascular Rehabilitation*
- *31.1 Cardiovascular Pharmacology: Cardiovascular Pharmacotherapy*
- *31.1.10 Cardiovascular Pharmacology: Lipid-Lowering Agents*

- *31.1.11 Cardiovascular Pharmacology: Anti-Diabetic Pharmacotherapy*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content of Chapters Imaging, Coronary artery disease and Acute Cardiac Care.
- *ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation (2017)*
- *ESC/EACTS Guidelines on myocardial revascularization (2018)*
- *ESC Guidelines for the diagnosis and management of chronic coronary syndromes (2019)*
- EAPCI textbook Part III, Chapter "Secondary prevention and follow-up" and Part IV, Chapter "Secondary prevention of atherothrombotic cardiovascular disease"

Objectives

- To be able to identify the risk factors associated with cardiovascular disease progression
- To be able to establish individual appropriate strategies for cardiovascular risk modification after PCI, including pharmacological therapy, lifestyle adaptations, and cardiac rehabilitation
- To conduct follow-up of special groups after PCI: women, the elderly, diabetic patients, chronic renal disease, those receiving oral anticoagulants and specific types of lesion subsets

Knowledge

- Burden of cardiovascular disease and the importance of optimal medical therapy and risk factors modification
- Optimal medical therapy
  a. Management of dyslipidaemias according to the most recent EAS/ESC guidelines
  b. Detection and control of diabetes
  c. Control of arterial hypertension
  d. Use and duration of antiplatelet agents
  e. Indication for cardioprotective medications such as ACE inhibitors, Renin-Angiotensin-Aldosterone System (RASS) and beta blockers
  f. Management of ischemic cardiomyopathy and LV dysfunction
- Cardiac rehabilitation programs
  a. Advice on return to routine physical activity
  b. Referral to individualized exercise rehabilitation programs
- Lifestyle modification
  a. Provide a structured approach towards smoking cessation and prescribe a smoking cessation program when indicated
  b. Weight management for an ideal body mass index through diet and exercise
  c. Follow a nutrition program that includes caloric and salt intake
- Follow-up
  a. Alert patients to symptoms that would necessitate medical assistance
  b. Schedule regular follow-up visits
  c. Monitor compliance with prescribed medications and life style modifications

Skills

The ability to:

- Establishment of practical strategies directed at cardiovascular risk modification and avoidance of disease progression, aiming at the goals proposed in the ESC guidelines
- Establishment of appropriate type, dosage and duration of antithrombotic therapy, considering the clinical presentation, disease and anatomical subsets, stent type and bleeding risk. Specific focus on anatomic subsets of PCI or PCI techniques that predict a higher risk of recurrent events
- Establishment of an appropriate plan for early and late follow-up after PCI and a plan for follow-up stress test, if indicated
- Monitoring of compliance with pharmacological therapy
- Optimization of secondary prevention in special subgroups of patients after PCI: women, elderly, chronic renal disease, diabetes and those on oral anticoagulants
- Management of disease progression after PCI, including specific events such as stent thrombosis and stent restenosis

Behaviours and Attitudes

- Commitment to establish a plan for preventing progression of atherosclerosis and recurrent events
- Commitment to establish a plan for lifestyle modification
- Commitment to establish a plan for clinical follow-up to detect early and late complications
- Commitment to work in a multidisciplinary team with clinical physicians and general practitioners in order to select the best plan for follow up and treatment
- Provide patients with appropriate information prior to initiation of mid to long-term therapy

Part III: Percutaneous interventions for structural and congenital heart disease (Non-coronary Track)

3.1 Transcatheter Aortic Valve treatment: aortic balloon valvuloplasty and TAVI

ESC topic list

- *3.6.11 Imaging: Imaging: Aortic Disease*
- *15.2 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Valvular Heart Disease – Epidemiology, Prognosis, Outcome*
- *15.6.1 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Aortic Valve Stenosis*
- *15.6.2 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Aortic Valve Regurgitation*
- *25.3.1 Interventional Cardiology and Cardiovascular Surgery: Aortic Valve Intervention*
- *26.2 Interventional Cardiology and Cardiovascular Surgery: Cardiovascular Surgery – Valves*
- *36.3.6 Basic Science: Basic Science - Cardiac Diseases: Valvular Heart Disease*
- *24.6.3 Aortic Disease, Peripheral Vascular Disease, Stroke: Stroke: Cardiogenic Embolism*

Essential reading:

- ESC/EACTS Guidelines for the management of valvular heart disease (2017);
- ESC core curriculum for general cardiology (2013): Content in Chapter Valvular Heart Disease;
- EAPCI Textbook Part II, chapter "Non-invasive imaging for structural heart disease" and Part III, chapters "Balloon aortic valvuloplasty" and "transcatheter aortic valve implantation"
- Transcatheter Aortic-Valve Replacement With a Balloon-Expandable Valve in Low-Risk Patients. N Engl J Med 2019 (22)

Objectives

- To assess, diagnose and treat patients with aortic stenosis including the identification of patients amenable to percutaneous treatment such as balloon valvuloplasty and TAVI
- To conduct follow-up of patients after Transcatheter Aortic Valve treatment

Knowledge

- Indication for balloon valvuloplasty and TAVI according to ESC Guidelines
- Acute and long-term results of aortic balloon valvuloplasty and identification of the main acute (including massive AR) and late complication (including restenosis)
- Description of the requirements (operating team, equipment) and of the main steps of aortic balloon valvuloplasty as performed through a transfemoral approach
- Acute and long-term results of TAVI in patients with symptomatic aortic valve stenosis and comparison with surgery as illustrated in the main randomized studies
- Results of TAVI in main subgroups (valve in valve, bicuspid, low gradient, low surgical risk, aortic regurgitation)
- Role of concomitant comorbidities (CAD, PVD, other valvular disease, respiratory disease, renal failure and liver failure) and their impact on percutaneous management
- Role of coronary revascularization prior to valve intervention
- Requirements and main step of the selection process leading to a percutaneous approach (medical team, medical investigation, imaging).
- Description of the content of the main Risk scores (EuroScore and STS)
- Role of imaging (TTE, TEE, MSCT) to describe the main characteristics of the aortic annulus/valvular complex, its suitability to TAVI and its value to choose the best device and size
- Role of imaging to investigate the various vascular access options and its value to predict complications
- Description of the operating team and institutional requirement to perform TAVI
- Description of the various vascular accesses.
- Description of the main and ancillary devices needed to perform a TAVI procedure through a femoral approach.
- Description of the mains steps of a TAVI performed through a transfemoral approach (anaesthesia, contralateral access, puncture, pre-closure, sheath insertion, antibiotic prophylaxis, prosthesis preparation, temporary pacemaker implantation, valve crossing,

predilatation, positioning post-valve deployment assessment, post-dilatation, haemostasis and vessel closure)
- Description of the frequency and clinical impact of the main peri-procedural complications of TAVI (including paravalvular leak, stroke, vascular injury, pacemaker requirement, and others) and late complications of TAVI (including stroke, endocarditis, valve thrombosis, and valve deterioration)
- Describe endpoints according to the academic research consortium
- Antithrombotic management: periprocedural and long term
- Role of the heart team in the decision-making, performance and evaluation of TAVI.

Skills

The ability to:
- Use appropriate non-invasive or invasive diagnostic techniques
- Identify vascular access issues preventing a percutaneous approach
- Conduct an invasive hemodynamic assessment of the aortic valve including retrograde crossing of the aortic valve
- Conduct an aortic balloon valvuloplasty under rapid pacing through a femoral approach
- Manipulate TAVI devices as second operator
- Identify patients at high, intermediate and low risk for surgery using risk scores (EuroScore, STS, etc) and other parameters (reoperation, hostile chest, porcelain aorta, frailty)
- Identify patients in whom intervention/surgery is not required (asymptomatic patients, futility)

Behaviours and Attitudes

- Commitment to work in a heart team with cardiovascular surgeons, anaesthetists, non-invasive cardiologists and geriatricians
- Commitment to follow this very rapidly evolving field.
- Provision of balanced, readily understood, and appropriate information to the patient with AS who are candidates for transcatheter aortic valve treatment
- Explanation of the pros and cons of each modality of treatment of AS (surgical vs percutaneous).

3.2 Transcatheter mitral and tricuspid interventions (TMTCI)

ESC topic list
- *15.2 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Valvular Heart Disease – Epidemiology, Prognosis, Outcome*
- *15.6.4 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Mitral Valve Stenosis*
- *15.6.5 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Mitral Valve Regurgitation*
- *15.6.8 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Tricuspid Valve Disease*

- *15.6.11 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Prosthetic Heart Valves*
- *25.3.2 Interventional Cardiology and Cardiovascular Surgery: Mitral Valve Intervention*
- *25.3.3 Interventional Cardiology and Cardiovascular Surgery: Tricuspid Valve Intervention*

Essential reading:

- ESC/EACTS Guidelines for the management of valvular heart disease (2017);
- ESC core curriculum for general cardiology (2013): Content of Chapter Valvular heart disease;
- EAPCI Textbook Part II, chapter "Non-invasive imaging for structural heart disease" and Part III, chapters "Percutaneous balloon mitral commissurotomy", "Percutaneous mitral valve repair", "transcatheter mitral valve implantation" and "transcatheter tricuspid valve interventions"
- Transcatheter Mitral-Valve Repair in Patients with Heart Failure. N Engl J Med. 2018 (23)

Objectives

- To identify patients with different stages of mitral and tricuspid disease (MTC) that may improve their status or prolong their lives with transcatheter or mixed interventions (TMTCI);
- To select patients with mitral stenosis (MS) that will benefit from gradient reduction with balloon mitral commissurotomy (BMC);
- To select patients with mitral regurgitation (MR) and/or disease (MD) that will benefit from reduced insufficiency with transcatheter mitral valve repair (TMVR) or transcatheter mitral valve implantation (TMVI);
- To know and understand the devices currently approved and/or used for TMTCI;
- To be able to engage in a multidisciplinary team discussion;
- To obtain fully informed patient consent for the procedure;
- To be able to clinically follow these patients and select cases needing reintervention;
- To be able to engage in data collection and structured investigation plans.

Knowledge

- Principles of epidemiology, classification, pathophysiology, grading, imaging and clinical features of different stages of MTC disease.
- Selection of patients based on:
  - *(a) Non-invasive diagnostic assessment*, by means of medical history, laboratory tests, cardiac imaging data (echocardiography, stress-echocardiography, MRI, CT scan), cardiopulmonary exercise test, quality of life (QoL) and frailty assessments;
  - *(b) Invasive diagnostic assessment*, by performing right and left heart cardiac catheterisation (haemodynamic assessment), transseptal puncture (angiographic and echocardiography landmarks guided);
- Indication TMC, TMVR, TMVI, TTVI according to ESC Guidelines;
- Understand and describe the main procedural steps for:

  - Percutaneous BMC: arterial and venous cannulation, transseptal puncture, interatrial dilation and mitral balloon valvuloplasty;
  - TMVR and TMVI: arterial and venous cannulation, transseptal puncture, large venous sheath progression to the left atria, delivery catheter orientation TEE guided, device control and precise delivery;
  - TMVI: arterial and venous cannulation, tricuspid orientation TEE guided and device delivery;
- Expected pathophysiological effects of TMTCI:
  (a) *Haemodynamic response: MR and/or TR reduction, reduction of pulmonary artery pressure;*
  (b) *TTE findings: MR and/or TR reduction, right and/or left atrial size reduction, change of pulmonary artery pressure;*
  (c) *Functional response: increase of exercise capacity, increase of peak oxygen consumption, improvement of functional class, symptomatic relief;*
- Complications:
  - Peri-procedural: conduction abnormalities (new RBBB, transient or persistent complete heart block), stroke, atrial and ventricular rupture, significant residual valvular stenosis or paravalvular regurgitation, pericardial tamponade, access-site-related complications, endocarditis.
  - Late complications: stroke, endocarditis, long-term structural valve deterioration.
- Comparison with surgery (mitral valvuloplasty, mitral annuloplasty, mitral prosthesis, tricuspid prosthesis and tricuspid annuloplasty): discuss this option in heart-team and with the patient.

Skills

The ability to:

- appropriately select patients with MTC disease that may benefit from the procedure;
- interpret and communicate intra-procedural imaging features
- evaluate and control arterial and large bore venous access routes;
- use arterial catheters for simultaneous pressure recording;
- implant a temporary pacemaker, if necessary;
- perform an urgent pericardiocentesis, if necessary;
- perform atrial and pulmonary angiography, aortography and right and left ventricular ventriculography;
- interpret haemodynamic and echocardiographic findings, as assessed during the procedure and adapt the procedure;
- perform safely and intentionally a transseptal puncture, according to the required technique and patient anatomy;
- create an arterio-venous wire loop using stiff wires and snares;
- prepare and manipulate large bore catheters for BMC, TMVR or TMVI;
- close arterial and large bore venous access, evaluate and solve vascular complications.

Behaviours and Attitudes

- Commitment to work and collaborate in a heart team program with imaging experts, anaesthetists, non-invasive cardiologists and geriatricians
- Commitment to follow this very rapidly evolving field.
- Provision of balanced, readily understood, and appropriate information to the patient candidate for transcatheter mitral valve treatment
- Explanation of the pros and cons of each modality of treatment of mitral disease (surgical vs percutaneous vs conservative).

3.3 Transcoronary ablation of septal hypertrophy (TASH)

ESC topic list

- *17.6.2 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Hypertrophic Cardiomyopathy*
- *25.3.99 Interventional Cardiology and Cardiovascular Surgery: Non-Coronary Cardiac Intervention, Other*

Essential reading:

- Content of the Chapters Imaging, Heart failure and Other cardiac diseases of the ESC core curriculum for general cardiology;
- EAPCI Textbook Part II, chapter "Non-invasive imaging for structural heart disease" and Part III, chapters "Alcohol septal ablation for hypertrophic obstructive cardiomyopathy" and "Alternative techniques to alcohol septal ablation for hypertrophic obstructive cardiomyopathy".

Objectives

- To assess, diagnose and treat patients with HCM including the identification of patients amenable to transcoronary ablation of septal hypertrophy (TASH)
- To conduct follow-up of patients after TASH

Knowledge

- Indication of TASH according to ESC Guidelines
- Principles of epidemiology, classification, pathophysiology and clinical features of HCM.
- Selection of patients based on:
  (a) Non-invasive diagnostic assessment, by means of clinical history, cardiac imaging data (echocardiography, stress-echocardiography, MRI), cardiopulmonary exercise test;
  (b) Invasive diagnostic assessment, by performing right and left heart cardiac catheterisation (haemodynamic assessment) and coronary angiography (anatomical assessment of septal branches to use during the index procedure);
- Understand and describe the main steps of the TASH procedure and the materials to use during the procedure

- Procedural guidance, based on interpretation of:
  - *(a) Electrocardiographic monitoring;*
  - *(b) Real-time transthoracic echocardiography;*
  - *(c) Myocardial contrast echocardiography (MCE),* used to demarcate the myocardium perfused by the target septal artery;
  - *(d) Invasive haemodynamic findings.*
- Expected pathophysiological effects of TASH:
  - (a) Haemodynamic response: significant LVOT gradient reduction, Reduction of pulmonary artery pressure;
  - (b) TTE findings: Septal thinning, posterior wall thickness reduction, mitral regurgitation reduction, left atrial size reduction;
  - (c) Functional response: increase of exercise capacity, increase of peak oxygen consumption, improvement of functional class, symptomatic relief, reduction of syncopal episodes;
  - (d) Conduction abnormalities (new RBBB, transient or persistent complete heart block).
- Potential complications: complete heart block, remote acute infarction due to alcohol leakage and/or misplacement, coronary dissection, acute mitral regurgitation, pericardial tamponade, access-site-related complications.
- Comparison with surgery (septal myectomy): discuss this option in heart-team and with the patient.

Skills

The ability to:

- appropriately select patients with HCM that may benefit from the procedure;
- interpret haemodynamic and echocardiographic findings, as assessed during the procedure;
- be able to perform the procedure under supervision from expert operators.

Behaviours and attitudes

- Commitment to work in a heart team with cardiovascular surgeons, non-invasive cardiologists and geriatricians
- Provision of balanced, readily understood, and appropriate information to the patient candidate for TASH
- Explanation of the pros and cons of each modality of treatment of obstructive HCM

3.4 Percutaneous pulmonary intervention (including valvuloplasty and valve implantation)

ESC topic list

- *2.15 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Valvular Heart Disease*
- *20.6.2 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Adult Congenital Heart Disease, Clinical*

- *21.6.3 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Pulmonary Hypertension*
- *25.1.1 Interventional Cardiology and Cardiovascular Surgery: Invasive Hemodynamic Assessment/Right Heart Catheterization*
- *25.3.4 Interventional Cardiology and Cardiovascular Surgery: Pulmonary Valve Intervention*

Essential reading:

- ESC/EACTS Guidelines for the management of valvular heart disease (2017);
- ESC core curriculum for general cardiology (2013): Content of Chapter Valvular heart disease;
- EAPCI Textbook Part II, chapter "Non-invasive imaging for structural heart disease" and Part III, chapters "Percutaneous pulmonary valvuloplasty" and "Percutaneous pulmonary valve implantation"

Objectives

- To assess, diagnose and treat patients with pulmonary stenosis (PS) including the identification of patients amenable to balloon valvuloplasty
- To assess, diagnose and timely treat patients with right ventricular outflow tract (RVOT) dysfunction including the identification of those amenable to percutaneous pulmonary valve implantation (PPVI)
- To know and understand the technique and devices currently approved and/or used for PPVI, namely the appropriate landing zone and size;
- To be able to engage in a multidisciplinary team discussion for percutaneous and/or hybrid approach;
- To obtain fully informed patient consent for the procedure including potential post-procedural complications;
- To be able to clinically follow these patients and select cases needing reintervention;
- To be able to engage in data collection and structured investigation plans.

Knowledge

- Principles of epidemiology, classification, pathophysiology, grading, imaging and clinical features of different stages of pulmonary disease.
- Selection of patients based on:
  (a) Non-invasive diagnostic assessment, by means of medical history, laboratory tests, cardiac imaging data (echocardiography, stress-echocardiography, MRI, CT scan) and cardiopulmonary exercise testing;
  (b) Invasive diagnostic assessment, by performing right and left heart cardiac catheterisation (haemodynamic assessment), heart angiography and coronary angiography
- Understand and describe the main procedural steps for pulmonary balloon valvuloplasty and PPVI: antibiotic prophylaxis, anaesthesia, arterial and venous cannulation, extra-support

wire progression, large venous sheath progression, tricuspid and pulmonary crossing, dilatation, pre-stent, valve device-controlled delivery, provisional post-dilatation, haemostasis and vascular access closure.

- Expected pathophysiological effects of pulmonary balloon valvuloplasty including haemodynamic response, TTE findings and functional response.
- Expected pathophysiological effects of PPVI including haemodynamic response, TTE findings and functional response.
- Complications
  - Balloon valvuloplasty: injury to the pulmonary valve or artery, the RVOT or the tricuspid valve; dynamic infundibular obstruction; cardiac tamponade, thrombosis, haemorrhage, transient arrhythmia,
  - Specific peri-procedural PPVI issues: conduit or homograft rupture, device dislodgement, coronary compression or pulmonary artery obstruction.
  - Late complications: restenosis, stent fractures and embolization, endocarditis, PV leak and long-term structural valve deterioration.
- To prescribe the adequate antithrombotic regimen and endocarditis prophylaxis

Skills

The ability to:

- appropriately select patients with pulmonary disease that may benefit from the procedures,
- Identify vascular access issues to optimize the percutaneous approach
- evaluate and control arterial and large bore venous access routes;
- use arterial catheters for simultaneous saturation and pressure recording
- interpret and communicate intra-procedural imaging features
- implant a temporary pacemaker, if necessary;
- perform coronary angiography, atrial and pulmonary angiography, aortography, right and left ventriculography;
- interpret haemodynamic and echocardiographic findings, as assessed during the procedure and adapt the procedure;
- prepare and manipulate large bore catheters for pulmonary balloon valvuloplasty and PPVI;
- conduct an invasive hemodynamic assessment of the pulmonary valve including anterograde crossing of the pulmonary valve
- conduct a pulmonary balloon valvuloplasty
- Manipulation of PPVI devices as second operator, namely helping device negotiation across the RVOT, pre-dilation, pre-stenting
- perform an urgent pericardiocentesis

Behaviours and attitudes

- Commitment to work in a heart team with cardiovascular surgeons, anaesthetists, non-invasive cardiologists and paediatricians
- Commitment to follow this very rapidly evolving field.
- Explanation of the pros and cons of each modality of treatment of PS (surgical vs hybrid vs. percutaneous).

- Provision of balanced, understandable and appropriate information to the candidate for transcatheter pulmonary valve treatment, including long-term prognosis

3.5 Atrial interventions (including Left atrial appendage occlusion and Atrial septal defect and patent foramen ovale closure)

ESC topic list

- *5.5 Arrhythmias and Device Therapy: Atrial Fibrillation - Stroke Prevention*
- *5.5.2 Arrhythmias and Device Therapy: Left Atrial Appendage Occlusion*
- *20.6.2 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Adult Congenital Heart Disease, Clinical*
- *21 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Pulmonary Circulation, Pulmonary Embolism, Right Heart Failure*
- *24.6.2 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Stroke: Persistent Foramen Ovale and PFO closure*
- *24.6.3.2 Aortic Disease, Peripheral Vascular Disease, Stroke: Stroke: LAA and LAA occlusion*
- *25.1.1 Interventional Cardiology and Cardiovascular Surgery: Invasive Hemodynamic Assessment/Right Heart Catheterization*
- *25.3.5 Interventional Cardiology and Cardiovascular Surgery: PFO/ASD Closure*
- *25.3.6 Interventional Cardiology and Cardiovascular Surgery: LAA Occlusion*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content in Chapters 2 Rhythm disorders and Other cardiac diseases;
- EAPCI Textbook Part II, chapter “Non-invasive imaging for structural heart disease” and Part III, chapters “Atrial septal defect and patent foramen ovale closure” and “Left atrial appendage occlusion”;

Objectives

- To assess, diagnose and treat patients with atrial fibrillation (AF), atrial septal defect (ASD) and patent foramen ovale (PFO) including the identification of patients amenable to left atrial appendage occlusion (LAAO) and ASD/PFO closure
- To know and understand the devices currently approved and/or used for LAAO and ASD/PFO closure
- To be able to engage in a multidisciplinary team discussion for percutaneous vs. surgical vs. conservative approach
- To obtain fully informed patient consent for the procedure
- To be able to clinically follow these patients
- To be able to engage in data collection and structured investigation plans

Knowledge

- Principles of epidemiology, classification, pathophysiology and clinical features of AF, ASD and PFO
- Description of the operating team and institutional requirement to perform percutaneous atrial interventions
- Description of the frequency and clinical impact of the main peri-procedural complications regarding LAAO and ASD/PFO closure
- Selection of patients, devices and sizing based on:
    - *(a) Clinical indication,* according to evidence and current guidelines
    - (b) *Non-invasive diagnostic assessment*, by means of clinical history, cardiac imaging data (transoesophageal echocardiography, cardiac-CT, additional trans-cranial echocardiography for ASD/PFO for shunt quantification);
    - *(c) Invasive diagnostic assessment for ASD/PFO closure:* right and left heart cardiac catheterisation (haemodynamic assessment, shunt quantification, angiographic assessment of the interatrial communication);
- Understand and describe the main procedural steps for:
    - LAAO: venous access, trans-septal puncture under trans-oesophageal echocardiographic guidance, use of the different device releasing systems and angiographic visualization of the LAA cavity with means of contrast injection through a pigtail catheter, haemostasis
    - ASD/PFO closure: venous access, extra-support wire positioning through the ASD/PFO, use of the different device releasing systems, haemostasis
- Role of the heart team in the decision-making, performance and evaluation of treatment of patients undergoing LAAO and ASD/PFO closure

Skills

The ability to:

- Appropriately select patients with AF or ASD/PFO that may benefit from the procedures
- Identify vascular access issues preventing a percutaneous approach
- Evaluate and control large bore venous access routes;
- Conduct an invasive hemodynamic assessment including shunt quantification
- Gather and interpret pre-procedural anamnestic, clinical and non-invasive imaging data, including ability to perform adequate sizing for device selection
- Perform safely and intentionally a transseptal puncture under echocardiographic guidance, according to the required technique and patient anatomy;
- Interpret haemodynamic and echocardiographic findings, as assessed during the procedure and adapt the procedure;

Behaviours and attitudes

- Commitment to work in a heart team with cardiovascular surgeons, electrophysiologists, paediatricians, anaesthetists and non-invasive cardiologists

- Provision of balanced, readily understood, and appropriate information to patients candidates for atrial interventions
- Explanation of the pros and cons of each modality of treatment of LAAO or ASD/PFO Closure

3.6 Percutaneous closure of paravalvular leaks and ventricular septal defect closure

ESC topic list

- *3.1.12 Imaging: Intraoperative and Interventional Echocardiography*
- *3.2.4 Imaging: Computed Tomography: Valve Disease*
- *15.6.11 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Prosthetic Heart Valves*
- *16.7 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Cardiac Implantable Device-related Endocarditis*
- *20.6.2 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Adult Congenital Heart Disease, Clinical*
- *25.1.1 Interventional Cardiology and Cardiovascular Surgery: Invasive Hemodynamic Assessment/Right Heart Catheterization*
- *25.3.1 Interventional Cardiology and Cardiovascular Surgery: Aortic Valve Intervention*
- *25.3.99 Interventional Cardiology and Cardiovascular Surgery: Non-Coronary Cardiac Intervention, Other*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content in Chapters Valvular Heart Disease and Other Cardiac diseases
- EAPCI Textbook Part II, chapter “Non-invasive imaging for structural heart disease” and Part III, chapters “Percutaneous closure of paravalvular leaks” and “Ventricular septal defect closure”

Objectives

- To identify patients with different stages of congenital or acquired ventricular septal defects (VSD), including post-myocardial infarction VSDs, and paravalvular leaks (PVL) that may improve their status with a closure device;
- To select patients with a mitral or aortic PVL and/or ventricular septal defect (VSD) that will benefit from reduced insufficiency with percutaneous closure devices (PCD);
- To know and understand the devices currently approved and/or used, namely the appropriate size;
- To be able to engage in a multidisciplinary team discussion;
- To obtain fully informed patient consent for the procedure;
- To be able to engage in data collection and structured investigation plans.

Knowledge

- Principles of epidemiology, classification, pathophysiology, grading, imaging and clinical features of different stages of paravalvular leaks presentations and VSDs.
- Selection of patients based on:
  (a) Non-invasive diagnostic assessment, by means of medical history, laboratory tests, cardiac imaging data (echocardiography, MRI, CT scan)
  (b) Invasive diagnostic assessment, by performing right and left heart cardiac catheterisation (haemodynamic assessment) and adequate angiographic planes
- Understand and describe the main procedural steps: antibiotic prophylaxis, anaesthesia, arterial and venous cannulation, anterograde and/or retrograde single or multiple crossing, extra-support wire progression and arteriovenous circuit technique, single or multiple device-controlled delivery, haemostasis and vessel closure
- Complications: vascular complications, valve damage and/or interference, cardiac tamponade, transient arrhythmia, complete heart block, device dislodgement, compression of coronaries, thromboembolism, endocarditis
- Expected pathophysiological effects of VSD or PVL closure including haemodynamic response and TTE findings

Skills

The ability to:

- use arterial catheters for simultaneous saturation and pressure recording;
- appropriately select patients with VSD or PVL disease that may benefit from the procedures,
- evaluate and control arterial and large bore venous access routes;
- interpret haemodynamic and multiple imaging modalities to visualise the three-dimensional relationship of intracardiac structures and to navigate within 3-dimensional space, as assessed during the procedure and adapt accordingly;
- select device sizing and define when to use a larger device or multiple simultaneously deployed devices
- implant a temporary pacemaker, if necessary;
- manage extra-support wire progression and establish an arteriovenous circuit;
- perform an urgent pericardiocentesis

Behaviours and attitudes

- Commitment to work and collaborate in a heart team program with imaging experts, anaesthetists, non-invasive cardiologists, paediatricians or geriatricians
- Commitment to follow this very rapidly evolving field and integrate different imaging modalities
- Provision of balanced, readily understood, and appropriate information to the patient candidate for VSD closure or PVL closure
- Explanation of the pros and cons of each modality of treatment (surgical vs percutaneous vs conservative).

3.7 Cell-based regenerative therapy and techniques of myocardial stem cell delivery

ESC topic list

- *10.4.8 Heart Failure: Devices for Autonomic Modulation*
- *10.4.9 Heart Failure: Chronic Heart Failure: Multidisciplinary Interventions*
- *25.3.99 Interventional Cardiology and Cardiovascular Surgery: Non-Coronary Cardiac Intervention, Other*
- *36.1.1 Basic Science: Basic Science - Cardiovascular Development and Anatomy: Stem Cells, Cell Cycle, Cell Senescence, Cell Death*
- *36.3.11 Basic Science: Basic Science - Cardiac Diseases: Gene Therapy, Cell Therapy*
- *36.4.1 Basic Science: Stem Cells, Cell Cycle, Cell Senescence, Cell Death*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content in Chapters Coronary artery disease, Heart Failure and Acute Cardiac Care
- EAPCI Textbook Part III, chapters "Techniques of myocardial stem cell delivery" and "Cell-based regenerative therapy"

Objectives

- To assess, diagnose and treat patients with acute myocardial infarction (AMI), dilated cardiomyopathy (DCM), refractory angina (RA), and chronic ischemic heart failure (CIHF), including the identification of potential candidates for myocardial stem cell delivery (MSCD)
- To obtain fully informed patient consent for the procedure
- To be able to clinically follow these patients
- To be able to engage in data collection and structured investigation plans

Knowledge

- Describe the rational for a cell-based therapy in patients with myocardial disease
    - Knowledge of the main cell types used for MSCD:
    - Allogeneic
    - Autologous (Adult stem cells)
    - Knowledge of the main populations:
    - Allogeneic
    - Autologous (Adult stem cells)
- To know and understand the different mechanisms (neovascularization and cardiomyogenesis) upon which a cardiac repair process might be initiated
- To know and understand the different types of percutaneous MSCD
- Understand and describe the main procedural steps for:
    - Cell therapy in AMI
    - Cell therapy in CIHF
    - Cell therapy in DCM
    - Cell therapy in RA

- Description of the operating team and institutional requirement to perform percutaneous MSCD
- Selection of patients, devices and sizing based on:
  (a) Non-invasive diagnostic assessment, by means of clinical history, cardiac imaging data (echocardiography, cardiac magnetic resonance);
  (b) Invasive diagnostic assessment: right and left heart cardiac catheterisation (haemodynamic assessment, coronary angiography, left ventricular angiography);

Skills

The ability to:

- Appropriately select patients with AMI, CIHF, AR or DCM that may benefit from MSCD
- Gather and interpret pre-procedural anamnestic, clinical and non-invasive imaging data, including ability to perform adequate cell type and access selection
- Perform safely intracoronary and endoventricular delivery of myocardial stem cells using percutaneous accesses
- Identify indicated delivery accesses for percutaneous MSCD
- Be familiar with the use of injection catheters used to perform percutaneous MSCD

Behaviours and attitudes

- Commitment to work in a heart team with clinical cardiologists, heart-failure and imaging experts and biologists
- Provision of balanced, readily understood, and appropriate information to patient candidates for enrolment in trials involving MSCD

3.8 Cardiac catheterisation in children and adults with grown-up congenital heart disease

ESC topic list

- *3.6.10 Imaging: Imaging: Congenital Heart Disease*
- *20.6.2 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Adult Congenital Heart Disease, Clinical*
- *20.7 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Paediatric Cardiology*
- *25.1.1 Interventional Cardiology and Cardiovascular Surgery: Invasive Hemodynamic Assessment/Right Heart Catheterization*
- *25.3 Interventional Cardiology and Cardiovascular Surgery: Non-coronary Cardiac Intervention*

Essential reading:

- ESC core curriculum for general cardiology (2013): Content in Chapters Valvular Heart Disease and Other cardiac diseases
- EAPCI Textbook Part I, chapter “Cardiac catheterisation in children and adults with grown-up congenital heart disease”

Objectives

- To assess, diagnose and treat children or patients with GUCH including the identification of patients amenable to cardiac catheterisation
- To conduct follow-up of children or GUCH patients after cardiac catheterisation

Knowledge

- Principles of epidemiology, classification, pathophysiology and clinical features of congenital heart disease (CHD)
- Indication of cardiac catheterisation for children and adults with GUCH according to ESC Guidelines
- Description of the operating team and institutional requirement to perform percutaneous interventions for CHD
- Description of various alternative vascular accesses used for cardiac catheterisation in CHD
- Description of main specific interventional settings and procedural steps for the following CHD:
  - Aortic coarctation
  - Branch pulmonary artery stenosis
  - Tetralogy of Fallot
  - Transposition of the great arteries
  - Aortopulmonary shunts
  - Venous shunts and univentricular palliation
- Description of the frequency and clinical impact of the main peri-procedural complications regarding cardiac catheterisation and percutaneous interventions for CHD
- Selection of patients based on:

  (a) Non-invasive diagnostic assessment, by means of clinical history, cardiac imaging data (echocardiography, stress-echocardiography, cardiac-CT, cardiac- MRI, functional tests, laboratory data);

  (b) Invasive diagnostic assessment, by performing right and left heart cardiac catheterisation (haemodynamic assessment, shunt quantification, right- and left-ventricular angiography);
- Role of the heart team in the decision-making, performance and evaluation of treatment of patients with congenital heart diseases.

Skills

The ability to:

- Perform patient selection with CHD that need a cardiac catheterisation
- Use appropriate non-invasive or invasive diagnostic techniques
- Gather full patient anamnesis and assess non-invasive imaging acquired before the index procedure
- Identify vascular access issues for percutaneous approach planning
- Conduct an invasive hemodynamic assessment including shunt quantification and use adequate vasodilator drugs

- Assist an experienced operator as second operator. Interpret haemodynamic and echocardiographic findings, as assessed during the procedure

Behaviours and attitudes

- Commitment to work in a heart team with cardiovascular surgeons, anaesthetists, non-invasive cardiologists and paediatricians
- Provision of balanced, readily understood, and appropriate information to the patient candidate for cardiac catheterisation
- Explanation of the pros and cons of each modality of treatment of GUCH

3.9 Percutaneous pulmonary intervention for pulmonary embolism and chronic pulmonary hypertension

ESC topic list

- *21.1 Pulmonary Circulation, Pulmonary Embolism, Right Heart Failure – Pathophysiology and Mechanisms*
- *21.2 Pulmonary Circulation, Pulmonary Embolism, Right Heart Failure – Epidemiology, Prognosis, Outcome*
- *21.3 Pulmonary Circulation, Pulmonary Embolism, Right Heart Failure – Diagnostic Methods*
- *21.4 Pulmonary Circulation, Pulmonary Embolism, Right Heart Failure - Treatment*
- *21.5 Pulmonary Circulation, Pulmonary Embolism, Right Heart Failure - Prevention*
- *21.6 Pulmonary Circulation, Pulmonary Embolism, Right Heart Failure – Clinical*

Essential reading:

- ESC Guidelines for the management of acute pulmonary embolism (2019) (11);
- ESC core curriculum for general cardiology (2013): Content of Chapters 2.18 Pulmonary arterial hypertension; and 2.26 Thrombo-embolic venous disease
- EAPCI Textbook Part III, chapter “pulmonary embolism and pulmonary hypertension” and Part III, chapter “Balloon pulmonary angioplasty”

Objectives

- To assess, diagnose and treat patients with acute pulmonary embolism (PE) including the identification of high-risk patients amenable to percutaneous catheter interventions
- To assess, diagnose and timely treat patients with chronic thromboembolic pulmonary hypertension (CTEPH) including the identification of those amenable to percutaneous pulmonary balloon angioplasty
- To know and understand the technique and devices currently approved and/or used for PE and CTEPH,
- To know and understand the technique and devices currently approved and/or used for Inferior vena cava filters

- To be able to engage in a multidisciplinary team discussion for percutaneous and/or surgical approach;
- To obtain fully informed patient consent for the procedure including potential post-procedural complications;
- To be able to clinically follow these patients and select cases needing reintervention;
- To be able to engage in data collection and structured investigation plans.

Knowledge

- Principles of epidemiology, classification, pathophysiology, grading, imaging and clinical features of different stages of pulmonary disease including PE and CTEPH.
- Selection of patients based on:
- Non-invasive diagnostic assessment, by means of medical history, laboratory tests, cardiac imaging data (echocardiography, stress-echocardiography, MRI, CT scan) and cardiopulmonary exercise testing;
- Invasive diagnostic assessment, by performing right and left heart cardiac catheterisation (haemodynamic assessment), heart angiography and coronary angiography
- Understand and describe the main procedural steps for balloon pulmonary angioplasty (BPA): venous cannulation, 6-7Fr long introducer sheath via a 9Fr sheath, heparin injection, choosing the right guiding catheter, pulmonary angiography, guide-wire progression to cross the lesion, haemodynamic PAP monitoring, vascular access closure.
- Expected pathophysiological effects of pulmonary balloon angioplasty including haemodynamic response, TTE findings and functional response.
- Complications
    - Balloon pulmonary angioplasty: lung injury
- To prescribe the adequate heparin dose and ACT goal

Skills

The ability to:

- appropriately select patients with pulmonary disease (PE and CTEPH) that may benefit from the procedures,
- Identify vascular access issues to optimize the percutaneous approach
- evaluate and control arterial and large bore venous access routes;
- use arterial catheters for simultaneous saturation and pressure recording
- interpret and communicate intra-procedural imaging features
- implant an inferior vena cava filter;
- perform coronary angiography, atrial and pulmonary angiography, aortography, right and left ventriculography;
- interpret haemodynamic and echocardiographic findings, as assessed during the procedure and adapt the procedure;
- prepare and manipulate large bore catheters for pulmonary balloon angioplasty;
- conduct a pulmonary balloon angioplasty (BPA)
- prevent lung injury following BPA

- perform an urgent pericardiocentesis

Behaviours and attitudes

- Commitment to work in a heart team with cardiovascular surgeons, anaesthetists, non-invasive cardiologists
- Commitment to follow this very rapidly evolving field.
- Explanation of the pros and cons of each modality of treatment (surgical vs. percutaneous).
- Provision of balanced, understandable and appropriate information to the candidate for pulmonary arterial disease treatment, including long-term prognosis

Part IV: Peripheral percutaneous interventions

4.1 Carotid, subclavian, brachiocephalic and vertebral interventions

ESC topic list

- *3.6.12 Imaging: Imaging: Peripheral Vascular Disease*
- *23 Aortic Disease, Peripheral Vascular Disease, Stroke: Peripheral Vascular and Cerebrovascular Disease*
- *23.4.3 Aortic Disease, Peripheral Vascular Disease, Stroke: Peripheral Vascular and Cerebrovascular Disease: Intervention*
- *24.6.1 Aortic Disease, Peripheral Vascular Disease, Stroke: Stroke: Carotid Stenosis*
- *25.1.3 Interventional Cardiology and Cardiovascular Surgery: Peripheral Angiography*
- *25.99 Interventional Cardiology and Cardiovascular Surgery: Interventional Cardiology - Other*

Essential reading:

- ESC core curriculum for general cardiology: Content of Chapter “Other cardiac conditions”.
- EAPCI Textbook Part I, chapter “Catheterisation for peripheral diagnostic and interventional procedures”, Part II, chapter “Imaging for peripheral artery disease” and Part III, chapters “Carotid artery stenting”, “Subclavian, brachiocephalic and vertebral interventions” and “Peripheral arterial occlusive disease”

Objectives

- To assess, diagnose and manage patients with carotid, subclavian, brachiocephalic and vertebral disease including the identification of patients amenable to percutaneous treatment;
- To conduct follow-up of patients after carotid, subclavian, brachiocephalic and vertebral interventions;
- To integrate carotid, subclavian, brachiocephalic and vertebral disease into the global evaluation of risk in common cardiovascular disease.

Knowledge

- Diagnostic criteria and dominant clinical features for carotid, subclavian, brachiocephalic and vertebral disease;
- Indications for intervention in carotid, subclavian, brachiocephalic or vertebral arteries;
- Anatomy and angiographic features of aortic arch, aortic arch vessels, vertebral and cerebral vessels including common anatomic variants (e.g. aortic arch types);
- Interpretation of pre-procedural imaging studies including ultrasound Doppler, computed tomography angiography and magnetic resonance angiography (MRA);
- Pathophysiology of carotid artery stenosis, including plaque rupture or erosion, thrombosis, vasospasm, impact at the level of carotid arteries and the brain circulation;
- Acute and long-term results of carotid, subclavian, brachiocephalic and vertebral interventions and identification of the main acute complication (including minor and major stroke) and late complication (including restenosis);
- Description of the requirements (operating team, equipment) and of the main steps of CAS as performed through a transfemoral or transradial approach;
- Acute and long term results of carotid artery stenting CAS in patients with symptomatic carotid artery stenosis and comparison with surgery as illustrated in the main randomized studies
- Results of CAS in main subgroups (with or without cerebral protection, bilateral carotid artery stenosis, acute carotid syndrome, string sign, aortic arch anomalies);
- Role of concomitant comorbidities (previous ischemic stroke, CAD, PVD, valvular disease, renal failure) and their impact on percutaneous management;

Skills

The ability to:

- Appropriately use non-invasive or invasive diagnostic techniques
- Identify vascular access issues preventing a percutaneous approach
- CAS techniques, stents, cerebral protection devices (proximal/distal)
- Conduct a CAS with or without cerebral protection device, predilatation and postdilatation
- Identify patients at high and intermediate risk for surgery
- Identify patients in which intervention/surgery is not required (asymptomatic patients)
- Requirements of the selection process (medical team, medical investigation, imaging)

Behaviours and attitudes

- Commitment to work in a heart team with cardiovascular surgeons, non-invasive cardiologists and neurology specialists;
- Commitment to pre-procedural planning of individual treatment strategy and performance by highly trained operators;
- Commitment to follow this very rapidly evolving field;
- Provision of balanced, readily understood and appropriate information to the patient with carotid artery disease, candidate for CAS;

- Explanation of the pros and cons of each modality of treatment of carotid artery stenosis (percutaneous vs surgical).

4.2 Endovascular interventions for Acute Ischemic Stroke

ESC topic list

- *3.6.12 Imaging: Imaging: Peripheral Vascular Disease*
- *24 Aortic Disease, Peripheral Vascular Disease, Stroke: Stroke*
- *24.4.3 Aortic Disease, Peripheral Vascular Disease, Stroke: Stroke: Acute Intervention*
- *24.6.3 Aortic Disease, Peripheral Vascular Disease, Stroke: Stroke: Cardiogenic Embolism*
- *25.1.3 Interventional Cardiology and Cardiovascular Surgery: Peripheral Angiography*

Essential reading:

- ESC core curriculum for general cardiology: Content of Chapter "Other cardiac conditions".
- EAPCI Textbook Part I, chapter "Catheterisation for peripheral diagnostic and interventional procedures", Part II, chapter "Imaging for peripheral artery disease" and Part III, chapter "Endovascular treatment of acute ischemic stroke"

Objectives

- To assess, diagnose and manage patients with acute ischemic stroke including the early identification of patients amenable to endovascular treatment such as thrombus aspiration and thrombus stent-retrieving or intra-cerebral artery stenting alone or together with intra-venous or intra-arterial Thrombolysis treatment.
- To be able to confirm large vessel occlusion by non-invasive imaging (CT or MR angiography, diffusion and perfusion)
- To work together with team of stroke dedicated specialists including neurologist, neuro-radiologist, neuro-interventionalist and neurosurgeon,
- To conduct follow-up of patients after endovascular treatment of acute ischemic stroke
- To integrate acute ischemic stroke patients to existing experience with acute myocardial infarction patients treatment into the routine stroke treatment.
- To consider using experienced STEMI intervention team for acute ischemic Stroke treatment.

Knowledge

- Diagnostic criteria and dominant clinical features for clinical evaluation of ischemic stroke, scales that define severity of neurologic deficit (NIHSS – National Institutes of Health Stroke Scale, and mRS - modified Rankin scale)
- Pathophysiology and evolution of ischemic stroke. CT or MR scans assessment of large vessel thrombus occlusion, infarct Core and Ischemic Penumbra and corresponding ratio.
- Defining Stroke onset by clinical and imaging features by time-based and perfusion-based patient selection for adequate interventional, IV thrombolysis or conservative treatment strategy

- Prompt and precise prevention, identification, address the main acute complication including intracerebral haemorrhage (ICH), distal embolization, reperfusion injury and perforation.
- Acute and long term results of endovascular acute ischemic stroke treatment in patients with high grade NIHSS deficit and comparison with IV Thrombolysis or conservative strategy as illustrated in the main studies.
- Role of adequate dosing or stopping the heparin, antiplatelet and thrombolytic medical treatment in the setting of mechanical or aspiration thrombectomy or primary stenting of cerebral arteries.
- Follow up and assessment of treated patients in cooperation with neurologist

Skills

The ability to:

- Use appropriate non-invasive imaging diagnostic techniques (CT or MR without and with contrast and imaging modalities together with neuroradiologist)
- Identify vascular access issues preventing a percutaneous approach
- Acquired and established successful team and operator experience in invasive carotid artery imaging via transfemoral or transradial access and experience in coronary interventions
- IA stroke treatment techniques, mechanical thrombectomy, aspiration thrombectomy, stent retrievers, stents, cerebral protection devices, concomitant medications
- Conduct invasive angiography and intervention of major intracranial artery
- Identify patients at high and intermediate risk for surgery
- Identify patients in which intervention is not required (late presenters, low score patients, patients with haemorrhage)
- Requirements of the selection process (medical team, medical investigation, imaging)

Behaviours and attitudes

- Commitment to work in a stroke team with neurologist, neurovascular interventionalist, neurosurgeons and radiologists in routine manner
- Commitment to follow this very rapidly evolving field
- Provision of balanced, readily understood and appropriate information to the patient and accompanying family members with acute ischemic stroke, candidate for endovascular treatment
- Be able and readily discus the pros and cons of each modality of treatment of stroke (Interventional vs. thrombolysis or conservative) with team and patient family

4.3 Thoracic and abdominal aortic disease

ESC topic list

- *3.6.11 Imaging: Imaging: Aortic Disease*
- *22 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Aortic Disease*
- *22.4.3 Aortic Disease, Peripheral Vascular Disease, Stroke: Aortic Disease: Intervention*
- *22.6.2 Aortic Disease, Peripheral Vascular Disease, Stroke: Aortic Aneurysm, Thoracic*

- *22.6.3 Aortic Disease, Peripheral Vascular Disease, Stroke: Aortic Aneurysm, Abdominal*

Essential reading:

- ESC core curriculum for general cardiology: Content of Chapter "Other cardiac conditions".
- EAPCI Textbook Part I, chapter "Catheterisation for peripheral diagnostic and interventional procedures", Part II, chapter "Imaging for peripheral artery disease" and Part III, chapters "Thoracic and abdominal aortic disease" and "Peripheral arterial occlusive disease"

Objectives

- To assess, diagnose, manage and treat patients with thoracic and abdominal aortic disease, including medical, endovascular and surgical treatment;
- To adopt a regular follow-up of patients with thoracic and abdominal aortic disease treated medically.

Knowledge

- Anatomy and anatomical variants of the thoracic and abdominal aorta;
- Classification and types of aortic diseases;
- Approach and early recognition of patients with thoracic and abdominal diseases;
- Role of diagnostic procedures in detection of the thoracic and abdominal aortic diseases;
- Medical management of patients with aneurysms of the thoracic and abdominal aorta and aortic dissection;
- Indications and eligibility criteria for endovascular treatment (TEVAR/EVAR) and surgical treatment of the aortic diseases;
- Management of patients with traumatic rupture of the aorta;
- Acute and long-term results and possible complications of endovascular procedures for aortic diseases (TEVAR/EVAR);
- Description of the requirements (operating team, equipment, materials) and main steps of the endovascular procedures for aortic diseases (TEVAR/EVAR).

Skills

The ability to:

- For early and on-time detection of patients with aortic disease, especially in an emergency situation, like in patients with acute aortic syndrome;
- To use various diagnostic techniques;
- To set an appropriate vascular access for endovascular procedures and anticipate possible vascular access complications; Percutaneous vascular closure devices or surgical closure for large vascular access;
- To select patients who are eligible for endovascular and surgical treatment;
- To estimate the most appropriate moment when medically treated patients with thoracic and abdominal disease become candidates for endovascular or surgical treatment;
- To prevent, detect and treat possible peri-procedural complications (endovascular or surgical procedures);

- To identify all requirements of the selection process (medical team, medical investigations, imaging modalities…).

Behaviours and attitudes

- Commitment to work in a heart team consisting of interventional cardiologists, cardiovascular surgeons, anaesthetists, and non-invasive cardiologists;
- Provision of balanced, appropriate and readily understood information to the patients who are candidates for endovascular procedures (TEVAR/EVAR);
- Provision of the patient`s informed consent prior to planned endovascular procedure.

4.4 Peripheral arterial occlusive disease

ESC topic list

- *3.6.12 Imaging: Imaging: Peripheral Vascular Disease*
- *23 Aortic Disease, Peripheral Vascular Disease, Stroke: Peripheral Vascular and Cerebrovascular Disease*
- *25.1.3 Interventional Cardiology and Cardiovascular Surgery: Peripheral Angiography*
- *25.3.99 Interventional Cardiology and Cardiovascular Surgery: Non-Coronary Cardiac Intervention, Other*

Essential reading:

- ESC core curriculum for general cardiology: Content of Chapter “Other cardiac conditions”.
- EAPCI Textbook Part I, chapter “Catheterisation for peripheral diagnostic and interventional procedures”, Part II, chapter “Imaging for peripheral artery disease” and Part III, chapter “Peripheral arterial occlusive disease”

Objectives

- To assess, diagnose, manage and treat patients with peripheral arterial occlusive disease, including medical, endovascular and surgical treatment;
- To adopt a regular follow-up of patients with peripheral arterial occlusive disease treated with interventional procedures (balloon angioplasty or stenting).

Knowledge

- Classification of peripheral arterial occlusive disease (Fontaine and Rutherford);
- Detailed anatomy and angiographic features of abdominal aorta, branches and lower limb vessels;
- Diagnostic procedures and interpretation of such studies in patients with peripheral arterial occlusive disease (clinical examination, oscillometry, determination of ABI, color-coded duplex ultrasonography (CDUS), magnetic resonance angiography (MRA), multi-detector

computed tomography angiography (MDCT angiography), intra-arterial digital subtraction angiography (DSA);
- Treatment modalities in patients with peripheral vascular disease (PVD) – conservative measures and arterial revascularisation (endovascular and open surgical techniques);
- Indications for arterial revascularisation in patients with PVD;
- Acute limb ischemia – clinical manifestations, diagnosis, and treatment modalities.

Skills

The ability to:
- For on-time detection of PVD, early detection of acute limb ischemia;
- To use various diagnostic tools and techniques;
- To set an appropriate vascular access with and without utilization of ultrasound guidance for interventional (endovascular) procedures (balloon angioplasty, stenting, plaque-debulking procedures);
- To utilize the various interventional tools and techniques (e.g. retrograde vascular access) available;
- To select patients who are eligible for medical (conservative) /interventional/surgical treatment;
- To prevent, detect and treat possible periprocedural complications (e.g.. vascular access-site bleeding, wound infection, sepsis etc.).

Behaviours and attitudes

- Provision of balanced, appropriate and readily understood information to the patients who are candidates for interventional procedures (PTA and/or stenting);
- Provision of the patient`s informed consent prior to planned interventional procedure;
- General attitude concerning invasive (non-conservative) treatment in patients with PVD should accept interventional (endovascular) and surgical procedures as complementary rather than competitive;
- The decision as to which revascularisation procedure to apply should be tailored to the specific patient`s needs and based on multidisciplinary consensus.

4.5 Renovascular interventions for arterial hypertension

ESC topic list
- *27 Hypertension*
- *27.1.4 Hypertension: Renal Artery Stenosis / Autonomic Nervous System*
- *27.4.3.1 Hypertension: Renal Denervation*

Essential reading:
- ESC core curriculum for general cardiology: Content of Chapter “Other cardiac conditions”.
- ESH/ESC Guidelines for the management of arterial hypertension;

- EAPCI Textbook Part I, chapter “Catheterisation for peripheral diagnostic and interventional procedures”, Part II, chapter “Imaging for peripheral artery disease” and Part III, chapters “Interventions in the reno-visceral circulation” and “Concept, Techniques and Clinical E□ectiveness of Renal Nerve Ablation in Hypertension”

Objectives

- To integrate renal artery interventions (including renal denervation and renal artery stenting) in the general management of hypertension according to available clinical data.

Knowledge

- Definition and classification of hypertension;
- Pathophysiology of hypertension: contribution of cardiac output, peripheral artery resistance, and age-related stiffening of the great arteries in the genesis of primary hypertension;
- Aetiology and pathophysiology of secondary hypertension (renovascular, renal, hormonal, oestrogen induced, and other causes);
- Epidemiology of renal artery stenosis;
- Diagnosis and management of fibromuscular disease as aetiology for renal artery stenosis including specific procedural considerations;
- Interaction between the sympathetic nervous system and blood pressure regulation;
- Definition and management of refractory hypertension;
- White-coat hypertension, masked hypertension, ambulatory blood pressure monitor (ABPM) and implications for measurement of BP and therapeutic decision-making;
- Individually tailored choice of antihypertensive drug or combination of drugs according to the patient’s age, profile, co-morbidities, genetic background, and ethnicity;
- Anatomy of kidney vasculature and histologic features of renal arteries;
- Interpretation and understanding of the advantages and limitations of each imaging modality during the pre-procedural imaging studies, such as ultrasound doppler, multi-slice computed tomography (MSCT) angiography and magnetic resonance angiography;
- Interventional techniques for BP control (e.g. renal artery stenosis dilatation, renal artery denervation);
- Up-to-date clinical research data on safety and efficacy of renovascular interventions and ablation for treatment of hypertension;
- Fractional flow reserve (FFR) and renal frame count (RFC) to invasively assess renal artery stenosis;
- Devices and mode of action (radiofrequency, ultrasound, pharmacological) for renal nerve denervation;
- Differentiate between typical (normal) and abnormal ablation induced renal artery changes;
- Acute and long-term complications of renovascular interventions and their management.

Skills

The ability to:

- Select appropriate patients for renovascular interventions according to ESC/ESH Guidelines and available clinical research data;
- Selection and management of an appropriate vascular access for renovascular interventions (femoral, brachial or radial);
- Semi-selective and selective angiography of the renal arteries and branches;
- Utilization of standard catheter techniques to deliver balloons, self-expanding stents or balloon expanding stents during renal artery stenting;
- Specific procedural considerations during ostial renal artery stenting;
- Ability to deliver and position ablation catheter in the correct location or locations (during multiple ablations) for renal nerve denervation;
- Control patient pain or discomfort during procedure;
- Manage acute or long-term complications of renovascular interventions;
- Acute and long term post-procedural hypertension management.

Behaviours and attitudes

- Develop a critical attitude towards the various technologies for renovascular interventions;
- Provision of balanced, readily understood and appropriate information to the patient with hypertension candidate for renovascular interventions;
- Commit to audit of long-term outcomes, including blood pressure control and procedural complications;
- Work closely with other health care professionals in the field of hypertension as necessary: including cardiologists, hypertension specialists and nephrologists.

Part V: Logistics, study interpretation and consensus on clinical end-points

5.1 Patient information, ethics and inform consent

ESC topic list

- *25 Interventional Cardiology and Cardiovascular Surgery: Interventional Cardiology*
- *35 E-Cardiology/ Digital Health, Public Health, Health Economic, Research Methodology: Research Methodology*
- *35.5 E-Cardiology/ Digital Health, Public Health, Health Economic, Research Methodology: Research Ethics*
- *35.99 E-Cardiology/ Digital Health, Public Health, Health Economic, Research Methodology: Research Methodology - Other*

Essential reading:

- EAPCI Textbook Part IV, chapters “Ethics in cardiovascular interventions”, “Quality of life assessment” and “Risk-benefit analysis”

Objectives

To be able to provide an appropriate and ethical information to the patient before a transcatheter investigation and/or intervention

Knowledge

- The patient is not entirely dependent on the physician decision of treatment
- The patient should have sufficient understanding and sufficient information before a decision, that should be made free from duress
- A valid consent should be objective and unbiased, patient orientated, evidence based, up-to-date, reliable, understandable, accessible, relevant, and consistent with legal requirements
- The medico-legal aspect should not obscure the effective communication by the physician
- The benefit and the potential risks of the procedure should be provided in the consent
- Alternative treatments (medical, surgery) should be discussed; in case of equipoise between options, the key is to place the patient at the centre of the discussion
- Before discharge, patient should receive information regarding the medications and post-procedural outcome.

Skills

The ability to:

- To communicate with the patient (or with a translator or the family in case of inability of understanding by the patient)
- To keep the interest of the patient at the centre of the discussion
- To explain the benefits and potential risks of the procedure
- To discuss the alternative therapeutic options without bias
- To evaluate whether the patient has a sufficient understanding, free from duress
- To avoid limiting the consent to the medico-legal aspect
- To briefly summarize the information in case of an emergent situation, in order to obtain an oral consent

Behaviours and attitudes

- Commitment to communicate and discuss with the patient as soon as possible before a transcatheter investigation/intervention
- Commitment to obtain a valid consent before a decision of treatment
- Evaluation of the capacity of understanding by the patient before the procedure
- Respect for autonomy of the patient and the principles of beneficence and non-maleficence

5.2 The Heart Team

ESC topic list

- *3.2.9 Imaging: CT Imaging of Structural Heart Disease*
- *3.5 Imaging: Hybrid and Fusion Imaging*
- *25 Interventional Cardiology and Cardiovascular Surgery: Interventional Cardiology*
- *26 Interventional Cardiology and Cardiovascular Surgery: Cardiovascular Surgery*

Essential reading:

- EAPCI Textbook Part IV, chapter "The Heart team"

Objectives

- To select appropriate patients for a heart team discussion.
- To understand the importance of a heart team conference for optimal patient management and decision making not only in patients with structural heart disease where catheter-based therapies are available (AS-TAVI, MR-mitraclip) but also in patients with coronary artery disease
- To know the main factors and comorbidities important for decision making in a heart team conference

Knowledge

- The minimum required members of a coronary heart team and a valvular heart team
- The risks of underuse and overuse of specific treatments considering literature (SYNTAX, PARTNER, COURAGE, ISCHEMIA, …)
- Appropriate development of risk-benefit ratios for different treatment strategies in order to take an evidence-based position and generate treatment preferences.
- Therefore, know whether PCI or CABG should be the preferred revascularization strategy (e.g. lesional complexity of CAD, presence of ischemia, left ventricular function, comorbidities of the patient).
- The importance of comorbidities for interventional and operative risk (e.g. PVD with impact on technical feasibility, COPD in case of open-heart surgery, renal dysfunction with risk for dialysis, left ventricular dysfunction, liver disease, other valvular diseases, reoperation, combined procedures) for a specific treatment
- The appropriate definitions and impact on decision making of comorbidities as defined by the VARC 2 criteria underrepresented in currently used risk scores
- The limitations of currently used risk scores for both coronary and valvular interventions
- The importance of active involvement of the patient in the Heart Team to allow shared decision-making and increase patient satisfaction
- The importance of accurate documentation of the heart team conferences –participants, patients' identifier, patients' characteristics, decision

Skills

The ability to:

- Appropriately calculate EuroScore, STS score, SYNTAX and SYNTAX II score to guide decision making
- Appropriately define the interventional risk for an individual patient
- Lead a heart team conference for an individual patient
- Actively involve the patient in decision making

Behaviours and attitudes

- Commitment to develop a local heart team if not already available
- Commitment to participate in regularly scheduled heart team conferences
- Commitment to refer all appropriate patients to the Heart Team
- Commitment to develop local institutional protocols based on international guidelines
    - For *ad hoc* PCI
    - And for cases that require discussion to avoid systematic discussion of all diagnostic coronary angiograms
- Respect for the decisions of the Heart Team
- Commitment to accurate documentation of the heart team conferences

5.3 The cardiac catheterisation laboratory environment

ESC topic list

- *3.1.12 Imaging: Intraoperative and Interventional Echocardiography*
- *3.5 Imaging: Hybrid and Fusion Imaging*
- *3.6 Imaging: Cross-Modality and Multi-Modality Imaging Topics*
- *25 Interventional Cardiology and Cardiovascular Surgery: Interventional Cardiology*
- *26 Interventional Cardiology and Cardiovascular Surgery: Cardiovascular Surgery*

Essential reading:

- EAPCI Textbook Part IV, chapters “The cardiac catheterisation laboratory environment” and “Administration and data collection”

Objectives

To know the optimal setup of the cardiac catheterization laboratory

Knowledge

- The cardiac cath lab should be a spacious room (500 - 600 square feet) allowing invasive heart imaging, using X-ray and iodinated contrast agent.
- Left and right cardiac catheterization, coronary angiography and angioplasty, intracoronary imaging (OCT, IVUS), invasive hemodynamic (FFR, iFR) and structural interventions should be performed in a sterile environment

- Material should be stored in a separate room adjacent to the main cath lab, and the stock/inventory management is a main part of the cath lab workflow
- Flat panel technology offers several advantages over the original image intensifier
- Bi-plane X-ray equipment reduces radiation and contrast exposure, improves some procedures (ventriculography, structural and congenital interventions, complex coronary anatomy)
- A technical room should allow an analysis from the hemodynamics and a review of the acquired images for an «off-line» analysis
- Monitors should integrate multimodality imaging (FFR, IVUS, echo, ...)
- Specific material for complications managements should be available (kit for pericardiocentesis, anaesthetic and resuscitation material, defibrillator, ...)

Skills

The ability to:

- Acquire coronary imaging using the biplane X-ray by moving and adjusting the table
- Know the rules of a sterile environment
- Use properly the lead protection against the radiation
- Acquire adequately the data of a right and left heart catheterisation
- Use a minimum of contrast and ionizing radiation
- Know the material for a coronary and for a structural intervention
- Manage the stock/inventory of material
- Optimize the use of space during the procedures needing multiple operators and multimodality
- Imaging
- Know the appropriate material to treat a procedural complication

Behaviours and attitudes

- Commitment to work in a sterile environment, using a minimum of X-ray and contrast
- Commitment to know the material needed for each procedure
- Integration of all information (hemodynamics, invasive and non-invasive imaging)

5.4 Clinical trial design and management

ESC topic list

- *33.4 EE-Cardiology/ Digital Health, Public Health, Health Economic, Research Methodology: Digital Health*
- *34.3 E-Cardiology/ Digital Health, Public Health, Health Economic, Research Methodology: Health Economics*
- *35 E-Cardiology/ Digital Health, Public Health, Health Economic, Research Methodology: Research Methodology*

Essential reading:

- EAPCI Textbook Part IV, chapters “E-Cardiology and Interventional cardiovascular medicine”, “Registry studies and post-marketing”, “Clinical trial design”, “Quality of life assessment”, “Risk-benefit analysis” and “Cost and cost-effectiveness”

Objectives

- Appropriate collection and administration of clinical data;
- Design a high-quality procedure report;
- Appreciate the importance of standardized data collection;
- Importance and utility of clinical quality registries;
- Appreciate the opportunities in conducting randomized clinical trial based on registry platform;
- The role of clinical registries in post marketing surveillance of new devices and medications;
- Recognize the principles of clinical trial design;
- Understand the advantages and disadvantages of randomized clinical trials;
- Key design issues in a superiority versus non-inferiority trials;
- Consider quality of life assessment as a subjective phenomenon which should, at least, include assessment of symptom status and its effect on physical functioning and mobility as well as social and emotional wellbeing;
- Utilize comparative effectiveness and cost-effectiveness of alternative treatments for heart disease in selecting optimal treatment modality;
- Understand basic principles of cost and cost effectiveness in assessment of new therapies;
- Critical appraisal of journal articles that present economic evaluations.

Knowledge

- Key fields for a procedure report;
- Service improvement processes to implement clinical governance;
- Four domains comprising clinical audit (structure, appropriateness, process, outcome)
- Standard dataset definitions according to CARDS (Cardiology Audits and Registration Data Standards) or others;
- Opportunities and limitations of observational research and clinical registries;
- Statistical considerations of clinical registries;
- Strengths and limitations of randomized registry-based clinical trials;
- Concept of bias and confounding factors in design of a clinical trial;
- Types of randomization techniques (simple- , block-, and stratified randomization);
- Assessment of population size needed to achieve the primary end point of the study (Power calculation);
- Select appropriate primary endpoint which would be clinically relevant, biologically important, and amenable to unbiased assessment;
- Utilize the clinical benefit in using combined end-points, secondary endpoints and surrogate end-points in a clinical trial;
- Interpret clinical trial results according to intention-to-treat analysis versus per-protocol (as-treated) analysis;

- The various quality of life questionnaires and assessment methods;
- Validated quality of life questionnaires for coronary artery disease and other cardiovascular disease;
- Various disease-specific risk benefit measures for various cardiovascular disease;
- The concept of "Comparative effectiveness research";
- The two components of economic evaluation are a measure of effectiveness and an estimate of costs.

Skills

The ability to:

- Implement clinical governance principles;
- Standardize dataset definitions;
- Establish research team to ensure consecutive enrolment of patients into clinical registry;
- Establish research team to ensure completeness of retrospective data collection and follow up process;
- Consecutive enrolment of complete patient population;
    - Select appropriate clinical end-points;
    - Employ appropriate statistical adjustments to retrospective data to correct for known data confounders;
    - Identify confounders during design of a clinical trial;
    - Write study protocols according to key components of trial design: Eligibility, treatments evaluated, endpoints and planned statistical analysis;
- Utilize appropriately generic or disease-specific instruments to assess quality of life;
- Conduct specific surveys to assess general clinical health outcomes and surveys to assess cardiovascular health outcomes;
- Interpret the presented results of a cost-effectiveness analysis expressed as a ratio of cost to life-years gained or cost to lives saved.

Behaviours and attitudes

- Employing clinical governance in order to maintain and improve the quality of patient care in a health system;
- Routine conduct of clinical audit;
- Appreciate the role of clinical registries as complementary to prospective randomized trials and not as substitute;
- Commitment for consecutive enrolment of patients into clinical registry;
- Efforts to obtain complete clinical data and follow up;
- Apprehend the concept of equipoise: it is only ethical to conduct clinical trials in areas of uncertainty;
- Adhere to basic principles of study design in order to ensure the validity and value of a clinical trial.
- Appreciate the role of quality of life assessment in clinical trials
- Select a specific treatment over alternative treatment based on risk-benefit ratio which is derived for multiple factors such as efficacy, risk and quality of life. Given the economic

downturn and the resulting constraints on healthcare expenditure, critically review new therapies and technologies in terms of cost and cost effectiveness

5.5 Study understanding, statistical knowledge and data collection

ESC topic list

- *33 E-Cardiology/ Digital Health, Public Health, Health Economic, Research Methodology: e-Cardiology / Digital Health*
- *33.4 E-Cardiology/ Digital Health, Public Health, Health Economic, Research Methodology: Digital Health*
- *34.3 E-Cardiology/ Digital Health, Public Health, Health Economic, Research Methodology: Health Economics*
- *35 E-Cardiology/ Digital Health, Public Health, Health Economic, Research Methodology: Research Methodology*
- *35.1 E-Cardiology/ Digital Health, Public Health, Health Economic, Research Methodology: Biostatistics*

Essential reading:

- EAPCI Textbook Part IV, chapters "E-Cardiology and Interventional cardiovascular medicine", "Registry studies and post-marketing", "Clinical trial design", "Quality of life assessment", "Risk-benefit analysis" and "Cost and cost-effectiveness"

Objectives

- To master basic concepts of clinical trials design;
- To critically read and interpret clinical trials.

Knowledge

- Statistical principles of significance tests, null hypothesis, alternative hypothesis and type-1 error;
- Estimating treatment effects: odds ratio, risk ratio, relative risk reduction, hazard ratio and differences in means;
- Comprehend the concept of assessing treatment effect by numbers needed to treat;
- Estimate treatment affect and results uncertainty with confidence intervals;
- Methods to assess and report time-to-event outcomes: Cox proportional hazard model (hazard ratio), Kaplan Meier plots;
- Methods to assess quantitative outcome endpoints;
- Principles of adjusting for baseline covariates

Skills

The ability to:

- Calculate risk ratio and relative risk reduction to assess relative treatment effect;
- Calculate the numbers needed to treat to assess efficacy of a treatment;

- Report appropriate Kaplan Meier plot with correct scale and range of vertical axis and patients at risk.

Behaviours and attitudes

- Recognize research as a pivotal activity in professional practice and maintain a positive attitude towards it;
- Conduct clinical research with highest standards in the ethical conduct of research.

5.6 Consensus on definitions of clinical endpoints

ESC topic list

- *35 E-Cardiology/ Digital Health, Public Health, Health Economic, Research Methodology: Research Methodology*
- *35.1 E-Cardiology/ Digital Health, Public Health, Health Economic, Research Methodology: Biostatistics*
- *90 Other: European Society of Cardiology*

Essential reading:

- EAPCI Textbook Part IV, chapters "Consensus on definitions of clinical endpoints: percutaneous coronary and valvular intervention trials", and "Consensus on definitions of clinical endpoints: carotid artery and supra-aortic trunk revascularization trials"

Objectives

- Understand the process of consensus clinical endpoint definitions generation
- Apprehend coronary and structural disease therapies consensus clinical endpoint definitions
- Apprehend carotid artery and supra-aortic trunk procedures consensus clinical endpoint definitions

Knowledge

- The roles of independent clinical event committees (CEC)
- The partners and roles of Academic Research Consortium in setting consensus definition of endpoints
- Various ARC consensus definitions (BARC, NARC, VARC 2, MVARC)
- Indications for treatment of internal carotid artery stenosis
- Indications for treatment of vertebral artery stenosis
- Consensus clinical and morphological endpoints for internal carotid and supra-aortic trunk procedures (carotid artery, vertebral artery, subclavian artery and innominate artery stenting)
- Various types of adverse events (serious adverse events, adverse/serious/unanticipated device effect)

Skills

The ability to:

- Describe the definitions of the various ARC endpoints (such as death, MI)
- Describe device related complications according to ARC (such as revascularization, stent or scaffold thrombosis)
  describe various endpoints of VARC (e.g. bleeding, stroke, MI)
- Evaluation recommended prior to treatment of internal carotid artery stenosis
  (Neurological evaluation, medications, other clinical evaluation)
- Classification of the aortic arch type
- Identification, classification, reporting and documenting major adverse events and vascular complications

Behaviours and attitudes

- Apprehend that consensus on uniform definitions is required to enable meaningful, albeit informal and indirect, comparisons between clinical trials and to aggregate outcome data within trial programmes and beyond.
- Creating consistent endpoint definitions and consensus recommendations for implementation in clinical research programmes dedicated to carotid stenting and supra-aortic trunk endovascular procedures

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