EAPCI
European Association of Percutaneous Cardiovascular Interventions

Percutaneous Valvular and Structural Heart Disease Interventions. 2024 Core Curriculum of the European Association of Percutaneous Cardiovascular Interventions (EAPCI) of the ESC

in collaboration with the European Association of Cardiovascular Imaging (EACVI) and the Cardiovascular Surgery Working Group (WG CVS) of the European Society of Cardiology

Extended Version

ESC
European Society of Cardiology

Percutaneous Valvular and Structural Heart Disease Interventions. 2024 Core Curriculum of the European Association of Percutaneous Cardiovascular Interventions (EAPCI) of the ESC Extended Version*

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Keywords:
Curriculum, Certification, Interventional Cardiology, European

Running title:
Percutaneous Valvular and Structural Heart Disease Interventions. 2024 Core Curriculum of the European Association of Percutaneous Cardiovascular Interventions (EAPCI) of the ESC

Manuscript words:	50608
References:	55
Figures:	8
Diagrames:	19
Tables:	0

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0. Table of Contents

Abstract

The percutaneous treatment of structural, valvular, and non-valvular heart disease (SHD) is rapidly evolving. While recommendations for physician training are essential to guarantee the quality-of-care delivery and for patient protection, none has been developed to date.

The current Core Curriculum (CC) proposed by the European Association of Percutaneous Cardiovascular Interventions (EAPCI) describes the knowledge, skills, and attitudes that define competency levels required by newly trained SHD interventional cardiologists (IC) and provides guidance on how a training centre should be organised.

The SHD ICs are cardiologists who have received complete interventional cardiology training. They are medical specialists who manage SHD patients from diagnosis to follow-up and perform percutaneous procedures in this area. As multidisciplinary team members, they are competent in interpreting advanced imaging techniques and master planning software.

The SHD ICs are expected to be proficient in the aortic, mitral, and tricuspid areas. They may have selective skills in either the aortic area or mitral/tricuspid areas. In that case, they must still have common transversal competencies in the aortic, mitral, and tricuspid areas. Additional SHD domain competencies are optional.
Completing dedicated SHD training, aiming for full aortic, mitral, and tricuspid competencies, requires at least 18 months. For full training in the aortic area, with basic competencies in mitral/tricuspid areas, the training can be reduced to 1 year. The same is true for training in the mitral/tricuspid area, with competencies in the aortic area.

The SHD IC CC promotes excellence and homogenous training across Europe and is the cornerstone of future certifications and patient protection. It may be a reference for future CC for national associations and other SHD specialities, including imaging and cardiac surgery.

Preface

The treatment of structural, valvular and non-valvular heart disease (SHD) has been revolutionised by the emergence and development of percutaneous techniques. Percutaneous treatment of SHD is now a mature field supported by robust scientific evidence developed in recent decades and has been associated with significant benefits for both individuals and populations. While regulation authorities and patients are expecting guidance for the individual training of physicians (cardiologists, imaging cardiologists, cardiac surgeons and interventional cardiologists) managing patients suffering from SHD, such recommendations are still lacking. The current Core Curriculum for Percutaneous SHD Interventions has been designed by the European Association of Percutaneous Cardiovascular Interventions (EAPCI) as the first key step to fill that gap in interventional cardiology. This innovative document has been prepared in collaboration with the European Association of Cardiovascular Imaging (EACVI) and the Cardiovascular Surgery Working Group (WG CVS) of the European Society of Cardiology. It will stimulate future Core Curricula in other SHD specialities where EAPCI is open to support and expects to collaborate, including imaging and cardiac surgery.

This curriculum was organised to follow and complement the Core Curriculum for Percutaneous Cardiovascular Interventions (2020) by the EAPCI Training and Certification Committee (TCC)[1]. It was initiated under the leadership of the EAPCI President Andreas Baumbach and completed under the Presidency of Dariusz Dudek.

The current EAPCI CC Percutaneous SHD Interventions 2022 is presented in two formats: a) The current Executive Summary that covers general aspects of training, and b) The EAPCI CC Percutaneous SHD Interventions 2022 Extended Version that is present as a Supplementary material and includes a detailed description of all areas of training.

1. Introduction

The Core Curriculum (CC) aims to support the educational requirements of anupdated European consensus. It defines and standardises competency levels required in Percutaneous Structural Heart Interventions to treat patients with thromboembolic diseases or heart failure related to valve disease (Figure 1).

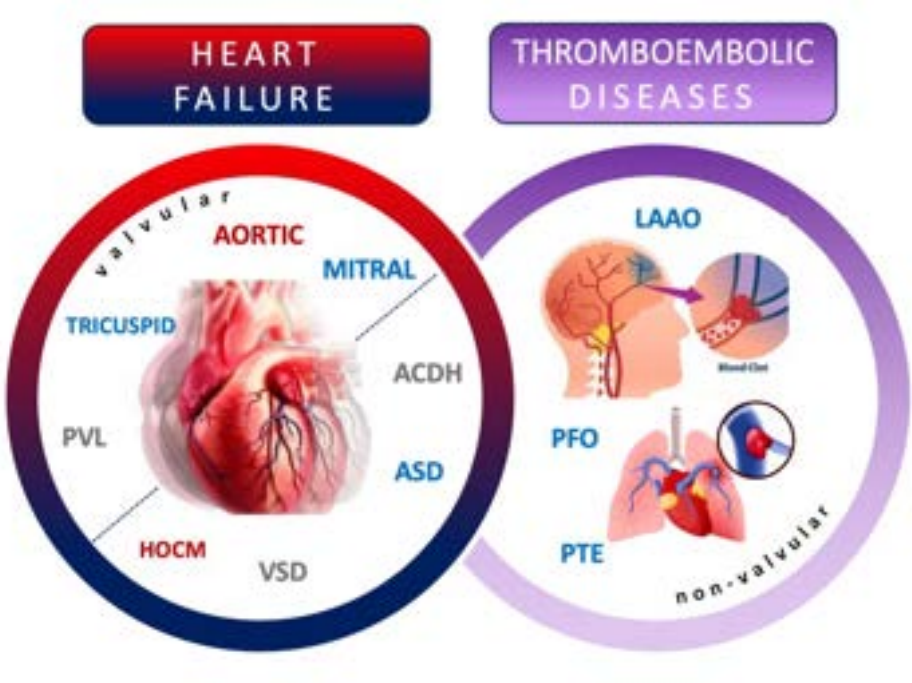


Figure 1: The spectrum of cardiology areas treated by percutaneous structural heart disease interventions: Valvular [aortic valve, mitral valve, tricuspid valves, paravalvular regurgitation (PVL)] and Non-nalvular [septal ablation (HOCM), ventricular septal defect (VSD), atrial septal defect (ASD), adult congenital heart disease (ACHD), patent foramen ovale (PFO), left atrial appendage occlusion (LAAO) and pulmonary thromboembolism (PTE)]. These interventions can be used separately - or combined- to treat patients with thromboembolic diseases or heart failure. The colour code is consistent with the prevailing percutaneous treatment route, arterial (red), venous (blue) or mixed (red/blue).

The CC promotes homogenous education and training programs in structural heart disease (SHD) percutaneous interventions among countries. It is the cornerstone of future nationwide and EAPCI certifications. It is designed to support and recognise the knowledge, skills and attitudes of newly trained SHD interventional cardiologists (IC). It is innovative and stimulates future Core Curriculum(s) in other specialities where EAPCI expects to collaborate.

Considering the distinct realities among European or other countries, the rapid growth of SHD and because procedure numbers are insufficient to describe the proficiency of an SHD IC, the present document does not recommend a minimal procedural volume for trainees or training centres. Instead, it provides guidance on «achievements» and «levels of competence» that the trainees must acquire. We also provide detailed information on how a training centre should be organised, including the need to involve at least two SHD ICs with more than five years' experience dedicated to the percutaneous cardiovascular interventional field.

2. Methodology

The EAPCI Education and Training Committee (ETC) under the chair of Professor Eric Van Belle and Professor Rui Campante Teles initiated discussions of the current project under the presidency of Professor Andreas Baumbach. The project was confirmed by the EAPCI board and launched by the Training and Certification Committee (TCC) under the chair of Professor Rui Campante Teles and Doctor Radoslaw Parma and the auspices of Professor Dariusz Dudek.

The writing task force included three coordinating authors (Rui Campante Teles, Eric Van Belle and Radoslaw Parma), a Nucleus Task Force (NTF) of 13 lead authors and an Extended Task Force (ETF) of 34 members. All members had substantial expertise in different aspects of SHD percutaneous interventions. The writing task force was divided into 13 groups consisting of 3 to 4 members each, developed, circulated, and revised the document using two rounds of the Delphi method under the direction of the NTF and the current EAPCI President, Professor Dariusz Dudek. The EACVI and the WG CVS of the European Society of Cardiology were invited to review the Executive Summary document and nominated three experts that collaborated with the EAPCI to write the manuscript. The document was updated accordingly and was blindly revised following the standard operating procedures approved by the EAPCI Scientific Documents and Initiatives Committee (SDAIC), under the chair of Professor Giuseppe Tarantini. Finally, the process was concluded after revision by the NTF and EAPCI Board. This version was circulated, revised and approved by all authors. The Clinical Practice Guidelines (CPG) formally approved the final version (Figure 2).

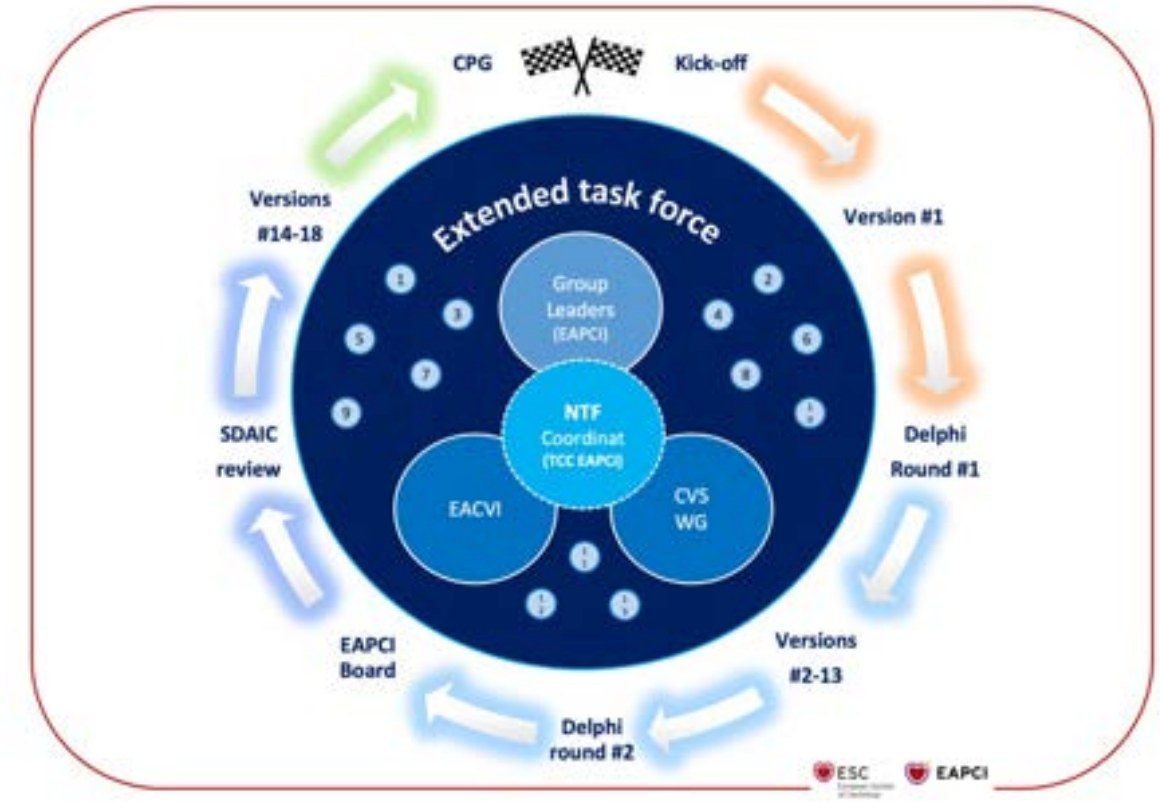


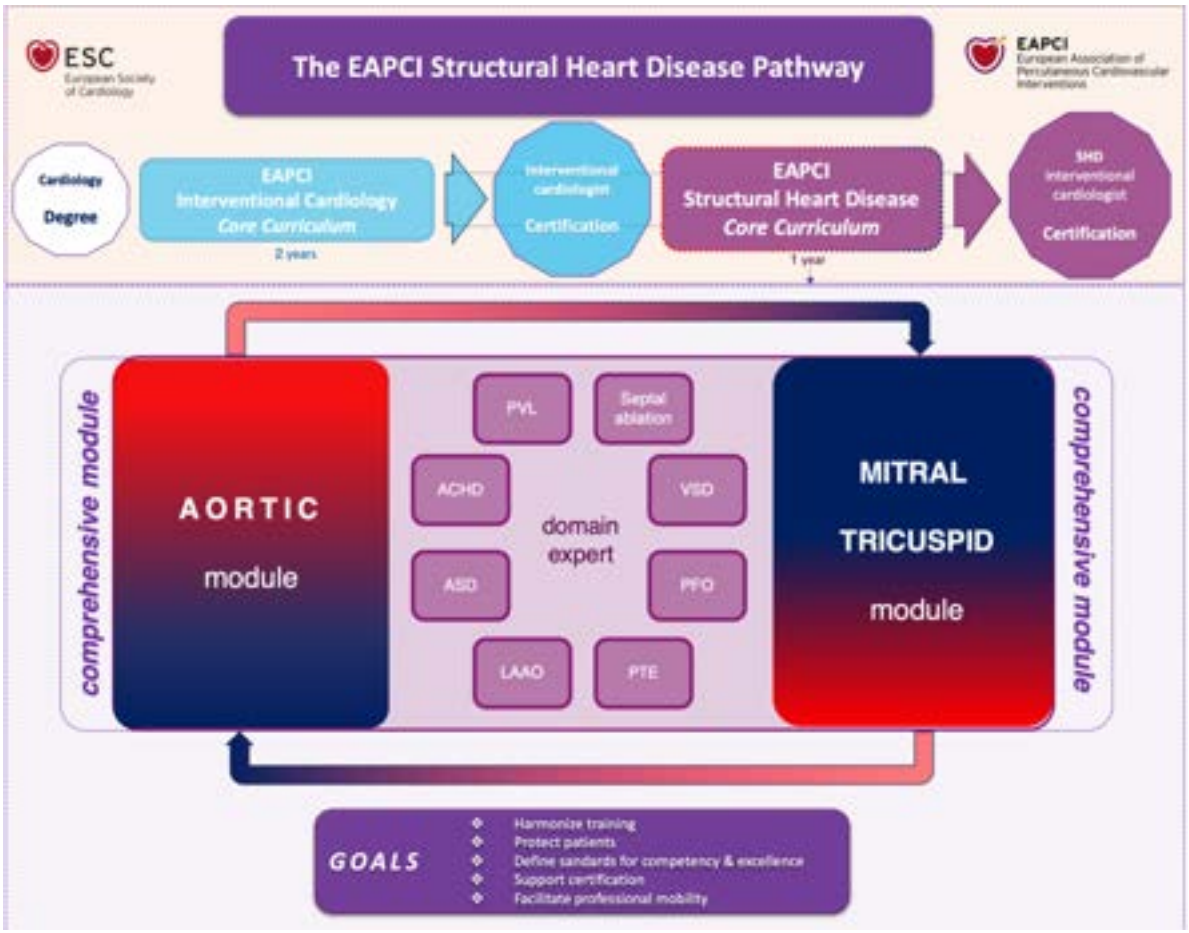
Figure 2: Methodology of the European Association of Percutaneous Cardiovascular Interventions (EAPCI) Training and Certification Committee (TCC) Task Force (TF): the writing TF included three coordinating authors, a Nuclear Task Force (NTF) of 13 lead authors & group coordinators; and an Extended Task Force of 34 members, including the European Association of Cardiovascular Imaging (EACVI) and the Cardiovascular Surgery Working Group (WG CVS) of the European Society of Cardiology. The document was blindly revised by the EAPCI Scientific Documents and Initiatives Committee (SDAIC) and concluded after revision by the NTF and EAPCI Board. This version was circulated, revised, and approved by all authors. Finally, the Clinical Practice Guidelines (CPG) formally approved the final version.

The structure of the SHD Core Curriculum follows the current ESC recommendations for Core Curriculums[1]. The content is based on the ESC guidelines review and the PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook in Percutaneous Interventional Cardiovascular Medicine. It defines the clinical, patient-oriented training of the SHD IC. In most subject areas, there was a broad, if not unanimous consensus, among the task force members on the training required for the SHD IC of the present and future. The SHD Core Curriculum is the basis of the future EAPCI IC certification and does not include minimum or optimal numbers of procedures to be undertaken. Periodic evaluation or recertification is planned according to the CC implementation.

The 2023 EAPCI Core Curriculum for Percutaneous Structural Heart Disease Interventions is presented in two formats: a) The 2023 EAPCI Core Curriculum for Percutaneous Structural Heart Disease Interventions Executive Summary that covers general aspects of training, and b) The current 2023 EAPCI Core Curriculum

for Percutaneous Structural Heart Disease Interventions Extended Version that is present as a Supplementary material and includes a a comprehensive description of the specific components in 5 areas, organised in 114 chapters and sub-chapters. Each includes statements of the objectives, and is further subdivided into the required objectives, knowledge, skills, behaviours, ESC topic list, essential reading and attitudes.

Finally, the percutaneous SHD intervention field is evolving quickly. As such, this landmark CC aims to be a reference for future iterations that will occur under the auspices of the EAPCI (Central Illustration).



Central Illustration: The European Association of Percutaneous Cardiovascular Interventions Interventional Cardiology Certification (EAPCI) Training and Certification development plan: starting from the General Cardiology Degree, the interventional cardiologist training follows the EAPCI Interventional Cardiology Core Curriculum to acquire the EAPCI Interventional Cardiology Certification. Sequentially, the same training path follows EAPCI Core Curriculum for Percutaneous Structural Heart Disease (SHD) Interventions to acquire the SHD Certification sequentially. An overlap between IC and SHD-IC certifications is accepted, allowing the IC to be certified 30 months after starting the IC Certification. Within the SHD Certification, the same principle is envisaged. While a comprehensive aortic/mitral/tricuspid is recommended, more dedicated training using the aortic or the mitral/tricuspid module is also possible, allowing an SHD training in 1 year. The additional domains can be acquired in parallel when conditions permit. (*paravalvular regurgitation (PVL), ventricular septal defect (VSD), atrial septal defect (ASD), adult congenital heart disease (ACHD), patent foramen ovale (PFO), left atrial appendage occlusion (LAAO) and pulmonary thromboembolism (PTE)).

3. The EAPCI Core Curriculum for Percutaneous Structural Heart Disease Interventions

3.1 The clinical field of percutaneous structural heart disease (SHD) interventions

The EAPCI Core Curriculum for Percutaneous Cardiovascular Interventions (2020), written by the Committee for Education and Training European of the Association of Percutaneous Cardiovascular Interventions (EAPCI) was published in 2020. It defines interventional cardiology as the clinical specialty that aims to deliver expert interventional care for patients presenting with disorders of the heart, the systemic, and pulmonary circulations[2].

The current SHD core curriculum (CC) is a comprehensive document explicitly dedicated to providing the standards for training in the management of patients with structural heart disease (SHD) requiring a percutaneous intervention, including, but not limited, to heart valves disease and vessels as well as congenital or acquired cardiac defects. Additionally, it constitutes a template for ensuring the competence of newly qualified interventional cardiologists in the field.

A solid background in coronary interventions, peripheral artery disease and management of any procedural complications is needed, requiring a level of competence in interventional cardiology that is equal to or above the EAPCI Interventional Cardiology Core Curriculum 2020[2].

The SHD interventional cardiologists (IC) are primarily medical specialists who manage patients suffering from SHD from diagnosis to follow-up and perform percutaneous interventional cardiovascular procedures in this domain. They are a fully trained cardiologist who received the complete "European Association of Percutaneous Cardiovascular Interventions Interventional Cardiology Certification" or corresponding national interventional cardiology certifications. The SHD ICs are members of a multidisciplinary team that can consider and apply interventional techniques to patients with structural and valvular heart disease. They interact closely with other cardiologists, cardiac surgeons and other medical specialties, nurses, paramedics, and other healthcare professionals[2–6].

This field encompasses specific and, often, complex diagnostic and interventional techniques, including advanced imaging. In that regard, the IC needs to be competent in the extensive use of multimodality imaging for diagnostic and periprocedural assessment: echocardiography, multi-slice computed tomography (MSCT), cardiac

magnetic resonance (CMR), and angiographic studies. To achieve that, IC needs to master dedicated imaging-based procedural planning software. A background in cardiac intensive care experience is strongly recommended, with a particular emphasis on vascular, acute heart failure, and rhythm management.

SHD IC should be skilled to provide a central role supporting comprehensive preprocedural evaluation of SHD therapy candidates. The SHD IC needs to acquire competence to collaborate with the Heart Team (HT), promote shared decision making, and select the most appropriate treatment.

Appreciating the broad field of SHD, it is reasonable that trainees may choose to pursue a narrower set of skills involving a focused area of competency aligned with their planned clinical practice. Therefore, the SHD CC differentiates between a "SHD IC" and a "Domain expert" IC that treat several clinical conditions (Figure 3):

- The SHD IC is expected to be parallelly trained in aortic, mitral, and tricuspid disease and interventions. A modular approach is proposed to the SHD IC that will have the option to be 1) fully skilled in aortic, mitral, and tricuspid percutaneous areas (AoMTC module), or 2) fully skilled in the aortic percutaneous area with competencies in mitral and tricuspid areas (AOR module) or 3) fully skilled in the mitral and tricuspid areas with competences in the aortic area (MTC module), as well in other SHD percutaneous therapies, where a minimum grade of expertise is recommended. The fields of expertise are extensive, including: transcatheter aortic valve implantation (TAVI), mitral valve intervention, tricuspid valve intervention, pulmonary valve intervention, paravalvular leak closure (PVL), septal ablation for hypertrophic obstructive cardiomyopathy (HOCM), transcatheter interventions in adult congenital heart disease (ACHD) diseases, ventricular septal defect (VSD) closure, atrial septal defect (ASD) closure, patent foramen ovale (PFO) closure, left atrial appendage occlusion (LAAO) pulmonary pulmonary embolism thrombectomy (PTE).
- The "Domain" expert ("TAVI expert", "Mitral expert", "LAAO expert", "PFO expert", etc) is an IC that does not fulfil the minimum competencies in any of the above three modules (AoMT, AOR of MTC). However, the IC was trained and has achieved the required competence in one or more dedicated specialised SHD interventions: aortic, mitral, tricuspid, PVL, septal ablation, ACHD, VSD, ASD, PFO, LAAO and PTE.

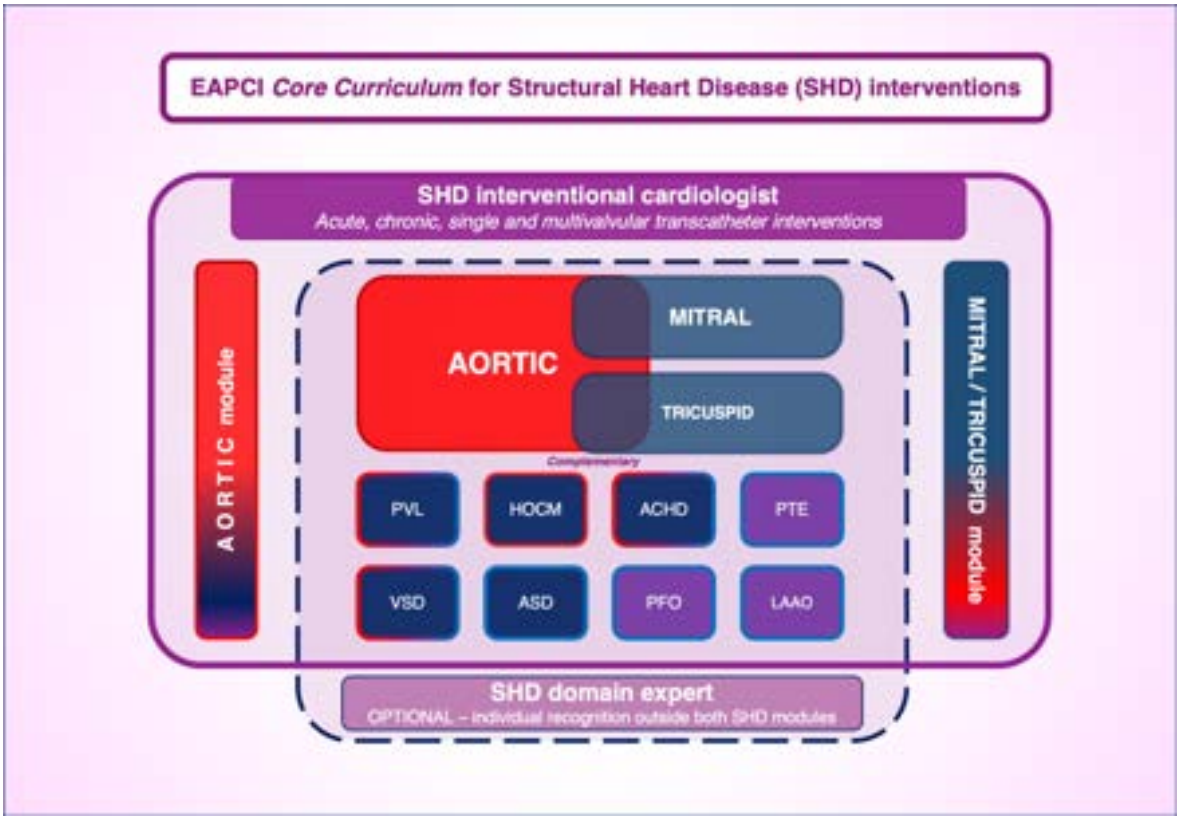


Figure 3: The EAPCI Core Curriculum for Percutaneous SHD Interventions Training plan, modules and domains: After the cardiology degree (minimum of 4 years of training) and IC certification (2 years) the trainee can engage in the comprehensive training module, the Aortic/Mitral/tricuspid (AoMTC), or choose between the Aortic (AOR) and Mitral/Tricuspid (MTC) modules, respectively in red or light blue background. These two are complementary, since each trainee involved in one module should still acquire minimal expertise from the other one. The recommended minimum duration of each of the two dedicated SHD IC training modules should be one year of training in SHD IC, for each one of these areas or 18 months when both are acquired in combination (AoMTC). In addition, as part of each module, the trainee will also have to acquire basic expertise in other specific SHD areas where full expertise can be acquired outside (or on top) of each SHD module (Figure 2), represented by the dark blue or magenta background, that are related, respectively, with the prevailing heart failure or thromboembolic disease. This optional "Domain expertise" recognition is designed to acknowledge the differentiation in any particular area included in the EAPCI SHD IC CC, without the requirement for transversal competencies as above: aortic intervention, mitral and tricuspid intervention, paravalvular regurgitation (PVL), septal ablation (HOCM), adult congenital heart disease (ACHD), ventricular septal defect (VSD), atrial septal defect (ASD), patent foramen ovale (PFO), left atrial appendage occlusion (LAAO) and pulmonary thromboembolism (PTE). Within the SHD Certification, practice overlap is possible to allow the training in the Aortic, Mitral/Tricuspid modules, and any other domain can be acquired in parallel when conditions permit. The colour code is consistent with the prevailing disease: thromboembolic (magenta) or heart failure (red or blue background, limited by different lines according to the usual percutaneous treatment route, arterial (red), venous (blue) or mixed (red/blue).

3.2. General aspects of training in percutaneous SHD interventions

The SHD interventional training aims to generate medical specialists who manage patients suffering from SHD from diagnosis to interventions and follow-up.

The candidates should be cardiologists licensed to practice IC in the country of training. A candidate should have completed a minimum of four years of training in general cardiology and two years of full-time training in IC. As part of the training in interventional cardiology, it is assumed that the IC has achieved all Level IV and Level V competencies described in the EAPCI IC CC[1].

Securing a dedicated time to the SHD interventional training is crucial. Such protected time is important to allow the trainee to remain truly focused on his training, to be immersed in the field and to benefit from the expected virtuous circle of the daily back and forth between theory and practice. While a complete aortic/mitral/tricuspid training is recommended over a course of 18 months, a more dedicated training focusing either on the aortic or the mitral/tricuspid module is also possible, allowing an SHD training in 1 year. Finally, the trainee should have the necessary linguistic ability to communicate with patients and colleagues in the country of training and later in the country of practice.

Simulators and software are becoming increasingly sophisticated and their adoption has shown benefits for the operator. They are strongly encouraged in the early phases of SHD training and whenever new tools, techniques or devices are used. Their use in the setting of advanced technical skills remains to be clarified. However, interactive technology enhancement shows promise in training and recertification, ameliorates intra-procedural performance and decreases radiation exposure[7].

These fields are continuously evolving, and, in many cases, specific training to master a new procedure, a different device or iterative technique is required. Along the time, the SHD ICs may require or act as a trainer or proctor. Therefore, they must be prepared to ask for support or for referral to a more skilled centre, especially in certain areas that, depending on the individual and the centre, require particular expertise. Dependent on career development, additional training beyond the interventional cardiology fellowship program or post fellowship training through courses, proctoring, or direct mentorship may be needed. So far there is no clear evidence to clarify the requirements and efficacy of the proctoring systems for improving clinical outcomes and their utility when introducing new devices.

The economic impact of SHD intervention is meaningful because many of these interventions are innovative, apply to a substantial population of patients and require expensive devices. The SHD IC should be conscious of this economic burden and the mainstay for adequate therapies and resources, avoiding futility[8–10].

The SHD IC process for medical decision-making and patient information is guided by the "four principles" of approach to healthcare ethics: autonomy, beneficence, non-maleficence and justice. The SHD 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 to deliver optimal patient-centred care. Moreover, because this is a very specialised and continuously demanding evolving field, it requires lifelong learning and continuous updating of knowledge. The SHD IC trainee is encouraged to engage in structured clinical investigation programs, to collaborate actively in patient follow-up and is required to integrate local audit programs.

To gain sufficient experience, the trainee should gain exposure to all aspects of SHD interventional cardiology, with an appropriate mix of the aortic or mitral/tricuspid as well as acute and elective cardiac care, including mandatory, strongly recommended or recommended elements, as described in Figure 4 that summarizes the general aspects and requirements required to organize a percutaneous training program in Structural Heart Disease:

- Participation in the clinical management of patients with SHD, focusing on aortic, mitral and tricuspid valve disease patients. Participation in other SHD areas is strongly recommended.
- SHD percutaneous training should define in advance a primary area: the aortic area (AOR), the mitral and tricuspid percutaneous area (MTC) or both at the same level of expertise (AoMTC). The candidate should progress from procedures with direct supervision, to second, then to main operator status and ultimately independent operator status by the end of the training period. The degree of expertise is defined by the levels of competence in practical clinical procedural and non-procedural skills (7)
- SHD percutaneous training must guarantee experience with multimodality large-bore arterial access, including guided puncture, closure and endovascular management of vascular complications.
- Exposure to other percutaneous SHD interventions, including LAAO, PVL, VSD ASD, PFO closure, is strongly recommended.

- The comprehensive use of multimodality imaging to plan and execute procedures is mandatory. It should include echocardiography, MSCT and CMR, as well as expertise on guidance of surgical and interventional procedures[11].
- Exposure to open-heart procedures, where applicants are scrubbed and can link imaging to tactile feedback to improve the ability to judge tissue texture and quality is recommended.
- Active preparation and collaboration 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 recommended:
  - 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.
- The training program should be clearly defined to all trainees, with regular progress assessment of competencies, preferably by audit and formal assessment.
- Participation in clinical/translational research in SHD is recommended to enhance critical appraisal of relevant scientific evidence.

AREA OF TRAINING	GENERAL ASPECTS OF TRAINING	REQUIREMENT
SUPERVISOR & MENTOR REQUIREMENTS	> 5 years dedicated to the percutaneous cardiovascular interventions	M
CONTINUOUS MEDICAL EDUCATION	Structured learning under supervision	M
OUTPATIENT CLINIC	Diagnostic, pre and post-procedural assessment	M
MULTIMODALITY IMAGING FOR CLINICAL EVALUATION	Comprehensive analysis of echocardiography, MSCT and CMR imaging	M
HEART TEAM	Active participation in regular meetings	M
CARDIAC SURGERY OR	Exposure to open heart procedures	R
MAIN STRUCTURAL INTERVENTIONS	Main exposure to aortic and/or to mitral/tricuspid areas (AOR or MTC or AoMTC modules)	M
OTHER STRUCTURAL INTERVENTIONS	Exposure to other structural domains	R+
PROCEDURAL IMAGING GUIDANCE	Imaging-based procedural planning software and interventional guidance	M
LARGE VASCULAR ACCESS	All aspects of management	M
PROCEDURAL SKILLS	Progress from cases with direct supervision to independent operator status (AORTIC or MITRAL module)	M
RESEARCH	Participation in research & critical appraisal of evidence.	R
EVALUATION	Regular & formal LoC progress assessment and Clinical audit program	M

EAPCI European Association of Percutaneous Cardiovascular Interventions

M *mandatory* R+ *strongly recommended* R *recommended*

ESC European Society of Cardiology

Figure 4: Summary of the structured requirements for percutaneous training programs in Structural Heart Disease.

3.3 Learning objectives

Learning objectives need to be clearly defined and are preferred to recommendations solely on time spent in a particular department or on the number of procedures performed. Training in SHD interventional cardiology should allow multilateral operator development to guarantee high-quality diagnosis and treatment of patients with structural heart diseases. The trainee education should include three competency domains of interventional cardiology: knowledge, skills and attitudes, which are defined below and be reinforced during ongoing training.

3.3.1 Knowledge

The operator should learn facts and information on SHD through education and personal training. The EAPCI Core Curriculum chapters define the recommended scope of knowledge. It includes SHD pathology, recommendation on their diagnosis and treatment, operator tools and techniques used in percutaneous interventions.

Such information should come from reading textbooks, guidelines, scientific journals, clinical case reports and online learning platforms, writing scientific reviews or examination questions. In addition, active participation in educational events or webinars allows the operator to learn the latest scientific achievements or expert consensus. Group learning or local HT meetings offer interaction with opinion leaders or peers, stimulating thought exchange, knowledge sharing, and constructive criticism.

A theoretical assessment may be considered to ensure that the candidate is adequately prepared to be recognised as an SHD IC. The current EAPCI Interventional Cardiology Certification includes a multiple-choice questionnaire exam that follows the ESC Education, Training and Certification recommendations.

3.3.2 Skills

Operator skills encompass the ability and expertise to apply the acquired knowledge to solve clinical problems. Consultative cardiology is an integral responsibility of the interventional cardiologist that should be valued and prioritized to help make diagnostic and treatment decisions, to perform interventional procedures, to manage potential complications and to collaborate with other professionals.

Skill-building requires personal involvement in patient diagnosis and treatment, HT decision-making, and assisting SHD interventions. Trainees should have the opportunity to discuss diagnostic and treatment strategies with their supervisors and multidisciplinary teams.

Simulation, operator guidance and supervision in interventional procedures are essential to gain competence in all aspects of the Core Curriculum. Strategic planning, preparation for solving procedural complications, simulator training and artificial intelligence (AI) facilitate growing these abilities in a safe environment. Supervised and guided interventional procedures allow operators to exercise their abilities progressing from general techniques and straightforward cases to more specific and complex procedures. Trainees should maintain a continuous logbook that captures all main and secondary operator procedures as throughout their training course.

3.3.3 Attitudes

The SHD training should allow critical thinking, urgent decision-making, and adaptation to changing clinical scenarios. Learning through observation and interaction in interventional procedures should allow the trainee to develop communication, different role-taking and teamwork. The operator leadership values, such as reliability, honesty, group support, constructive feedback and openness, are necessary to maintain high standards of patient care.

A shared decision-making process should be implemented. The multidisciplinary team should incorporate all necessary professionals as cardiac surgeons, imagers, electrophysiologists, non-invasive cardiologists, acute cardiac care specialists, heart failure specialists, vascular surgeons, neurologists, nurses, technicians, social assistance specialists and administrative assistants. Collaboration between centres must be established, ensuring good communication and a patient-centred approach whenever a particular technique is not available at the reference institution.

Supervisors and trainers should support operators abilities to react positively in changing interventional scenarios, grow their endurance and communicate the need for consultation. With all values centred around the SHD patient, the trainee should keep the focus on patient safety, well-being and long-term interest. Supervisors and trainers should assess the trainees behaviours and provide valuable feedback to allow positive operator development.

Clinical audit is a mandatory component of training for quality improvement and bridges the gap between science and practice. It is an opportunity to investigate and engage with registries, developing a greater depth of understanding about the strengths and weaknesses of the data available and instilling the desire to contribute and support continuous registries.

3.4 Categories and levels of competence translating into SHD interventional cardiology procedural and non-procedural skills

Practical experience is crucial in learning interventional cardiology techniques. SHD interventions are frequently complex procedures, so the volume performed by trainees is considered an essential but not the sole measure of performance. The authors acknowledge the variability among training centres. The document focuses on the acquisition of competencies, which can be acquired outside the primary training centre, as part of a cooperation programme. Whenever feasible, national associations may set procedural thresholds afterward and agree with EAPCI for their inclusion in the practical part of the envisaged SHD certification.

This section describes the definition of EAPCI levels of competence (LoC) recommendation into procedural or non-procedural skills. Their ascending order is defined as follows and summarised in Figure 5. It has been adapted from Entrustable Professional Activities (EPA) description.

- Levels I and II*. The trainee must have acquired experience in selecting an appropriate diagnosis or therapy and interpreting results or choosing an appropriate treatment for a referred patient. Procedures during training may be valuable.
- Level II. The competency indicates the acquisition of some procedural skills as an operator, usually as co-operator, obtained in the primary or external training centres.
- Level III. The trainee must interpret clinical data, recognise treatment indications, perform the technique or procedure, and manage related complications as the main operator, but still requires working under the direct supervision of a senior SHD IC operator.
- Level IV. The trainee must be independent in interpreting clinical data, recognising treatment indications, performing the technique or procedure, and managing related complications as the main operator without the direct supervision of a senior SHD 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 other colleagues.

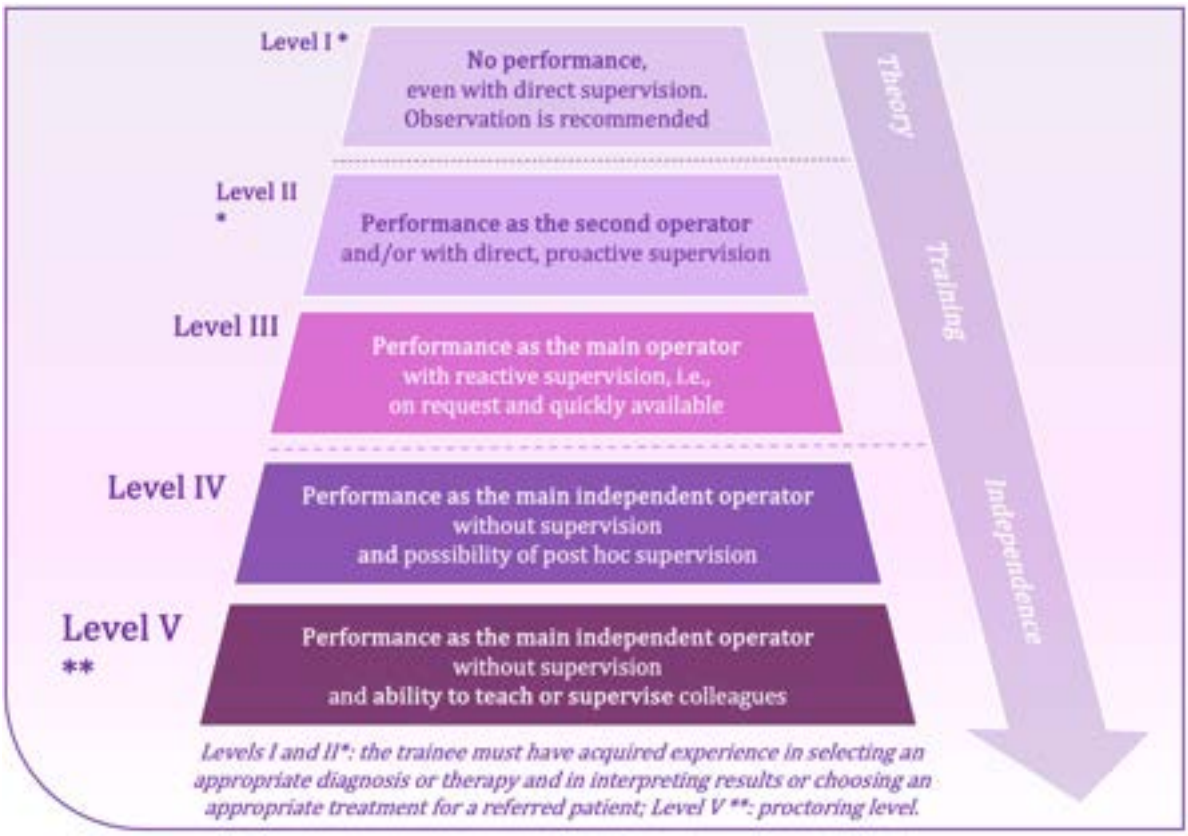


Figure 5. Description of levels of competence (LoC) for non-procedural or procedural skills (adapted from Entrustable Professional Activities).
The level IV is required for any basic procedural skill and for the performance of any technique with a class A indication. If an emerging technique becomes supported by robust clinical evidence and receives a class A indication, the level of recommendation becomes IV. The assumption is valid without an official update of this document, which is planned every 5 years.

3.5 Requirements for training institutions, trainees and trainers

3.5.1 Requirements for training institutions

3.5.1.1 GENERAL ASPECTS

A percutaneous SHD training centre is an institution or healthcare network that performs SHD procedures and provides a structured training program for certified interventional cardiologists aiming to achieve the required EAPCI SHD CC LoC in a favourable environment.

3.5.1.2 THE STRUCTURAL HEART DISEASE TRAINING CENTRE

The technical portfolio, organisation, referral network, volume and performance of the SHD training centre define the extent and quality of training in SHD[12]. The institution and affiliates must be compliant with the requirements and recommendations of their national regulatory bodies, first, and follow the ESC

recommendations and Heart Valve Centres concept, second[11]. By EAPCI standards, the institutions must be standardised using reports of procedural characteristics, volume, and performance measures. An SHD training centre should have an established clinical, research and training SHD program approved by the centre managers and run by Heart Teams (HT).

All training modules should be well structured and may integrate hybrid training programs for interventional cardiologist, as well as cardiac surgeons, and imaging specialists[11].

3.5.1.2.1 The healthcare networks

SHD diagnosis and treatment require specialist cooperation in multiple medical fields to allow for optimal diagnosis and therapy of this complex group of patients. The SHD centre involved in operator training should be a high tier national referral centre for patient screening and treatment. The national and international SHD healthcare network should connect institutions to allow optimal patient treatment and research activities. In such an environment, the trainees can learn these coordination pathways and follow the methodology of HT activities.

Short-term delegation of IC trainees to other national or foreign SHD centres broadens operator abilities and future connections and widens treatment possibilities. The SHD centre healthcare network should extend from clinical to scientific activities, including national and international scientific bodies to promote quality, allow audits, and stimulate progress. Early involvement of SHD trainees in scientific activity promotes education and training in the latest SHD achievements and highlights needs to address locally.

3.5.1.2.2 Overview of shd training regulations

With rapidly evolving technology and therapeutic procedures, current training in SHD interventions is often fragmented, incomplete and continuously evolving worldwide[13]. SHD's cognitive and technical skillsets differ from traditional interventional cardiology and require dedicated training. SHD training program standardisation is needed to ensure the high-level performance of IC operators. The calls for urgent action to improve and harmonise training pathways are rising.

3.5.1.2.3 Institutional volumes and public metric reporting

Procedural volumes of centres significantly impact the availability of training opportunities, performance measures, and intervention outcomes.

The number, scope and complexity of SHD procedures, patient screening and follow-up, define the quality of an SHD centre and its ability to train interventional fellows. Public reporting of centre training programmes, procedural volumes and clinical outcomes is advisable to guide trainee choice of the training centre.

This document does not recommend a minimum or optimal number of procedures. It defines the clinical, patient-oriented training of the SHD IC. The document recommends that competence acquisition requires at least one year of exclusive and dedicated training in SHD IC. Variable implementation rates of maturing SHD treatment modalities result in their geographical diversity. The SHD excellence may require the introduction of procedural thresholds in regions with solid and escalating SHD programs.

3.5.1.2.3.1 *Registries And Clinical Audit*

Since the launch of the Cardiology Audit and Registration Data standards (CARDS) initiative in 2005 under the auspices of European Union[14] , registries, database and clinical audit have been shown to improve patient care[15] and are progressively implemented in interventional cardiology.

With the emergence of TAVI several countries have developed prospective national database which have been proven to be important to document temporal trends and their results[16,17]. It has also been shown that centers participating in such large national registries improve their practice over time[15].

It is important for the SHD trainees get used to this practice (Figure 4). Accordingly, training centres should collect data as part of a national registry. In case such a national registry does not exist, they should run their database and have regular meetings to analyse their practice by comparison to published standards. Trainees should be instructed to cardiology registry and audit by their mentor by participating in data collection and preparing meetings reporting on local practice.

3.5.1.2.3.2 *Clinical And Qualitative Endpoints. Valve Academic Research Consortium (VARC)*

Interpretation and comparison of SHD treatment outcomes should be based on standardised definitions of clinical endpoints. The Valve Academic Research Consortium (VARC) identified and standardised them for transcatheter and surgical aortic valve clinical trials. With changing scenarios of complications, clinical indications, and novel therapeutic strategies,

the rapid evolution of the SHD field mandates these definitions to ensure their clinical relevance. Clinical SHD trials and observational studies may use the VARC endpoint during data collection, adjudication, and reporting. Therefore, it is essential for the SHD trainees to learn definitions of VARC endpoints and their interpretation in clinical practice, planned research activities, and assessment of ongoing SHD research[12,18].

3,5,1,2,3,3 *Patient-reported outcomes measures (proms and prems)*

The quality of care for SHD patients may be assessed using standardised patient-reported outcome and experience measures (PROMs and PREMs)[19]. PROMs are questionnaires measuring patients' views of their health status to determine the perceptions of patient health status, level of disability, and health-related quality of life during the perioperative period. PREMs gather information on patients' views of their experience, level of communication, and assistance while receiving care. They differ from satisfaction surveys by reporting objective patient experiences, removing the ability to report subjective views. The SHD training centre should allow assessment of these indices and involve trainees and allied professionals in their performance and interpretation[12,20].

3,5,1,2,3,4 *Personnel and Facilities*

The Heart Team approach to SHD treatment is at the core of the interventional cardiology training in this field.

The learning networking facilitates direct communication, optimal therapy and urgent backup in an emergency. The defining principle is an integrated interventional cardiology and cardiac surgery approach to SHD patients, whenever needed. Additional personnel should be involved in the SHD training to provide a comprehensive education in complex SHD scenarios. They include imaging specialists, anaesthesiologists, nurses, SHD program coordinators, data managers and administrative support. The trainee should be involved in SHD consultations with other specialists or sub-specialists, namely electrophysiologists, neurologists, nephrologists, cardiac and vascular surgeons.

The SHD training centre for an interventional cardiologist should be compliant with national regulations for SHD therapies, offering a range of diagnostic, imaging and therapeutic facilities, including:

1. A 24/7 interventional cardiology unit, including a cardiac and/or hybrid catheterization laboratory equipped with high-quality fixed radiographic imaging systems.

2. A dedicated cardiology unit, department or ward, in order to manage patients throughout hospitalisation. The trainee should be educated to manage patients from admission through their invasive procedures to their discharge. Institutional workflow allowing the SHD programme attendees to follow the patient throughout their hospitalisation and outpatient clinic is mandatory.

3. Non-invasive imaging:
   a. Imaging department equipped with computed a MSCT scanner and dedicated SHD and vascular algorithms. Imagers should be trained in cardiac and vascular interpretation.
   b. Echocardiography unit offering transthoracic, transoesophageal echocardiography and intracardiac capabilities, including 3D modalities. The imaging specialists should have core competencies and skills encompassing clinical and technical aspects of SHD and intraprocedural guidance.

4. Multidisciplinary Heart and Vascular team:
   a. An intensive care unit (ICU).
   b. Electrophysiology laboratory allowing the preventive diagnosis of heart rhythm and conduction disorders.
   c. An approved protocol for emergency vascular specialist's support, interpretation and surgical or hybrid intervention.
   d. An approved protocol for intra- and extra-institutional HT referra.
   e. An approved protocol for emergency cardiac surgery support and surgical or hybrid intervention.

5. The training centres should be encouraged to develop a structured simulation centre program and incorporate SHD simulator sessions in low-frequency procedures and since the early phases of IC training or implementation of an SHD technique.

3.5.2 Requirements for trainees and trainers

3.5.2.1 GENERAL ASPECTS AND LEVELS OF COMPETENCE (LOC)

A dedicated training organisation should facilitate the delivery of the SHD CC. It is highly recommended to organise a formal environment that includes a supervisor, training mentor, procedural HT leader, and clinical trainers. The supervisor should be an experienced SHD IC with national and/or preferably EAPCI certification who has been performing unsupervised structural imaging for a minimum of 5 years. The supervisors should be responsible for organising the SHD training programme, coordinating external rotations to referral centres and attendance to courses and congresses. , and organising structured learning. They are responsible for organising structured learning programs, providing trainers development on use of assessment methods, effective feedback, coaching, and confirming trainee experience and competence. Both training mentors and trainees should be assessed periodically. Trainees should be both supported and encouraged to present their findings at meetings and submit them for publication in peer reviewed journals.

This document defines the clinical, patient-oriented training of the SHD IC and does not recommend a minimum or optimal number of procedures. The emphasis remains not on specific metrics but rather on obtaining the required expertise and competencies and in gaining experience across a wide range of procedures, complications, and potential therapeutic options. The CC recommends at least one year of exclusive and dedicated training in SHD IC. Variable implementation rates of maturing SHD treatment modalities result in their geographical diversity. The SHD excellence may require the introduction of procedural thresholds in regions with solid and escalating SHD programs.

The LoC defines what the EAPCI recommendations for a trainee in interventional cardiology to achieve at the end of the training according to the comprehensive AoMTC plan, the modular training (AOR or MTC) or the domain expertise recognition (Figure 6).

The domain expertise recognizes differentiation in particular areas included in the EAPCI SHD IC CC, where the IC trainee should complete all theoretical requirements and achieve a minimum LoC IV, as requested in their chapter or sub-chapter (aortic, mitral/tricuspid, PVL, septal ablation, VSD, ASD, ACHD, PFO, LAAO and PTE).

Although the organisation of cardiac services and resources for training are not uniform across Europe and ESC member countries, the SHD core curriculum aspires to an optimal rather than a minimal standard. In countries or centres currently unable to deliver training in all aspects required, the SHD core curriculum should be used as a benchmark to promote policies for improvement. Also, the rotation of trainees between different centres may provide an adequate solution.

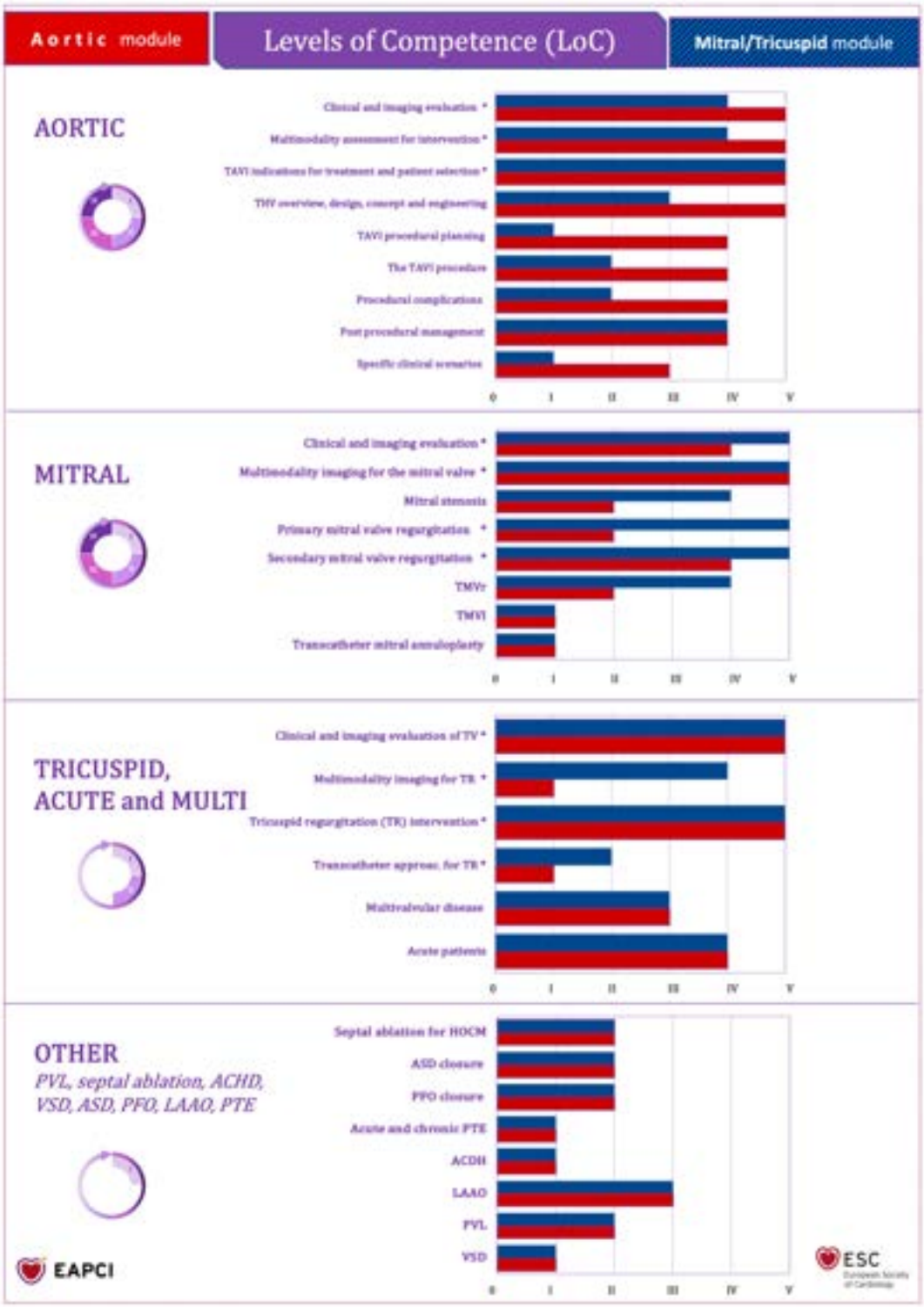


Figure 6: Condensed comparison of the level of competence (LoC) for non-procedural* and procedural interventional cardiology skills in the AOR or MTC modules of the SHD IC (from I/1 to V/5). The AoMTC training requires, for any competence, the highest LoC of either AOR or MTC and is not presented to prevent confusion. The optional "Domain expert" recognition demands all theoretical requirements and a minimum LoC IV in all the domains of interventional cardiology, which are defined in their chapter or sub-chapter: aortic, mitral/tricuspid, septal ablation (HOCM), paravalvular leak (PVL), ventricular septal defect (VSD), atrial septal defect (ASD), adult congenital heart disease (ACHD), patent foramen ovale (PFO), left atrial appendage occlusion (LAAO) and pulmonary thromboembolism (PTE).

3.5.2.2 TRAINER'S TRAINING

Several changes have occurred in medical education over the last several years. The education design should provide relevant content, adhere to clinical settings and provide opportunities for practice and feedback. It should embrace interactive learning methods and continuous assessment of outcomes[1].

Trainers using interactive techniques (case discussion, role-playing, hands-on practice sessions) were more effective in creating a competency-based curriculum. On the other end, the trainer should be challenged on its assumptions and roles by dedicated courses that will discuss the main learning principle, namely to:

- Address gaps in knowledge, competence and performance
- Motivate learning
- Create relevance and enable translation to real-world settings
- Lead to verifiable outcomes through constructive alignment
- Promote learner engagement
- Provide and seek feedback
- Allow opportunities for reflection and backward planning

Many educational technologies are available to link research, quality improvement and medical education. They help to teach the healthcare team as well as to perceive learners' work and environment:

- Social media serve not only as a marketing tool, but also for pre or post-assessments, learner pre-tests, learner dialogue with faculty, a communication tool for the community of practices.
- Online learning provides a more flexible format, supplemental materials for self-directed learning, comparing learner knowledge with guidelines and colleagues' level of knowledge, connection to search engines and point-of-care learning, easy to add modifications or new content and learner preference of physicians.
- Critical evaluation & assessment of educational outcomes to scrutinise activity and organisational evaluation to track what is known and how much was learned and applied in practice, provide data on outcomes, and maintain certification.

There is constant evolution in science and education that run parallel for both trainers and trainees.

3.5.2.3 BUILDING YOUR TRAINING PATHWAY

IC training in SHD is based on proficiency in percutaneous coronary interventions (PCI) and peripheral procedures. The knowledge, skills and attitudes gained in these areas are necessary to guarantee cohesive and multilateral operator growth in the SHD domain. The trainee experience in PCI should be objectively assessed and documented, following the EAPCI Core Curriculum guidance on the training time and scope. Therefore, we recommend that IC operators receive the EAPCI Interventional Cardiology certification before starting the SHD training.

A standardized SHD CC ensures the optimal approach for IC to enter this field. It is a "top-down" approach by establishing a benchmark for clinical proficiency and by creating pathways that ensure basic proficiency before independent practice.

4. Interventional management of aortic valve diseases

4.1 Clinical and imaging evaluation of aortic valve disease

4.1.1 Epidemiology, natural history and staging of aortic valve disease

Objectives

- To understand the pathology and pathophysiology of congenital and acquired aortic valve disease., including the importance of systemic illness
- To acknowledge the epidemiology of aortic valve disease
- To understand the stages and prognosis of aortic valve disease

Knowledge

- Pathology, pathophysiology, epidemiology and natural history of aortic valve stenosis (AoS), regurgitation and combined aortic valve disease

Skills

- To interpret clinical history, signs and symptoms of aortic valve disease, peri-valvular damage and concomitant (aortic) disease
- To select the appropriate non-invasive tests to diagnose and stage aortic valve disease
- To establish a plan for clinical follow-up of aortic valve disease
- To assess prognosis and counsel patients with respect to medical treatment and timing of aortic valve intervention and discuss the impact of concomitant coronary disease, mitral disease and other co-morbidities

Attitudes

- To perform an accurate patient evaluation and prescribe the most appropriate diagnostic exams with respect to select the optimal treatment modality
- To examine all patient-related information and to integrate and interpret imaging tests adequately within the HT
- To be able to assist patients in shared decisions with respect to timing and type of treatment of their aortic valve disease and concomitant procedures

ESC topic list

- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms,
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome
- 20.3.1.1 Valvular Heart Disease – Diagnostic Methods – Imaging-Echocardiography
- 20.3.1.2 Valvular Heart Disease – Diagnostic Methods – Imaging – Cardiac Computed Tomography

- 20.3.1.3 Valvular Heart Disease – Diagnostic Methods – Imaging – Cardiac Magnetic Resonance
- 20.4.1 Valvular Heart Disease – Treatment – Pharmacotherapy
- 20.4.2.1 Valvular Heart Disease – Treatment – Intervention – Aortic Valve Stenosis
- 20.4.2.2 Valvular Heart Disease – Treatment – Intervention – Aortic Valve Regurgitation
- 20.4.3 Valvular Heart Disease – Treatment - Surgery
- 20.6.1 Valvular Heart Disease – clinical – Aortic Valve stenosis
- 20.6.2 Valvular Heart Disease – clinical - Aortic Valve Regurgitation
- 20.6.3 Valvular Heart Disease – clinical – Aortic Valve disease – Other
- 20.6.10 Valvular Heart Disease – Clinical - Rheumatic Heart Disease
- 27.6.2 Diseases of the Aorta – clinical – Aortic Aneurysm, Thoracic
- 30.3.1 Interventional cardiology – Noncoronary Cardiac Intervention – Aortic Valve Intervention
- 31.2 Cardiovascular Surgery - Valves
- 41.3.6. Basic Science – Cardiac Diseases – Valvular Heart disease

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- ESC 2020 Core Curriculum for the General Cardiologist: 4.1 Manage a patient with aortic valve regurgitation; 4.2: Manage a patient with aortic stenosis; group Manage a patient with multivalvular disease
- EAPCI Core Curriculum for Percutaneous Cardiovascular Interventions 2020 Part III Non-Coronary Track: 3.1 Transcatheter Aortic Valve Treatment: Aortic Balloon Valvuloplasty and TAVI
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume I - Diagnosis – Part II – Chapter on "Non-invasive Imaging for Structural Heart Disease"
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III – Intervention II – Chapters on "Balloon aortic valvuloplasty" and "Transcatheter aortic valve implantation"

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.1

4.1.2 Anatomy of aortic valvular complex and thoracic aorta

Objectives

- To understand the anatomy of the aortic valvular complex and its implications in percutaneous aortic valve implantation

- To understand the anatomy of the thoracic aorta, its branches and anatomic variants
- To know which diseases affect the aortic valve and their basic pathophysiological mechanisms
- To understand the variability of the ageing aorta and the basic mechanisms of aortic diseases

Knowledge

- To know the normal size and configuration of the aortic root and valve and its anatomical relations with the coronary arteries, left ventricle outflow tract, mitral valve and conduction system
- To know anatomical variations of the aortic valve complex
- To recognize the pathophysiological consequences of aortic valvular disease
- To know the geometric structure of the aorta root and ascending aorta and its influence on valvular function

Skills

- To properly request and interpret diagnostic tests to evaluate aortic diseases
- To be able to interpret MSCT of the aortic root for planning purposes
- The ability to identify aortic valve disease features more favorable to surgery or percutaneous treatment

Attitudes

- To perform an accurate patient evaluation and prescribe the most appropriate diagnostic exams to select the optimal treatment modality
- To examine all patient-related information and to integrate and interpret imaging tests adequately within the HT

ESC Topic List

- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome
- 20.3 Valvular Heart Disease - Diagnostic Methods
- 20.6.1 Valvular Heart Disease - Clinical - Aortic Valve Stenosis
- 20.6.2 Valvular Heart Disease - Clinical - Aortic Valve Regurgitation
- 20.6.3 Valvular Heart Disease - Clinical - Aortic Valve Disease, Other
- 27.1 Diseases of the Aorta - Pathophysiology and Mechanisms

Essential reading

- PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook PART I - Fluoroscopic anatomy for the guidance of percutaneous transcatheter interventions

- PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II - Non-invasive imaging for structural heart disease
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.1

4.1.3 Surgery of aortic valve and the ascending aorta

Objectives

- To know the timing and indications for surgery for aortic valve disease and diseases of the ascending aorta, in the acute and chronic setting
- To council patients for surgery versus percutaneous management of aortic valve disease and diseases of the ascending aorta

Knowledge

- To acknowledge the surgical techniques used to treat aortic valve disease and factors contributing to a potential suboptimal result
- To acknowledge the surgical techniques used to treat diseases of ascending aorta, including aortic dilatation and dissection

Skills

- To be able to interpret clinical history, signs and symptoms of aortic valve disease and diseases of the ascending aorta
- To select the appropriate non-invasive tests to diagnose and stage aortic valve disease and diseases of the ascending aorta
- To select which patients should be referred for surgery or percutaneous intervention

Attitudes

- To inform and counsel patients on the different approaches to intervene on the aortic valve disease and diseases of the ascending aorta
- To be able to support patients in taking shared informed decisions with respect to timing and type of treatment of their aortic valve disease and diseases of ascending aorta
- To set the indication for treatment in the HT

ESC topic list

- 20.3.1.1 Valvular Heart Disease – Diagnostic Methods – Imaging – Echocardiography;
- 20.3.1.2 Valvular Heart Disease – Diagnostic Methods – Imaging – Cardiac Computed Tomography;
- 20.3.1.3 Valvular Heart Disease – Diagnostic Methods – Imaging – Cardiac Magnetic Resonance

- 20.4.2.1 Valvular Heart Disease – Treatment – Intervention – Aortic Valve Stenosis
- 20.4.2.2 Valvular Heart Disease – Treatment – Intervention – Aortic Valve Regurgitation
- 20.4.3 Valvular Heart Disease – Treatment – Surgery
- 20.6.1 Valvular Heart Disease – clinical – Aortic Valve stenosis
- 20.6.2 Valvular Heart Disease – clinical – Aortic Valve Regurgitation
- 20.6.3 Valvular Heart Disease – clinical – Aortic Valve disease – Other
- 27.6.2 Diseases of the Aorta – clinical – Aortic Aneurysm, Thoracic
- 30.3.1 Interventional cardiology – Noncoronary Cardiac Intervention – Aortic Valve Intervention
- 31.2 Cardiovascular Surgery – Valves

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- ESC 2020 Core Curriculum for the General Cardiologist: 4.1 Manage a patient with aortic valve regurgitation; 4.2: Manage a patient with aortic stenosis 4.9 Manage a patient with multivalvular disease
- EAPCI Core Curriculum for Percutaneous Cardiovascular Interventions 2020 Part III Non-Coronary Track: 3.1 Transcatheter Aortic Valve Treatment: Aorti Balloon Valvuloplasty and TAVI
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume I -Diagnosis – Part II – Chapter on "Non-invasive Imaging for Structural Heart Disease"
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III – Intervention II – Chapters on "Balloon aortic valvuloplasty" and "Transcatheter aortic valve implantation"

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.1

4.1.4 History of transcatheter techniques for aortic valve diseases treatment

Objectives

- To know the evolution of transcatheter techniques
- To know the different technologies that are used
- To understand the path which brings from patient selection, alternative access and procedural steps
- To understand the procedural complications evolution

Knowledge

- To have knowledge of the different techniques, devices, access routes for transcatheter treatment of aortic valve disease
- To have knowledge of the procedural complications and their management along the evolution

Skills

- To integrate the experience with older devices and be able to use it in current TAVI procedures

Attitudes

- To explain to the patient what to expect with current optimized devices and techniques
- To integrate innovation in the HT discussion.

ESC topic list

- 20.1 Valvular Heart Disease – Pathophysiology and Mechanisms,
- 20.2 Valvular Heart Disease – Epidemiology, Prognosis, Outcome
- 20.3.1.1 Valvular Heart Disease – Diagnostic Methods – Imaging – Echocardiography
- 20.3.1.2 Valvular Heart Disease – Diagnostic Methods – Imaging – Cardiac Computed Tomography
- 20.3.1.3 Valvular Heart Disease – Diagnostic Methods – Imaging – Cardiac Magnetic Resonance
- 20.4.1 Valvular Heart Disease – Treatment – Pharmacotherapy;
- 20.4.2.1 Valvular Heart Disease – Treatment – Intervention – Aortic Valve Stenosis
- 20.4.2.2 Valvular Heart Disease – Treatment – Intervention – Aortic Valve Regurgitation
- 20.4.3 Valvular Heart Disease – Treatment – Surgery
- 20.6.1 Valvular Heart Disease – clinical – Aortic Valve stenosis
- 20.6.2 Valvular Heart Disease – clinical – Aortic Valve Regurgitation
- 20.6.3 Valvular Heart Disease – clinical – Aortic Valve disease – Other
- 30.3.1 Interventional cardiology – Noncoronary Cardiac Intervention – Aortic Valve Intervention

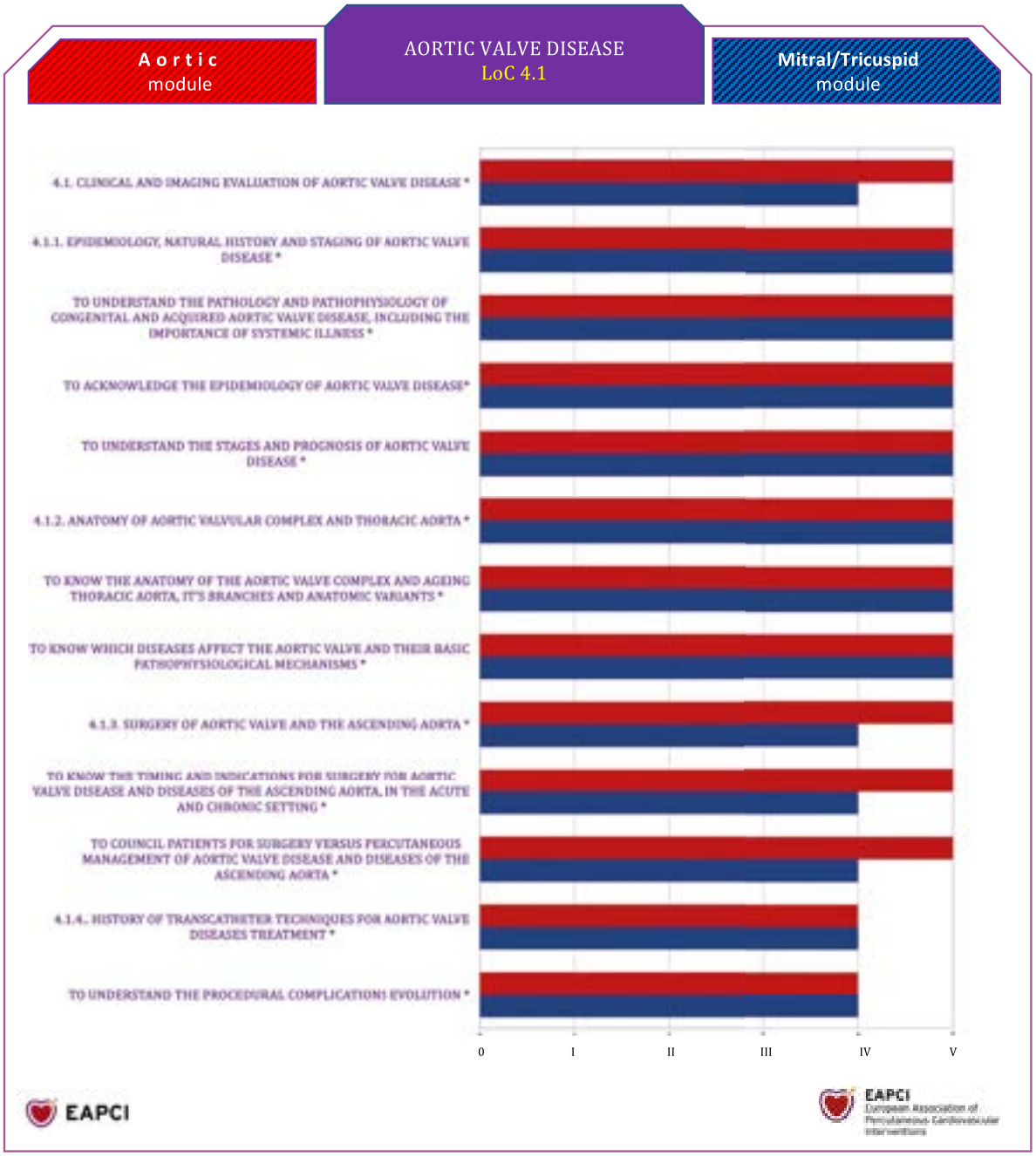
Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- ESC 2020 Core Curriculum for the General Cardiologist: 4.1 Manage a patient with aortic valve regurgitation; 4.2: Manage a patient with aortic stenosis; 4.9 Manage a patient with multivalvular disease
- EAPCI Core Curriculum for Percutaneous Cardiovascular Interventions 2020 Part III Non-Coronary Track: 3.1 Transcatheter Aortic Valve Treatment: Aortic Balloon Valvuloplasty and TAVI

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II –Non-invasive Imaging for Structural Heart Disease
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III –Balloon aortic valvuloplasty
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III – Intervention II –Transcatheter aortic valve implantation

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.1



4.2 Multimodality assessment of aortic valve disease

4.2.1 The role of imaging

Objectives

- To interpret 2-dimensional and 3-dimensional imaging techniques (TEE, TOE, stress testing, MSCT) and to select the most adequate tests for each patient.
- To predict procedural risks based on non-invasive imaging testing.
  To conduct preprocedural evaluation.

Knowledge

- The role of imaging in preprocedural evaluation of aortic valve disease.
- Relevant echocardiographic parameters, pre and post procedure
- Role of nuclear imaging in cardiac amyloidosis
- High-risk features and anatomical challenges
- To understand which imaging modality features best suits to assess pending questions.

Skills

- To adequately prescribe and interpret non-invasive imaging tests to evaluate the patient with aortic valve disease.
- To interpret two-dimensional transthoracic echocardiography performed in the context of aortic valve disease.
- To accurately plan the TAVI procedure by preprocedural MSCT analysis and measurements, including the most important parameters such as aortic annulus dimensions, aortic valve and root anatomy, LVOT angle, valvular and aortic calcification, thoracic aorta and coronary artery anatomy, LV anatomy and presence of intracardiac thrombus, MV apparatus and peripheral artery disease (PAD).
- To identify patients with high-risk anatomic features.

Attitudes

- To prescribe non-invasive imaging tests.
- Commitment to work with all members of the HT during all the phases of the diagnostic work-up of aortic valve disease.
- Commitment to explain the imaging results and consequences to the patient.

ESC Topic List

- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 20.3 Valvular Heart Disease – Diagnostic Methods
  - 20.3.1 Valvular Heart Disease – Diagnostic Methods – Imaging
  - 20.3.1.1 Valvular Heart Disease – Diagnostic Methods – Imaging Echocardiography

- 20.3.1.2 Valvular Heart Disease – Diagnostic Methods – Imaging – Cardiac Computed Tomography (CT)
- 20.3.1.3 Valvular Heart Disease – Diagnostic Methods – Imaging – Cardiac Magnetic Resonance (CMR)
- 20.3.1.4 Valvular Heart Disease – Diagnostic Methods – Imaging – Nuclear Imaging
- 20.3.1.99 Valvular Heart Disease – Diagnostic Methods – Imaging – Imaging, Other

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II – Non-invasive imaging for structural heart disease
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- Valve Academic Research Consortium (VARC)[12]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.2

4.2.2 The role of Invasive techniques

Objectives

- To know the indications, risks and benefits of invasive assessment of aortic valve disease.
- To perform and interpret the results of cardiac catheterization, including retrograde crossing of the aortic valve, for hemodynamic and angiographic invasive assessment in aortic valve disease.

Knowledge

- Indications and risks for invasive assessment in aortic valve diseases.
- Pressure waveforms in aortic regurgitation.
- Techniques for the measurement of aortic valve gradient and cardiac output.
- To acknowledge the Gorlin equation and the simplified version developed by Hakki for the calculation of aortic valve area.
- To perform the aortic regurgitation severity semiquantitative assessment with angiography and to know the Sellers' Criteria.
- To be aware of the role of invasive physiological assessment of coronary artery stenoses and their limitations in patients with aortic valve disease.

Skills

- To prescribe invasive hemodynamic assessment in patients in whom is indicated.
- To perform a cardiac catheterization, including retrograde crossing of the aortic valve, for hemodynamic and angiographic assessment of aortic valve disease.

- To interpret the waveforms and to calculate the cardiac output, the mean aortic gradient and the aortic valve area.
- To identify and manage complications which occur during invasive assessment of aortic valve disease (cerebral embolism, cardiac perforation, contrast nephropathy, others).

Attitudes

- To identify patients in whom invasive assessment is not required
- Commitment to work with all members of the HT during all the phases of the diagnostic work-up of aortic valve disease.
- Commitment to provide balanced, readily understood, and complete information to the patient with aortic valve disease.

ESC topic list

- 20.3.2 Valvular Heart Disease- Diagnostic Methods- Invasive Hemodynamic Assessment
- 20.6.1 Valvular Heart Disease- Clinical- Aortic Valve Stenosis
- 20.6.2 Valvular Heart Disease- Clinical- Aortic Valve Regurgitation
- 30.3.1 Interventional cardiology – Noncoronary Cardiac Intervention – Aortic Valve Intervention

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part I; Right and left heart catheterization
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II; Invasive hemodynamic assessment
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- ESC 2020 Core Curriculum for the General Cardiologist: 4.1 Manage a patient with aortic valve regurgitation; 4.2: Manage a patient with aortic stenosis; 4.9 Manage a patient with multivalvular disease
- EAPCI Core Curriculum for Percutaneous Cardiovascular Interventions 2020 Part III Non-Coronary Track: 3.1 Transcatheter Aortic Valve Treatment: Aortic Balloon Valvuloplasty and TAVI

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.2

4.2.3 The role of biochemical markers and exercise tests

Objectives

- To understand the evolving role of available biomarkers in the diagnosis, staging and follow-up of aortic valve disease.
- To use exercise tests to help staging aortic valve disease.

Knowledge

- To acknowledge the biomarkers evidence and limitations in the management of aortic valve disease.
- Role of natriuretic peptides in the timing and selection of appropriate treatment of aortic valve disease.
- Importance of high-sensitivity troponin in patients with aortic valve disease.
- Indication for exercise tests in aortic valve disease according to ESC guidelines.

Skills

- To carefully interpret biomarkers and exercise tests according to disease staging, timing of the intervention and prognostic evaluation.
- To carefully interpret biomarkers in the follow-up of the patient undergoing TAVI

Attitudes

- Commitment to work together with all members of the HT during all phases of the diagnostic work-up of aortic valve disease.
- Commitment to provide balanced, readily understood, and complete information to the patient and reference physician about the role and significance of biomarkers determination in aortic valve disease.

ESC topic list

- 15.3.1 Chronic Heart Failure- Diagnostic Methods- Biomarkers
- 18.3.1 Acute Coronary Syndromes – Diagnostic Methods – Biomarkers
- 20.1 Valvular Heart Disease Pathophysiology and Mechanisms.
- 20.2 Valvular Heart Disease- Epidemiology, Prognosis, Outcome
- 20.3.99 Valvular Heart Disease- Diagnostic Methods- Diagnostic Methods, Other
- 20.6.1 Valvular Heart Disease- Clinical- Aortic Valve Stenosis
- 20.6.2 Valvular Heart Disease- Clinical- Aortic Valve Regurgitation

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- To understand the role of available biomarkers in the pathophysiology of aortic valve disease

- To understand the role of biomarkers in the follow-up of the patient who underwent TAVI
- See Figure 6 (condensed LoC) and Diagram LoC 4.2

4.3 TAVI indications for treatment and patient selection

4.3.1 Evidence from randomized clinical trials (RCT)

Objectives

- To understand patient selection in clinical trials
- To apply results of RCT in TAVI or surgical aortic valve replacement (SAVR) in practice
- To understand how the ESC/EACTS Guidelines for the management of valvular heart disease reflect the evidence

Knowledge

- Design, pitfalls and conclusions of RCT in TAVI and SAVR
- To appraise applicability of RCT

Skills

- To distinguish between scientific value of randomized and non-randomized clinical studies on TAVI and SAVR
- To recognize the limitations in current knowledge and understand to which patient populations the respective results are applicable to
- To recognize population profiles not studied by recent RCTs in TAVI and SAVR
- To distinguish between TAVI systems and populations based on results of their assessment in RCTs

Attitudes

- To discuss with surgical colleagues the application of the RCT trial data to a specific patient.
- To apply optimal diagnostic and treatment pathways for specific patients based on the results of recent RCTs and in reference to ESC Guidelines

ESC topic list

- 20. Valvular Heart Disease
- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome
- 20.4 Valvular Heart Disease - Treatment
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 20.4.3 Valvular Heart Disease - Treatment - Surgery
- 20.6 Valvular Heart Disease – Clinical
- 20.6.1 Valvular Heart Disease - Clinical - Aortic Valve Stenosis

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, Percutaneous management of valve bioprotheses dysfunction
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, Transcatheter aortic valve implantation

Level of competence recommendation

- To understand which patient populations are reflected in the respective clinical trials
  To apply results of RCT in TAVI or surgical aortic valve replacement (SAVR) in practice
- To understand how the ESC/EACTS Guidelines for the management of valvular heart disease reflect the evidence
- See Figure 6 (condensed LoC) and Diagram LoC 4.3

4.3.2 Evidence from national registries

Objectives

- To know national TAVI and SAVR registries in the country of current practice
- To interpret practices, regional differences and outcomes based on published national registries
- To learn short- and long-term economic assessment of TAVI therapy based on national registries

Knowledge

- National TAVI and SAVR registries: definitions, limitations, population characteristics and main outcomes
- Regional TAVI practices and their predisposing factors
- Factors influencing the outcomes of current national registries

Skills

- To follow and analyze national registry publications in the country of practice
- To adapt patient management according to available options in the region of practice
- To know the dataset collection submitted to the national registries
- To critically analyze different national registries

Attitudes

- To participate in the discussion of the results of national TAVI and SAVR registries and compare them to local practice
- To cooperate in data collection for the national TAVI registry

ESC topic list

- 20. Valvular Heart Disease
- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome
- 20.3 Valvular Heart Disease - Diagnostic Methods
- 20.4 Valvular Heart Disease - Treatment
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 20.4.3 Valvular Heart Disease - Treatment – Surgery
- 20.6 Valvular Heart Disease – Clinical
- 20.6.1 Valvular Heart Disease - Clinical - Aortic Valve Stenosis

Essential reading

- ESC Valve Durability (TAVI) Registry
- EURObservational Registry Programme (EORP) publications
- ESC Valvular Heart Disease Survey
- National TAVI registries publications

Level of competence recommendation

- To know national TAVI and SAVR registries in the country of current practice
- To interpret practices, regional differences and outcomes based on published national registries
- To learn short- and long-term economic assessment of TAVI therapy based on national registries
- See Figure 6 (condensed LoC) and Diagram LoC 4.3

4.3.3 European guidelines for TAVI and SAVR

Objectives

- To be aware and apply in clinical practice the contemporary guidelines for the management of valvular heart disease
- To acknowledge national recommendations regulating aortic stenosis management

Knowledge

- ESC/EACTS Guidelines for the management of valvular heart disease and levels of recommendations in practice

Skills

- To understand the relevant scientific evidence and rational for various guidelines
- To offer the recommended diagnostic and therapeutic pathway to patients with aortic stenosis

- To acknowledge the levels of ESC Guidelines recommendations for the diagnosis and treatment of patients with aortic stenosis
- To optimize selection between TAVI and SAVR

Attitudes

- To integrate the ESC/EACTS Guidelines for the management of valvular heart disease in the organization and workflow of the HT
- To discuss levels of recommendations in specific patients undergoing HT assessment
- To incorporate the ESC/EACTS Guidelines for the management of valvular heart disease
- In the patient shared decision-making process.

ESC topic list

- 20. Valvular Heart Disease
- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome
- 20.4 Valvular Heart Disease - Treatment
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 20.4.3 Valvular Heart Disease - Treatment - Surgery
- 20.6 Valvular Heart Disease – Clinical
- 20.6.1 Valvular Heart Disease - Clinical - Aortic Valve Stenosis

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, Transcatheter aortic valve implantation

Level of competence recommendation

- To apply the contemporary ESC Guidelines in VHD
- To know national recommendations regulating aortic stenosis management
- See Figure 6 (condensed LoC) and Diagram LoC 4.3

4.3.4 Rationale and knowledge for potential indications of TAVI: symptomatic moderate aortic stenosis (AoS) or asymptomatic significant AoS

Objectives

- To know current indications for the treatment based on symptom status, functional performance, severity, and presence of downstream cardiac damage secondary to AoS
- To consider factors associated with under- or overestimation of severity of AoS

- To determine the degree of AoS by multimodality imaging, functional test or invasive assessment

Knowledge

- Biochemical markers indicative of heart failure in AoS patients
- Echocardiographic, MSCT and CMR parameters of AoS severity
- Rationale and parameters of dobutamine stress echo.
- Exercise test role in AoS
- Invasive assessment of AoS

Skills

- To assess symptoms of aortic stenosis in the clinical context
- To review multimodal imaging and determine the AoS severity
- To perform invasive assessment of AoS

Attitudes

- To discuss available clinical data on the severity of AoS in the HT

ESC topic list

- 20. Valvular Heart Disease
- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome
- 20.4 Valvular Heart Disease - Treatment
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 20.4.3 Valvular Heart Disease - Treatment - Surgery
- 20.6 Valvular Heart Disease – Clinical
- 20.6.1 Valvular Heart Disease - Clinical - Aortic Valve Stenosis

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2017 ACC/AATS/AHA/ASE/EACTS/HVS/SCA/SCAI/SCCT/SCMR/STS 2017 Appropriate Use Criteria for the Treatment of Patients With Severe Aortic Stenosis. J Am Soc Echocardiogr. 2018 [21]
- 2020 ACC/AHA Guidelines on the Management of Valvular Heart Disease[22]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, Transcatheter aortic valve implantation

Level of competence recommendation

- To know current indications for the treatment of patient with AoS based on symptom status, functional performance, severity of AoS, and presence of downstream cardiac damage secondary to AoS
- To consider factors associated with under- or overestimation of severity of AoS

- To determine the degree of AoS by multimodality imaging, functional test or invasive assessment
- See Figure 6 (condensed LoC) and Diagram LoC 4.3

4.3.5 Patient selection: role of the Heart Team, geriatric evaluation, frailty assessment

Objectives

- To assess the entire range of patients for potential efficacy and futility
- To understand the status, composition and interdisciplinary concept of the HT, and its role in shared decision-making in the diagnosis and treatment of patients with AoS

Knowledge

- Recommendations of HT organization in structural heart disease centre
- Roles of HT members in the assessment, treatment and follow-up of patients with AoS
- Pathway of patient qualification to the treatment of AoS
- Geriatric scales used in the set of TAVI
- Frailty definitions and assessment

Skills

- To interpret imaging data and potential risks to participate in HT discussion of patients qualified to TAVI or SAVR or none
- To implement geriatric and frailty scales in the assessment of patients with AoS

Attitudes

- To actively engage into HT discussions
- To develop a collegial environment for discussion.

ESC topic list

- 20. Valvular Heart Disease
- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome
- 20.4 Valvular Heart Disease - Treatment
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 20.4.3 Valvular Heart Disease - Treatment - Surgery
- 20.6 Valvular Heart Disease – Clinical
- 20.6.1 Valvular Heart Disease - Clinical - Aortic Valve Stenosis

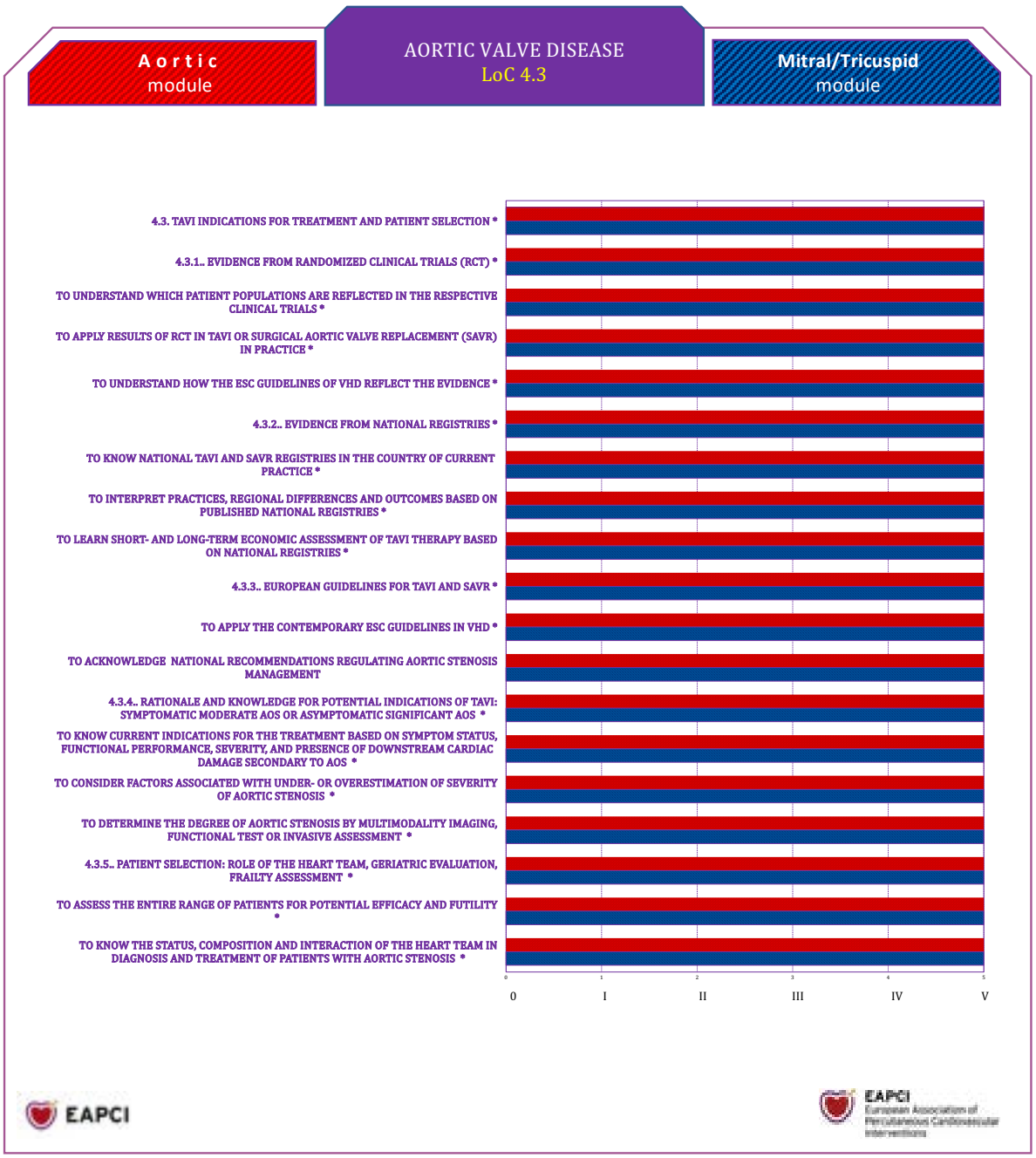
Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, Transcatheter aortic valve implantation
- Frailty and cardiac rehabilitation: A call to action from the EAPC Cardiac Rehabilitation Section Eur J Prev Cardiol. 2017[23]

Level of competence recommendation

- To assess the entire range of patients for potential efficacy and futility
- To know the status, composition and interaction of the HT in diagnosis and treatment of patients with AoS
- See Figure 6 (condensed LoC) and Diagram LoC 4.3



4.4 Transcatheter heart valves (THV) comprehensive overview, design, concept and engineering

Objectives

- To understand the construction, design and differences between aortic THV devices:
  - balloon expandable, self-expandable, mechanically expandable
  - intra-annular, supra-annular
  - bovine, porcine or other leaflets
  - with or without skirts
  - delivery system features
  - inline, fixed-bore and expandable-sheaths
- To distinguish between structural and physiological features
- To understand how to tailor the aortic THV to the individual patient

Knowledge

- The features of each system with respect to patient anatomy
- Design and specific features of THV, including delivery systems, vascular systems, assembly, frame, markers, anchoring method, radial strength curves, leaflets, skirts and imaging characteristics
- Design and specific features of surgical bioprosthetic heart valves, including frame, leaflets and suturing or expansion methods.
- Vascular access requirements with respect to patient anatomy
- Evidence in degenerated surgical aortic valves and degenerated THV

Skills

- To select the most appropriate system and size for each patient.
- To understand THV assembly and/or crimping process
- To operate and deploy aortic THV delivery systems according to their instruction for use (IFU)
- To recognize an implanted THV on echocardiography, fluoroscopy or MSCT

Attitudes

- To optimize the aortic THV center selection according to referral population
- To define the optimal timing of valve assembly and/or crimping during TAVI procedure
- To discuss and advise on optimal TAVI techniques during the procedure with the operating team according to THV design
- To explain to the patient the THV selection criteria

ESC topic list

- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 20. Valvular Heart Disease

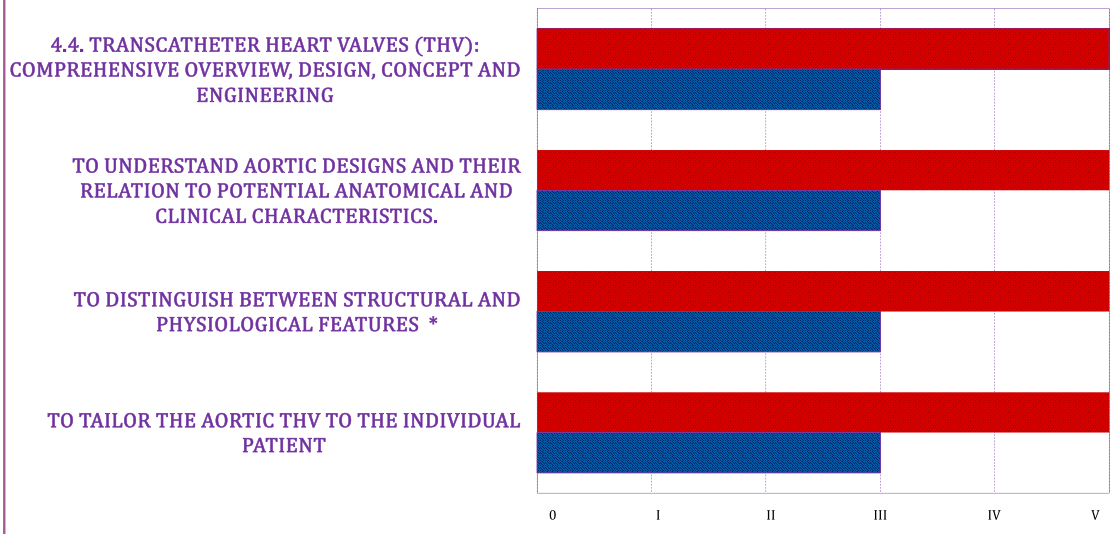
- 20.4 Valvular Heart Disease – Treatment
- 20.4.2.1 Valvular Heart Disease – Treatment – Intervention – Aortic Valve Stenosis
- 20.4.3 Valvular Heart Disease – Treatment – Surgery
- 20.6 Valvular Heart Disease – Clinical
- 20.6.1 Valvular Heart Disease – Clinical – Aortic Valve Stenosis

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III Transcatheter aortic valve implantation
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III Percutaneous management of valve bioprotheses dysfunction
- Mobile applications dedicated to THV identification and description
- IFUs of approved aortic THV systems

Level of competence recommendation

- To understand aortic designs and their relation to potential anatomical and clinical characteristics.
- To distinguish between structural and physiological features
- To tailor the aortic THV to the individual patient
- See Figure 6 (condensed LoC) and Diagram LoC 4.4


4.4. TRANSCATHETER HEART VALVES (THV): COMPREHENSIVE OVERVIEW, DESIGN, CONCEPT AND ENGINEERING
TO UNDERSTAND AORTIC DESIGNS AND THEIR RELATION TO POTENTIAL ANATOMICAL AND CLINICAL CHARACTERISTICS.
TO DISTINGUISH BETWEEN STRUCTURAL AND PHYSIOLOGICAL FEATURES *
TO TAILOR THE AORTIC THV TO THE INDIVIDUAL PATIENT
0
I
II
III
IV
V

4.5 TAVI procedural planning

4.5.1 Principles of THV selection

Objectives

- To know clinical evidence on THV safety and durability specific to their design
- To assess the anatomy of the aorto-valvular complex (dimensions, ellipticity, morphology, coronary height, sinus width, sino-tubular junction; degree, distribution and extension of calcification; horizontality) and peripheral access (diameter, calcification, tortuosity)
- To tailor THV choice to the anatomy and comorbidities (i.e. reduced left ventricular function, concomitant coronary artery disease, pre-existing conductance disturbances) of the patient.

Knowledge

- Principles of anatomy of the aorto-valvular complex and surrounding structures.
- Design and specific features of specific THV: expansion type, radial strength curves, frame height, markers, leaflet position and composition, anchoring method, skirts, delivery systems and vascular systems
- Available evidence for impact of THV design factors on safety, hemodynamics, durability and clinical outcomes
- IFU indications (CE mark approval) and procedural IFU steps to implant approved THVs
- Most common complications of individual THV designs

Skills

- To evaluate the aortic valve: annulus, sinus, sino-tubular junction, coronary assessment, degree and distribution of calcification, aortic root anatomy, leaflet number and characteristics.
- To understand the aortic THV behavior in the individual patient
- To select the optimal THV available to patient anatomy and clinical profile
- To select and optimize the vascular approach
- To recognize THV systems with optimal periprocedural and long-term clinical outcomes

Attitudes

- Provision of a balanced interpretation of opportunities and risks associated with different THV designs.
- To discuss clinical evidence for specific THV with TAVI patients
- To discuss optimal THV design tailored to patient clinical profile in the HT

- Commitment to follow the development of new THV designs in this rapidly evolving field.
- Assumption of responsibility for THV selection.

ESC topic list

- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 4.4. Cardiac Computed Tomography (CT) – Valvular Heart Disease
  8.3. Cross-Modality and Multi-Modality Imaging Topics – Imaging of Valvular Heart

Disease

- 20. Valvular Heart Disease
- 20.3.1. Valvular Heart Disease – Diagnostic Methods – Imaging
- 20.4 Valvular Heart Disease – Treatment
- 20.4.2.1 Valvular Heart Disease – Treatment – Intervention – Aortic Valve Stenosis
- 20.4.3 Valvular Heart Disease – Treatment – Surgery
- 20.6 Valvular Heart Disease – Clinical
- 20.6.1 Valvular Heart Disease – Clinical – Aortic Valve Stenosis

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, Transcatheter aortic valve implantation
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- To understand differences between aortic THV designs
- To know clinical evidence on THV safety and durability specific to their design
- To assess the anatomy of the aorto-valvular complex
- To tailor THV choice to the anatomy and comorbidities
- See Figure 6 (condensed LoC) and Diagram LoC 4.5

4.5.2 MSCT imaging skills in TAVI

Objectives

- To assess the aortic annulus, sinus, sino-tubular junction, coronary assessment, degree of calcification, aortic root anatomy, leaflet number and characteristics, LVOT anatomy, septum membranosum and valve-in-valve specificities.
- To identify the main anatomic determinants of valve sizing and selection of an appropriate THV design.
- To assess the risk of coronary obstruction in patients with valve-in-valve implantation.
- To predict the cusp overlap technique (COT) imaging projections

Knowledge

- Anatomy of the surrounding cardiac structures.
- Principles of image acquisition and interpretation for the assessment of the aorto-valvular complex.
- Difference between perimeter-derived and area-derived annular diameter and their implications for THV sizing in balloon-expandable and self-expanding prostheses.
- To acknowledge the risk of annular rupture based on localization of LVOT calcification
- To understand the intricacies of valve sizing in bicuspid anatomy.
- Implantation depth assessment.

Skills

- To conduct a quantitative assessment of the aorto-annular complex using available software and measure the dimensions of the aortic annulus and coronary ostia height.
- To identify anatomical challenges for TAVI (raphe, extent and location of calcification, associated aortopathy and LVOT calcification)
- To assess the risk of LVOT obstruction
- To identify the optimal projection angle for valve implantation with cusp coplanar view and cusp overlap view.
- To develop strategies to prevent coronary obstruction.

Attitudes

- To build a consistent analytical approach to help THV size and selection.
- To be responsible for the device choice.

ESC topic list

- 20.3.1.3 Valvular Heart Disease – Diagnostic Methods – Imaging – Cardiac Computed Tomography

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, chapter "transcatheter aortic valve implantation"
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.5

4.5.3 TAVI primary vascular access planning according to anatomy.

Objectives

- To gain an understanding of the various access routes for TAVI

- To assess suitability of femoral vascular anatomy for large-bore arterial access considering diameter, calcification and tortuosity
- To know the methods available to achieve hemostasis after large-bore arterial access

Knowledge

- To know the relevant landmarks for large bore femoral access
- To identify candidates suitable for percutaneous access and surgical cut-down.
- To understand the mechanisms of action of available vascular closure devices
- To anticipate complex transfemoral access (diameter, tortuosity, calcification) and identify strategies to facilitate transition of the delivery system through the ilio-femoral axis
- To recognize when further assessment of vascular complications is required

Skills

- The ability to gain arterial access using anatomical landmarks
- To perform ultrasound-guided vascular access
- To use micro puncture for vascular access
- The ability to navigate tortuous and calcified vessels
- To perform PTA and lithotripsy to facilitate transfemoral access, if required
- The ability to close large bore arterial access, evaluate and solve vascular complications, if required

Attitudes

- To inform the patient about vascular access options, and potential complications and their management
- To individualize choice of primary vascular access according to vascular anatomy, and to be prepared to change strategy in case of complications.
- To communicate challenges of vascular access to other members of the multi-disciplinary team and communicate effectively with vascular surgeons
- To follow the development of new devices for large-bore vascular access closure

ESC topic list

- 30.3.1 Interventional Cardiology – Noncoronary Cardiac Intervention – Aortic Valve Intervention

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II, chapter "transcatheter aortic valve implantation"
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.5

4.5.4 Challenging arterial access: the role of alternative access routes and of percutaneous interventions

Objectives

- To acknowledge that alternative access must be weighed in the decision to send to SAVR or TAVI
- To understand the role of alternative access routes (transcarotid, transaxillary (percutaneous / surgical), transaortic, transapical, transcaval) and the role of percutaneous interventions (balloon, stenting, etc)
- To understand the anatomical requirements for transfemoral access, and various alternative access routes

Knowledge

- Imaging tools required in the assessment of alternative access routes.
- Criteria for alternative access route based on anatomical characteristics and patient comorbidities
- Approach for different alternative access routes.

Skills

- The ability to select the most appropriate alternative access and coordinate the TAVI Team in the performance of the alternative access TAVI
- The ability to use techniques and perform percutaneous procedures to facilitate transfemoral access (extra-stiff wires, percutaneous transluminal angioplasty, lithotripsy, stent implantation), where available
- To participate in alternative surgical access (transcarotid, transubclavian, transaortic, transapical) and identify the relevant landmarks.
- To recognize vascular complications (dissection, rupture, thrombosis) and formulate a treatment strategy.

Attitudes

- Interdisciplinary decision making in patients with challenging access.
- Lead an informed discussion of benefits and risks associated with different access routes and THV.
- Effective communication with cardiovascular surgeons.

ESC topic list

- 30.3.1 Interventional Cardiology – Noncoronary Cardiac Intervention – Aortic Valve Intervention
- 31.2 Cardiovascular Surgery – Valves

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, chapter "transcatheter aortic valve implantation"

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.5

4.5.5 TAVI secondary vascular access planning.

Objectives

- To understand the anatomical requirements for a secondary access in each patient
- To recognize potential advantages and disadvantages of radial versus femoral approach

Knowledge

- Selection of imaging tools required for the assessment of secondary approach.
- Step-by-step technique for each alternative secondary access and potential complications
- Material necessary to perform bail-out procedures from either secondary radial or femoral access

Skills

- To use alternative secondary access routes
- To understand the steps to treat vascular complications (dissection, rupture, thrombosis) in the main access from any of the secondary accesses
- To recognize and manage specific complications of each of the alternative secondary accesses

Attitudes

- Prompt identification of complexity and call for interdisciplinary decision making in patients with challenging access regarding best secondary access.
- Informed discussion of benefits and risks associated with different secondary access routes.
- Effective communication with cardiovascular surgeons.

ESC topic list

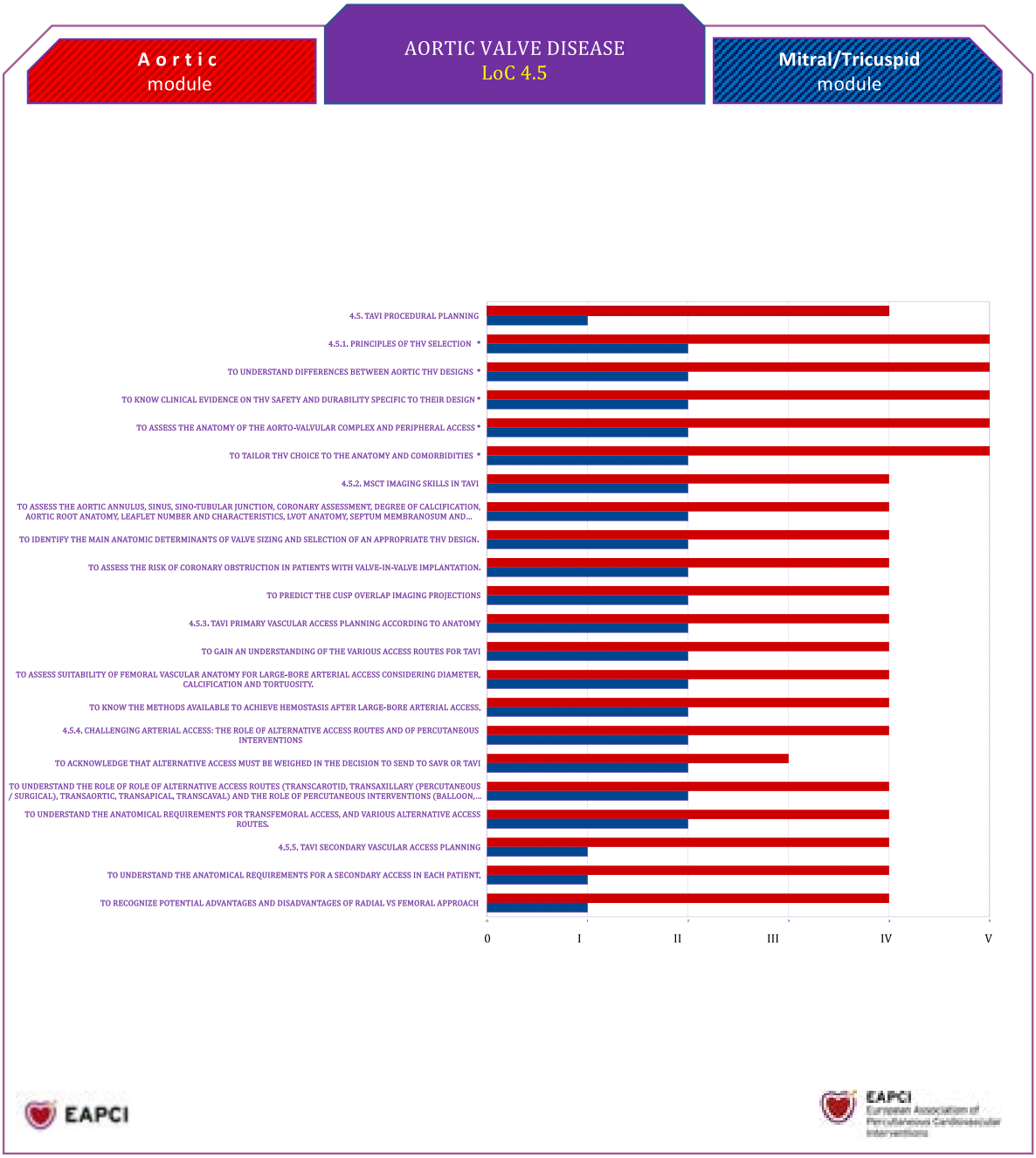
- 30.3.1 Interventional Cardiology – Noncoronary Cardiac Intervention – Aortic Valve Intervention
- 31.2 Cardiovascular Surgery – Valves

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II, chapter "transcatheter aortic valve implantation"

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.5



4.6 The TAVI procedure

4.6.1 Procedural set-up

Objectives

- To acknowledge the minimal logistic requirements for TAVI procedures: catheterization laboratory, imaging and surgical backup according to ESC guidelines with respect to Heart Valve Center
- To plan the type of anesthesia (general, conscious sedation, local anesthesia) and personnel and how to prioritize over the other
- To organize the room for femoral or alternative access procedures

Knowledge

- Risks of anesthesia for TAVI candidates
- Catheterization laboratory facilities requirements

Skills

- To determine which cases are at high risk for need to conversion to open surgery
- To identify specific risks of a particular patient (vascular injury, annular rupture, aortic dissection, etc)
- To perform percutaneous minimally invasive procedures with adequate local anesthesia
- To use the imaging tools available in the operating room

Attitudes

- To plan, organize and coordinate the teamwork during the procedure
- To lead an informed shared discussion of benefits and risks associated with different level of anesthesia
- To timely request other specialties support whenever needed

ESC topic list

- 30.3.1 Interventional Cardiology – Noncoronary Cardiac Intervention – Aortic Valve Intervention
- 31.2 Cardiovascular Surgery – Valves
- 3.4 Echocardiography – Valvular Heart Disease
- 3.10 Echocardiography – Transesophageal echocardiography (TEE)

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, chapter "Transcatheter aortic valve implantation"
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.6

4.6.2 Pharmacological strategies

Objectives

- To know and to understand the use of anti-thrombotic strategies prior to, during, and after TAVI
- To identify TAVI patients in need of individualized strategies (aspirin allergy, Type II HIT, very high bleeding risk, prior (resolved) valve thrombosis, procedural use of an embolic protection device
- To know when and to antagonize anti-thrombotic therapies

Knowledge

- Differences of anti-platelet and anti-coagulation mechanisms
- Recommendations regarding procedural management of anti-platelet and anti-thrombotic therapies (P2Y12-loading, ACT monitoring and management).
- Risk and timing of bleeding (access site, tamponade, ICH)
- Thrombotic events (stroke, coronary embolism, others)

Skills

- Evaluate TAVI patients' risk for procedural complications linked to bleeding or embolic events
- To use of ACT monitoring during TAVI, adjust heparin dose and reversal
- Appropriately select patients that may benefit from individualized anti-thrombotic and anti-coagulation management

Attitudes

- Commitment to respond vigilantly to new evidence
- Provision of a balanced interpretation of opportunities and risks associated with individualized pharmacological management

ESC topic list

- 10.5.1.5 Atrial Fibrillation (AF) – Stroke Prevention – Oral Anticoagulation – Reversal Agents
- 41.5.4 Basic Science – Vascular Diseases

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, chapter "transcatheter aortic valve implantation"
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.6

4.6.3 Large bore access

Objectives

- To understand the principles of large bore access with respect to several THV requirements
- To know the anatomical landmarks of common vascular access routes in fluoroscopy, angiography and ultrasound
- To know the benefits and drawbacks of alternative puncture methods (fluoroscopy-, angiography-, ultrasound-guided, micro-puncture)
- To assess the risks and benefits of alternative secondary vascular access routes (ipsilateral distal femoral, contralateral femoral, radial)
- To know the process and limitations of vascular closure devices
- To anticipate the potential use of secondary access routes for the management of vascular complications

Knowledge

- Integrated anatomy of the ilio-femoral system based on the MSCT scan
- Access site puncture techniques and imaging modalities in large bore arteries
- Material for the management of complications, namely bleeding, stenosis, dissection, occlusion
- Portfolio for complication management of peripheral arteries (sheath size, working length, sizing and design of peripheral balloons and covered stents, thrombectomy devices)
- Interventional imaging projections for the management of arterial complications

Skills

- To assess the anatomy (diameter, tortuosity, calcification, stenosis) of vascular access site
- To decide on the differential use of a vascular closure device
- To anticipate the risk of bleeding based on localization and distribution of vascular calcification
- To be able to perform techniques to prevent or solve access site complications (contralateral or radial access angioplasty, wire protection, pressure hemostasis, etc)

Attitudes

- A systematic approach to select the appropriate access route in anticipation of access site complications

- To adapt the anesthesia accordingly
- The ability to discuss case and complications with vascular team

ESC topic list

- 8.11 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Aortic Disease
- 8.12 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Peripheral Vascular Disease
- 28.6.1 Peripheral Vascular and Cerebrovascular Disease - Clinical - Peripheral Artery Disease

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II, chapter "Transcatheter aortic valve implantation"
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- SSee Figure 6 (condensed LoC) and Diagram LoC 4.6

4.6.4 Rapid pacing techniques

Objectives

- To achieve transient functional cardiac arrest with cardiac pacing
- To determine the individual risk and options with respect to the left-ventricular function, the revascularization status and other pathologies

Knowledge

- To understand transient circulatory depression during rapid ventricular pacing for valvuloplasty
- To know the available cardiac pacing methods to achieve cardiac pacing during TAVI: transvenous RV-pacing (femoral, brachiocephalic), transarterial LV-pacing), implantable devices (pacemaker, CDI, CRTD/P) or others
- To know the peri complications with respect to different pacing modalities

Skills

- To individualize and perform rapid pacing for BAV and deploying THV
- To obtain vascular access for a temporary pacemaker via jugular or femoral vein
- To anticipate (refractory) circulatory depression after rapid ventricular pacing
- To solve troubleshoot pacing issues: failure to capture, av node conduction and others

Attitudes

- To inform the patient about the need of rapid cardiac pacing, and potential complications and their management.

- To individualize THV implantation strategy.
- To consider the option of direct THV implantation without BAV under rapid cardiac pacing

ESC topic list

- 30.3.1 Interventional Cardiology – Noncoronary Cardiac Intervention – Aortic Valve Intervention
- 9. Arrhythmias - General

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, chapter "Transcatheter aortic valve implantation"
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.6

4.6.5 Balloon aortic valvuloplasty (BAV)

Objectives

- To select patients with the necessity of BAV prior or after THV implant
- To safely perform BAV

Knowledge

- To acknowledge the principles, benefits and risks of BAV
- To know the differences between semi-compliant or non-compliant balloons.
- To understand how to select and size the balloon for each patient

Skills

- To be able to gain vascular access and use closure devices
- To know how to cross the aortic valve and position stiff guidewires in the LV
- To accurately measure a pressure gradient across a stenotic aortic valve
- To understand how to select and size the balloon for each patient
- To perform dilation and use rapid pacing
- To know how to bail-out in case of vascular complications
- To decide when to pre and/or post-dilate

Attitudes

- To lead an informed discussion of benefits and risks associated with BAV.
- To have a structured approach on risk-assessment for balloon sizing and compliant properties
- To assess the risk for complications

ESC topic list

- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, chapter "Balloon aortic valvuloplasty"
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.6

4.6.6 Technical considerations for THV deployment

Objectives

- To understand the imaging requirements for successful TAVI procedure: angiography, echocardiography and MSCT
- To know the anatomic criteria for valve positioning and adequate sizing for each THV
- To use imaging tools and softwares in pre procedural planning
- To use multimodality to determine procedural success

Knowledge

- Parallax angulation, S-curve and COT
- Valve sizing based on MSCT and 3-D echocardiography
- To know the steps and IFU for each THV

Skills

- To integrate different imaging information
- To take advantage of fusion imaging techniques
- To adapt when facing challenging anatomies
- To be able to assess the result of the THV implantation with respect to imaging and hemodynamic findings

Attitudes

- To promote interdisciplinary decision-making in patient screening and THV selection
- To attend device-specific training courses and certifications

ESC topic list

- 30.3.1 Interventional Cardiology – Noncoronary Cardiac Intervention – Aortic Valve Intervention
- 31.2 Cardiovascular Surgery – Valves
- 3.4 Echocardiography – Valvular Heart Disease

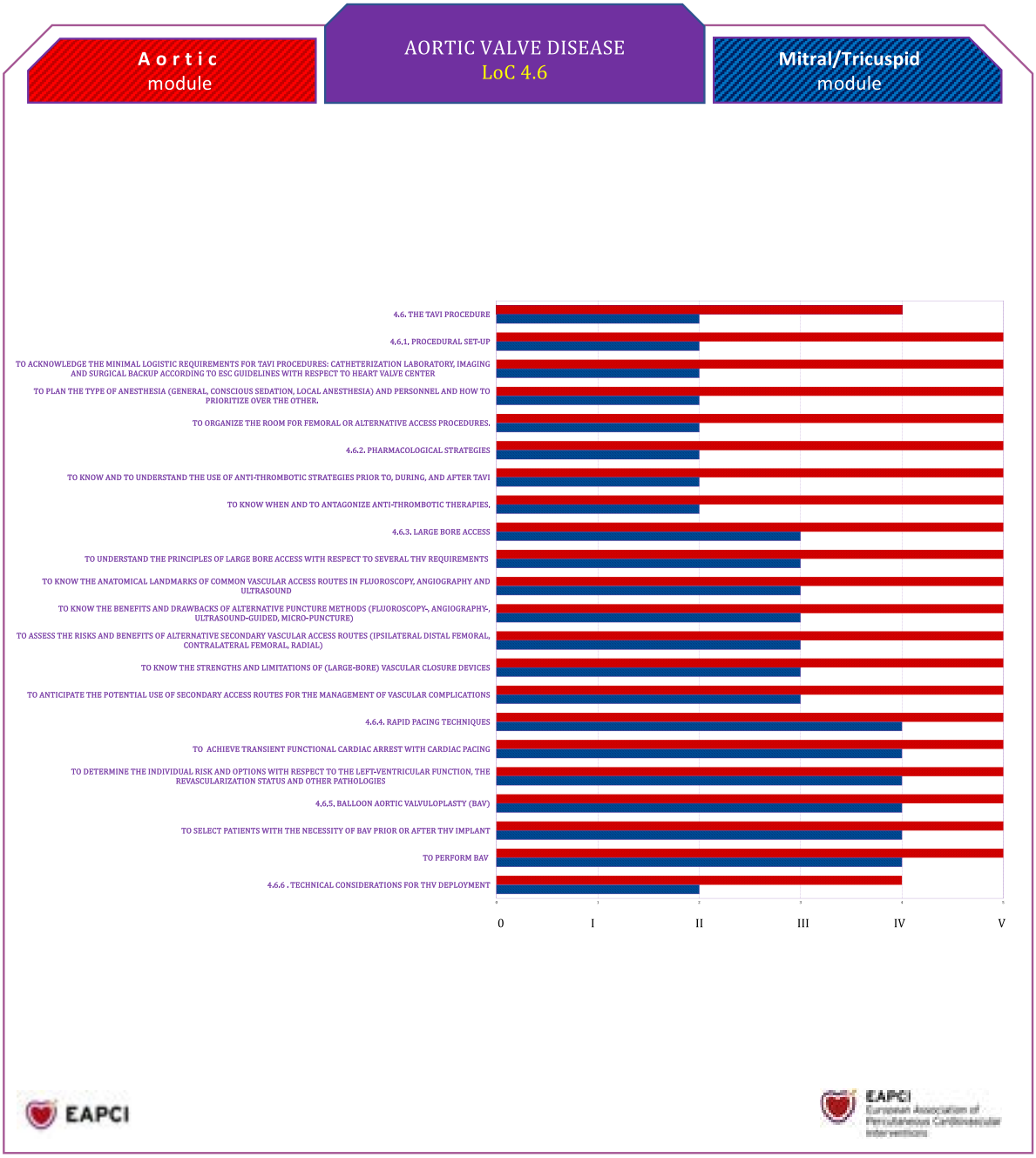
- 3.10 Echocardiography – Transesophageal echocardiography (TEE)
- 4.4 Cardiac Computed Tomography (CT) – Valvular Heart Disease

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, chapter "transcatheter aortic valve implantation"
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.6



4.7 Prediction, prevention and management of procedural complications

4.7.1 Preparation for complications: essential equipment, vascular and surgical access, team training

Objectives

- To ensure material, equipment, devices and personnel resources to respond swiftly, promptly and appropriately to possible complications
- To organize the cath lab according to ESC guidelines with respect to Heart Valve Center

Knowledge

- To acknowledge the variety of complications that may occur during a TAVI including annular rupture, LVOT obstruction, valve embolization, coronary obstruction, ventricular perforation, paravalvular regurgitation and vascular complications
- Acquire pertinent information provided by the multimodality imaging
- To know how to manage with specific complications during the TAVI procedure

Skills

- To perform an embracing pre-procedural planning considering patient's clinical and anatomic variables
- To anticipate material and equipment in the cath lab to solve all possible complications
- The ability to apply the necessary technical skills to address specific complications

Attitudes

- To discuss the risks of serious complications with the patient and family
- To coordinate and discuss with members of the multidisciplinary HT with respect to specific care pathways to manage serious complications
- To secure appropriate back-up, including other specialties

ESC topic list

- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 30.2.5 Interventional Cardiology - Percutaneous Coronary Intervention (PCI) - Complications

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III, chapter "transcatheter aortic valve implantation"
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.7

4.7.2 Vascular access: pre-procedure assessment of access site selection, procedure performance, and use of closure devices.

Objectives

- To understand the importance of access site assessment and selection in the clinical result of a TAVI procedure.
- To have thorough knowledge about the different vascular closure strategies.
- To use the correct implantation technique for closure devices.

Knowledge

- Anatomic variants and morphologic characteristics of puncture site that can be associated with vascular complications
- Classic angiographic, fluoroscopic, CT angiographic and ultrasound morphologic assessment of the arterial access site.
- Specific techniques (fluoroscopic, ultrasound, etc) for the primary percutaneous intra-arterial access namely transfemoral, transaxillary/subclavian.
- Principles of arterial cannulation by Seldinger, modified Seldinger and surgical cut-down techniques
- Principles of access in transcaval/transaortic and transcarotid routes.
- Technical use of various closure devices

Skills

- To evaluate patient, clinical, imaging, and procedure / morphologic characteristics to choose the primary and secondary access sites.
- To gain safe access to the artery using standard or adjunctive (fluoroscopic or ultrasound) methodology – selective or routinely
- To use the appropriate closure technique and device for the vascular access
- To use more than one closure device for large bore arterial access site.
- To detect a malfunctioning device/inappropriate technique while performing access site closure.
- To be prepared to use more than one access site or closure devices for an individualized choice according to the procedural needs

Attitudes

- To provide the patient with an overview of vascular access options and potential complications and clinical impact as part of informed consent for the procedure
- To develop a systematic but tailored approach concerning access site selection and closure device use.

- To discuss with the interventional team the best access site for the individual patient

ESC topic list

- 20.3.1.2- Valvular Heart Disease - Diagnostic Methods - Imaging - Cardiac Computed Tomography (CT)
- 30.2.2- Interventional Cardiology - Percutaneous Coronary Intervention (PCI) - Vascular Access
- 30.3.1- Interventional Cardiology - Noncoronary Cardiac Intervention - Aortic Valve Intervention

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part I: Fluoroscopic anatomy for the guidance of percutaneous transcatheter interventions; Vascular access; Vascular closure
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See See Figure 6 (condensed LoC) and Diagram LoC 4.7

4.7.3 Endovascular management of vascular complications: perforation, dissection, and occlusion

Objectives

- To promptly identify, assess and treat complications of large bore arterial access
- To manage the short and long-term vascular complications associated with TAVI

Knowledge

- Ilio-femoral and supra-aortic anatomy
- Pre-procedural planning to identify patients at higher risk for vascular complications
- Complications of available vascular closure devices
- Indications for intervention and conservative management

Skills

- To perform pre-procedural analysis of MSCT
- To perform and interpret control angiography and gain bailout vascular access whenever needed
- To be familiar with the various invasive or non-invasive techniques to manage failed closure devices
- To know bail-out techniques (balloon tamponade, balloon angioplasty, stenting and other)
- To manage hemodynamic instability with vascular complications

Attitudes

- To assess and discuss the risk of vascular access complications with patients and multidisciplinary team
- To implement a protocol to diagnose and treat invasively vascular complications promptly.
- To be able to treat or seek urgent specialized assistance.

ESC topic list

- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 23.4.2 Pericardial Disease - Treatment - Intervention and Surgery

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part I; "Vascular access" and "Vascular closure"
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III; Chapter: Transcatheter Aortic Valve Implantation
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.7

4.7.4 Management of bleeding complications: femoral, pericardial, and remote

Objectives

- To recognize, assess, and manage acute bleeding complications
- To manage the long-term vascular implications of bleeding

Knowledge

- Potential sources of bleeding during TAVI
- High risk factors for bleeding prior to, during, and after TAVI
- Diagnostic tools to identify the source of bleeding
- Medical and surgical treatment of acute hemodynamic instability due to major bleeding, pericardial effusion or tamponade
- Risks and benefits of the transfusion

Skills

- To manage hemodynamic instability due to major bleeding
- To perform manual and mechanical arterial compression whenever adequate
- To consider additional percutaneous closure devices to stop overt bleeding
- Use of peripheral balloons and covered stents for the control of iliofemoral or alternate access site bleeding
- To manage anticoagulation strategies in acute bleeding

- To perform urgent imaging procedures (ex: echocardiography, aortography and peripheral angiography) to promptly recognize and treat the bleeding source
- To perform emergent pericardiocentesis

Attitudes

- To assess and discuss the risk of bleeding with patients and multidisciplinary team
- To implement a protocol for the management of major bleeding in the catheterization laboratory

ESC topic list

- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 23.4.2 Pericardial Disease - Treatment - Intervention and Surgery

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III; Chapter: Transcatheter Aortic Valve Implantation
- Management of antithrombotic therapy in patients undergoing transcatheter aortic valve implantation: a consensus document of the ESC Working Group on Thrombosis and the European Association of Percutaneous Cardiovascular Interventions (EAPCI), in collaboration with the ESC Council on Valvular Heart Disease. Eur Heart J. 2021 Jun 14;42(23):2265-2269. doi:10.1093/eurheartj/ehab196. PMID: 33822924[24]
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.7

4.7.5 Conduction disorders: impact, prediction, prevention, management

Objectives

- To identify and manage patients at risk for conduction disturbances during and after the TAVI procedure, according to ESC Guidelines
- To optimize the procedural technique to prevent conduction disturbances

Knowledge

- Anatomic details of the conduction system and clinically relevant relationships
- Potential indication and utility of an electrophysiology study
- To know the indication for permanent pacemaker after TAVI
- To acknowledge the techniques that can reduce the conduction system interaction

Skills

- To correlate clinical, electrocardiographic and multimodality imaging findings in preparation for the TAVI procedure
- To use the appropriate implantation views and optimize the implant technique accordingly
- To prepare and execute venous access when indicated (internal jugular versus femoral) in anticipation for urgent pacemaker lead insertion
- To interpret baseline, intraprocedural and post procedure ECG findings
- To coordinate intraprocedural pharmacologic drugs for new conduction disturbances
- To perform temporary pacing during the TAVI procedure when indicated
- To manage new or acquired conduction disturbances
- To know how and when to monitor conduction disturbances in TAVI patients.

Attitudes

- Team-based approach regarding the need for preventive or secondary permanent pacemaker device implantation or in case of a coexisting cardiomyopathy, the need for implantable cardioverter-defibrillator (ICD) versus cardiac resynchronization therapy
- To promote outpatient monitoring post discharge when deemed beneficial

ESC topic list

- 4. Interventional management of aortic valve diseases - Prediction, prevention and management of procedural complications

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III - Intervention II - Part III Transcatheter aortic valve implantation.
- 2020 ACC Expert Consensus Decision Pathway on Management of Conduction Disturbances in Patients Undergoing Transcatheter Aortic Valve Replacement: A Report of the American College of Cardiology Solution Set Oversight Committee. Lilly SM, Deshmukh AJ, Epstein AE, Ricciardi MJ, Shreenivas S, Velagapudi P, Wyman JF. J Am Coll Cardiol. 2020 Nov 17;76(20):2391-2411[25]
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.7

4.7.6 Valve malposition: migration, embolization or ectopic deployment

Objectives

- To predict, prevent and manage valve malposition

Knowledge

- THV device implantation technique
- Predictors of valve malposition, namely predominant aortic regurgitation and calcified aortic stenosis
- Procedural techniques to reduce the risk of malposition
- Procedural techniques to reposition and/or snare THV

Skills

- To interpret aortography and parallax to assess the height of a TAVI implant
- To manage TAVI malposition using a snare catheter to reposition the valve
- To decide upon a second THV after embolization
- To provide access to circulatory support if needed

Attitudes

- To anticipate the risk of device malposition with the patient and the multidisciplinary team
- To adapt the THV device and technique of implantation to prevent migration
- To prepare treatment strategies in high-risk patients for valve migration
- To be able to discuss the treatment options with the cardiac surgical team when valve embolization occurs

ESC topic list

- 20.4.2.1 - Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 30.3.1 – Interventional Cardiology - Noncoronary Cardiac Intervention - Aortic Valve Intervention

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume II- Part III – The prevention and management of complications during percutaneous coronary intervention
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III- Part III - Transcatheter aortic valve implantation
- VARC-3
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.7

4.7.7 Paravalvular regurgitation (PVL) peri-TAVI

Objectives

- To predict, assess and manage PVL procedural TAVI
- To acknowledge the risks and benefits of post-dilation

Knowledge

- To understand the role of pre-procedural planning in identifying patients and anatomies at higher risk for PVL
- To know the importance of a multimodality approach to grade intra-procedural PVL severity: hemodynamic aortographic, echocardiographic and CMR
- To anticipate the indications and options available for treatment of chronic PVL

Skills

- To be able to interpret MSCT to optimize device selection as well as pre- and post-dilation aiming to reduce possible PVL
- To be able to safely cross a THV and perform a safe post-dilatation

Attitudes

- Commitment to work in a HT
- Provision of balanced, readily understood, and appropriate information to the patient and their family

ESC topic list

- 8.3 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Valvular Heart Disease
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 20.4.2.2 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Regurgitation

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II; Chapter: Invasive hemodynamic assessment
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III; Chapter: Transcatheter Aortic Valve Implantation
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III; Chapter: Percutaneous Closure of Paravalvular Leaks
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.7

4.7.8 Coronary obstruction: prediction, risk-assessment, prevention, management

Objectives

- To predict the risk of coronary obstruction, to undertake strategies to avoid coronary obstruction prior to and during TAVI, and to manage coronary occlusion when it occurs

Knowledge

- Risk factors and coronary occlusion presentation
- Planning strategies and techniques to prevent or mitigate coronary occlusion risk
- To know the various presentations of coronary obstruction (acute, sub-acute)

Skills

- To analyze imaging for risk of coronary occlusion
- To select the THV type and size to mitigate coronary occlusion risk
- To know when and how to perform coronary artery protection with a coronary wire, balloon and/or stent
- To deploy a bailout coronary stent in case of coronary occlusion
- To use a snare to emergently dislodge a THV that is causing coronary obstruction

Attitudes

- To discuss the risks of coronary occlusion with the patients and the HT
- To understand when to seek advice from fellow TAVI operators or proctors in cases at high-risk for coronary occlusion without a surgical option
- To be able to lead a team through a TAVI procedure in a patient at high risk for coronary occlusion

ESC topic list

- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 30.2.99 Interventional Cardiology - Percutaneous Coronary Intervention (PCI) - Percutaneous Coronary Intervention (PCI), Other

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III; Chapter: Transcatheter Aortic Valve Implantation
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III; Chapter: Ostial Lesions
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part IV; Chapter: The Heart Team
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.7

4.7.9 Aortic injury: prediction, avoidance, and management of aortic dissection and annular rupture

Objectives

- To identify anatomic risk factors for aortic root dissection and annular rupture and reduce risks during TAVI procedure

- To manage aortic root injury swiftly and appropriately

Knowledge

- Clinical and anatomic risk factors that could lead to aortic root injury
- TAVI preparation using multimodality imaging for proper THV choice and sizing

Skills

- To understand and integrate the anatomic details provided by MSCT including aortic annulus, aortic valve leaflets, sinotubular junction, sinus of Valsalva, subannular calcification, left ventricular outflow size and burden of calcification
- To reduce trauma from the catheter or wire and follow careful criteria for pre and post balloon dilatation
- To manage hemodynamic instability due to aortic injury
- To seal an annular rupture with a second transcatheter valve and/or consider emergent surgical repair versus conservative medical management and close monitoring
- To manage anticoagulation strategies in acute bleeding

Attitudes

- To discuss the risks of aortic injury with the patients and the HT
- To adapt urgent decision making and assign the tasks to the cardiac catherization staff and support personnel

ESC topic list

- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 8.11 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Aortic Disease

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III - Intervention II - Part III Transcatheter aortic valve implantation.
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.7

4.7.10 Acute hypotension: algorithm to identify cause of hypotension and acute management

Objectives

- To develop a systematic approach to prevent and treat acute hypotension episodes associated with TAVI

Knowledge

- Normal invasive arterial pressure (IAP) throughout a TAVI procedure according to device types and technical steps
- Potential causes of acute hypotension: anaphylaxis, hypovolemia, acute hemorrhage, pericardial tamponade, rhythm conduction disorders, severe aortic regurgitation, LVOT obstruction
- Vasopressor drug therapy and fluid resuscitation
- Endovascular therapies to manage acute hypotension
- Pericardiocentesis technique
- Mechanical support therapies to improve acute hypotension during TAVI

Skills

- To be able to IAP readings and understand pitfalls
- To have a systematic, thorough, and rapid assessment of the main causes for acute hypotension during TAVI
- To perform urgent imaging procedures and to be able to interpret the imaging findings
- To undertake the most appropriate steps to stabilize acute hypotension according to the underlying etiology

Attitudes

- To be able to communicate and lead a multidisciplinary team during an acute hypotensive episode
- To be able to engage other professionals in the management of acute hypotension

ESC topic list

- 16.1.1- Acute Heart Failure - Pathophysiology and Mechanisms – Haemodynamics
- 16.1.1.3- Acute Heart Failure - Diagnostic Methods - Invasive Haemodynamic Monitoring
- 16.4.1- Acute Heart Failure - Treatment – Pharmacotherapy
- 16.4.2.1- Acute Heart Failure - Treatment - Nonpharmacological Treatment - Circulatory Support
- 16.6.4.3.- Acute Heart Failure - Clinical - Cardiogenic Shock - Acute Percutaneous Mechanical Circulatory Support
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 23.4.2 Pericardial Disease - Treatment - Intervention and Surgery
- 23.6.2.- Pericardial Disease - Clinical - Pericardial Effusion

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook
- Part I - Pericardiocentesis

- Part II – Invasive hemodynamic assessment
- Part III – Cardiogenic shock
- Part III – The prevention and management of complications during percutaneous coronary intervention
- Part III - Transcatheter aortic valve implantation

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.7

4.7.11 Stroke: risk evaluation, cerebral protection devices, acute management, clinical outcomes

Objectives

- To understand risks factors associated with stroke, to minimize the risk of stroke, and to collaborate or refer to the multidisciplinary team to manage periprocedural stroke

Knowledge

- Mechanisms and risk factors for stroke associated with TAVI
- Risks and benefits of cerebral embolic protection devices
- Recognition of periprocedural stroke symptoms, timely referral for imaging and stroke classification
- Contemporary treatment of stroke

Skills

- To prescribe peri-procedural antiplatelet therapy and anticoagulation
- To use a cerebral embolic protection device
- To assess patients and optimize patient care with suspected stroke

Attitudes

- Clear communication and collegiate relationships with neuro specialist and other health care professionals
- Appropriate and timely communication with the patient and their family

ESC topic list

- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 10.6 Atrial Fibrillation (AF) - Stroke Treatment

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III; Chapter: Transcatheter Aortic Valve Implantation
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III; Chapter: Endovascular treatment of acute ischemic stroke

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.7

4.7.12 Patient prosthesis mismatch (PPM): prevention, diagnosis, outcomes

Objectives

- To understand the pathophysiology, risk factors, diagnosis, and clinical impact of PPM

Knowledge

- Pathophysiology, definition and risk factors
- Role of echocardiography in the diagnosis of PPM
- Morbidity and mortality associated with PPM

Skills

- To assess the potential of PPM
- To perform invasive hemodynamic assessment of PPM and intra-procedural echocardiography
- To perform TAVI pos-dilatation, including VIV bioprothesis valve fracture, when appropriate

Attitudes

- To be able to discuss the risk, options and impact of patient PPM with a patient and with the multidisciplinary HT
- To liaise with imaging and surgical colleagues to diagnose PPM

ESC topic list

- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III; Chapter: Transcatheter Aortic Valve Implantation
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.7

Aortic module

AORTIC VALVE DISEASE
LoC 4.7

Mitral/Tricuspid module

EAPCI

EAPCI European Association of Percutaneous Cardiovascular Interventions

4.8 Post procedural management

4.8.1 Discharge from hospital: timing, planning, execution, and liaison with family

Objectives

- Prepare a safe and timely discharge post TAVI
- Minimize the risk of an adverse event post discharge

Knowledge

- Risk criteria for adverse events following discharge
- Know how to optimize length of stay while considering patient safety as well as healthcare cost

Skills

- To review and assessment of clinical indicators post TAVI and during hospitalization
- To select patients for early or late discharge based on clinical criteria including NYHA class, hemodynamic instability, ischemic chest discomfort, cerebrovascular accidents, arrhythmias, signs of infection, kidney injury, vascular access complications, transfusion requirements, paravalvular leak.
- To evaluate patient ambulation and degree of independence and self-care and integrate in discharge planning

Attitudes

- To inform and liaise with patient and family prior to and after TAVI
- To discuss with care teams to outline multidisciplinary discharge planning
- To produce clear post-discharge follow-up plans with care-givers

ESC topic list

- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III - Intervention II - Part III Transcatheter aortic valve implantation.
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.8

4.8.2 Anti-thrombotic therapy after TAVI

Objectives

- To know the appropriate evidence based anti-thrombotic regimen after a TAVI procedure

- To prescribe anti-thrombotic regimens in specific clinical settings such as atrial fibrillation, valve-in-valve, recent acute coronary syndrome (ACS) or percutaneous coronary intervention (PCI), and especially those at high bleeding risk

Knowledge

- Anti-thrombotic regimens
- Bleeding risk scores

Skills

- To apply the current evidence-based anti-thrombotic regimen in a native aortic stenosis TAVI treated patient
- To implement a tailored anti-thrombotic regimen following TAVI according to bleeding/thrombotic risk and in specific clinical settings such as valve-in-valve procedures and atrial fibrillation

Attitudes

- To discuss with the patient the type and duration of antithrombotic therapy that will be needed after TAVI, including the benefits and risks, as part of the informed consent process. To secure his/her compliance to the therapeutic regimen
- To apply judgement, weighing up the balance between safety and effectiveness, in determining the appropriate anti-thrombotic regimen in specific clinical settings where gaps in evidence-based medicine still exist

ESC topic list

- 10.5.1.1 - Atrial Fibrillation (AF) - Stroke Prevention - Oral Anticoagulation - Indications
- 17.4.3 - Coronary Artery Disease (Chronic) / Chronic Coronary Syndromes (CCS) - Treatment – Pharmacotherapy
- 20.4.1 - Valvular Heart Disease - Treatment – Pharmacotherapy
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook: Part III - Peri-procedural and post-procedural antithrombotic pharmacotherapy ; Part III – The high bleeding risk patient; Part V – Interventional Pharmacology
- Management of antithrombotic therapy in patients undergoing transcatheter aortic valve implantation: a consensus document of the ESC Working Group on Thrombosis and the European Association of Percutaneous Cardiovascular Interventions (EAPCI), in collaboration with the ESC Council on Valvular Heart Disease. Eur Heart J. 2021 Jun 14;42(23):2265-2269. doi: 10.1093/eurheartj/ehab196. PMID: 33822924[24]
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.8

4.8.3 Clinical and imaging follow-up after TAVI: clinical review, imaging, endocarditis prevention, rehabilitation

Objectives

- To ensure appropriate follow-up of patients after TAVI

Knowledge

- Ultrasound morphology of the different TAVI prostheses, including position in the aortic root, and expected normal gradients and valve area of different valve types and sizes.
- VARC criteria to quantify paravalvular leak
- Long-term complications of TAVI, including bioprosthetic valve dysfunction and failure, subclinical and clinical leaflet thrombosis, and infective endocarditis (IE)
- Risk of late conduction disturbance
- To know current IE prophylaxis
- Indications for cardiac rehabilitation

Skills

- To use appropriate non-invasive or invasive diagnostic techniques
- To order serial clinical and imaging follow-up on an individual patient basis
- To interpret the post-TAVI ECG and respond appropriately to the findings

Attitudes

- Commitment to establish appropriate follow-up to detect early and late complications
- To work in a multidisciplinary HT with physicians and general practitioners to determine the optimal follow-up plan
- To hand over patient care to the referring clinician where appropriate
- To be able to prevent IE

ESC topic list

- 15.4.3 Chronic Heart Failure - Treatment - Rehabilitation
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III; Chapter: Transcatheter Aortic Valve Implantation
- 2015 ESC Guidelines for the management of infective endocarditis: The Task Force for the Management of Infective Endocarditis of the European Society of Cardiology (ESC). Endorsed by: European Association for Cardiac Surgery

(EACTS), the European Association of Nuclear Medicine (EANM). Eur Heart J. 2015 Nov 21;36(44):3075-3128. doi: 10.1093/eurheartj/ehv319. Epub 2015 Aug 29. PMID: 2632010926.
- Valve Academic Research Consortium 3: updated endpoint definitions for aortic valve clinical research. Eur Heart J. 2021 May 14;42 (19):1825–1857: doi.org/10.1093/eurheartj/ehaa799[12]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.8

4.8.4 Bioprosthetic valve dysfunction (BVD): definitions, operative classification and outcomes.

Objectives

- To define and categorize BVD
- To recognize the occurrence of subclinical and clinical THV thrombosis

Knowledge

- Diagnostic criteria for BVD
- Rates of bioprosthetic valve failure of transcatheter and surgical heart valves
- Treatment options for patients with BVD

Skills

- To use and interpret MSCT to determine if sub-clinical or clinical valve thrombosis is present
- To evaluate the indication for antithrombotic therapy and preventative measures
- To be aware of the requirement for follow-up imaging after initiation of treatment strategies

Attitudes

- To be able to discuss the diagnosis and management options of structural valve failure with a patient, the family, and colleagues within the HT
- To discuss the diagnosis of structural valve failure with imaging colleagues
- To discuss the work-up, diagnosis and treatment of IE with colleagues from infectious disease and cardiac surgery.
- To educate the patient regarding potential cerebrovascular complications, bleeding risks or other clinical sequalae

ESC topic list

3.99 Echocardiography - Echocardiography, Other

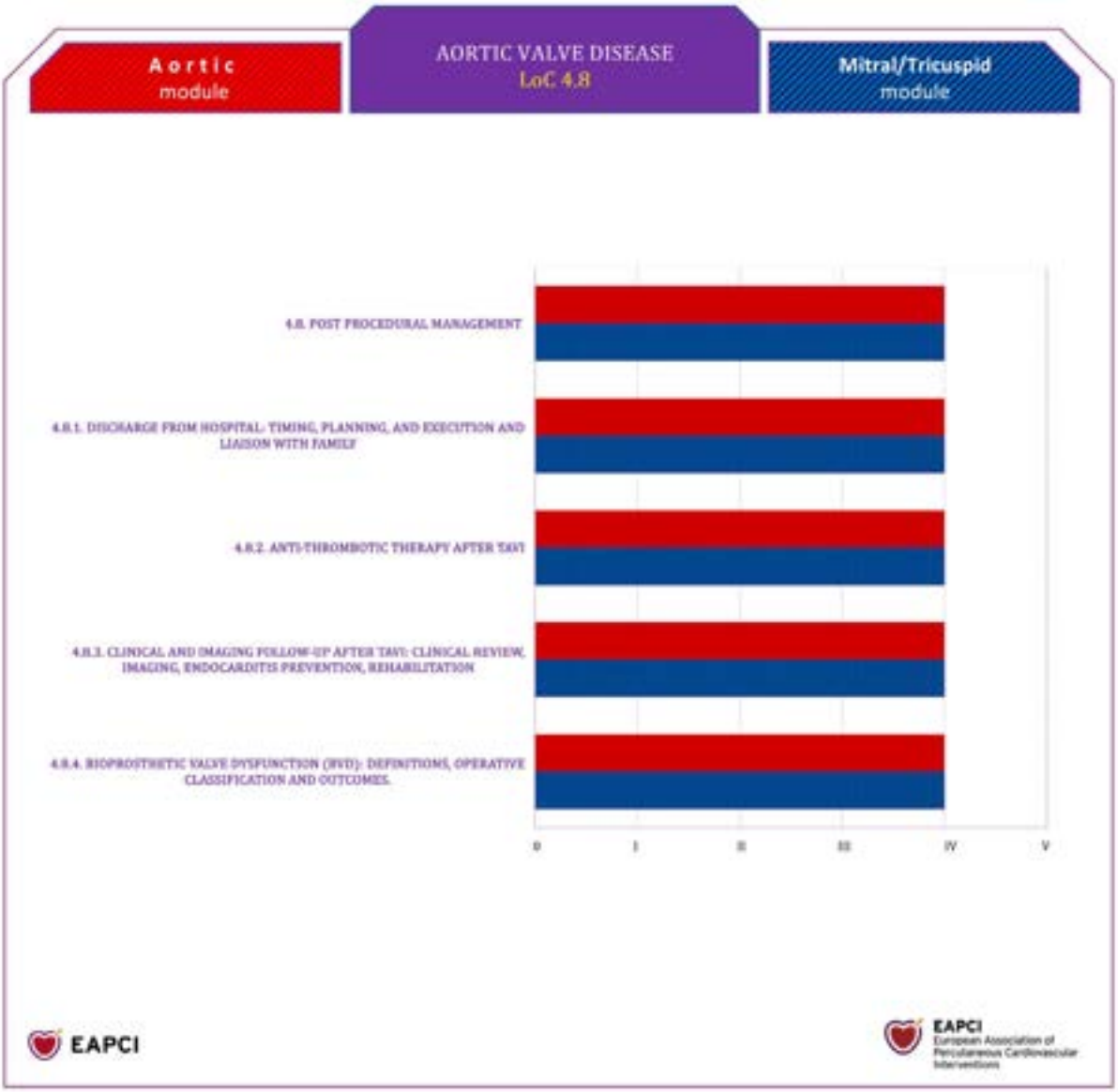
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 20 4.4 Cardiac Computed Tomography (CT) - Valvular Heart Disease

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III; Chapter: Transcatheter Aortic Valve Implantation
- Valve Academic Research Consortium 3: updated endpoint definitions for aortic valve clinical research. Eur Heart J. 2021 May 14;42 (19):1825-1857: doi.org/10.1093/eurheartj/ehaa799[12]
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.8



4.9 Specific clinical scenarios

4.9.1 Low gradient AoS: low flow, normal flow, low EF, preserved EF

Objective

- To understand the principles of echocardiographic assessment of aortic stenosis including the specific modalities within echo used to assess the severity of AoS.
- To diagnose aortic stenosis with low gradient in the setting of both low and preserved ejection fraction
- To understand the role of other forms of non-invasive testing to confirm the diagnosis of AoS.
- To perform TAVI in low gradient aortic stenosis patients

Knowledge

- Pathophysiology and etiologies of AoS, including the mechanism of low gradient AoS with both low and normal flow.
- Subgroup outcome data in patients undergoing TAVI and SAVR with low gradient AoS with preserved and reduced LVEF
- Role of multimodality imaging (TTE, TOE, MSCT, CMR) to evaluate aortic stenosis severity in the setting of low gradient AoS
- Algorithm for management of low gradient AoS
- Impact of low gradient AoS on procedural risk and clinical outcome.

Skills

- To be able to understand and interpret echocardiographic data in low gradient AoS
- To be able to select the appropriate non-invasive modalities to compliment echocardiography and correctly identify true severe AoS
- To be able to perform TAVI in this patient population, when indicated, understanding procedural considerations to minimize risk

Attitudes

- To adhere to a HT approach in the evaluation and discussion in managing these patients
- To discuss treatment options including the risks and benefits with the patient

ESC topic list

- 20.2 - Valvular Heart Disease – Epidemiology, Prognosis, Outcome
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis

Essential Reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume I- Part II – Diagnostic cardiovascular modalities and their application: Non-invasive imaging for structural heart disease; Invasive hemodynamic assessment
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.9

4.9.2 TAVI and coronary artery disease (CAD)

Objective

- To understand when to appropriately select either coronary angiography, physiologic measurement and/or MSCT prior to TAVI
- To risk stratify patients with CAD prior to TAVI
- To understand the anatomic and clinical considerations with respect to revascularization strategy in the setting of planned TAVI
- To be able to select the most appropriate THV to facilitate coronary re-access in patients who may require PCI after TAVI

Knowledge

- Impact of significant CAD on outcome in patients undergoing TAVI
- Evaluation of coronary lesions in patients undergoing TAVI using multiple modalities including OCT, IVUS, and functional assessment
- Aortic root anatomy delineated by MSCT imaging in guiding the management of CAD in patients undergoing TAVI
- Technical challenges and solutions in achieving coronary access after TAVI, according to THV type and root anatomy
- To know THV dimensions including commissure and leaflet heights, and optimal guiding catheter choice

Skills

- To be able to understand and interpret CAD angiographic and MSCT findings and their relevance to TAVI patient planning
- To be able to perform TAVI commissural alignment
- To identify patients in whom coronary protection should be considered during the procedure
- To be able to perform coronary angiography and PCI in the post TAVI patient

Attitudes

- To adhere to a HT approach in the evaluation, discussion, and management of these patients
- To tailor TAVI and PCI therapy to the individual patient to ensure a good long-term outcome.

ESC topic list

- 20.2 - Valvular Heart Disease – Epidemiology, Prognosis, Outcome
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 20.4.2.2 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Regurgitation

Essential Reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume II Part II – Diagnostic cardiovascular modalities and their application: Non-invasive imaging for structural heart disease; Invasive hemodynamic assessment
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.9

4.9.3 TAVI in bicuspid aortic valves

Objectives

- To understand the epidemiology, pathophysiology and natural history of bicuspid aortic valve disease
- To understand and risk stratify patients with bicuspid aortic disease prior to TAVI
- To understand the key anatomic and clinical considerations when performing TAVI in bicuspid aortic valve disease.

Knowledge

- To know and be able to classify patients anatomically according to the MSCT using the Sievers and/or the international consensus classification.
- To acknowledge the difference between virtual basal ring and virtual raphe ring and its anatomical implication in THV pre-procedural planning
- To understand the role of aortic root anatomy delineated by MSCT, and to be aware of the association of aortopathy with bicuspid anatomy, and its impact on management and the TAVI procedure
- To understand the unique technical challenges and increased risks associated with TAVI in bicuspid aortic valves.

Skills

- To be able to interpret MSCT data in the bicuspid aortic valve disease patient and risk stratify accordingly
- To be able to perform TAVI in bicuspid aortic valves and adopt techniques tailored to the specific anatomy
- To understand the factors affecting THV selection according to the anatomy

Attitudes

- To adhere to a HT approach in the evaluation, discussion, and management of patients with bicuspid anatomy
- To understand the important role that surgical intervention plays in the management of these patients.

SC topic list

- 20.2 - Valvular Heart Disease – Epidemiology, Prognosis, Outcome
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis

Essential Reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume I- Part II – Diagnostic cardiovascular modalities and their application: Non-invasive imaging for structural heart disease; Invasive hemodynamic assessment
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- A classification system for the bicuspid aortic valve from 304 surgical specimens. J Thorac Cardiovasc Surg. 2007 May;133(5):1226-33. doi: 10.1016/j.jtcvs.2007.01.039[27]
- International consensus statement on nomenclature and classification of the congenital bicuspid aortic valve and its aortopathy, for clinical, surgical, interventional and research purposes. Eur J Cardiothorac Surg. 2021 Sep 11;60(3):448-476. doi: 10.1093/ejcts/ezab038[28]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.9

4.9.4 TAVI for aortic regurgitation (AR)

Objectives

- To understand and interpret aortic root anatomy in aortic regurgitation (AR) patients, including calcium distribution
- To know the different THV platforms and to understand their limitations
- To perform TAVI in AR

Knowledge

- Interpret MSCT planning including aortic root calcification and dimensions
- To know THV designs and failure modes

Skills

- To optimize planning with respect to THV selection and sizing
- To master the technique of TAVI and bail-out in case of THV mal-positioning
- To use temporary pacing to stabilize the THV during deployment

Attitudes

- To operate in HT context and engage in a shared decision-making process
- To manage procedural expectations

ESC Topic List

- 30.3.1 Noncoronary Cardiac Intervention – Aortic Valve Intervention
- 20.4.2.2 Valvular Heart Disease Treatment – Intervention – Aortic Valve regurgitation
- 20.6.2 Valvular Heart Disease Clinical – Aortic Valve Regurgitation
- 20.3.1.1 Valvular Heart Disease – Diagnostic Methods – Imaging – Echocardiography
- 20.3.1.2 Valvular Heart Disease – Diagnostic Methods – Imaging – Cardiac Computed Tomography

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook PART III Transcatheter Aortic Valve Implantation
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[8]

Level of competence recommendation

- Risk stratification
- To communicate to colleagues, patient and family
- To perform TAVI
- See Figure 6 (condensed LoC) and Diagram LoC 4.9

4.9.5 TAVI for valve in valve (VIV): TAVI in SAVR and TAVI in TAVI

Objectives

- To risk stratify and select proper candidates for safe VIV TAVI
- To optimize outcome in the context of a failing surgical or transcatheter aortic bioprosthesis

Knowledge

- To know the failure modes of surgical or transcatheter aortic bioprostheses
- To master multimodality imaging (angiography, echo and MSCT) for diagnosis and planning of VIV procedures

- To recognize the risk of patient-prosthesis-mismatch (PPM) and coronary occlusion

Skills

- To identify patients at high risk of PPM or coronary occlusion
- To anticipate the technical and anatomical challenges of coronary catheterization after VIV
- To understand the principles of coronary preservation techniques (BASILICA, Chimney and others)
- To master the technique of VIV TAVI and to strive to optimize PPM in relation to THV choice, implantation height and bioprosthetic valve fracture, particularly in small anatomies

Attitudes

- To anticipate potential complications and adopt preventive technical and team measures to mitigate difficulties
- To operate in a multi-disciplinary HT context and be able to engage in a shared decision-making process

ESC Topic List

- 20.4.2.1 Valvular Heart Disease Treatment – Intervention – Aortic Valve Stenosis
- 20.6.1 Valvular Heart Disease Clinical – Aortic Valve Stenosis
- 30.3.1 Noncoronary Cardiac Intervention – Aortic Valve Intervention
- 20.4.3 Valvular Heart Disease – treatment – Surgery
- 20.3.1.1 Valvular Heart Disease – Diagnostic Methods – Imaging – Echocardiography
- 20.3.1.2 Valvular Heart Disease – Diagnostic Methods – Imaging – Cardiac Computed Tomography

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook PART III Transcatheter Aortic Valve Implantation
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook PART III Percutaneous management of valve bioprothesis dysfunction
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[8]

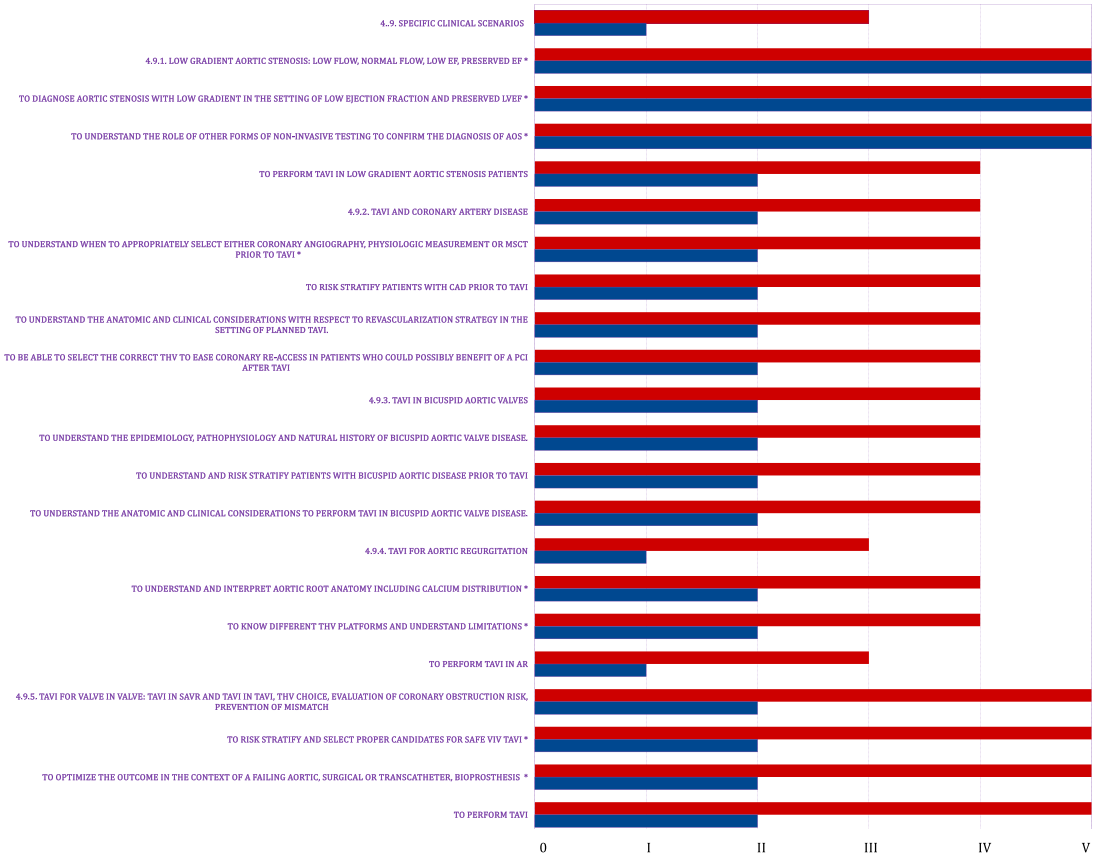
Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 4.9

Aortic module

AORTIC VALVE DISEASE
LoC 4.9

Mitral/Tricuspid module



5. Interventional management of mitral valve diseases

5.1 Clinical and imaging evaluation of mitral valve disease

5.1.1 Epidemiology of mitral valve disease

Objectives

- To understand the demographic distribution of congenital and acquired mitral valve disease according to etiology
- To understand the age-, gender-, and geographic-dependent increase in mitral valve disease prevalence and its impact on the health care system

Knowledge

- Heart valve disease epidemiology in different regions according to wealth and other geographical factors
- Prevalence of different etiologies of mitral valve disease, and its relationship to other valvular heart diseases
- Current access to mitral valve therapies

Skills

- To become familiar with the contemporary epidemiology of heart valve disease
- To interpret and review the nature and impact of mitral valve disease, including its prevalence and progression over time
- To interpret mitral valve disease etiology using multiple diagnostic tools
- To develop specific therapeutic strategies according to disease etiology in order to optimize outcomes

Attitudes

- To study the current barriers in the diagnosis and treatment of mitral valve disease
- To develop plans to overcome the challenges addressing patients, family, colleagues, centers and decision makers

ESC topic-list

- 20.2 - Valvular Heart Disease – Epidemiology, Prognosis, Outcome

Essential Reading

- The ESC Textbook of Cardiovascular Medicine, 3rd edition
- 7.6: Epidemiology and global burden of rheumatic heart disease
- 35.4: Mitral regurgitation
- 35.5: Mitral stenosis
- 36.1: Epidemiology and physiopathology

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.1

5.1.2 Anatomy of mitral valve

Objectives

- To know the anatomy of the mitral valve apparatus and its physiological and pathological variations
- To understand how disease affects mitral valve anatomy and function

Knowledge

- Size and shape of the mitral apparatus, and its anatomical relationship with other cardiac structures
- Histopathological characteristics of the mitral apparatus
- Physiological impact of anatomical and pathological variations in the mitral apparatus

Skills

- To plan a mitral valve procedure according to patient-specific anatomy
- To interpret intra-procedural echocardiographic, angiographic, and fusion images

Attitudes

- To explain, prescribe and select appropriate diagnostic examinations according to the individual patient
- To interact with all members of the HT, particularly imaging specialists, during all stages of therapy

ESC topic list

- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome
  20.3 Valvular Heart Disease - Diagnostic Methods

Essential Reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II – Diagnostic cardiovascular modalities and their application: Non-invasive imaging for structural heart disease
- 2021 ESC/EACTS Guidelines for the management of valvular heart diseas[11]

Level of competence recommendation

- To critically prescribe, interpret and review several anatomical mitral diagnostic exams
- To interpret intra-procedural echocardiographic, angiographic, and fusion images
- See Figure 6 (condensed LoC) and Diagram LoC 5.1

5.1.3 Multimodality imaging for the mitral valve

Objectives

- To understand the indication for single or multiple cardiac imaging modalities in the context of different types of mitral valve disease, and different planned therapies
- To select, interpret, and integrate imaging of mitral valve anatomy from multiple imaging modalities including 2D, 3D, and stress-echocardiography, MSCT, CMR, and others
- To use imaging data to determine the most appropriate therapeutic strategy, and for pre-procedural planning

Knowledge

- Basic principles of 2D and 3D echocardiography, MSCT and CMR
- How to use multiple modalities including qualitative and quantitative parameters.
- To acknowledge the limitation of different imaging techniques
- To understand the principles of stress testing, including treadmill, bicycle, handgrip exercise, and sympathomimetic stress tests
- To understand radiation exposure with different imaging modalities

Skills

- To choose the most appropriate diagnostic algorithm to reach a correct determination of the etiology and severity of mitral valve disease
- To interpret the results of imaging examinations, and to extract prognostic and therapeutic information regarding the underlying mitral valve disease
- To ensure safety through understanding the different imaging modalities, their benefits, and their potential side effects

Attitudes

- To engage the patient in the objectives and results of multimodality imaging[a]
- To define protocols to optimize utilization of diagnostic imaging

ESC topic list

- 20.3.1- Valvular Heart Disease – Imaging
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography

Essential Reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The ESC Textbook of Cardiovascular Medicine, 3rd edition - 15.1: Choice of imaging techniques
- ESC Textbook of Cardiovascular Imaging, 2nd edition – chapter 1-2; 12: Mitral valve stenosis; 13: Mitral valve regurgitation

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.1

5.1.4 The pathophysiology of mitral valve disease

Objectives

- To know the etiology of mitral valve
- To understand the pathophysiological changes in hemodynamics, and their impact on heart function and circulation.
- To stage mitral valve disease and plan the timing of intervention
- To understand how different therapeutic strategies can impact on pathophysiological mechanisms

Knowledge

- Primary and secondary causes of mitral regurgitation (MR) and mitral stenosis (MS)
- Hemodynamics and pathophysiology of MR and MS, and their impact on the heart and circulation
- Natural history, prognosis, symptoms and clinical signs of MR and MS

Skills

- To evaluate symptoms and signs of mitral valve disease, and to use appropriate diagnostic modalities to confirm clinical suspicion
- To identify anatomo-pathological correlations and understand their implications in different therapeutic options
- To merge pathophysiological and clinical information with imaging findings to stage the disease, to optimize therapy and to define the appropriate timing for intervention

Attitudes

- To provide balanced, understandable, and appropriate information to the patient on the predicted clinical course and timing of intervention
- To integrate the main pathophysiological changes in the HT decision making process

ESC topic-list

- 20.1 - Valvular Heart Disease – Pathophysiology and Mechanisms

Essential Reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II – Diagnostic cardiovascular modalities and their application: Non-invasive imaging for structural heart disease

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II – Diagnostic cardiovascular modalities and their application: Invasive hemodynamic assessment

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.1

5.2 Mitral stenosis (MS)

5.2.1 MS pathophysiology and natural history

Objectives

- To know the demographic distribution of rheumatic and degenerative MS
- To know the natural history of MS according to the specific etiology and pathology
  To understand how to evaluate patients with MS and to assess their co-morbidities

Knowledge

- Principles of epidemiology, classification, pathophysiology, grading, imaging and clinical features of different stages of MS
- Pathophysiological changes in cardiac hemodynamics in MS, and their cardiovascular impact
- Management of clinically significant MS
- Appropriate serial imaging surveillance of asymptomatic patients with MS
- Risk stratification in MS patients to guide decision-making between medical therapy vs intervention, particularly for elderly patients

Skills

- The ability to evaluate the clinical features of MS, and to utilize different diagnostic modalities to achieve a correct diagnosis and staging
- The ability to recognize the importance of significant comorbidities (CAD, PAD, other valvular disease, respiratory disease, renal failure, liver failure etc.) and their impact on management, particularly intervention

Attitudes

- To facilitate patient understanding of the disease process, guided by clear and appropriate information predicting the clinical course, timing and type of intervention
- To collaborate in the HT decision making process to select the best treatment strategy

ESC topic list

- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome

Essential Reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II – Diagnostic cardiovascular modalities and their application: Non-invasive imaging for structural heart disease; Invasive hemodynamic assessment

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.2

5.2.2 MS imaging, diagnosis and percutaneous stratification

Objectives

- To understand the use of echocardiographic imaging for diagnosis, evaluation of prognosis, and for supporting treatment decisions and monitoring therapy in patients with MS by providing morphological, functional and etiological information.
- To identify patients with MS that will benefit from gradient reduction with balloon mitral commissurotomy (BMC) or transcatheter mitral valve intervention (TMVI)
- To conduct follow-up of patients after transcatheter mitral valve treatment

Knowledge

- Principles of echocardiographic imaging and valvular heart disease assessment
- Role of echocardiographic imaging (TTE and TOE) to define mitral valve anatomy and function, as well as to determine etiology and mechanism of MS
- Role of multimodality echocardiography to investigate mitral valve anatomy suitability for BMC or TMVI

Skills

- To provide multimodality echocardiographic imaging of the mitral valve apparatus to reach a proper diagnosis with respect to the etiology and severity of MS
- To integrate clinical and echocardiographic data to provide prognostic information to guide management for the individual MS patient
- To interpret the results of multimodality echocardiographic assessment of mitral valve anatomy to identify patients who may benefit from percutaneous treatment

Attitudes

- To organize multimodality imaging to guide the decision-making process
- Commitment to work together with the cardiovascular imaging expert to fully explore the potential of complementary imaging techniques

ESC topic list

- 3.4 Echocardiography - Valvular Heart Disease
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 20.3.1.1 Valvular Heart Disease – Diagnostic Methods – Imaging – Echocardiography
  20.4.2.3 Valvular Heart Disease – Treatment – Intervention – Mitral Valve Stenosis

Reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- Baumgartner H, Hung J, Bermejo J, Chambers JB, Evangelista A, Griffin BP, Iung B, Otto CM, Pellikka PA, Quiñones M; EAE/ASE. Echocardiographic assessment

of valve stenosis: EAE/ASE recommendations for clinical practice. Eur J Echocardiogr. 2009 Jan;10(1):1-25. doi: 10.1093/ejechocard/jen303. Epu 2008 Dec 8. Erratum in: Eur J Echocardiogr. 2009 May;10(3):479[29]

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II –Non-invasive imaging for structural heart disease.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.2

5.2.3 Surgical treatment for mitral stenosis

Objectives

- To know the indications for surgical treatment of MS
- To be able to participle in a HT discussion on the treatment of patients with MS

Knowledge

- To understand how the morphological features of the underlying MS can influence the choice of surgical technique
- To know the different surgical techniques available for the treatment of MS
- To evaluate the risk / benefit ratio of a surgical procedure for a given patient

Skills

- To interpret imaging examinations in cooperation with cardiovascular imaging specialist colleagues
- To discuss with cardiac surgeons all the therapeutic options available for a given patient
- To direct patients to the appropriate surgical treatment according to individual clinical and anatomical characteristics

Attitudes

- To commit to follow and critically appraise relevant scientific evidence in the field of MS intervention
- To build trusting partnerships with cardiac surgeons
- To interact with all members of the HT to direct patients to the appropriate therapy
- To plan patient follow-up after surgical valve treatment

ESC topic list

20.4.2.3 Valvular Heart Disease – Treatment – Intervention – Mitral Valve Stenosis

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III – Percutaneous interventions for cardiovascular disease – Percutaneous balloon mitral commissurotomy
- PCI textbook Tips and Tricks of new techniques beyond stenting – Part II Therapeutic procedures – Transseptal puncture and percutaneous mitral valvuloplasty
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.2

5.2.4 Risk stratification, technical aspects and results of balloon mitral commissurotomy (BMC) for MS

Objectives

- To identify appropriate indications for BMC based on individual patient anatomy and risk
- To perform BMC safely and effectively

Knowledge

- Risk scores and anatomical predictors of BMC
- Mechanisms of action of BMC, technical steps, and potential complications
- Equipment and materials required for BMC

Skills

- To recognize mitral stenosis anatomy suitable for BMC, including the use of the Wilkin's score, based on echocardiographic images
- To perform transeptal puncture and use the Inoue balloon
- To manage complications

Attitudes

- To prescribe adequate diagnostic examinations according to the clinical pathway of the patient
- To apply evidence-based medicine and current guidelines on treatment of mitral valve diseases
- To commit enough time for a well-structured learning curve
- To provide balanced, readily and individualized information regarding the risks and benefits of the BMC procedure
- To interact with HT members, especially imaging specialists, during all phases of therapy

ESC topic list

- 20.4.2.3 Valvular Heart Disease – Treatment – Intervention – Mitral Valve Stenosis
- 30.3.2 Interventional Cardiology – Noncoronary Cardiac Intervention – Mitral Valve Intervention
- 20.4.2.3 Valvular Heart Disease – Treatment – Intervention – Mitral Valve Stenosis
- 25.3 Congenital Heart Disease and Paediatric Cardiology – Diagnostic Methods
- 30.3.2 Interventional Cardiology – Noncoronary Cardiac Intervention – Mitral Valve Intervention

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III – Percutaneous interventions for cardiovascular disease – Percutaneous balloon mitral commissurotomy
- PCI textbook Tips and Tricks of new techniques beyond stenting – Part II Therapeutic procedures – Transseptal puncture and percutaneous mitral valvuloplasty

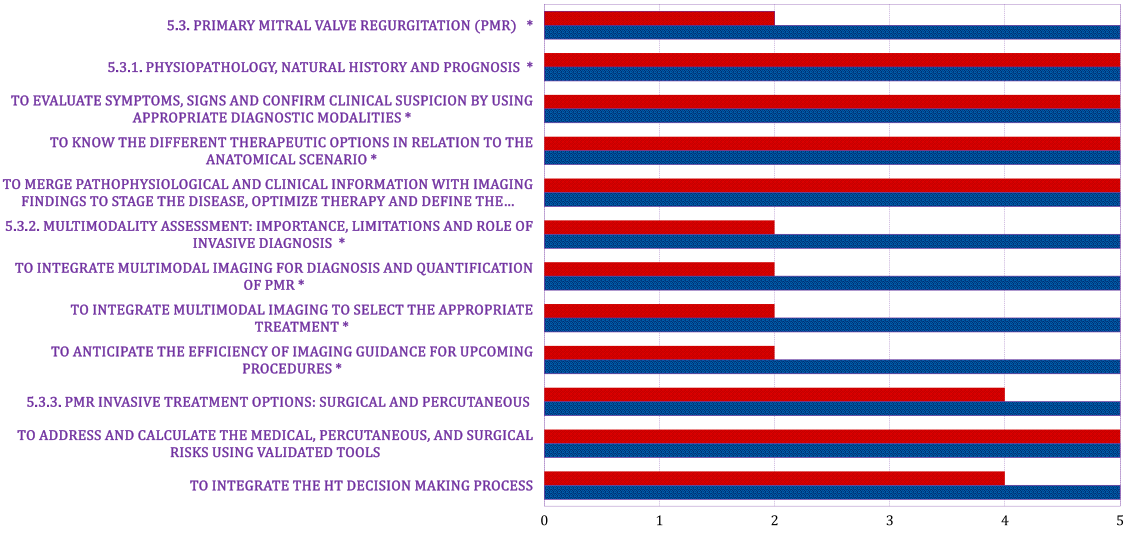
Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.2

Aortic module

AORTIC VALVE DISEASE
LoC 5.2

Mitral/Tricuspid module



5.3 Primary mitral valve regurgitation (PMR)

5.3.1 Physiopathology, natural history and prognosis

Objectives

- To understand the pathological substrates of PMR according to different etiologies
- To interpret physio-pathological changes and provide information about the severity of the disease and its natural history as well as treatment options
- To identify patients who may benefit from either medical or invasive therapies

Knowledge

- Normal mitral valve anatomy and function and relationship with other cardiac structures
- Pathophysiology, epidemiology, natural history, clinical presentation and prognosis of PMR
- Hemodynamics consequences of acute and chronic PMR on the LV, left atrium, pulmonary artery and right-sided heart structures
- To know the factors associated with progressive disease and unfavorable prognosis

Skills

- To evaluate symptoms, signs and confirm clinical suspicion of PMR by using appropriate diagnostic modalities
- To understand different anatomic scenarios causing PMR and their implication in the therapeutic path
- To combine pathophysiological and clinical information with imaging findings to stage the disease, optimize therapy and define the appropriate timing for intervention

Attitudes

- To provide balanced, readily and appropriate information to the patient on the predicted clinical course and timing of intervention
- To lead the HT decision making process to get a tailored treatment strategy, integrating clinical information and multimodality imaging assessment

ESC topic list

- 20.1 – Valvular Heart Disease – Pathophysiology and Mechanisms
- 20.6.4 Valvular Heart Disease – Clinical – Mitral Valve Stenosis
- 20.6.5 – Valvular Heart Disease – Clinical – Mitral Valve Regurgitation
- 20.6.10 – Valvular Heart Disease – Clinical – Rheumatic Heart Disease

Essential Reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II – Diagnostic cardiovascular modalities and their application: Non-invasive imaging for structural heart disease; Invasive hemodynamic assessment

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.3

5.3.2 Multimodality assessment: importance, limitations and role of invasive diagnosis

Objectives

- To understand the value of multimodal imaging for the assessment of PMR
- To understand the type of information provided by different imaging modalities and their limitations for the evaluation of PMR
- To determine the invasive hemodynamic parameters of MR on the ventricles, the atria, the pulmonary bed and on other cardiac structures

Knowledge

- Principles of echocardiographic studies (TEE, TOE, 3D-TOE) exploring the mechanism and the anatomical lesions of PMR
- Invasive assessment of acute and chronic PMR
- Importance of MSCT study of the anatomy and the dimensions of the mitral valve in PMR
- Role of CMR for PMR
- Limitations and pitfalls of echocardiography, MSCT, CMR and invasive diagnosis for the diagnosis of PMR and the planning of transcatheter interventions

Skills

- To interpret and integrate multimodal imaging for diagnosis and quantification of PMR
- To interpret and integrate multimodal imaging to select the appropriate treatment
- To anticipate the efficiency of imaging guidance for upcoming procedures

Attitudes

- To correlate patient symptoms with imaging findings
- To lead multidisciplinary HT discussion about evaluation and treatment options for PMR
- To explain different imaging modalities and their sequence of utilization to patients suffering from PMR

ESC topic list

- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 20.3 Valvular Heart Disease - Diagnostic Methods
- 20.3.1 Valvular Heart Disease - Diagnostic Methods - Imaging
- 20.3.1.1 Valvular Heart Disease - Diagnostic -Method- - Imaging - Echocardiography
- 20.3.1.2 Valvular Heart Disease - Diagnostic -Method- - Imaging - Cardiac Computed Tomography (CT)
- 20.3.1.3 Valvular Heart Disease - Diagnostic -Method- - Imaging - Cardiac Magnetic Resonance (CMR)
- 20.3.1.4 Valvular Heart Disease - Diagnostic -Method- - Imaging - Nuclear Imaging
- 20.3.1.99 Valvular Heart Disease - Diagnostic -Method- - Imaging - Imaging, Other
- 20.3.2 Valvular Heart Disease - Diagnostic Methods Hemodynamic Assessment
- 20.3.99 Valvular Heart Disease - -Diagnostic Methods - Diagnostic Methods, Other

Essential Reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II – Diagnostic cardiovascular modalities and their application: Cardiac biomarkers; Imaging for peripheral artery disease; Invasive hemodynamic assessment Updated chapter

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.3

5.3.3 PMR invasive treatment options: surgical and percutaneous

Objectives

- To know the different treatment options available
- To stratify risk and propose the patient treatment plan priorities within the HT decision making process

Knowledge

- Individual risk stratification tools
- To know the available therapeutic options for PMR strength and weakness, both surgical and percutaneous
- To acknowledge the clinical and echocardiographic predictors of residual or recurrent MR

Skills

- To address and calculate the medical, percutaneous, and surgical risks using validated tools

- To tailor and timely propose the best therapeutic option, surgical or percutaneous, on the anatomical features and surgical risk of the patient
- To provide balanced, understandable, and appropriate information to the patient

Attitudes

- To coordinate the HT decision making process to integrate clinical information and multimodality imaging assessment
- To provide therapeutic options according to anatomical findings, comorbidities , surgical risk and active engagement in shared decision-making
- To support and follow patients in their clinical course according to their profile and decision

ESC topic list

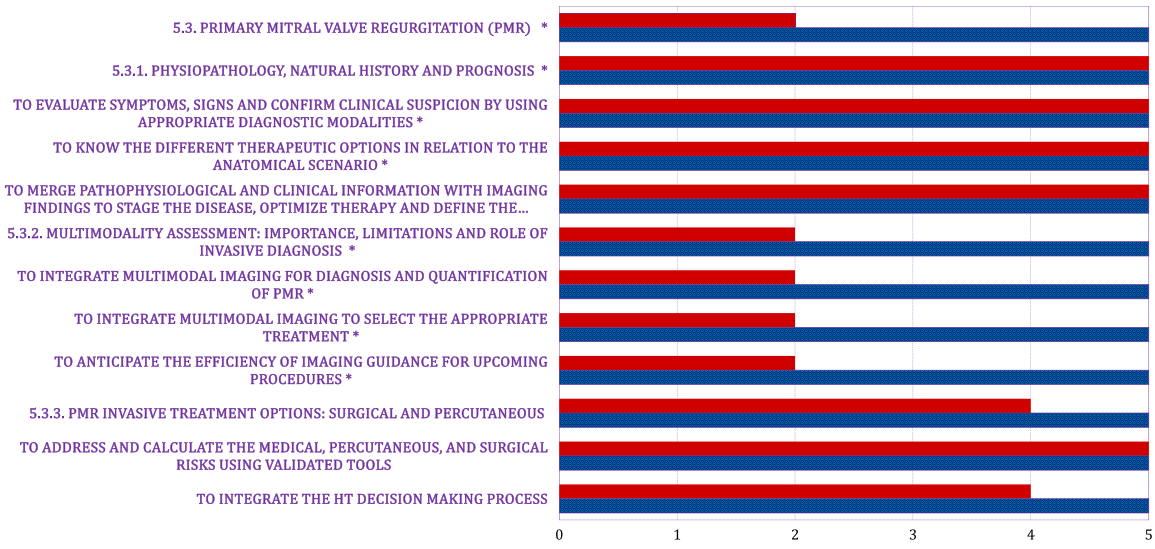
- 20.4.2.3 Valvular Heart Disease-- Treatment - Intervention - Mitral Valve Stenosis
- 20.4.2.4 Valvular Heart Disease-- Treatment - Intervention - Mitral Valve Regurgitation
- 20.4.3 Valvular Heart Disease - Treatment – Surgery
- 20.6.5-Valvular -Heart Disease - Clinical - Mitral Valve Regurgitation
- 20.6.5.1 --Valvular -Heart Disease - Clinical - Mitral Valve Regurgitation - Primary Mitral Valve Regurgitation
- 20.6.5.2-Valvular -Heart Disease - Clinical - Mitral Valve Regurgitation - Secondary Mitral Valve Regurgitation
- 20.6.5.99-Valvular -Heart Disease - Clinical - Mitral Valve Regurgitation - Mitral-Valve Regurgitation, -therapy
- 20.6.6 --Valvular -Heart Disease - Clinical - Mitral Valve Prolapse
- 20.6.7-Valvular -Heart Disease - Clinical - Mitral Valve Disease, Other

Essential Reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventions- Cardiovascular Medicine Textbook Part III – Percutaneous interventions for cardiovascular disease: Percutaneous balloon mitral commissurotomy; Transcatheter mitral valve repair; Transcatheter mitral valve implantation

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.3


5.3. PRIMARY MITRAL VALVE REGURGITATION (PMR) *
5.3.1. PHYSIOPATHOLOGY, NATURAL HISTORY AND PROGNOSIS *
TO EVALUATE SYMPTOMS, SIGNS AND CONFIRM CLINICAL SUSPICION BY USING APPROPRIATE DIAGNOSTIC MODALITIES *
TO KNOW THE DIFFERENT THERAPEUTIC OPTIONS IN RELATION TO THE ANATOMICAL SCENARIO *
TO MERGE PATHOPHYSIOLOGICAL AND CLINICAL INFORMATION WITH IMAGING FINDINGS TO STAGE THE DISEASE, OPTIMIZE THERAPY AND DEFINE THE...
5.3.2. MULTIMODALITY ASSESSMENT: IMPORTANCE, LIMITATIONS AND ROLE OF INVASIVE DIAGNOSIS *
TO INTEGRATE MULTIMODAL IMAGING FOR DIAGNOSIS AND QUANTIFICATION OF PMR *
TO INTEGRATE MULTIMODAL IMAGING TO SELECT THE APPROPRIATE TREATMENT *
TO ANTICIPATE THE EFFICIENCY OF IMAGING GUIDANCE FOR UPCOMING PROCEDURES *
5.3.3. PMR INVASIVE TREATMENT OPTIONS: SURGICAL AND PERCUTANEOUS
TO ADDRESS AND CALCULATE THE MEDICAL, PERCUTANEOUS, AND SURGICAL RISKS USING VALIDATED TOOLS
TO INTEGRATE THE HT DECISION MAKING PROCESS
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5.4 Secondary mitral valve regurgitation (SMR)

5.4.1 SMR pathophysiology, natural history and prognosis

Objectives

- To understand the pathophysiological relationship between MR and underlying disease in the left atrium and/or ventricle
- To interpret physio-pathological changes and provide information about the severity of the disease and its natural history as well as treatment options
- To identify patients who may benefit from either medical or invasive therapies

Knowledge

- Normal mitral valve anatomy and function and relationship with other cardiac structures
- Pathophysiology, epidemiology, natural history, clinical presentation and prognosis of SMR
- Hemodynamic consequences of SMR on the LV, left atrium, pulmonary artery and right-sided heart structures
- To know the factors associated with progressive disease and unfavorable prognosis, considering the severity and mechanism of SMR, LV dysfunction and LV/LA remodeling

Skills

- To evaluate symptoms, signs and confirm clinical suspicion of SMR by using appropriate diagnostic modalities
- To know the different anatomic scenarios causing SMR and their implication in the therapeutic path
- To take in accounts the factors associated with poor prognosis
- To combine pathophysiological and clinical information with imaging findings to stage the disease, optimize therapy and define the appropriate timing for intervention, surgical or percutaneous

Attitudes

- To provide balanced, understandable, and appropriate information to the patient on the predicted clinical course and timing of intervention
- To lead the HT decision making process to get a tailored treatment strategy, integrating clinical information and multimodality imaging assessment
- To educate patients on the pathophysiology and natural history of SMR and on the risks and benefits of medical, transcatheter and surgical interventions.

ESC topic list

- 41.3.6 Basic Science, Cardiac Diseases, Valvular Heart Disease

- 20.6.5.2 Valvular Heart Disease - Clinical - Mitral Valve R-gurgitation - Secondary Mitral Valve Regurgitation
- 15.1.8 Chronic Heart Failure - Pathophysiology and Mechanisms – Heart Failure with Reduced Ejection Fraction (HFrEF)

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]
- De Bonis et al. Treatment and management of mitral regurgitation. Nat. Rev. Cardiol. 9, 133-146, 2011[31]
- El Sabbagh et al. Mitral Valve Regurgitation in the Contemporary Era: Insights Diagnosis, Management, and Future Directions. JACC Cardiovasc Imaging 2018 Apr;11(4):628-643[32]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.4

5.4.2 Echocardiographic diagnosis and role of multimodality imaging in SMR

Objectives

- To identify different mechanisms and stages of SMR using echocardiography
- To understand the additional value of multimodality imaging techniques in assessment of SMR causes and mechanisms
- To determine the hemodynamic impact of the SMR on the ventricles, the atria, the pulmonary bed and on other cardiac structures

Knowledge

- To understand the principles of multi-parametric Doppler-echocardiographic approach (TEE, TOE, 3D-TOE) to quantify SMR, pitfalls and limitations,
- To know the indications of quantitative exercise echocardiographic assessment of SMR
- Invasive assessment of acute and chronic SMR
- Importance of MSCT study of the anatomy and the dimensions of the mitral valve in SMR
- Role of CMR for SMR
- To acknowledge the value of multiple imaging techniques in assessing cause and mechanism of SMR, including CMR, coronary angiography and invasive hemodynamic assessment.

Skills

- To interpret and integrate multimodal imaging for diagnosis and quantification of SMR

- To interpret and integrate multimodal imaging to select the appropriate treatment
- To anticipate the efficiency of imaging guidance for upcoming procedures

Attitude

- To correlate patient symptoms with imaging findings
- To actively take part of multidisciplinary HT discussion about evaluation and treatment options for SMR
- To explain different imaging modalities and their sequence of utilization to patients suffering from SMR

ESC topic list

- 3.4 Echocardiography – Valvular Heart Disease
- 3.10 Echocardiography – Transesophageal Echocardiography

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume I - PART 2 Chapter – Noninvasive imaging for structural heart disease
- De Bonis et al. Treatment and management of mitral regurgitation. Nat. Rev. Cardiol. 9, 133–146 2011[31]
- El Sabbagh et al. Mitral Valve Regurgitation in the Contemporary Era: Insights Into Diagnosis, Management, and Future Directions. JACC Cardiovasc Imaging 2018 Apr;11(4):628-643[32]
- Lancelotti et al. Recommendations for the echocardiographic assessment of native valvular regurgitation: an executive summary from the European Association of Cardiovascular Imaging. European Heart Journal – Cardiovascular Imaging, 2013 14, 611–644[33]
- Watanabe et al. Functional Mitral Regurgitation: Imaging Insights,Clinical Outcomes and Surgical Principles. Prog Cardiovasc Dis. 2017;60(3):351-360[34]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.4

5.4.3 Guideline-directed medical therapy for SMR

Objectives

- To optimize medical therapy in patients with SMR based on clinical history, examination and diagnostic techniques in accordance with current ESC guidelines

Knowledge

- To understand the principles of pharmaceutical interventions in both acute and chronic HF associated with significant SMR and how these affect loading conditions and reverse remodeling
- To know the indications, contraindications, adverse effects and optimal timing of medical therapy for SMR
- To acknowledge the limitations of optimized medical therapy in SMR

Skills

- To select and use patient-tailored medical therapy to treat both acute and chronic heart failure associated with significant SMR
- To determine the frequency and strategy of follow-up for SMR patients
- To monitor treatment effects
- To recognize the risks and limitations of medical therapy and identify when additional invasive therapy is required (resynchronization or valve intervention therapies).

Attitude

- Commitment to keep updated with new insights and ESC guidelines on the medical treatment of SMR
- To provide clear patient information on indications, risks and limitations of medical therapy, and check the patient's understanding and involve him/her in treatment plan.
- To educate patient on importance of treatment compliance and lifestyle.
- To adapt to changing clinical scenarios (i.e. deterioration of clinical situation) that warrant treatment modification, including the use of multiple pharmaceutical agents, additional device therapy (resynchronization and/or valve intervention therapy) or need for palliative care

ESC topic list

- 36.1 Pharmacology and Pharmacotherapy - Cardiovascular Pharmacotherapy
- 15.1.8 Chronic Heart Failure - Pathophysiology an- Mechanisms - Heart Failure with Reduced Ejection Fraction (HFrEF)
- 15.4 Chronic Heart Failure - Treatment

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]

Level of competence recommendation

- SSee Figure 6 (condensed LoC) and Diagram LoC 5.4

5.4.4 Surgical and transcatheter treatment of SMR

Objectives

- To know the different treatment options available
- To propose candidates for surgical or transcatheter interventions for SMR within the HT decision making process

Knowledge

- Individual risk stratification tools
- To know the indications, contra-indications, risks and benefits of various surgical and transcatheter interventions in SMR taking into account the impact of concomitant CAD and in accordance with current valvular and heart failure ESC guidelines
- To acknowledge the clinical and echocardiographic predictors of post-operative residual or recurrent MR

Skills

- To address and calculate the medical, percutaneous, and surgical risks using validated tools
- To tailor and timely propose the best therapeutic option, surgical or percutaneous, on the anatomical features and surgical risk of the patient
- To provide balanced, understandable, and appropriate information to the patient
- To understand the different surgical and transcatheter strategies and advocate for a specific therapy in a heart-team setting.

Attitudes

- To integrate the HT decision making process to integrate clinical information and multimodality imaging assessment
- To provide the patient the proper therapeutic options according to anatomical findings, comorbidities, surgical risk and active engagement in shared decision-making
- To support and follow patients in their clinical course according to their profile and decision

ESC topic list

- 31.2 Cardiovascular Surgery – Valves
- 20.4.2.4 Valvular Heart Disease - Treatment - Intervention - Mitral Valve Regurgitation

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- De Bonis et al. Treatment and management of mitral regurgitation. Nat. Rev. Cardiol. 9, 133–146 (2012)[31]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.4

5.5 Transcatheter mitral valve repair (TMVr)

5.5.1 Indications for TMVr

Objectives

- To select and interpret the pre-procedural diagnostic evaluations of the mitral valve (MV)
- To understand the therapeutic path of a patient affected by MV disease
- To understand how TMVr affects outcomes according to patients' symptoms/ comorbidities and valvular characteristics
- To select patients for TMVr
- To discuss the access and imaging features that determine the TMVr success

Knowledge

- Anatomy of the MV apparatus and its pathological variations with non-invasive and invasive diagnostic exams
- Pathway for the treatment of a patient affected by severe MV disease

Skills

- To critically interpret the anatomic findings of diagnostic exams
- To understand the correct timing and prognostic impact of TMVr in different clinical scenarios
- To identify patients which might have a clinical benefit from a TMVr
- To select the proper transcatheter device according to MV anatomy

Attitudes

- To prescribe adequate diagnostic exams according to the clinical pathway of the patient
- To interact with the HT members during all phase of therapy
- To promote shared decision making

ESC topic list

- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome
- 20.3 Valvular Heart Disease Diagnostic Methods
- 20.3.1 Valvular Heart Disease - Diagnostic methods imaging
- 20.3.1.1 Valvular Heart Disease - Diagnostic Methods - Imaging – Echocardiography
- 20.3.2 Valvular Heart Disease - Diagnostic Methods - Invasive Haemodynamic Assessment
- 20.6.5.2 Valvular Heart Disease - Clinical - Mitral Valve R-gurgitation - Secondary Mitral Valve Regurgitation

- 20.4.2.4 Valvular Heart Disease-- Treatment - Intervention - Mitral Valve Regurgitation
- 30.3.2 Interventiona- Cardiology - Noncoronary Cardiac Intervention - Mitral Valve Intervention

Essential Reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook, Volume III, Intervention II, Transcatheter mitral valve repair

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.5

5.5.2 Transeptal puncture techniques

Objectives

- To perform transeptal puncture safely and effectively

Knowledge

- To know the anatomy and echocardiographic views of the interatrial septum
- To know the appropriated type of transeptal puncture required according to the type of procedure performed
- To know the technical steps and solutions required for transeptal puncture
- To know potential complications of transeptal puncture

Skills

- To know the material and equipment required to perform transeptal puncture
- To perform transeptal puncture based on anatomical fluoroscopic landmarks and/or TOE guidance and/or ICE guidance
- To identify complex anatomy requiring echo-guidance for transeptal puncture
- To be able to manage complications including percutaneous treatment of iatrogenic atrial septal defect

Attitudes

- To commit enough time for a well-structured learning curve and constant update in this field
- To interact with HT members especially imaging specialist during all phase of therapy

ESC topic list

- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 20.4.2.3 Valvular Heart Disease – Treatment – Intervention – Mitral Valve Stenosis

- 20.4.2.4 Valvular Heart Disease – Treatment – Intervention – Mitral Valve Regurgitation; 30.3.2 Interventional Cardiology – Noncoronary Cardiac Intervention – Mitral Valve Intervention
- 30.3.5 Interventional Cardiology – Noncoronary Cardiac Intervention – Patent Foramen Ovale (PFO) / Atrial Septal Defect (ASD) Closure
- 30.3.6 Interventional Cardiology – Noncoronary Cardiac Intervention – Left Atrial Appendage (LAA) Closure
- 30.3.7 Interventional Cardiology – Noncoronary Cardiac Intervention – Closure of Paravalvular Leaks

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III – Percutaneous interventions for cardiovascular disease – Percutaneous balloon mitral commissurotomy
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III – Percutaneous interventions for cardiovascular disease – Transcatheter mitral valve repair
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III – Percutaneous interventions for cardiovascular disease – Transcatheter mitral valve implantation
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III – Percutaneous interventions for cardiovascular disease – left atrial appendage occlusion
- PCI textbook Tips and Tricks of new techniques beyond stenting – Part II Therapeutic procedures – Transseptal puncture and percutaneous mitral valvuloplasty

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.5

5.5.3 Transcatheter edge-to-edge repair (TEER) devices design, concept and engineering

Objectives

- To be aware of the design, concept and engineering of edge-to-edge (E2E) repair devices
- To learn to select the most suitable system according to the mitral valve anatomy and index pathology
- To understand unmet needs with current devices

Knowledge

- Mostly used TMVr systems
- Technical features of different TEER devices and their impact on clinical performance

Skills

- To learn the use of TMVr edge-to-edge systems
- To select the most suitable TMVr system according to the patient MR anatomy and pathology
- To learn technical tricks in bail-out situations with devices

Attitudes

- To provide HT members with an overview of technical performance of different TMVr devices
- To develop critical thinking about TEER devices safety and efficacy depending on the etiology of MR and other coexisting cardiac disease

ESC topic list

- 20.1 Valvular Heart Disease – Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease – Epidemiology, Prognosis, Outcome
- 20.3 Valvular Heart Disease Diagnostic Methods
- 20.3.1 Valvular Heart Disease – Diagnostic methods imaging
- 20.3.1.1 Valvular Heart Disease – Diagnostic Methods – Imaging – Echocardiography –
- 20.3.2 Valvular Heart Disease – Diagnostic Methods – Invasive Haemodynamic Assessment
- 20.6.5.2 Valvular Heart Disease – Clinical – Mitral Valve Regurgitation – Secondary Mitral Valve Regurgitation
- 20.4.2.4 Valvular Heart Disease – Treatment – intervention – Mitral Valve Regurgitation
- 30.3.2 Interventional Cardiology – Noncoronary Cardiac intervention – Mitral Valve Intervention

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook, Volume III, Intervention II, Transcatheter mitral valve repair
- The ESC Textbook of Cardiovascular Medicine

Level of competence recommendation

- To be aware of the design, concept and engineering of TEER devices
- To learn to select the most suitable system according to the mitral valve anatomy and index pathology
- See Figure 6 (condensed LoC) and Diagram LoC 5.5

5.5.4 Principles of TMVr

Objectives

- To know the principles, limitations and risk of available devices for TMVr
- To identify challenging anatomical features that may affect technical success.

Knowledge

- To accurately know atrial septal anatomy, different sites and techniques of atrial septal punctures, depending on the TMVr procedure.
- To understand the rational of transcatheter E2E (TEER) and transcatheter annuloplasty, both direct and indirect.
- To know how to integrate echocardiographic and fluoroscopic images.

Skills

- To interpret catheter movement in three-dimensional space, combining intraprocedural echocardiographic and fluoroscopic views.
- To be able to select the most appropriate TMVr device for each anatomical and clinical scenario.
- To know the steps to perform a TMVr with different techniques.
- In TEER, to decide among different device to optimize leaflets capture.
- In transcatheter annuloplasty, to evaluate anatomical annulus and coronary sinus features to set a direct or indirect strategy.

Attitudes

- To demonstrate collaborative working and decision-making in therapeutic process of high surgical risk patients.
- To be aware of anatomical features associated with potential procedural complications.

ESC topic list

- 20.1 Valvular Heart Disease – Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease – Epidemiology, Prognosis, Outcome
- 20.3 Valvular Heart Disease Diagnostic Methods
- 20.3.1 Valvular Heart Disease – Diagnostic methods imaging
- 20.3.1.1 Valvular Heart Disease – Diagnostic Methods – Imaging – Echocardiography
- 20.3.2 Valvular Heart Disease – Diagnostic Methods – Invasive Haemodynamic Assessment
- 20.6.5.2 Valvular Heart Disease – Clinical – Mitral Valve Regurgitation – Secondary Mitral Valve Regurgitation
- 20.4.2.4 Valvular Heart Disease – Treatment – Intervention – Mitral Valve Regurgitation 30.3.2 Interventional Cardiology – Noncoronary Cardiac Intervention – Mitral Valve Intervention

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Textbook, Percutaneous Interventional Cardiovascular Medicine, Volume III, Intervention II, Transcatheter mitral valve repair

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.5

5.5.5 Role of TMVr in FMR

Objectives

- To identify patients with functional MR eligible for TMVr according to symptoms, surgical risk and anatomical features.
- To understand the different prognostic impact of TMVr treatment in proportionate and disproportionate FMR.
- To understand the rational and steps of different transcatheter procedures: TEER, direct and indirect annuloplasty.

Knowledge

- The correlation between mitral valve complex and left ventricular remodeling to properly identify and treat disproportionate MR.
- To learn how transcatheter repair devices correct pathological alteration of mitral apparatus in FMR.
- To understand the medical and interventional management of FMR in both chronic and acute heart failure with reduced ejection fraction (HFrEF) settings.

Skills

- To learn mechanism and technical features of TMVr devices to customize treatment on patient's anatomy.
- To recognize challenging anatomical features that may affect technical success.
- The ability to optimize the clinical result according to patient anatomy
- To learn how to manage MR downgrading and trans-mitral gradient.

Attitudes

- Provide HT members with an overview of advantages and disadvantages of TMVr.
- To integrate clinical symptoms, surgical risk and echocardiographic anatomical assessment in planning individual management strategy.
- To develop critical thinking about TMVr devices depending on the etiology of functional MR.
- To engage patients in shared clinical decision making

ESC topic list

- 20.1 Valvular Heart Disease – Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease – Epidemiology, Prognosis, Outcome
- 20.3 Valvular Heart Disease Diagnostic Methods
- 20.3.1 Valvular Heart Disease – Diagnostic methods imaging
- 20.3.1.1 Valvular Heart Disease – Diagnostic Methods – Imaging – Echocardiography
- 20.3.2 Valvular Heart Disease – Diagnostic Methods – Invasive Haemodynamic Assessment
- 20.6.5.2 Valvular Heart Disease – Clinical – Mitral Valve Regurgitation – Secondary Mitral Valve Regurgitation
- 20.4.2.4 Valvular Heart Disease – Treatment – intervention – Mitral Valve Regurgitation
- 30.3.2 Interventional Cardiology – Noncoronary Cardiac intervention – Mitral Valve Intervention

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook , Volume III, Intervention II, Transcatheter mitral valve repair

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.5

5.5.6 Role of TMVr in PMR

Objectives

- To identify patients with chronic or acute primary MR eligible for TMVr according to symptoms, surgical suitability and anatomical features.
- To learn rational and steps of different transcatheter procedures: TEER, transapical chordal implantation or valve replacement.

Knowledge

- To comprehend the optimal time point of primary MR repair among symptomatic and asymptomatic patients.
- To comprehend the limitations of TMVr procedures in this setting
- To learn how TMVr devices correct pathological alteration of mitral apparatus in PMR.
- To understand the medical and interventional management of both acute and chronic PMR

Skills

- To learn mechanism and technical features of TMVr devices to customize treatment on patient's anatomy.
- To recognize challenging anatomical features that may affect technical success.
- To optimize the clinical result according to patient anatomy and trans-mitral gradient.

Attitudes

- To provide HT members with an overview of advantages and disadvantages of TMVr.
- To integrate clinical symptoms, surgical risk, and echocardiographic anatomical assessment in planning individual management strategy.
- To develop critical thinking about TMVr devices depending on the etiology of primary MR and other coexisting cardiac disease.
- To engage patient in clinical decision making

ESC topic list

- 20.1 Valvular Heart Disease – Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease – Epidemiology, Prognosis, Outcome
- 20.3 Valvular Heart Disease Diagnostic Methods
- 20.3.1 Valvular Heart Disease – Diagnostic methods imaging
- 20.3.1.1 Valvular Heart Disease – Diagnostic Methods – Imaging – Echocardiography
- 20.3.2 Valvular Heart Disease – Diagnostic Methods – Invasive Haemodynamic Assessment
- 20.6.5.2 Valvular Heart Disease – Clinical – Mitral Valve Regurgitation – Secondary Mitral Valve Regurgitation
- 20.4.2.4 Valvular Heart Disease – Treatment – intervention – Mitral Valve Regurgitation
- 30.3.2 Interventional Cardiology – Noncoronary Cardiac intervention – Mitral Valve Intervention

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI, Percutaneous Interventional Cardiovascular Medicine, Volume III, Intervention II, Transcatheter mitral valve repair

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.5

5.5.7 Atypical clinical scenarios: cardiogenic shock, papillary muscle rupture, for treatment of HCM, left ventricle obstruction syndrome.

Objectives

- To identify patients with MR accompanying atypical clinical scenarios (cardiogenic shock, papillary muscle rupture, left ventricle obstruction syndrome) eligible for any TMVr
- To identify patients in need of mechanical circulatory support (MCS) for TMVr in these clinical settings

Knowledge

- Rational and steps of different transcatheter procedures: TEER, valve replacement or transseptal alcohol ablation
- Limitations of transcatheter repair procedures in this setting
- Impact of TMVr or transseptal alcohol ablation to correct pathological alteration of mitral apparatus in PMR and reduce FMR related to LV obstruction syndrome

Skills

- To learn mechanism and technical features of transcatheter repair devices to customize treatment on patient's anatomy
- To recognize challenging anatomical features that may affect technical success.
- To learn the steps of transseptal alcohol ablation procedure
- To consider septal alcohol ablation procedure in selected patients

Attitudes

- To comprehend suitability or futility of TMVr options in these clinical settings.
- To provide HT members with an overview of advantages and disadvantages of TMVr
- To integrate clinical symptoms, surgical risk and echocardiographic anatomical assessment in planning individual management strategy.
- To develop critical thinking about percutaneous repair devices or TASH procedure with or without MCS depending on the etiology of MR, other coexisting cardiac disease and hemodynamic situation.

ESC topic list

- 16.1 Acute Heart Failure – Pathophysiology and Mechanisms
- 20.1 Valvular Heart Disease – Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease – Epidemiology, Prognosis, Outcome
- 20.3 Valvular Heart Disease Diagnostic Methods
- 20.3.1 Valvular Heart Disease – Diagnostic methods imaging
- 20.3.1.1 Valvular Heart Disease – Diagnostic Methods – Imaging – Echocardiography
- 20.3.2 Valvular Heart Disease – Diagnostic Methods – Invasive Haemodynamic Assessment

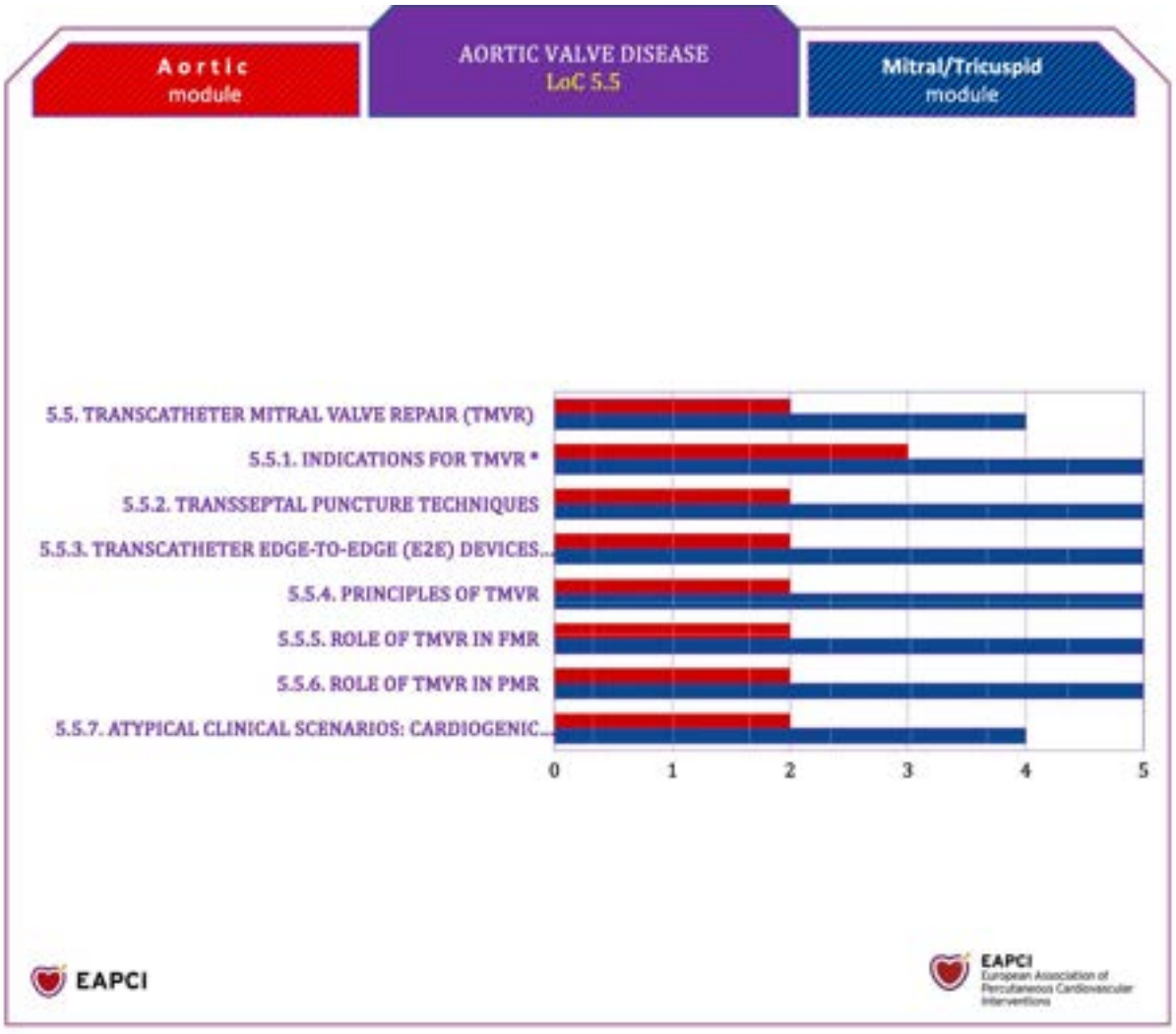
- 20.6.5.2 Valvular Heart Disease – Clinical – Mitral Valve Regurgitation – Secondary Mitral Valve Regurgitation
- 20.4.2.4 Valvular Heart Disease – Treatment – intervention – Mitral Valve Regurgitation
- 30.3.2 Interventional Cardiology – Noncoronary Cardiac intervention – Mitral Valve Intervention

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Textbook, Percutaneous Interventional Cardiovascular Medicine, Volume III, Intervention II, Transcatheter mitral valve repair

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.5



5.6 Transcatheter mitral valve implant (TMVI)

5.6.1 TMVI: Valve-in-Valve implantion and Valve-in-Ring implantion

Objectives

- To select patients with mitral regurgitation (MR) and/or stenosis (MS) due to failed prostheses or rings that will benefit with transcatheter mitral valve implantation (TMVI) valve-in-valve
- To know and understand the devices currently approved and/or used for TMVI valve-in-valve

Knowledge

- Principles of epidemiology, classification, pathophysiology, grading, imaging and clinical features of different stages of mitral valve disease
- Common bioprotheses and working mechanism of THV

Skills

- To appropriately select patients with failed MV bioprotheses or rings that may benefit from TMVI valve-in-valve
- To interpret and communicate intra-procedural imaging features
- To understand and perform the main procedural steps for: -TMVI valve-in-valve: arterial and venous cannulation, transseptal puncture, large venous sheath progression to the left atria, delivery catheter orientation TEE guided, device control and precise delivery
- To interpret haemodynamic and echocardiographic findings, as assessed during the procedure and adapt the procedure
- To perform residual ASD closure, if indicated
- To be able to diagnose and treat potential complications

Attitudes

- The commitment to work and collaborate in a HT program with cardiac surgeons, imaging experts, anesthetists, non-invasive cardiologists and geriatricians
- 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)

ESC topic list

- 3.4 Echocardiography - Valvular Heart Disease
- 3.10 Echocardiography – Transoesophageal echocardiography (TEE)
- 3.15 Echocardiography – Intraoperative and Interventional echocardiography
- 20.4.2.3 Valvular Heart Disease -- Treatment - Intervention– Mitral Valve Stenosis

- 20.4.2.4 Valvular Heart Disease-- Treatment - Intervention - Mitral Valve Regurgitation
- 30.3.2 Interventional Cardiology – Noncoronary Cardiac Intervention - Mitral Valve Intervention
- 90.4 European Society o- Cardiology – European Association of Percutaneous Cardiovascular Intervention (EAPCI)

Essential Reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II, chapter "Non-invasive imaging for structural heart disease" and Part III, chapter "transcatheter mitral valve implantation"
- VIV Mitral app and similar

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.6-5.8

5.6.2 TMVI for Valve-in- Mitral annular calcification (MAC)

Objectives

- To identify the appropriate patients for Valve-in-MAC procedures (clinical and anatomical criteria)
- To be able to perform Valve-in-MAC procedures and to manage potential complications

Knowledge

- Mitral valve anatomy and relationship to adjacent cardiac structures
- Current devices use and limitations
- TMVI indications and patients' selection
- Potential complications and their management

Skills

- To identify severe mitral valve disease requiring therapy
- To assess surgical risk and to balance this risk compared to that of percutaneous therapy
- To analyze MSCT, for calcification assessment, sizing and risk of LVOT obstruction
- To manage potential complications: severe ASD with shunt, tamponade, vascular complications

Attitudes

- To collaborate with surgeons and clinicians for appropriate patients and procedural selection
- To provide balanced information regarding the expected risks and benefits
- To remain aware of new techniques and devices

ESC topic list

- 3.10. Echocardiography – Transoesophageal echocardiography (TEE)
- 3.15. Echocardiography – Intraoperative and Interventional echocardiography
- 20.4.2. Valvular Heart Disease -- Treatment – Intervention
- 20.4.2.3. Valvular Heart Disease-- Treatment – Intervention – Mitral Valve Stenosis
- 20.4.2.4. Valvular Heart Disease-- Treatment – Intervention - Mitral Valve Regurgitation
- 30.3.2. Interventional Cardiology-Noncoronary Cardiac Intervention-Mitral Valve Intervention
- 90.4. European Society of Cardiology - European Association of Percutaneous Cardiovascular Intervention (EAPCI)

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II, chapter "Non-invasive imaging for structural heart disease" and Part III, chapter "transcatheter mitral valve implantation"

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.6-5.8

5.6.3 TMVI for native valve with dedicated devices

Objectives

- To select the appropriate patients for TMVI procedures using dedicated devices (clinical and anatomical criteria)
- To plan and perform TMVI procedures for native valve with dedicated devices and to manage potential complications

Knowledge

- Mitral valve anatomy and relationship to adjacent cardiac structures
- Current devices use and limitations
- TMVI indications and patients' selection
- Potential complications and their management

Skills

- To identify severe mitral valve disease requiring percutaneous therapy
- To assess surgical risk and that of percutaneous therapy risks
- To analyze MSCT, for calcification assessment, sizing and risk of LVOT obstruction
- To manage potential complications: severe ASD with shunt, tamponade, vascular complications

Attitudes

- To collaborate with surgeons and clinicians for appropriate patients and procedural selection
- To provide balanced information o regarding the expected risks and benefits
- To remain aware of new techniques and devices

ESC topic list

- 3.10. Echocardiography – Transoesophageal echocardiography (TEE)
- 3.15. Echocardiography – Intraoperative and Interventional echocardiography
- 20.4.2. Valvular Heart Disease -- Treatment - Intervention
- 20.4.2.3. Valvular Heart Disease-- Treatment - Intervention – Mitral Valve Stenosis
- 20.4.2.4. Valvular Heart Disease-- Treatment - Intervention - Mitral Valve Regurgitation
- 30.3.2. Interventional Cardiology-Noncoronary Cardiac Intervention-Mitral Valve Intervention
- 90.4. European Society o– Cardiology - European Association of Percutaneous Cardiovascular Intervention (EAPCI)

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- ESC core curriculum for general cardiology (2013): Content of Chapter Valvular heart disease
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II, chapter "Non-invasive imaging for structural heart disease" and Part III, chapter "transcatheter mitral valve implantation"

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.6-5.8

5.7 Transcatheter mitral annuloplasty

Objectives

- To understand the basic principles of transcatheter mitral annuloplasty
- To select candidates to transcatheter mitral annuloplasty

Knowledge

- To know available devices used for this procedure
- To prescribe the appropriate imaging modalities for patient selection and procedural planning

Skills

- To understand the basic steps of the procedure and the generic catheter lab skills required

Attitudes

- To appreciate the evidence gaps and discuss of the role and benefit of this procedure
- To discuss ongoing research.

ESC topic list

- 20.4.2.4 Valvular Heart Disease-Treatment-Intervention-Mitral Valve Regurgitation.
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 20.3.1 Valvular Heart Disease- Diagnostic Methods - Imaging

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter Mitral valve repair.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.6-5.8

5.8 MV post procedural management

Objectives

- To know post procedural management of patients after transcatheter mitral valve repair
- To know post procedural management of patients after transcatheter mitral valve replacement

Knowledge

- Echocardiography assessment in patients after transcatheter mitral valve repair during hospital stay and outpatient follow-up
- Echocardiography assessment in patients after transcatheter mitral valve replacement during hospital stay and outpatient follow-up
- Pharmacotherapy after transcatheter mitral valve intervention
- Complications following mitral valve interventions

Skills

- To coordinate patient care following mitral valve intervention
- To analyze echocardiography evaluation after mitral valve intervention
- To estimate clinical heart failure symptom reduction or worsening in patients undergoing mitral valve interventions

Attitudes

- Cooperation with personnel of departments caring for patients after mitral valve interventions, including intensive care units, imagers and rehabilitation

ESC topic list

- 20.4.2.4 Valvular Heart Disease-Treatment-Intervention-Mitral ValveRegurgitation
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 20.3.1 Valvular Heart Disease- Diagnostic Methods - Imaging

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter Mitral valve repair.
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.6-5.8

5.8.1 Discharge from hospital: timing, planning, execution, and liaison with family

Objectives

- To plan the timing and process of patient care after mitral valve implantation
- To coordinate patient clinical and imaging follow-up after mitral valve implantation

Knowledge

- MV intervention post-procedural hospital (fast) track
- Heart failure patient evaluation
- Heart failure patient rehabilitation tracks
- The clinical follow-up in patients evaluation after mitral valve interventions: the timing, needs for echocardiography imaging, pharmacology check-up, biomarkers evaluation

Skills

- To plan in-hospital track of patients following mitral valve interventions
- To decide between fast-tracks and intensive care tracks for selected patients following mitral valve interventions
- To communicate with mitral valve care coordinators on patient follow-up after hospital discharge

Attitudes

- Coordination of patient care and rehabilitation during hospital stay after mitral valve interventions

- Communication skills with patient family to explain post-procedural follow-up plan, including rehabilitation, outpatient visits and pharmacology regimes

ESC topic list

- 20.4.2.4 Valvular Heart Disease-Treatment-Intervention-Mitral Valve Regurgitation
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 20.3.1 Valvular Heart Disease- Diagnostic Methods - Imaging

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter Mitral valve repair.
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.6-5.8

5.8.2 Anti-thrombotic therapy after MV intervention

Objectives

- To know the appropriate evidence based anti-thrombotic regimen after a mitral valve intervention
- To prescribe anti-thrombotic regimens in specific clinical settings: atrial fibrillation, valve-in-valve procedures, recent percutaneous coronary interventions (PCI), especially those at high bleeding risk

Knowledge

- Anti-thrombotic regimens
- Bleeding risk scores

Skills

- To apply the current evidence-based anti-thrombotic regimen in patients after mitral valve interventions
- To implement anti-thrombotic regimen following mitral valve interventions according to their bleeding/thrombotic risk, type of mitral valve intervention and presence of atrial fibrillation

Attitudes

- To discuss with the patient the type and duration of antithrombotic therapy that will be needed after the mitral valve intervention, including the benefits and risks, as part of the informed consent process. To secure his/her compliance with the therapeutic regimen

- To apply judgement, weighing up the balance between safety and effectiveness, in determining the appropriate anti-thrombotic regimen in specific clinical settings where gaps in evidence-based medicine still exist

ESC topic list

- 20.4.2.4 Valvular Heart Disease-Treatment-Intervention-Mitral Valve Regurgitation
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 20.3.1 Valvular Heart Disease- Diagnostic Methods - Imaging

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter Mitral valve repair.
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]
- Calabrò P, Gragnano F, Niccoli G, Marcucci R, Zimarino M, Spaccarotella C, Renda G, Patti G, Andò G, Moscarella E, Mancone M, Cesaro A, Giustino G, De Caterina R, Mehran R, Capodanno D, Valgimigli M, Windecker S, Dangas GD, Indolfi C, Angiolillo DJ. Antithrombotic Therapy in Patients Undergoing Transcatheter Interventions for Structural Heart Disease. Circulation. 2021 Oct 19;144(16):1323-1343. doi: 10.1161/CIRCULATIONAHA.121.054305. Epub 2021 Oct 18. PMID: 34662163.[35]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.6-5.8

5.8.3 Clinical and imaging follow-up after MV intervention: clinical review, imaging, endocarditis prevention, rehabilitation

Objectives

- To ensure appropriate follow-up of patients after mitral valve intervention

Knowledge

- Echocardiography criteria to assess severity of residual mitral regurgitation and mitral stenosis
- Echocardiography criteria to assess severity of mitral stenosis
- Echocardiography evaluation of mitral device position and stability
- Computed tomography evaluation of mitral device, left ventricular outflow tract, cardiac chambers
- Magnetic resonance evaluation of mitral valve and quantification of mitral regurgitation
- Ultrasound morphology of the transcatheter mitral valve prostheses

- VARC criteria to quantify paravalvular leak
- Long-term complications of mitral valve interventions, including bioprosthetic valve dysfunction and failure, subclinical and clinical leaflet thrombosis, and infective endocarditis (IE)
- Risk of left ventricular outflow obstruction
- To know current IE prophylaxis
- Indications for cardiac rehabilitation

Skills

- To use appropriate non-invasive or invasive diagnostic techniques to assess mitral valve function and morphology
- To order serial clinical and imaging follow-up on an individual patient basis

Attitudes

- Commitment to establish appropriate follow-up to detect early and late complications
- To work in a multidisciplinary HT with physicians and general practitioners to determine the optimal follow-up plan
- To hand over patient care to the referring clinician where appropriate
- To be able to prevent IE

ESC topic list

- 20.4.2.4 Valvular Heart Disease-Treatment-Intervention-Mitral Valve Regurgitation.
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 20.3.1 Valvular Heart Disease- Diagnostic Methods - Imaging

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter Mitral valve repair.
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.6-5.8

5.8.4 Mitral Valve Reintervention

Objectives

- To ensure appropriate patient assessment and qualification to reintervention on dysfunctional mitral valve after surgical ring or prosthesis implantation
- To ensure appropriate patient assessment and qualification to reintervention on dysfunctional mitral valve after transcatheter repair

- To ensure appropriate patient assessment and qualification to reintervention on dysfunctional mitral valve after transcatheter valve implantation

Knowledge

- Criteria for reintervention in significant mitral stenosis or regurgitation
- Knowledge of surgical mitral valve bioprostheses design and their characteristics and differences
- Echocardiography and computed tomography planning of mitral valve-in-valve procedures
- Echocardiography planning of repeat mitral clip device implantation

Skills

- To recognize surgical mitral valve prosthesis types and define their characteristics
- To perform transcatheter mitral valve-in-valve interventions
- To perform mitral valve clip reintervention
- To use appropriate non-invasive or invasive diagnostic techniques to assess mitral valve function and morphology during mitral valve interventions

Attitudes

- To discuss the risks of mitral valve reintervention with the patients and the HT
- To coordinate echocardiography and computed tomography assessment supportive of mitral valve reintervention during patient qualification to reintervention
- To cooperate with echocardiographers during mitral valve reintervention

ESC topic list

- 20.4.2.4 Valvular Heart Disease-Treatment-Intervention-Mitral Valve Regurgitation
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography
- 20.3.1 Valvular Heart Disease- Diagnostic Methods - Imaging

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter Mitral valve repair.
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]

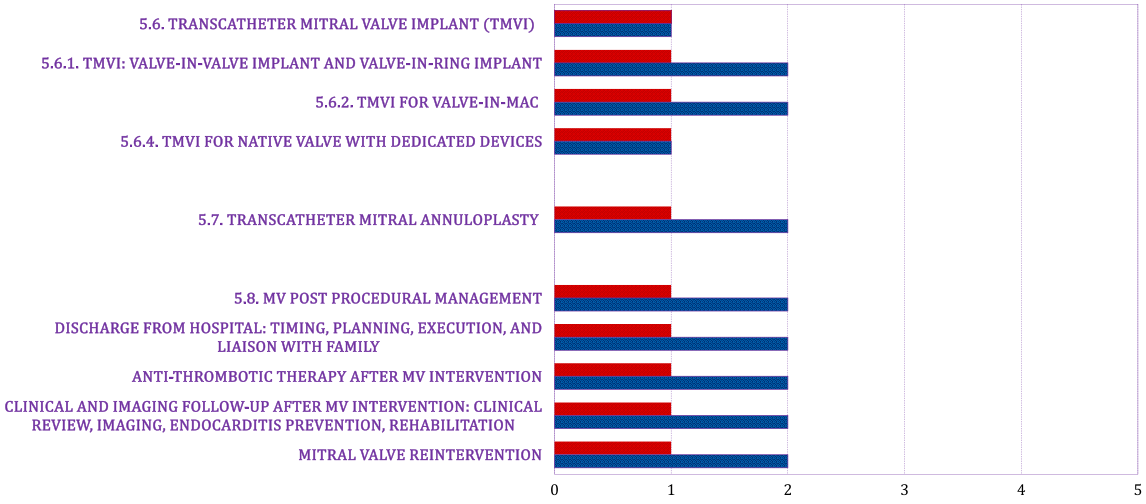
Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 5.6-5.8

Aortic module

AORTIC VALVE DISEASE
LoC 5.6-5.8

Mitral/Tricuspid module



EAPCI

EAPCI European Association of Percutaneous Cardiovascular Interventions

6 Interventional management of tricuspid valve failure

6.1 Clinical and imaging evaluation of tricuspid valve

6.1.1 Epidemiology of tricuspid valve (TV) disease

Objectives

- To acknowledge the prevalence of the TV disease and the impact on the health care system.
- To acknowledge the magnitude of TR undertreatment and develop plans to overcome possible barriers.
- To understand the different etiologies, demographic distribution, clinical implication, and potential therapies for tricuspid regurgitation (TR).

Knowledge

- Etiologies of TV disease.
- Grades of TV disease.
- To acknowledge the current medical, transcatheter and surgical therapies for TR.

Skills

- To recognize the symptoms, to interpret the etiology and to identify the progression of TV disease.
- To distinguish and use properly the currently available diagnostic tools to categorize adequately the stage of the disease.

Attitudes

- To identify current limitations on TR diagnosis and therapy.
- To develop strategies to improve patients care including all the different estates involved (including patients, nurses, physicians)

ESC topic list

- 20.2-Valvular Heart Disease- Epidemiology, prognosis, outcome

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- Iung B, Baron G, Butchart EG, Delahaye F, Gohlke-Bärwolf C, Levang OW, Tornos P, Vanoverschelde JL, Vermeer F, Boersma E, Ravaud P, Vahanian A. A prospective survey of patients with valvular heart disease in Europe: The Euro Heart Survey on Valvular Heart Disease. Eur Heart J. 2003 Jul;24(13):1231-43. doi: 10.1016/s0195-668x(03)00201-x. PMID: 12831818.[36]
- Topilsky Y, Maltais S, Medina Inojosa J, Oguz D, Michelena H, Maalouf J, Mahoney DW, Enriquez-Sarano M. Burden of Tricuspid Regurgitation in Patients Diagnosed in the Community Setting. JACC Cardiovasc Imaging. 2019 Mar;12(3):433-442. doi: 10.1016/j.jcmg.2018.06.014. Epub 2018 Aug 15. PMID: 30121261.[37]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.1.2 Anatomy of tricuspid valve

Objective

- To understand the TV apparatus anatomy, its components, and possible anatomic variations.
- To understand the different mechanisms originating TR.
- To select properly the tests required to assess the TR study based on the anatomical findings.

Knowledge

- Normal anatomic references of the TV.
- To recognize the surrounding structures and the relationship with the TV.
- Hemodynamic impact of the TR in the cardiac chambers and changes in other affected organs.

Skills

- To recognize the components of the tricuspid valve apparatus in the different imaging modalities.

Attitudes

- To select adequately the diagnostic tests required by the clinical and anatomical findings.

ESC topic list

- 20.1-Valvular Heart Disease- Pathophysiology and Mechanisms.

Essential reading

- Arsalan M, Walther T, Smith RL 2nd, Grayburn PA. Tricuspid regurgitation diagnosis and treatment. Eur Heart J. 2017 Mar 1;38(9):634-638. doi: 10.1093/eurheartj/ehv487. PMID: 26358570[38]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.2 Tricuspid regurgitation (TR) intervention

6.2.1 Clinical assessment of TR

Objectives

- To understand and grade the severity of symptomatic TR.

- To understand and prescribe multimodal assessment of TR

Knowledge

- To recognize the symptoms and signs more frequently related to TR.
- To identify other signs that might suggest concomitant valve disease.

Skills

- To perform properly a clinical anamnesis and physical exam to identify those signs and symptoms related to TR.
- To prescribe tests to assess the patient
- To grade adequately the stage of the valve disease of the patient.
- To recognize the different therapeutic approaches for TR and level of evidence including medical, transcatheter and surgical therapies.

Attitudes

- To actively take part of multidisciplinary discussion about evaluation and treatment options for TR
- To explain different imaging modalities and their sequence of utilization to patients suffering from TR

ESC topic list

- 20.6-Valvular Heart Disease-Clinical.

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[8]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.2.2 Medical therapy of TR

Objectives

- To understand the effect of the pharmacotherapy used to treat patients with TR.
- To acknowledge the prognostic impact of guideline-directed medical therapies (GDMT)

Knowledge:

- To know the medical armamentarium disposable to use on patients with TR.
- To acknowledge potential side effects related to the medical therapy.

Skills

- To select properly the medical therapy needed at each stage of the disease.

Attitudes

- To recognize the effects of the medical therapy on TR and its limitations.

ESC topic list

- 20.4-Valvular Heart Disease-Treatment.

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- Arsalan M, Walther T, Smith RL 2nd, Grayburn PA. Tricuspid regurgitation diagnosis and treatment. Eur Heart J. 2017 Mar 1;38(9):634-638. doi: 10.1093/eurheartj/ehv487. PMID: 26358570.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.2.3 Hemodynamics and right heart catheterization in TR

Objectives

- To understand and interpret right heart catheterization on patients with TR.

Knowledge

- To acknowledge the potential risks, benefits and limitations of the invasive diagnosis
- To recognize the standard values of the pressures in the right heart chambers.
- To identify the pressure curve morphology belonging to every heart chamber.

Skills

- To perform a right heart catheterization
- To recognize and manage the possible complication (pulmonary artery perforation, iatrogenic pulmonary valve insufficiency)

Attitudes

To interpret properly the results of a right heart catheterization.

- To integrate the invasive information in the patient assessment

ESC topic list

- 20.3.2-Valvular Heart Disease-Diagnostic Methods-Invasive Haemodynamic Assessment.

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part I- Right and left heart catheterization.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.3 Multimodality imaging for the TR assessment

6.3.1 TTE and TOE in TR

Objectives

- To quantify the severity of TR by using TTE and TOE
- To understand the mechanism of TR (functional, degenerative or mixed) and to identify potential causes for it.
- To determine the hemodynamic effects of TR on right ventricular function and cardiac function in total.
- To identify prosthetic structures and the possible impact of this to the TV function (i.e., pacemaker leads, prosthetic rings/valves)

Knowledge

- To know and identify the various components of TV anatomy (leaflets, chords, papillary muscles)
- To understand the various views for imaging the TV apparatus

Skills

- To identify the structures of the TV accurately
- To be able to interpret the severity of the TR by evaluating the functional components of the TV function (continuous and pulsatile wave Doppler, color Doppler, hepatic veins flow)
- To understand and request the appropriate guidance to facilitate the communication among HT members for an optimal procedural conduct.
- To determine the immediate outcome for the patient and potential complications.

Attitudes

- To be able to function as a part of a multidisciplinary HT evaluating the severity, mechanisms and anatomical features of tricuspid valve disease in relationship with the potential therapeutic options
- To coordinate the percutaneous procedure

ESC topic list

- 20.3.1.1 Valvular Heart Disease-Diagnostic Methods-Imaging-Echocardiography.

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- Badano LP, Muraru D, Enriquez-Sarano M. Assessment of functional tricuspid regurgitationT. Eur Heart J. 2013 Jul;34(25):1875-85. doi: 10.1093/eurheartj/ehs474[39].
- Agricola E, Asmarats L, Maisano F, Cavalcante JL, Liu S, Milla F, Meduri C, Rodés-Cabau J, Vannan M, Pibarot P. Imaging for Tricuspid Valve Repair and Replacement. JACC Cardiovasc Imaging. 2021 Jan;14(1):61-111. doi: 10.1016/j.jcmg.2020.01.031[40].

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.3.2 Multi Slice Computed Tomography (MSCT) in TR

Objectives

- To recognize the anatomic components of the TV operators as they are depicted on the MSCT
- To be able to recognize the surrounding structures and their anatomic relationship with the TV with special attention to the right coronary artery.

Knowledge

- To obtain accurate measurements of the TV apparatus, caval veins, prosthetic valves and/or rings in tricuspid position.

Skills

- To be able to obtain accurate reviews and formulate adequate MSCT protocol addressing the specific needs of TV imaging
- To be able to evaluate the results of a percutaneous procedure, especially the anatomic relationship of any implants with the surrounding structures.

Attitudes

- To interact with interventional HT and be able to screen and select patients for the most appropriate therapeutic options based on the MSCT

ESC topic list

- 20.3.1.2 Valvular Heart Disease-Diagnostic Methods-Imaging- Cardiac Computed Tomography (CT).

Essential reading

- van Rosendael PJ, Kamperidis V, Kong WK, van Rosendael AR, van der Kley F, jmone Marsan N, Delgado V, Bax JJ. Computed tomography for planning transcatheter tricuspid valve therapy. Eur Heart J. 2017 Mar 1;38(9):665-674. doi: 10.1093/eurheartj/ehw499. PMID: 27807057[41]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.3.3 Cardiac Magnetic Resonance (CRM) in TR

Objectives

- To be able to interpret the parameters for a correct quantification of the degree of TR
- To evaluate the right ventricular function and anatomy as part of a comprehensive CMR protocol

Knowledge

- To be familiar with the acquisition protocols of CMR with a special focus on TV disease and right ventricular function

Skills

- To be able to give additional information based on the CMR findings about the possible mechanism of TR, the specific anatomic findings and possible etiology
- To be able to provide information regarding the right ventricular function and possible scarring or other anatomical disease of the right ventricle

Attitudes

1. To integrate information from different imaging modalities and provide the possible information from the CMR that could add incremental value.

ESC topic list

2. 20.3.1.3 Valvular Heart Disease-Diagnostic Methods-Imaging-Cardiac Magnetic Resonance (CMR)

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.4 Transcatheter approaches for native valve TR

6.4.1 Tricuspid regurgitation TEER

Objectives

- To understand the principles and limitations of TEER
- To assess potential candidates for TEER

Knowledge

- To have a basic understanding of TOE images of the tricuspid valve
- To know the devices available, their advantages and limitations
- To acknowledge pre-operative patient preparation, the steps of the procedure and post-procedural care
- To advise patients and relatives on the risk-benefit of TEER

Skills

- To understand what this procedure involves and have an appreciation of case selection and procedural risks

- To understand and interpret echocardiograms of patients who may be suitable for TEER and the challenges of quantifying TR post-procedure

Attitudes

- To integrate the multidisciplinary HT
- To recognize that this is a procedure with an evolving evidence base
- To understand the importance of ongoing research efforts to evaluate its efficacy

ESC topic list

- 20.4.2.8 Valvular Heart Disease-Treatment-Intervention-Tricuspid Valve Regurgitation
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter tricuspid valve interventions.
- Taramasso M, Maisano F. Novel Technologies for percutaneous treatment of tricuspid valve regurgitation. Eur Heart J. 2017 Sep 21;38(36):2707-2710. doi: 10.1093/eurheartj/ehx475. PMID: 29044389[42]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.4.2 Tricuspid regurgitation annuloplasty

Objectives

- To understand the basic principles of TR transcatheter annuloplasty
- To evaluate a potential candidate for TR transcatheter annuloplasty

Knowledge

- To be aware of the available devices used for this procedure

Skills

- To understand the basic echocardiographic images used for intraprocedural guidance
- To understand the basic steps of the procedure and the generic catheter lab skills required

Attitudes

- To appreciate the evidence level and acknowledge that the role and benefit of this procedure is still evolving
- To appreciate the importance of ongoing research studies in evaluating these techniques.

ESC topic list

- 20.4.2.8 Valvular Heart Disease-Treatment-Intervention-Tricuspid Valve Regurgitation
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter tricuspid valve interventions.
- Taramasso M, Maisano F. Novel Technologies for percutaneous treatment of tricuspid valve regurgitation. Eur Heart J. 2017 Sep 21;38(36):2707-2710. doi: 10.1093/eurheartj/ehx475. PMID: 29044389[42]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.4.3 Transcatheter valve implantation, caval valve implantation (CAVI) and other techniques

Objectives:

- To evaluate a potential candidate for novel techniques to treat TR when patient is refractory to medical therapy and surgical treatment not indicated

Knowledge

- To acknowledge the devices available for the treatment of TR
- To understand the basic steps of the procedure and the generic catheter lab skills required

Skills

- To determine which patients may be considered for these novel procedures

Attitudes

- To appreciate the evidence level and acknowledge that the role and benefit of this procedure is still evolving
- To appreciate the importance of ongoing research studies in evaluating these techniques.

ESC topic list

- 20.4.2.8 Valvular Heart Disease-Treatment-Intervention-Tricuspid Valve Regurgitation

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter tricuspid valve interventions.

- Taramasso M, Maisano F. Novel Technologies for percutaneous treatment of tricuspid valve regurgitation. Eur Heart J. 2017 Sep 21;38(36):2707-2710. doi: 10.1093/eurheartj/ehx475. PMID: 29044389[42]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.4.4 Specific transcatheter approaches for tricuspid bioprostheses failure: valve-in-valve (VIV) and valve-in-ring (VIR)

Objectives

- To evaluate a potential candidate for the transcatheter technique of tricuspid VIV and VIR

Knowledge

- To understand the technical features of TV surgical annuloplasty rings and surgical bioprostheses
- To know the established transcatheter techniques to treat the failing tricuspid bioprostheses and/or surgically repaired TV
- To understand the anatomical and technical features of device selection
- To recommend which THV can be used to treat these patients
- To know the basic steps of the procedure

Skills

- To interpret the imaging of failing TV and bioprostheses
- To determine which patients may be considered for these novel procedures
- To appreciate the limitations and potential complications of these procedures

Attitudes

- To actively take part in multidisciplinary discussion about evaluation and treatment options for tricuspid bioprostheses failure
- To explain different imaging modalities and their sequence of utilization for patients with tricuspid bioprostheses failure

ESC topic list

- 20.4.2.8 Valvular Heart Disease-Treatment-Intervention-Tricuspid Valve Regurgitation
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
  2021 ESC/EACTS Guidelines for the management of heart failure[30]

The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter tricuspid valve interventions.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.5 Tricuspid post procedural management

Objectives

To know post procedural management of patients after transcatheter tricuspid valve repair

- To know post procedural management of patients after transcatheter tricuspid valve replacement

Knowledge

- Echocardiography assessment in patients after transcatheter tricuspid valve repair during hospital stay and outpatient follow-up
- Echocardiography assessment in patients after transcatheter tricuspid valve replacement during hospital stay and outpatient follow-up
- Pharmacotherapy after transcatheter tricuspid valve intervention
- Electrophysiology assessment in patients after transcatheter tricuspid valve intervention
- Complications following tricuspid valve interventions

Skills

- To coordinate patient care following tricuspid valve intervention
- To analyze echocardiography evaluation after tricuspid valve intervention
- To estimate clinical heart failure symptom reduction or worsening in patients undergoing tricuspid valve interventions

Attitudes

- Cooperation with personnel of departments caring for patients after tricuspid valve interventions, including intensive care units, imagers, electrophysiologist and rehabilitation

ESC topic list

- 20.4.2.8 Valvular Heart Disease-Treatment-Intervention-Tricuspid Valve Regurgitation.
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter tricuspid valve interventions.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.5.1 Discharge from hospital: timing, planning, execution, and liaison with family

Objectives

- To plan the timing and process of patient care after tricuspid valve implantation
- To coordinate patient clinical and imaging follow-up after tricuspid valve implantation

Knowledge

- TV intervention post-procedural hospital (fast) track
- Heart failure patient evaluation
- Heart failure patient rehabilitation tracks
- The clinical follow-up in patients evaluation after tricuspid valve interventions: the timing, needs for echocardiography imaging, pharmacology check-up, biomarkers evaluation

Skills

- To plan in-hospital track of patients following tricuspid valve interventions
- To decide between fast-tracks and intensive care tracks for selected patients following tricuspid valve interventions
- To communicate with tricuspid valve care coordinators on patient follow-up after hospital discharge

Attitudes

- Coordination of patient care and rehabilitation during hospital stay after tricuspid valve interventions
- Communication skills with patient family to explain post-procedural follow-up plan, including rehabilitation, outpatient visits and pharmacology regimes

ESC topic list

- 20.4.2.8 Valvular Heart Disease-Treatment-Intervention-Tricuspid Valve Regurgitation
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter tricuspid valve interventions.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.5.2 Anti-thrombotic therapy after tricuspid intervention

Objectives

- To know the appropriate evidence based anti-thrombotic regimen after a tricuspid valve intervention
- To prescribe anti-thrombotic regimens in specific clinical settings: atrial fibrillation, valve-in-valve procedures, recent percutaneous coronary interventions (PCI), especially those at high bleeding risk

Knowledge

- Anti-thrombotic regimens
- Bleeding risk scores

Skills

- To apply the current evidence-based anti-thrombotic regimen in patients after tricuspid valve interventions
- To implement anti-thrombotic regimen following tricuspid valve interventions according to their bleeding/thrombotic risk, type of tricuspid valve intervention and presence of atrial fibrillation

Attitudes

- To discuss with the patient the type and duration of antithrombotic therapy that will be needed after the tricuspid valve intervention, including the benefits and risks, as part of the informed consent process. To secure his/her compliance with the therapeutic regimen
- To apply judgement, weighing up the balance between safety and effectiveness, in determining the appropriate anti-thrombotic regimen in specific clinical settings where gaps in evidence-based medicine still exist

ESC topic list

- 20.4.2.8 Valvular Heart Disease-Treatment-Intervention-Tricuspid Valve Regurgitation
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter tricuspid valve interventions.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.5.3 Clinical and imaging follow-up after tricuspid intervention: clinical review, imaging, endocarditis prevention, rehabilitation

Objectives

- To ensure appropriate follow-up of patients after tricuspid valve intervention

Knowledge

- Echocardiography criteria to assess severity of residual tricuspid regurgitation and tricuspid stenosis
- Echocardiography criteria to assess severity of tricuspid stenosis
- Echocardiography evaluation of tricuspid device position and stability
- Computed tomography evaluation of tricuspid device, left ventricular outflow tract, cardiac chambers
- Magnetic resonance evaluation of tricuspid valve and quantification of tricuspid regurgitation
- Ultrasound morphology of the transcatheter tricuspid valve prostheses
- VARC criteria to quantify paravalvular leak
- Long-term complications of tricuspid valve interventions, including bioprosthetic valve dysfunction and failure, subclinical and clinical leaflet thrombosis, and infective endocarditis (IE)
- Risk of left ventricular outflow obstruction
- To know current IE prophylaxis
- Indications for cardiac rehabilitation

Skills

- To use appropriate non-invasive or invasive diagnostic techniques to assess tricuspid valve function and morphology
- To order serial clinical and imaging follow-up on an individual patient basis

Attitudes

- Commitment to establish appropriate follow-up to detect early and late complications
- To work in a multidisciplinary HT with physicians and general practitioners to determine the optimal follow-up plan
- To hand over patient care to the referring clinician where appropriate
- To be able to prevent IE

ESC topic list

- 20.4.2.8 Valvular Heart Disease-Treatment-Intervention-Tricuspid Valve Regurgitation
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter tricuspid valve interventions.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5

6.5.4 Tricuspid reintervention

Objectives

- To ensure appropriate patient assessment and qualification to reintervention on dysfunctional tricuspid valve after surgical ring or valve implantation
- To ensure appropriate patient assessment and qualification to reintervention on dysfunctional tricuspid valve after transcatheter repair
- To ensure appropriate patient assessment and qualification to reintervention on dysfunctional tricuspid valve after transcatheter valve implantation

Knowledge

- Criteria for reintervention in significant tricuspid stenosis or regurgitation
- Knowledge of surgical tricuspid valve bioprostheses design and their characteristics and differences
- Echocardiography and computed tomography planning of tricuspid valve-in-valve procedures
- Echocardiography planning of repeat tricuspid clip device implantation

Skills

- To recognize surgical tricuspid valve prosthesis types and define their characteristics
- To perform transcatheter tricuspid valve-in-valve interventions
- To perform tricuspid valve clip reintervention
- To use appropriate non-invasive or invasive diagnostic techniques to assess tricuspid valve function and morphology during tricuspid valve interventions

Attitudes

- To discuss the risks of tricuspid valve reintervention with the patients and the HT
- To coordinate echocardiography and computed tomography assessment supportive of tricuspid valve reintervention during patient qualification to reintervention
- To cooperate with echocardiographers during tricuspid valve reintervention

ESC topic list

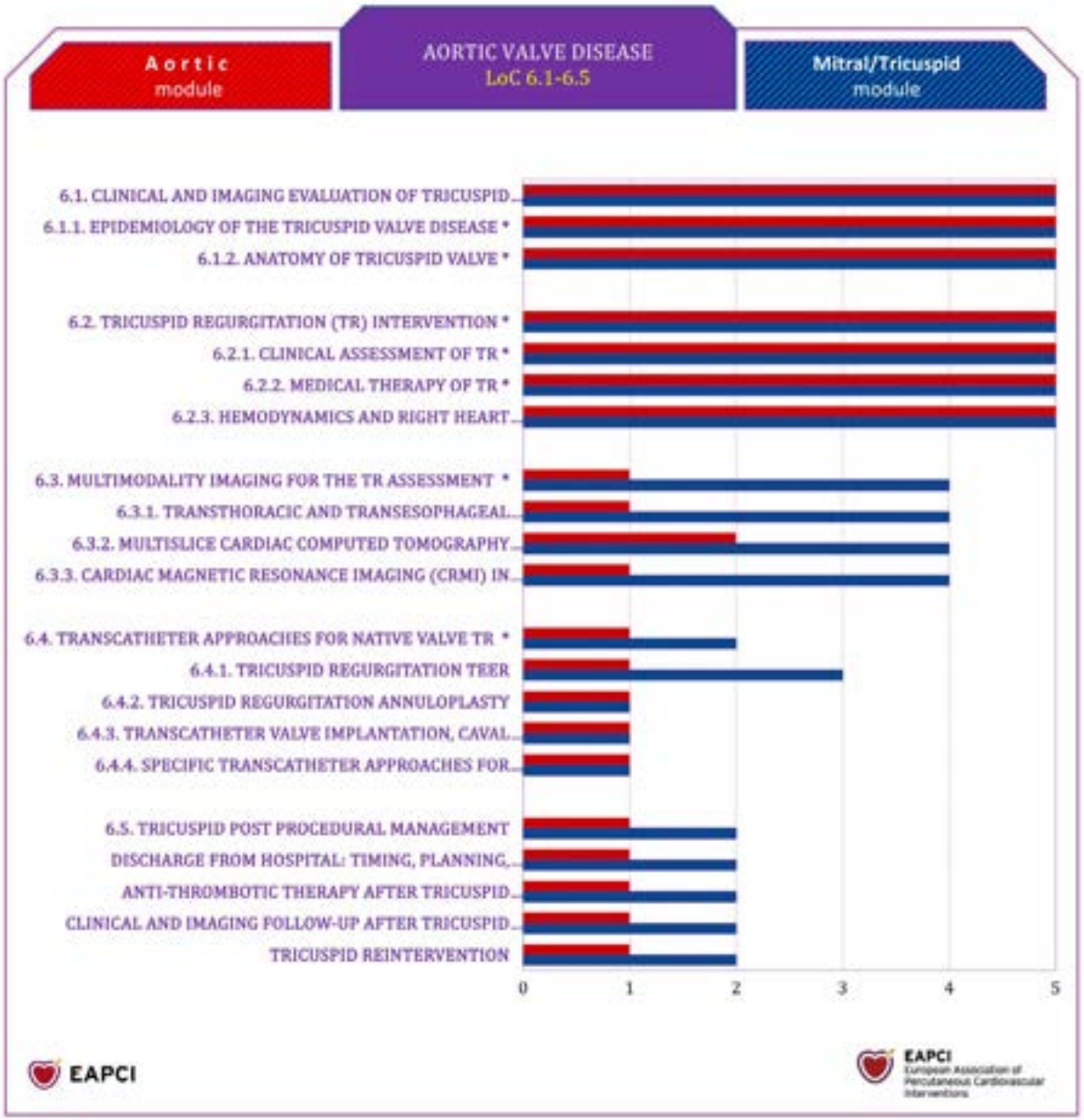
- 20.4.2.8 Valvular Heart Disease-Treatment-Intervention-Tricuspid Valve Regurgitation
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Transcatheter tricuspid valve interventions.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 6.1-6.5



7 Acute and Multi Valvular Transcatheter Structural Interventions

7.1 Multivalvular disease treatment

7.1.1 Combined aortic and mitral valve intervention

Objectives

- To interpret the clinical complexity of patients suffering from multiple valve related problems.
- To investigate the physiological effects of intervening on each of the affected valves.
- To understand the increased risks associated with interventions on more than one valve.
- To discuss the best sequence and timing of treating two valves, taking into account the type of MR (PMR or SMR)

Knowledge

- To know the pathophysiology of combined valve disorders and how to assess the severity in relation to ventricular function
- To evaluate MSCT, TTE and TOE images of aortic and mitral valve anatomy to guide transcatheter valve implantations
- To know the indications for TAVI and transcatheter mitral interventions according to guidelines
- To know the anatomical requirements for arterial and venous access sites
- To understand the role of the HT in decision-making for patients with aortic and mitral valve disease

Skills

- To perform the clinical assessment of patients with combined valve disorders
- To know the appropriate medical therapy for patients with combined valve disorders
- To interpret MSCT and echocardiographic images of aortic and mitral valve anatomy
- To perform TAVI and understand the indications for TMVr and TMVI

Attitudes

3. To work collaboratively within a HT in the management of complex valve patients
4. To be able to determine if, and when, complex combined valve interventions are appropriate and whether they should be avoided or referred to other centers

5. To understand the ability to offer high-risk intervention when it is in the patient's best interests

ESC topic list

- 20.3.1.1 Valvular Heart Disease - Imaging - Echocardiography
- 20.3.1.2 Valvular Heart Disease - Imaging - Cardiac Computed Tomography (CT)
- 20.4.2.1 Valvular Heart Disease-- Treatment - Intervention - Aortic Stenosis
- 20.4.2.1 Valvular Heart Disease-- Treatment - Intervention - Aortic Regurgitation
- 20.4.2.3 Valvular Heart Disease-- Treatment - Intervention - Mitral Valve Stenosis
- 20.4.2.4 Valvular Heart Disease-- Treatment - Intervention - Mitral Valve Regurgitation

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[8]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II. Chapter: Non-invasive imaging for structural heart disease
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Chapters: Trans-catheter aortic valve implantation
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Chapters: Trans-catheter Mitral valve intervention

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 7.1

7.1.2 Combined mitral and tricuspid valve interventions

Objectives

- To understand common etiologies, pathophysiology and interaction of mitral and TV disease
- To understand the likelihood that treatment of one valve may result in improvement of the other valve deficiency and understand when to decide to proceed with combined treatment vs. a potential staged strategy
- To be familiar with the complexity and specifics of combined mitral and TV interventions
- To identify and study patients in whom combined procedure should be considered

Knowledge

- To understand cardiac conditions impacting on both mitral and TV function (HFrEF, HFpEF, atrial fibrillation, especially in atrial MR/TR)

- To know the natural cause of disease in combined MR and TR and stage the patient accordingly
- To understand the mutual implications of mitral valve and TV dysfunction
- To acknowledge the risks and benefits of the different techniques available for combined mitral and TV interventions

Skills

- To apply diagnostics informing on the underlying pathophysiology and interaction between mitral and TV dysfunction
- To address mitral and TV function in the assessment of procedural success of atrioventricular valve therapies
- To be familiar with techniques and interpretation of assessing the interaction between right and left sided valvular lesions and function
- To be familiar with procedural steps and determine the proper strategy to treat mitral and TV in sequence, either in a single procedure or as a staged intervention

Attitudes

- To optimize guideline directed therapy and determine adequate diagnostic examinations in the setting of combined mitral and tricuspid disease
- To implement the results of multimodal assessment to guide decision making in combined mitral and TV disease
- To interact with the HT and other disciplines relevant to the treatment of both left and right heart failure
- To monitor institutional experience and expertise with combined mitral/tricuspid valve interventions

ESC topic list

- 16.6.4 Acute Heart Failure - Clinical - Cardiogenic Shock
- 16.4.2.1 Acute Heart Failure-- Treatment - Nonpharmacologic-I Treatment - Circulatory Support
- 20.3.1.1 Valvular Heart Disease - Diagnostic Methods - Imaging - Echocardiography
- 20.3.1.2 Valvular Heart Disease - Diagnostic Methods - Imaging - Cardiac Computed Tomography (CT)
- 20.4.2.3 Valvular Heart Disease-- Treatment - Intervention - Mitral Valve Stenosis
- 20.4.2.4 Valvular Heart Disease-- Treatment - Intervention - Mitral Valve Regurgitation

Essential Reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]

- Chieffo A, Dudek D, Hassager C, Combes A, Gramegna M, Halvorsen S, Huber K, Kunadian V, Maly J, Møller JE, Pappalardo F, Tarantini G, Tavazzi G, Thiele H, Vandenbriele C, Van Mieghem N, Vranckx P, Werner N, Price S. Joint EAPCI/ACVC expert consensus document on percutaneous ventricular assist devices. EuroIntervention. 2021 Jul 20;17(4):e274-e286. doi: 10.4244/EIJY21M05_01. PMID: 34057071.[43]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 7.1

7.1.3 Management of combined aortic, mitral and tricuspid valve interventions

Objectives

- To coordinate treatment of patient with multi-valvular heart diseases
- To decide and perform transcatheter heart valvular interventions in agreement with patient and Heart Team decisions
- To define sequence of multi-valvular interventions to guarantee safe and effective patient treatment

Knowledge

- To know conservative and interventional treatment of patients with multi-valvular heart diseases
- To know the options of transcatheter interventions in patients with multiple valvular dysfunctions
- To know the options of surgical interventions in patients with multiple valvular dysfunctions
- To plan the sequence of treatment in patients requiring combined heart valvular therapy

Skills

- Coordination of treatment of patient with multi-valvular heart diseases between outpatient clinics and in-hospital departments
- Heart Team patient discussion, qualification to optimal therapy, including conservative treatment, single and multi-valvular interventions
- Heart Team decision making for the optimal sequence of combined aortic, mitral or tricuspid interventions.
- Abilities to perform aortic, mitral, or tricuspid procedures safely and effectively

Attitudes

- Heart Team approach to patients with multivalvular heart diseases

- Discussion of safe and effective treatments in patients with multivalvular heart diseases, including results of imaging, invasive assessments, multidisciplinary team evaluation and patient expectations
- Participation in the screening, treatment and follow-up of patients with complex multi-valvular diseases

ESC topic list

- 16.6.4 Acute Heart Failure - Clinical - Cardiogenic Shock
- 16.4.2.1 Acute Heart Failure-- Treatment - Nonpharmacologic-l Treatment - Circulatory Support
- 20.3.1.1 Valvular Heart Disease - Diagnostic Methods - Imaging - Echocardiography
- 20.3.1.2 Valvular Heart Disease - Diagnostic Methods - Imaging - Cardiac Computed Tomography (CT)
- 20.4.2.3 Valvular Heart Disease-- Treatment - Intervention - Mitral Valve Stenosis
- 20.4.2.4 Valvular Heart Disease-- Treatment - Intervention - Mitral Valve Regurgitation

Essential Reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]
- Chieffo A, Dudek D, Hassager C, Combes A, Gramegna M, Halvorsen S, Huber K, Kunadian V, Maly J, Møller JE, Pappalardo F, Tarantini G, Tavazzi G, Thiele H, Vandenbriele C, Van Mieghem N, Vranckx P, Werner N, Price S. Joint EAPCI/ACVC expert consensus document on percutaneous ventricular assist devices. EuroIntervention. 2021 Jul 20;17(4):e274-e286. doi: 10.4244/EIJY21M05_01. PMID: 34057071.[43]

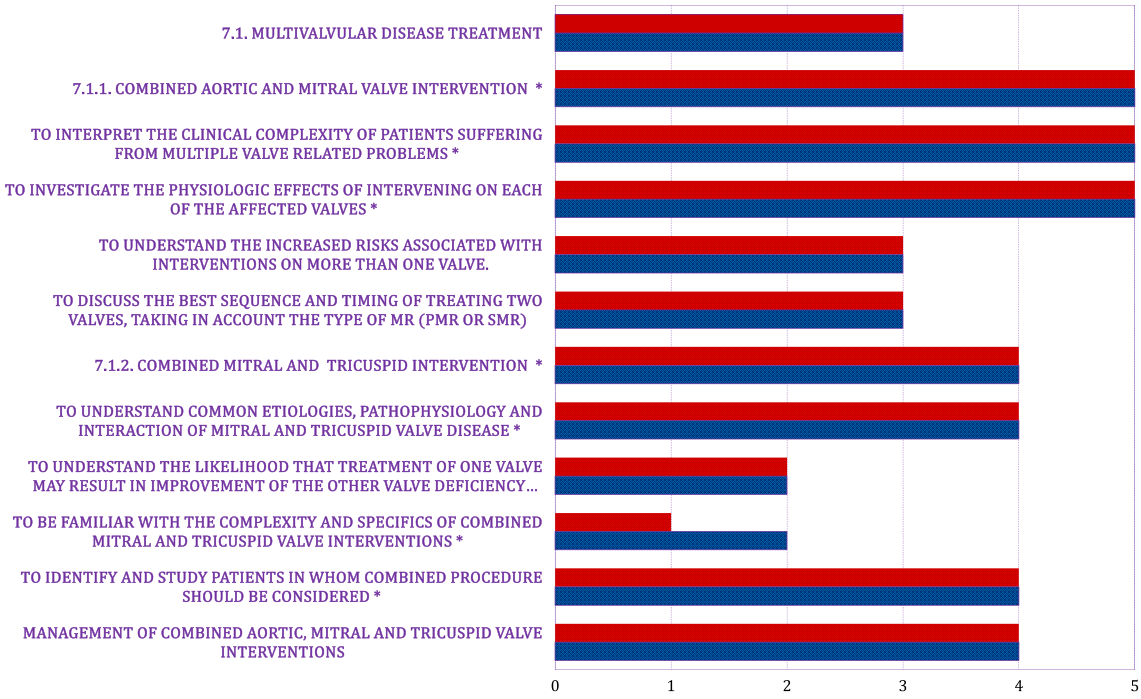
Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 7.1

Aortic module

AORTIC VALVE DISEASE
LoC 7.1

Mitral/Tricuspid module



EAPCI

EAPCI European Association of Percutaneous Cardiovascular Interventions

7.2 Valvular intervention in acute patients

7.2.1 Decompensated aortic valve disease

Objectives

- To assess patients with acute decompensated AoS and/or regurgitation presenting with HF and/or cardiogenic shock (CS)
- To interpret imaging in patients with decompensated aortic valve disease including TTE and TOE
- To assess risks and benefits of different strategies including emergency/urgent surgery, TAVI, BAV and avoid futility
- To perform BAV or TAVI in unstable patients

Knowledge

- To understand the mechanism of CS diagnosis and staging
- To know the role of anaesthetic ventilatory support, inotropic use and MCS in emergent aortic valve procedures
- To know the haemodynamic effects of different TAVI valve types
- To know the indications for BAV and TAVI
- To follow a rational approach to preprocedural planning and treatment strategies

Skills

- To perform clinical assessment of patients with decompensated aortic valve disease and screen for futility
- To interpret imaging of decompensated patients with aortic valve disease, including low-flow low-gradient AoS
- To optimize appropriate medical therapy for patients in heart failure and CS due to aortic valve disease
- To master the technique of BAV and TAVI in hemodynamically unstable patients

Attitudes

- To work collaboratively in a HT to discuss whether, and when, urgent or emergency high-risk interventions are appropriate is in the patient's best interests
- To interact with decompensated patients and their relatives
- To provide the best possible care to acutely hemodynamically unstable patients

ESC topic list

- 3.15 Echocardiography – Intraoperative and Interventional Echocardiography
- 16.4 Acute Heart Failure - Treatment
- 16.4.1 Acute Heart Failure - Treatment - Pharmacotherapy
- 16.4.2 Acute Heart Failure - Treatment - Non-pharmacological treatment

- 16.4.3 Acute Heart Failure – treatment – multi-disciplinary interventions
- 16.6.4 Acute Heart Failure - Clinical - Cardiogenic shock
- 19.4 Acute Cardiac Care – Cardiogenic Shock
- 20.3.1.1 Valvular Heart Disease - Imaging - Echocardiography
- 20.3.1.2 Valvular Heart Disease - Imaging - Cardiac Computed Tomography (CT)
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Stenosis
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Regurgitation
- 20.6.1 Valvular Heart Disease Clinical – Aortic Valve Stenosis
- 30.3.1 Noncoronary Cardiac Intervention – Aortic Valve Intervention

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- ESC Core Curriculum for general cardiology (2020): Chapter Valvular Heart Disease
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II. Chapter: Non-invasive imaging for structural heart disease
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Chapters: Balloon aortic valvuloplasty; Trans-catheter aortic valve implantation

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 7.2

7.2.2 Acute and decompensating mitral regurgitation (MR)

Objectives

- To learn how to assess patients with decompensated severe MR
- To interpret imaging in patients with severe MR, including TTE and TOE
- To optimize medical treatment and assess the risks and benefits associated with intervention when decompensated
- To perform TMVr

Knowledge

- To know the echocardiographic criteria for the assessment of the severity of MR and LVEF in a decompensated state
- To understand the optimal medical therapy in patients with decompensated severe MR
- To know the role of inotropic, anesthetic, ventilatory and mechanical support in emergent mitral valve procedures
- To discuss the hemodynamic effects of percutaneous mitral valve interventions

Skills

- To perform clinical assessment of patients with severe decompensated MR and identify patients in whom urgent transcatheter mitral valve intervention would offer a definite prognostic impact
- To interpret echocardiographic imaging in decompensated patients with MV disease
- To determine and implement appropriate medical therapy for patients in heart failure and CS due to MR
- To perform TMVr procedures.

Attitudes

- To show a commitment to assess, manage and optimize acutely decompensated patients
- To work collaboratively in a HT to discuss whether, and when, urgent or emergency high-risk interventions are appropriate and in the patient's best interests
- To deal with decompensated patients and their relatives
- To provide the best possible care to acutely hemodynamically unstable patient

ESC topic list

- 16.4 Acute Heart Failure - Treatment
- 16.4.1 Acute Heart Failure - Treatment - Pharmacotherapy
- 16.4.2 Acute Heart Failure - Treatment - Non-pharmacological treatment
- 16.6.4 Acute Heart Failure - Clinical - Cardiogenic shock
- 20.3.1.1 Valvular Heart Disease - Imaging - Echocardiography
- 20.3.1.2 Valvular Heart Disease - Imaging - Cardiac Computed Tomography (CT)
- 30.3.2 Interventional Cardiology - Noncoronary Cardiac Intervention - Mitral Valve Intervention
- 20.4.2.4 Valvular Heart Disease - Treatment - Intervention – Mitral valve Regurgitation

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- ESC Core Curriculum for general cardiology (2020): Chapter Valvular Heart Disease
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II. Chapter: Non-invasive imaging for structural heart disease

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 7.2

7.2.3 Acute severe MR post-MI

Objectives

- To learn how to assess patients with decompensated severe MR following acute MI
- To interpret imaging in patients with severe MR, including TTE and TOE, following acute myocardial infarction
- To understand the potential role TMVr in patients with acute severe MR following acute MI
- To optimize medical treatment and assess the risks and benefits associated with intervention in a decompensated patient

Knowledge

- To know the echocardiographic features of acute severe MR following acute MI and the anatomical suitability for TMVr
- To understand the role of inotropic, mechanical circulatory support (MCS) in patients with acute severe MR following acute MI in urgent settings
- To understand the value of IABP and MCS

Skills

- To perform a clinical assessment of patients with acute severe MR following acute MI
- To interpret echocardiographic imaging of patients with acute severe MR following acute MI
- To optimize and implement appropriate medical therapy and/or IABP for patients in HF and CS due to acute severe MR following acute MI
- To understand urgent & emergent TMVr in patients with acute severe MR post-MI.

Attitudes

- To demonstrate commitment to assess, manage and optimize acutely decompensated patients
- To work collaboratively in a HT to discuss whether, and when, urgent or emergency high-risk interventions are appropriate is in the patient's best interests, including MCS and TMVr
- To deal with decompensated patients and their relatives
- To provide the best possible care to acutely unwell patients hemodynamically unstable patients

ESC topic list

- 16.4 Acute Heart Failure - Treatment
- 16.4.1 Acute Heart Failure - Treatment - Pharmacotherapy
- 16.4.2 Acute Heart Failure - Treatment - Non-pharmacological treatment

- 16.6.4 Acute Heart Failure - Clinical - Cardiogenic shock
- 20.3.1.1 Valvular Heart Disease - Imaging - Echocardiography
- 20.4.2.4 Valvular Heart Disease - Treatment - Intervention - Mitral regurgitation

Essential reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- ESC Core Curriculum for general cardiology (2020): Chapter Valvular Heart Disease
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II. Chapter: Non-invasive imaging for structural heart disease
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part III. Chapters: Trans-catheter mitral valve repair
- Chieffo A, Dudek D, Hassager C, Combes A, Gramegna M, Halvorsen S, Huber K, Kunadian V, Maly J, Møller JE, Pappalardo F, Tarantini G, Tavazzi G, Thiele H, Vandenbriele C, Van Mieghem N, Vranckx P, Werner N, Price S. Joint EAPCI/ACVC expert consensus document on percutaneous ventricular assist devices. EuroIntervention. 2021 Jul 20;17(4):e274-e286. doi: 10.4244/EIJY21M05_01. PMID: 34057071.[43]
- Haberman D, Estévez-Loureiro R, Benito-Gonzalez T, Denti P, Arzamendi D, Adamo M, Freixa X, Nombela-Franco L, Villablanca P, Krivoshei L, Fam N, Spargias K, Czarnecki A, Pascual I, Praz F, Sudarsky D, Kerner A, Ninios V, Gennari M, Beeri R, Perl L, Wasserstrum Y, Danenberg H, Poles L, George J, Caneiro-Queija B, Scianna S, Moaraf I, Schiavi D, Scardino C, Corpataux N, Echarte-Morales J, Chrissoheris M, Fernández-Peregrina E, Di Pasquale M, Regueiro A, Vergara-Uzcategui C, Iñiguez-Romo A, Fernández-Vázquez F, Dvir D, Maisano F, Taramasso M, Shuvy M. Conservative, surgical, and percutaneous treatment for mitral regurgitation shortly after acute myocardial infarction. Eur Heart J. 2022 Feb 12;43(7):641-650. doi: 10.1093/eurheartj/ehab496. PMID: 34463727.[44]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 7.2

7.2.4 Interpret percutaneous assist devices in acute heart failure (HF)

Objectives

- To know the available MCS devices, their physiologic effects and specific risks and benefits in acute HF
- To consider or refer patients for percutaneous assist devices in acute HF

Knowledge

- To understand the epidemiology and pathophysiology of acute HF
- To know the non-interventional therapy of acute HF
- To understand the mode of action and physiologic effect of available MCS devices, including ventricular unloading and venting
- To understand the bleeding and thrombotic complications of mechanical assist devices along with access site management and other characteristics

Skills

- To promptly recognize CS and pre-shock conditions
- To know when drafting a strategy of LV unloading in a pre-shock condition
- To reduce the risk of access site complications when using large bore catheters and use vascular access site closure devices
- To be able to deliver MCS devices and manage potential complications including thrombi formation and access site bleeding

Attitudes

- To consider mechanical support therapies as an interdisciplinary HT effort, potentially involving intensive care specialist, HF specialists, cardiac perfusionists and cardiac and/or vascular surgeons
- To carefully balance risks and benefits of using MCS devices
- To show commitment to follow, participate and critically appraise research in this field

ESC topic list

- 16.6.4 Acute Heart Failure - Clinical - Cardiogenic Shock
- 16.4.2.1 Acute Heart Failure - Treatment - Nonpharmacological Treatment - Circulatory Support

Essential Reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- 2021 ESC/EACTS Guidelines for the management of heart failure[30]
- Chieffo A, Dudek D, Hassager C, Combes A, Gramegna M, Halvorsen S, Huber K, Kunadian V, Maly J, Møller JE, Pappalardo F, Tarantini G, Tavazzi G, Thiele H, Vandenbriele C, Van Mieghem N, Vranckx P, Werner N, Price S. Joint EAPCI/ACVC expert consensus document on percutaneous ventricular assist devices. EuroIntervention. 2021 Jul 20;17(4):e274-e286. doi: 10.4244/EIJY21M05_01. PMID: 34057071.[43]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 7.2

8 Other valvular and structural interventions

8.1 Percutaneous closure of paravalvular regurgitation (PVL)

Objectives

- To know the various clinical presentations, the indications for and the impact of closure.
- To acknowledge the risks and benefits of dedicated PVL closure
- To understand the anatomical classification of aortic and mitral PVL and the impact on procedural complexity and strategy.
- To refer to or use the various interventional techniques, imaging techniques and material to perform PVL closure

Knowledge

- To acknowledge the epidemiology and pathophysiology of PVL.
- To know the multimodality criteria to define and grade PVL according to aortographic, echocardiographic, MSCT, CMR and, when needed, invasive parameters
- To know the various interventional and imaging techniques and equipment
- To learn the procedural approaches including anterograde, retrograde and transapical.
- To know the vascular plug devices characteristics, and their efficacy and safety according to anatomies.

Skills

- To master large bore venous access
- To perform transeptal puncture when needed
- To perform procedural planning including the determination of the optimal fluoroscopic projections for device implantation using available software solutions.
- To interpret real time 3D-TOE and fusion imaging.
- To perform an arteriovenous rail and to manipulate stiff and extra-stiff guidewires
- To select and deliver an appropriately sized device across a defect.
- To capture an embolized device using snares and other techniques

Attitudes

- To adhere and collaborate in the HT approach in the evaluation and discussion of these patients
- To work in a multidisciplinary team during the procedure with refined and efficient communication with the imaging specialist during the procedure.

ESC topic list

- 8.3 Cross-Modality and Multi-Modality Imaging Topics – Imaging of Valvular Heart Disease
- 20.2 – Valvular Heart Disease – Epidemiology, Prognosis, Outcome
- 20.99 Valvular Heart Disease – Valvular Heart Disease, Other
- 20.4.2.2 Valvular Heart Disease – Treatment – Intervention – Aortic Valve Regurgitation
- 30.3.7 Interventional Cardiology – Noncoronary Cardiac Intervention – Closure of Paravalvular Leaks

Essential Reading

- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Part II – Diagnostic cardiovascular modalities and their application: Non-invasive imaging for structural heart disease; Invasive hemodynamic assessment
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume–1, Part II - Diagnostic cardiovascular modalities and their application in hemodynamic assessment
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume, Part III - Percutaneous closure of paravalvular leaks

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.2 Transcatheter closure of ventricular septal defect (VSD)

Objectives

- To know how to diagnose and treat VSD
- To identify VSD phenotypes amenable for catheter-based intervention
- To plan an appropriate procedural strategy

Knowledge

- Etiology and pathophysiology of the VSD
- To understand the anatomic classification of VSD for catheter-based therapy
- To know transcatheter devices and accessories for VSD closure

Skills

- To master large bore vascular access
- To be able to interpret real time TTE, TOE and 3D-TOE.
- To perform an arteriovenous rail and to manipulate stiff and extra-stiff guidewires
- To select and deliver an appropriately sized device across a defect.
- To capture an embolized device using snares or other techniques

Attitudes

- To adhere and collaborate in the HT approach in the evaluation and discussion of these patients
- To work in a multidisciplinary team during the procedure with refined and efficient communication with the imaging specialist during the procedure.

ESC Topic List

- 18.6.5 Acute Coronary Syndromes – Clinical – Mechanical Complications
- 3.15 Echocardiography – Intraoperative and Interventional Echocardiography
- 25.3.1.1 Congenital Heart Disease and Paediatric Cardiology – Diagnostic Methods – Imaging – Echocardiography
- 25.3.1.2 Congenital Heart Disease and Paediatric Cardiology – Diagnostic Methods – Imaging – Cardiac Computed Tomography
- 25.6.2 Congenital Heart Disease and Paediatric Cardiology – Clinical – Adult Congenital Heart Disease

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III Part II – chapter "Ventricular Septal Defect Closure"

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.3 Atrial septal defect (ASD) closure

Objectives

- To identify patients with ASD from a clinical and multimodality assessment
- To perform, collaborate with, or refer to the multidisciplinary HT performing ASD closure
- To acknowledge the expertise in device selection and percutaneous treatment of ASD

Knowledge

- To understand the embryology , the different types of Atrial Septal Defects (ASD) and anatomical relationship with other cardiac structures
- To correlation other congenital heart disease and the presence of complex ASDs (e.g. multiple defects, Eisenmenger's syndrome)
- To understand the physiology of right-to-left and left-to-right shunts and correlation with compliance and pressure in RV and LV
- To know the clinical manifestations of ASD in relation to hemodynamic parameters and the clinical relevance of paradoxical embolism

Skills

- To properly select suitable patients and identify the best timing for ASD treatment
- To conduct and interpret appropriate imaging to determine the defect morphology and position, fenestrations, multiplicity, rims for percutaneous closure, RV status, as well as TV function
- To perform and interpret findings from right cardiac catheterization and hemodynamic evaluation with test balloon occlusion and vasoreactivity test if needed
- To acquire expertise of the main procedural steps, including venous access, hemostasis, sizing of the ASD, device selection and implantation of multiple or different devices
- To interpret intraprocedural echocardiographic real time images to allow the intervention strategy to adapt (deficient aortic and/or posterior rims, floppy rims, multiple ASDs or large ASDs)
- To understand how to manage complications such as device dislocation, embolization, entrapment of right atria structures, defect dilation or rupture

Attitudes

- To properly select suitable candidates for percutaneous ASD procedure, including proper devices according to anatomical and physiological aspects
- To interact with all members of the HT, during all phases of patient selection, percutaneous procedure and follow-up care
- To implement IE prophylaxis and anti-thrombotic treatment

ESC topic list

- 3.1.12 Imaging: Intraoperative and Interventional Echocardiography
- 3.10 Echocardiography - Transoesophageal Echocardiography (TEE)
- 3.11 Echocardiography - Contrast Echocardiography
- 5.2 Cardiac Magnetic Resonance (CMR) - Morphology, Dimensions, Volumes and Mass
- 20.6.2 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Adult Congenital Heart Disease, Clinical
- 25.3.99 Interventional Cardiology and Cardiovascular Surgery: Non Coronary Cardiac Intervention, Other
- 30.3.5 Interventional Cardiology - Noncoronary Cardiac Intervention - Patent Foramen Ovale (PFO) / Atrial Septal Defect (ASD) Closure.

Essential Reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III, Part II, Atrial septal defect and patent foramen ovale closure
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.4 Septal ablation for hypertrophic obstructive cardiomyopathy (HOCM)

Objectives

- To select which patients presenting with HOCM may be considered for septal ablation
- To perform, collaborate with, or refer to the multidisciplinary HT performing HOCM septal ablation or to engage a multi-disciplinary HT involved in the treatment of HOCM

Knowledge

- To know the indications for septal ablation.
- To understand the principles, risk and benefits of septal ablation
- To know the anatomical, functional and clinical features which render the patient eligible for septal ablation, including septal bulge enhancement during echocardiographic contrast
- To know the material, equipment, and procedural steps of septal ablation
- To estimate which patients may need a permanent pacemaker based on pre and post procedural ECG

Skills

- To select the appropriate candidate for septal ablation based on indications and coronary angiography with detailed septal anatomy.
- To be able to recognize the area supplied by the septal perforator
- To secure no spill of the contrast back to the LAD and properly administer alcohol or another agent during the septal ablation
- To assess and treat procedural complications, namely the need for a permanent pacemaker

Attitudes

- To plan the septal ablation procedure and to discuss with the patient the risks and benefits of the procedure.
- To create a referral network for alcohol septal ablation as part of a multidisciplinary HT with expertise in the management of hypertrophic cardiomyopathy.
- To lead the procedure and share with the imager the decision to proceed with the alcohol septal ablation

ESC Topic list

- 13.1.4 Ventricular Arrhythmias and Sudden Cardiac Death (SCD) - Pathophysiology and Mechanisms - Hypertrophic Cardiomyopathy
- 22.6.2 Myocardial Disease - Clinical - Hypertrophic Cardiomyopathy

Essential reading

- 2020 ESC Core curriculum
- 2014 ESC Guidelines on diagnosis and management of hypertrophic cardiomyopathy: the Task Force for the Diagnosis and Management of Hypertrophic Cardiomyopathy of the European Society of Cardiology (ESC). Eur Heart J. 2014 Oct 14;35(39):2733-79[45].

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.5 Patent foramen ovale (PFO) closure

Objectives

- To identify patients with PFO from a clinical and multimodality assessment
- To perform, collaborate with, or refer to the multidisciplinary HT performing PFO closure
- To acknowledge the expertise in device selection and percutaneous treatment of PFO

Knowledge

- To know the prevalence and embryology of patent foramen ovale (PFO) and the anatomical relationship with other cardiac structures
- To understand the anatomical variations associated a PFO (presence of atrial septal aneurysm, septum thickness, embryological remnants)
- To understand the physiology of right-to-left and left-to-right shunts and correlation with compliance and pressure in right and LV
- To know the non-invasive evaluation of a PFO and how to properly perform Valsalva manoeuvres to make the diagnosis
- To know the clinical manifestations of PFO (stroke) and correlate with other conditions (platypnea-orthodeoxia, decompression illness, migraine, high-altitude pulmonary oedema)

Skills

- To conduct and interpret imaging, including the ability to perform adequate sizing and device selection in PFO closure

- To understand the impact on anatomical variations of percutaneous closure of PFO.
- To properly select patients who may benefit from PFO treatment
- To acquire expertise of the main procedural steps, including venous access, haemostasis, different devices and how to manage complications

Attitudes

- To properly select suitable candidates for the procedure of percutaneous closure, including selection of proper devices according to anatomical and physiological aspects
- To interact with all members of the multidisciplinary team, namely neurologists, during patient selection, post-procedure care and follow-up
- To implement IE prophylaxis and anti-thrombotic treatment

ESC topic list

- 3.1.12 Imaging: Intraoperative and Interventional Echocardiography
- 3.10 Echocardiography - Transoesophageal Echocardiography (TEE)
- 3.11 Echocardiography - Contrast Echocardiography
- 5.2 Cardiac Magnetic Resonance (CMR) - Morphology, Dimensions, Volumes and Mass
- 20.6.2 Valvular, Myocardial, Pericardial, Pulmonary, Congenital Heart Disease: Adult Congenital Heart Disease, Clinical
- 25.3.99 Interventional Cardiology and Cardiovascular Surgery: Non-Coronary Cardiac Intervention, Other
- 30.3.5 Interventional Cardiology - Noncoronary Cardiac Intervention - Patent Foramen Ovale (PFO) / Atrial Septal Defect (ASD) Closure

Essential Reading

- ESC core curriculum for general cardiology (2013): Content in Chapters Valvular Heart Disease and Other Cardiac diseases
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume III, Part II, chapter "Atrial septal defect and patent foramen ovale closure"
- Pristipino C, Sievert H, D'Ascenzo F, Mas JL, Meier B, Scacciatella P, Hildick-Smith D, Gaita F, Toni D, Kyrle P, Thomson J, Derumeaux G, Onorato E, Sibbing D, Germonpré P, Berti S, Chessa M, Bedogni F, Dudek D, Hornung M, Zamorano J; European Association of Percutaneous Cardiovascular Interventions (EAPCI); European Stroke Organisation (ESO); European Heart Rhythm Association (EHRA); European Association for Cardiovascular Imaging (EACVI); Association for European Paediatric and Congenital Cardiology (AEPC); ESC Working group on GUCH; ESC Working group on Thrombosis; European Haematological Society

(EHA). European position paper on the management of patients with patent foramen ovale. General approach and left circulation thromboembolism. EuroIntervention. 2019 Jan 20;14(13):1389-1402. doi: 10.4244/EIJ-D-18-00622. PMID: 30141306[46].

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.6 Left atrial appendage occlusion (LAAO)

8.6.1 Patient selection and clinical outcomes

Objectives

- To identify and study patients eligible for LAAO, based on clinical and anatomical characteristics.
- To follow-up patients after LAAO.

Knowledge

- Management of oral anticoagulation in patients with AF according to ESC Guidelines for the diagnosis and management of atrial fibrillation.
- Principles, risks and benefits of different treatment modalities for stroke prevention in patients with AF, and in particular LAAO.
- Selection criteria and risk scores to evaluate patients possibly eligible for percutaneous LAAO.

Skills

- To discuss a conservative medical, transcatheter or surgical approach for the prevention of embolic stroke in patients with AF.
- To assess and present treatment options, with risks and benefits, to patients in a balanced and informative manner
- To monitor and diagnose thrombo-embolic, hemorrhagic and other adverse clinical events after LAAO.

Attitudes

- To work in a multidisciplinary team with non-invasive cardiologists, neurologists, internal medicine specialists, electrophysiologists and cardiac surgeons.

ESC topic list

- 10.2.2 Atrial Fibrillation (AF) - Epidemiology, Prognosis, Outcome - Stroke in Atrial Fibrillation
- 10.5.2.1 Atrial Fibrillation (AF) - Stroke Prevention - Left Atrial Appendage Closure - Indications

- 10.5.2.3 Atrial Fibrillation (AF) - Stroke Prevention - Left Atrial Appendage Closure - Outcomes and Complications
- 29.6.3.2 Stroke – Clinical Cardiogenic Embolism - Left Atrial Appendage (LAA) and Left Atrial Appendage (LAA) Closure

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook , Part II- Left atrial appendage occlusion
- The ESC Textbook of Cardiovascular Medicine
- EHRA/EAPCI expert consensus statement on catheter-based left atrial appendage occlusion – an update. EuroIntervention 2020;15(13):1133-1180. doi: 10.4244/EIJY19M08_01. PMID: 31474583.[47]
- 2020 ESC Guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association for CardiacSurgery (EACTS): The Task Force for the diagnosis and management of atrial fibrillation of the European Society of Cardiology (ESC) Developed with the special contribution of the European Heart Rhythm Association (EHRA) of the ESC. Eur Heart J. 2021;42(5):373-498. doi: 10.1093/eurheartj/ehaa612. Erratum in: Eur Heart J. 2021 Feb 1;42(5):507. Erratum in: Eur Heart J. 2021 Feb 1;42(5):546-547. Erratum in: Eur Heart J. 2021 Oct 21;42(40):4194. PMID: 32860505.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.6.2 Design and concept of LAAO devices

Objectives

- To know the different devices approved for LAAO and understand their characteristics.

Knowledge

- IFU and technical specifications of devices currently approved and/or used for LAAO.
- To acknowledge the scientific and practical advantages and limitations of currently available LAA occluders.

Skills

- To understand how to perform patient tailored LAAO device selection based on clinical and anatomical characteristics.

Attitudes

- The commitment to seek updates in the LAAO field.
- To build a structured approach on device selection

ESC topic list

- 10.5.2.2 Atrial Fibrillation (AF) - Stroke Prevention - Left Atrial Appendage Closure Technology and Implantation Technique
- 10.5.2.3 Atrial Fibrillation (AF) - Stroke Prevention - Left Atrial Appendage Closure Outcomes and Complications
- 29.6.3.2 Stroke – Clinical Cardiogenic Embolism - Left Atrial Appendage (LAA) and Left Atrial Appendage (LAA) Closure

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook, Part II- Left atrial appendage occlusion
- EHRA/EAPCI expert consensus statement on catheter-based left atrial appendage occlusion – an update. EuroIntervention 2020;15(13):1133-1180. doi: 10.4244/EIJY19M08_01. PMID: 31474583.[47]
- An overview of current and emerging devices for percutaneous left atrial ppendage closure. Trends Cardiovasc Med. 2019;29(4):228-36.[48]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.6.3 Peri-procedural LAAO imaging

Objectives

- To select and be able to interpret the different imaging modalities for pre-, peri-, and post-procedural imaging involved in LAAO
- To follow-up patients undergoing LAAO

Knowledge

- LAA anatomy and relationship with other cardiac structures.
- Morphological and anatomical characteristics of the LAA on echocardiography (TOE, ICE) and MSCT.
- To acknowledge how different anatomical features observed at pre-procedural and intra-procedural imaging can be associated with LAA closure outcomes and complications.

Skills

- To interpret pre-procedural non-invasive imaging data, including the ability to perform adequate sizing for device size selection.
- To identify and measure the different anatomical aspects of the LAA at MSCT, TOE and ICE to optimize procedural outcomes and prevent possible complications.

- To integrate in real time the echocardiographic and fluoroscopic views during the LAAO procedure and to use fusion imaging, when available
- To interpret echocardiographic and/or MSCT post-procedural LAA imaging.

Attitude

- To recognize challenging anatomical features that may affect technical success.
- To strive for optimal collaboration and communication with imaging cardiologists and professionals involved in echocardiography and cardiac MSCT.

ESC topic list

- 10.5.2.2 Atrial Fibrillation (AF) - Stroke Prevention - Left Atrial Appendage Closure Technology and Implantation Technique
- 10.5.2.3 Atrial Fibrillation (AF) - Stroke Prevention - Left Atrial Appendage Closure Outcomes and Complications
- 29.6.3.2 Stroke – Clinical Cardiogenic Embolism - Left Atrial Appendage (LAA) and Left Atrial Appendage (LAA) Closure

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook
- The ESC Textbook of Cardiovascular Medicine
- EHRA/EAPCI expert consensus statement on catheter-based left atrial appendage occlusion – an update. EuroIntervention 2020;15(13):1133-1180. doi: 10.4244/EIJY19M08_01. PMID: 31474583.[47]
- Expert Recommendations on Cardiac Computed Tomography for Planning Transcatheter Left Atrial Appendage Occlusion. JACC Cardiovasc Interv. 2020;13(3):277-292.[49]
- The use of imaging in new transcatheter interventions: an EACVI review paper. Eur Heart J Cardiovasc Imaging. 2016 Aug;17(8):835-835af. doi: 10.1093/ehjci/jew043. Epub 2016 Jun 16. PMID: 27311822[50].

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.6.4 Percutaneous LAAO procedure

Objectives

- To safely perform LAAO

Knowledge

- Principles, benefits and risks of LAAO
- Operating team and institutional requirement to perform LAAO.

- Main interventional settings, materials and procedural steps: from obtaining venous access, to performing a safe transseptal puncture, implanting the LAA occluder and obtaining adequate hemostasis.
- Frequency and clinical impact of the main peri-procedural complications.

Skills

- To gain venous access, namely ultrasound guided.
- To perform a transseptal puncture under echocardiographic and fluoroscopic guidance, according to the specific device and patient anatomy.
- To perform procedural planning including the determination of the optimal fluoroscopic projections for device implantation using available software solutions.
- To implant and release the LAAO device and to check for proper device position and stability, to avoid device embolization and important peri-device leaks.
- To obtain adequate hemostasis at the end of the procedure.
- To rapidly recognize and treat possible procedural complications.

Attitude

- To adopt a collaborative attitude with the imagers and all professionals involved in the procedure.

ESC topic list

- 10.5.2.2 Atrial Fibrillation (AF) - Stroke Prevention - Left Atrial Appendage Closure Technology and Implantation Technique
- 10.5.2.3 Atrial Fibrillation (AF) - Stroke Prevention - Left Atrial Appendage Closure Outcomes and Complications
- 29.6.3.2 Stroke – Clinical Cardiogenic Embolism - Left Atrial Appendage (LAA) and Left Atrial Appendage (LAA) Closure

Essential reading

- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook
- EHRA/EAPCI expert consensus statement on catheter-based left atrial appendage occlusion – an update. EuroIntervention 2020;15(13):1133-1180. doi: 10.4244/EIJY19M08_01. PMID: 31474583.[47]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.7 Pulmonary Interventions for acute and chronic thromboembolic disease

8.7.1 Acute pulmonary thromboembolism (PTE)

Objectives

- To acknowledge the risk and benefits of catheter-directed interventions (CDIs) to reduce fibrinolysis-related hemorrhage in patients eligible for reperfusion
- To perform safely and efficiently, collaborate with, or refer to the Pulmonary Embolism Response Team (PERT) performing CDIs

Knowledge

- To know the anatomy and physiology of the pulmonary circulation
- To know the echocardiographic features of acute right heart failure in PTE
- To understand the role of invasive (angiography) and non-invasive (MSCT and CMR) imaging in acute PTE
- To know the indications and modalities for CDIs and role of ECMO as a bridge to surgical embolectomy

Skills

- To interpret a MSCT scan and to perform pulmonary angiography
- To perform, collaborate with, or refer to CDI with or without local administration of a reduced dose of fibrinolytics or other approved drugs
- To assess the effectiveness of the procedure (angiographic score, pulmonary pressure drop and LV to RV ratio)

Attitudes

- To participate in the decision-making to proceed to urgent CDIs or surgical thromboembolectomy
- To participate in, or design, local or regional protocols for the treatment of intermediate-high- and high-risk acute PE needing reperfusion and, if possible, engage in a PERT
- To strive to act as a team leader in the unstable patient referred to CDIs, to train cath lab staff and collaborate in the post-procedural care alongside intensive care personnel

Essential Reading

- 2019 ESC Guidelines for the diagnosis and management of acute pulmonary embolism developed in collaboration with the European Respiratory Society (ERS): The Task Force for the diagnosis and management of acute pulmonary embolism of the European Society of Cardiology (ESC). Eur Respir J. 2019 Oct 9;54(3):1901647. doi: 10.1183/13993003.01647-2019. PMID: 31473594.[51]

- Jaber WA, Fong PP, Weisz G, Lattouf O, Jenkins J, Rosenfield K, Rab T, Ramee S. Acute Pulmonary Embolism: With an Emphasis on an Interventional Approach. J Am Coll Cardiol. 2016 Mar 1;67(8):991-1002. doi: 10.1016/j.jacc.2015.12.024. PMID: 26916490.[52]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.7.2 Chronic pulmonary embolism

Objectives

- To understand the risk factors for chronic PTE and the prevention of chronic thromboembolic pulmonary hypertension (CTEPH)
- To collaborate, refer or participate in the assessment of patients with CTEPH
- To select optimal treatment for patients with deep vein thrombosis or CTEPH

Knowledge

- Incidence, risk factors, diagnostic criteria and preventive measures of CTEPH
- Antiphospholipid syndromes, thrombophilia and malignancy
- Differential diagnosis of chronic versus acute PTE
- To know the diagnostic features of imaging in CTEPH on echocardiography, chest x-ray, pulmonary angiography, perfusion lung scintigraphy, MSCT and CMR angiography
- General principles of pulmonary endarterectomy (PEA) and balloon angioplasty (BPA) to treat CTEPH
- Diagnosis, assessment and mitigation of PEA complications

Skills

- To identify signs and symptoms of chronic PTE and to differentiate between acute and chronic course of PTE
- To interpret the imaging methods for CTEPH
- To know how to perform right heart catheterization

Attitudes

- To participate in patient screening, diagnosis and treatment of deep vein thrombosis
- To cooperate with the imager in the diagnosis and assessment of pulmonary hypertension
- To participate in the treatment and diagnosis of patients following acute PTE
- To engage in multidisciplinary pulmonary hypertension groups in referral centers

Essential Reading

- 2019 ESC Guidelines for the diagnosis and management of acute pulmonary embolism developed in collaboration with the European Respiratory Society (ERS): The Task Force for the diagnosis and management of acute pulmonary embolism of the European Society of Cardiology (ESC). Eur Respir J. 2019 Oct 9;54(3):1901647. doi: 10.1183/13993003.01647-2019. PMID: 31473594.[51]
- Duffett L, Castellucci LA, Forgie MA. Pulmonary embolism: update on management and controversies. BMJ. 2020 Aug 5;370:m2177. doi: 10.1136/bmj.m2177. PMID: 32759284.[53]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8 Catheter-based interventions in Adults with Congenital Heart Diseases (ACHD)

8.8.1 Transcatheter pulmonary valve interventions (TPVI) in RV-PA conduit

8.8.1.1 DIAGNOSIS, TIMING OF INTERVENTION AND PRE-PROCEDURAL PLANNING

Objectives

- To understand the signs and findings of the underlying clinical conditions (e.g., Tetralogy of Fallot (ToF), aortic valve disease operated with Ross-procedure, double outlet right ventricle (DORV) and transposition of the great arteries with ventricular septal defect (D-TGA VSD) and other conditions operated with Rastelli procedure etc.) leading to surgical implantation of an RV-PA conduit
- To know the indications for intervention with pulmonary re-valving regarding both PVR and PVS
- To know how to use imaging modalities, including MSCT, to plan TPVI

Knowledge

- Principles of epidemiology, pathophysiology, and clinical features of the above-mentioned conditions with RV-PA conduits
- Indications for intervention in RV-PA conduit dysfunction/failure in ACHD
- To acknowledge the benefits and risks related to surgical vs. transcatheter pulmonary re-valving, including conduit calcification and risk of coronary compression.

Skills

- To perform and interpret non-invasive (echocardiography, CMR, MSCT) and invasive diagnostic techniques
- To balance benefits and risks of surgical and catheter-based pulmonary re-valving and discuss the recommendation for surgical or catheter-based treatment of RV-PA conduit dysfunction/failure

Attitudes

- The commitment to work in a HT with cardiovascular surgeons, anaesthetists, non-invasive cardiologists and paediatricians
- To provide a balanced, readily understood and appropriate information to patient candidate for catheter-based intervention

ESC Topic list

- 3.7 Echocardiography - Congenital Heart Disease.
- 4.7 Cardiac Computed Tomography (CT) - Congenital Heart Disease.
- 5.7 Cardiac Magnetic Resonance (CMR) - Congenital Heart Disease.
- 8.10 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Congenital Heart Disease.
- 20.4.2.5 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve Stenosis 20.4.2.6 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve Regurgitation.
- 20.6.9 Valvular Heart Disease - Clinical - Pulmonary Valve Disease.
- 25.3.1.1 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods Imaging - Echocardiography.
- 25.3.1.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods Imaging - Cardiac Computed Tomography (CT).
- 25.3.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods Invasive Haemodynamic Assessment.
- 25.4.3 and 25.4.4 congenital heart disease and pediatric cardiology - treatment intervention and surgery.
- 25.6.2 Congenital Heart Disease and Paediatric Cardiology - Clinical - Adult Congenital Heart Disease (ACHD).
- 30.1.1 Interventional Cardiology - Invasive Imaging and Functional Assessment - Right Heart Catheterization.
- 3.7 Echocardiography - Congenital Heart Disease.
- 3.14 Echocardiography - 3D Echocardiography.
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography.

Essential reading

- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 3286002854.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.1.2 INTERVENTION AND POTENTIAL COMPLICATIONS

Objectives

- To safely perform TPVI in native RV-PA conduit

Knowledge

- Anatomy of vascular access
- Principles, benefits and risks of performing TPVI in native RV-PA conduit
- Main interventional settings, materials and procedural steps of TPVI in native RV-PA conduit
- To know the frequency and clinical impact of the peri-procedural complications, as well as how to handle them

Skills

- To gain vascular access for large bore sheaths and perform diagnostic right heart catheterization
- To understand how to use and position ultra-stiff guidewires in the distal right or left pulmonary artery.
- To perform pre-stenting with either covered or bare stent prior to TPVI
- To perform device preparation according to the IFU and implant the appropriate valve in pulmonary position
- To bail-out in case of vascular complications, valve embolization, or conduit rupture

Attitudes

- The commitment to work in a HT with cardiovascular surgeons, anaesthetists, imagers, non-invasive cardiologists, and paediatricians
- To build a structured approach on risk-assessment for device selection
- To respect the procedural risks and when these outweigh the potential benefits

ESC Topic List

- 3.15 intra-operative and interventional echocardiography
- 20.4.2.5-6: valvular heart disease-treatment-intervention-pulmonary valve stenosis and regurgitation

- 30.3.4 Interventional Cardiology - Noncoronary Cardiac Intervention - Pulmonary Valve Intervention
- 31.1 Interventional Cardiology noncoronary cardiac intervention - pulmonary valve intervention
- 31.3 Cardiovasc surgery - congenital heart disease

Essential reading

- Butera G, Morgan GJ, Ovaert C, Anjos R, Spadoni I. Recommendations from the Association of European Paediatric Cardiology for training in diagnostic and interventional cardiac catheterization. Cardiol Young. 2015 Mar;25(3):438-46. doi: 10.1017/S1047951114001309. Epub 2014 Jul 28. PMID: 25069005.[55]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.1.3 POST-PROCEDURAL MANAGEMENT

Objectives

- To lifelong follow patients undergoing TPVI in a RV-PA conduit

Knowledge

- Signs, work-up and treatment of long-term TPVI complications
- Risk and importance of monitoring for stent fractures by regular chest x-rays and changes in gradients across the implanted valve be TTE
- Understand the importance of immediate work-up if there is suspicion of IE

Skills

- To monitor and diagnose TPVI complications in the post-procedural period
- To know the principles for life-time follow-up of patients who have undergone TPVI in RV-PA conduit, including the risk of IE

Attitudes

- Commitment to work with non-invasive cardiologists and paediatricians during a lifelong follow-up of patients with RV-PA conduits undergoing TPVI

ESC Topic List

- 20.4.2.5 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve Stenosis 20.4.2.6 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve Regurgitation. 25.6.2
- 21.5; 25.4.3 Congenital Heart Disease and Paediatric Cardiology - Treatment - Intervention 25.6.2 Congenital Heart Disease and Paediatric Cardiology - Clinical - Adult Congenital Heart Disease (ACHD)

Essential reading

- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 3286002854.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.2 Transcatheter pulmonary valve implantation in native right ventricular outflow tract (RVOT)

8.8.2.1 DIAGNOSIS, TIMING OF INTERVENTION AND PRE-PROCEDURAL PLANNING

Objectives

- To understand the clinical signs and findings of conditions (e.g., ToF operated with transannular patch, valvular pulmonary stenosis/regurgitation) leading to severe or free pulmonary regurgitation (PVR)
- To know the indications for intervention with pulmonary re-valving regarding both PR and pulmonary valve stenosis (PVS)
- To use imaging modalities to plan catheter-based intervention in PR

Knowledge

- Principles of epidemiology, pathophysiology, and clinical features of the above-mentioned conditions.
- Indications for intervention in severe or free PR in ACHD
- Benefits and risks related to surgical vs. transcatheter pulmonary re-valving, including size limitations related to TPVI.

Skills

- To perform and interpret non-invasive (echocardiography, CMR, MSCT) and invasive diagnostic techniques
- To balance benefits and risks of surgical and catheter-based pulmonary re-valving

Attitudes

- The commitment to work in a HT with cardiovascular surgeons, anaesthetists, non-invasive cardiologists, and paediatricians
- To provide balanced, readily understood, and appropriate information to patient candidate for catheter-based intervention

ESC Topic List

- 20.4.2.5 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve Stenosis 20.4.2.6 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve Regurgitation. 25.6.2

- 21.5; 25.4.3 Congenital Heart Disease and Paediatric Cardiology - Treatment - Intervention 25.6.2 Congenital Heart Disease and Paediatric Cardiology - Clinical Adult Congenital Heart Disease (ACHD)

Essential reading

- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 3286002854.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.2.2 INTERVENTION AND POTENTIAL COMPLICATIONS

Objectives

- To safely perform TPVI in native RVOT

Knowledge

- Anatomy of vascular access
- Principles, benefits and risks of TPVI in native RVOT
- Main interventional settings, materials and procedural steps of TPVI in native RVOT
- To know the frequency and clinical impact of the peri-procedural complications, as well as how to handle them

Skills

- To gain vascular access for large bore sheaths and perform diagnostic right heart catheterization
- To understand how to use and position ultra-stiff guidewires in the distal right or left pulmonary artery.
- To perform pre-stenting with either covered or bare stent prior to TPVI
- To perform device preparation according to the IFU and implant the appropriate valve in pulmonary position
- To bail-out in case of vascular complications or valve embolization

Attitudes

- The commitment to work in a HT with cardiovascular surgeons, anaesthetists, imagers, non-invasive cardiologists, and paediatricians
- To build a structured approach on risk-assessment for device selection
- To assess and balance the procedural risks and whether these outweigh the potential benefits

ESC Topic List

- 3.7 Echocardiography - Congenital Heart Disease.
- 4.7 Cardiac Computed Tomography (CT) - Congenital Heart Disease.
- 5.7 Cardiac Magnetic Resonance (CMR) - Congenital Heart Disease.
- 8.10 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Congenital Heart Disease.
- 20.4.2.5 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve Stenosis 20.4.2.6 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve Regurgitation.
- 20.6.9 Valvular Heart Disease - Clinical - Pulmonary Valve Disease.
- 25.3.1.1 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods - Imaging - Echocardiography.
- 25.3.1.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods - Imaging - Cardiac Computed Tomography (CT).
- 25.3.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods - Invasive Haemodynamic Assessment.
- 25.4.3 and 25.4.4 congenital heart disease and pediatric cardiology - treatment - intervention and surgery.
- 25.6.2 Congenital Heart Disease and Paediatric Cardiology - Clinical - Adult Congenital Heart Disease (ACHD).
- 30.1.1 Interventional Cardiology - Invasive Imaging and Functional Assessment - Right Heart Catheterization.
- 3.7 Echocardiography - Congenital Heart Disease.
- 3.14 Echocardiography - 3D Echocardiography.
- 3.15 Echocardiography - Intraoperative and Interventional Echocardiography.

Essential reading

- Butera G, Morgan GJ, Ovaert C, Anjos R, Spadoni I. Recommendations from the Association of European Paediatric Cardiology for training in diagnostic and interventional cardiac catheterization. Cardiol Young. 2015 Mar;25(3):438-46. doi: 10.1017/S1047951114001309. Epub 2014 Jul 28. PMID: 25069005.[55]
- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 328600282020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 3286002854.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.2.3 POST-PROCEDURAL MANAGEMENT

Objectives

- To lifelong follow-up patients undergoing TPVI in native RVOT.

Knowledge

- To know the signs, work-up and treatment of long-term complications
- Importance of monitoring for stent fractures by regular chest x-rays and changes in gradients across the implanted valve be TTE
- To understand the importance of immediate work-up if there is suspicion of IE.

Skills

- To monitor and diagnose TPVI complications in the post-procedural period
- To know the principles for life-time follow-up of patients who have undergone TPVI in RVOT, including the risk of IE

Attitudes

- The commitment to work with non-invasive cardiologists and paediatricians during a lifelong follow-up of patients with RVOT conduits undergoing TPVI.

ESC topic List

- 20.4.2.5 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve Stenosis
- 20.4.2.6 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve Regurgitation.
- 25.4.3 Congenital Heart Disease and Paediatric Cardiology - Treatment – Intervention
- 25.6.2 Congenital Heart Disease and Paediatric Cardiology - Clinical - Adult Congenital Heart Disease (ACHD)
- 30.3.4 Interventional Cardiology - Noncoronary Cardiac Intervention - Pulmonary Valve Intervention

Essential reading

- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 32860028[54]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.3 Balloon pulmonary valvuloplasty in pulmonary valve stenosis (PVS)

8.8.3.1 Diagnosis, timing of intervention and pre-procedural planning

Objectives

- To understand the clinical signs and findings of PVS
- To know the indications for intervention in PVS
- To know about the risks and limitations of balloon pulmonary valvuloplasty in PVS in adults
- To know about the difference in management between PVS and other forms of right RVOT (double chambered right ventricle, infundibular stenosis, supravalvular pulmonary stenosis)
- To use imaging modalities to plan catheter-based therapy in PVS

Knowledge

- Epidemiology, pathophysiology, and clinical features of PVS in contrast to other forms of RVOT obstruction
- Indications for intervention in PVS in adults

Skills

- To perform and interpret non-invasive (echocardiography, MSCT, CMR) and invasive diagnostic techniques
- To balance the benefits and risks of surgical and catheter-based treatment of PVS

Attitudes

- The commitment to work in a HT with cardiovascular surgeons, anaesthetists, imagers, non-invasive cardiologists, and paediatricians
- To provide balanced, readily understood, and appropriate information to patient candidate for catheter-based intervention

ESC Topic List

- 3.7 Echocardiography - Congenital Heart Disease
- 4.7 Cardiac Computed Tomography (CT) - Congenital Heart Disease
- 5.7 Cardiac Magnetic Resonance (CMR) - Congenital Heart Disease
- 8.10 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Congenital Heart Disease
- 20.4.2.5 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve Stenosis
- 20.6.9 Valvular Heart Disease - Clinical - Pulmonary Valve Disease
- 30.3.4 Interventional Cardiology - Noncoronary Cardiac Intervention - Pulmonary alve Intervention

- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome
- 20.3.1.1 Valvular Heart Disease - Diagnostic Methods - Imaging - Echocardiography
- 20.3.1.2 Valvular Heart Disease - Diagnostic Methods - Imaging - Cardiac Computed Tomography (CT)
- 20.3.1.3 Valvular Heart Disease - Diagnostic Methods - Imaging - Cardiac Magnetic Resonance (CMR)
- 20.3.2 Valvular Heart Disease - Diagnostic Methods - Invasive Haemodynamic Assessment
- 20.4.2.5 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve Stenosis
- 20.6.9 Valvular Heart Disease - Clinical - Pulmonary Valve Disease
- 25.1 Congenital Heart Disease and Paediatric Cardiology - Pathophysiology and Mechanisms
- 25.2 Congenital Heart Disease and Paediatric Cardiology - Epidemiology, Prognosis, Outcome
- 25.3.1.1 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods - Imaging - Echocardiography
- 25.3.1.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods - Imaging - Cardiac Computed Tomography (CT)
- 25.3.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods - Invasive Haemodynamic Assessment
- 30.3.4 Interventional Cardiology - Noncoronary Cardiac Intervention - Pulmonary Valve Intervention

Essential reading

- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 3286002854.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.3.2 INTERVENTION AND POTENTIAL COMPLICATIONS

Objectives

- To safely perform BAV in PVS

Knowledge

- Anatomy of vascular access
- Principles, benefits and risks of performing BAV in PVS

- Main interventional settings, materials and procedural steps of BAV in PVS
- To know the frequency and clinical impact of the peri-procedural complications, as well as how to handle them

Skills

- To gain vascular access and perform diagnostic right heart catheterization
- To use and position ultra-stiff guidewires in the distal right or left pulmonary artery.
- To accurately measure a pressure gradient across a stenotic pulmonary valve
- To select the appropriate balloon for balloon dilatation of the pulmonary valve
- To bail-out in case of vascular complications

Attitudes

- The commitment to work in a HT with cardiovascular surgeons, anaesthetists, imagers, non-invasive cardiologists, and paediatricians
- To build a structured approach on risk-assessment for balloon sizing and compliant properties
- To assess and balance the procedural risks and whether these outweigh the potential benefits

ESC Topic List

- 3.7 Echocardiography - Congenital Heart Disease
- 4.7 Cardiac Computed Tomography (CT) - Congenital Heart Disease
- 5.7 Cardiac Magnetic Resonance (CMR) - Congenital Heart Disease
- 8.10 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Congenital Heart Disease
- 20.4.2.5 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve S tenosis
- 20.6.9 Valvular Heart Disease - Clinical - Pulmonary Valve Disease
- 30.3.4 Interventional Cardiology - Noncoronary Cardiac Intervention - Pulmonary Valve Intervention
- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome
- 20.3.1.1 Valvular Heart Disease - Diagnostic Methods - Imaging - Echocardiography
- 20.3.1.2 Valvular Heart Disease - Diagnostic Methods - Imaging - Cardiac Computed Tomography (CT)
- 20.3.1.3 Valvular Heart Disease - Diagnostic Methods - Imaging - Cardiac Magnetic Resonance (CMR)
- 20.3.2 Valvular Heart Disease - Diagnostic Methods - Invasive Haemodynamic Assessment

- 20.4.2.5 Valvular Heart Disease - Treatment - Intervention - Pulmonary Valve Stenosis
- 20.6.9 Valvular Heart Disease - Clinical - Pulmonary Valve Disease
- 25.1 Congenital Heart Disease and Paediatric Cardiology - Pathophysiology and Mechanisms
- 25.2 Congenital Heart Disease and Paediatric Cardiology - Epidemiology, Prognosis, Outcome
- 25.3.1.1 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods - Imaging - Echocardiography
- 25.3.1.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods - Imaging - Cardiac Computed Tomography (CT)
- 25.3.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods - Invasive Haemodynamic Assessment
- 25.4.3 Congenital Heart Disease and Paediatric Cardiology - Treatment - Intervention
- 25.4.4 Congenital Heart Disease and Paediatric Cardiology - Treatment - Surgery
- 30.1.1 Interventional Cardiology - Invasive Imaging and Functional Assessment - Right Heart Catheterization
- 30.2.2 Interventional Cardiology - Percutaneous Coronary Intervention (PCI) - Vascular Access
- 30.3.4 Interventional Cardiology - Noncoronary Cardiac Intervention - Pulmonary Valve Intervention
- 31.3 Cardiovascular Surgery - Congenital Heart Disease

Essential reading

- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 32860028[54]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.3.3 POST-PROCEDURAL MANAGEMENT

Objectives

- To monitor for complications in the post-procedural period
- To know how to assess for residual RVOT obstruction, PVS or PVR
- To manage severe infundibular obstruction following balloon valvuloplasty of severe PVS
- To learn about the need of lifelong follow-up of patients with PVS

Knowledge

- Signs, work-up and treatment of procedural complications
- Importance of monitoring clinical status, right ventricular size and function, pulmonary valve function

Skills

- To diagnose procedural complications in the post-procedural period
- To understand the principles for life-time follow-up of patients with PVS

Attitudes

- The commitment to work with non-invasive cardiologists and paediatricians during a lifelong follow-up of patients with PVS

ESC Topic List

- 21.5 Infective Endocarditis - Prevention
- 25.6.2 Congenital Heart Disease and Paediatric Cardiology - Clinical - Adult Congenital Heart Disease (ACHD)
  30.3.4 Interventional Cardiology - Noncoronary Cardiac Intervention - Pulmonary Valve Intervention
- 31.3 Cardiovascular Surgery - Congenital Heart Disease

Essential reading

- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 32860028[54]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.4 Balloon aortic valvuloplasty in ACHD stenotic valves

8.8.4.1 DIAGNOSIS, TIMING OF INTERVENTION AND PRE-PROCEDURAL PLANNING

Objectives

- To understand the signs and findings of ACHD aortic valve stenosis (AoS)
- To know about the risks and benefits of surgical valvotomy in ACHD patients presenting AoS.
- To know about the difference between AoS and other forms of LVOT obstruction (fibromuscular subvalvar AoS, supravalvular AoS)
- To use imaging modalities to plan catheter-based therapy in AoS

Knowledge

- Principles of epidemiology, pathophysiology, and clinical features of ACHD AoS in contrast to other forms of LVOT
- Indications for intervention in ACHD patients presenting AoS

Skills

- To perform and interpret non-invasive (echocardiography, MSCT, CMR) and invasive diagnostic techniques
- To balance the benefits and risks of surgical and catheter-based treatment of CHD AoS

Attitudes

- The commitment to work in a HT with cardiovascular surgeons, anaesthetists, imagers, non-invasive cardiologists, and paediatricians
- To assess and balance the procedural risks and whether these outweigh the potential benefits

ESC Topic List

- 3.4 Echocardiography - Valvular Heart Disease
- 3.7 Echocardiography - Congenital Heart Disease
- 4.4 Cardiac Computed Tomography (CT) - Valvular Heart Disease
- 4.7 Cardiac Computed Tomography (CT) - Congenital Heart Disease
- 5.4 Cardiac Magnetic Resonance (CMR) - Valvular Heart Disease
- 5.7 Cardiac Magnetic Resonance (CMR) - Congenital Heart Disease
- 5.9 Cardiac Magnetic Resonance (CMR) - Flow Imaging
- 8.3 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Valvular Heart Disease
- 8.10 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Congenital Heart Disease
- 20 to 20.3.99 Valvular Heart Disease
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 20.6.1 Valvular Heart Disease - Clinical - Aortic Valve Stenosis
- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome
- 20.3.1 Valvular Heart Disease – Diagnostic Methods – Imaging
- 20.3.2 Valvular Heart Disease - Diagnostic Methods - Invasive Haemodynamic Assessment
- 20.3.99 Valvular Heart Disease - Diagnostic Methods - Diagnostic Methods, Other
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 20.4.3 Valvular Heart Disease - Treatment - Surgery

- 20.6.1 Valvular Heart Disease - Clinical - Aortic Valve Stenosis
- 20.6.10 Valvular Heart Disease - Clinical - Rheumatic Heart Disease
- 30.2.2 Interventional Cardiology - Percutaneous Coronary Intervention (PCI) - Vascular Access
- 30.3.1 Interventional Cardiology - Noncoronary Cardiac Intervention - Aortic Valve Intervention
- 31.2 Cardiovascular Surgery - Valves
- 31.3 Cardiovascular Surgery - Valves

Essential reading

- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 3286002854.
  2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.4.2 INTERVENTION AND POTENTIAL COMPLICATIONS

Objectives

- To safely perform BAV in patients with ACHD

Knowledge

- Anatomy of vascular access
- Principles, benefits and risks of BAV
- To acknowledge the differences between semi-compliant or non-compliant balloons.
- To know the frequency and clinical impact of the peri-procedural complications, as well as how to handle them

Skills

- To gain vascular access and use closure devices
- To cross the aortic valve and position stiff guidewires in the LV
- To accurately measure a pressure gradient across a stenotic aortic valve
- To select and size the balloon for each patient
- To perform dilation and use transient adenosine induced transient ventricular asystole and/or rapid pacing
- To bail-out in case of vascular complications

Attitudes

- The commitment to work in a HT with cardiovascular surgeons, anaesthetists, non-invasive cardiologists, and paediatricians

- To build a structured approach on risk-assessment for balloon sizing and compliant properties
- To provide balanced, readily understood, and appropriate information to patient candidate for catheter-based intervention
- To assess and balance the procedural risks and whether these outweigh the potential benefits

ESC topic List

- 3.4 Echocardiography - Valvular Heart Disease
- 3.7 Echocardiography - Congenital Heart Disease
- 4.4 Cardiac Computed Tomography (CT) - Valvular Heart Disease
- 4.7 Cardiac Computed Tomography (CT) - Congenital Heart Disease
- 5.4 Cardiac Magnetic Resonance (CMR) - Valvular Heart Disease
- 5.7 Cardiac Magnetic Resonance (CMR) - Congenital Heart Disease
- 5.9 Cardiac Magnetic Resonance (CMR) - Flow Imaging
- 8.3 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Valvular Heart Disease
- 8.10 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Congenital Heart Disease
- 20 to 20.3.99 Valvular Heart Disease
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis
- 20.4.3 Valvular Heart Disease - Treatment - Surgery
- 20.6.1 Valvular Heart Disease - Clinical - Aortic Valve Stenosis
- 20.6.10 Valvular Heart Disease - Clinical - Rheumatic Heart Disease
- 30.2.2 Interventional Cardiology - Percutaneous Coronary Intervention (PCI) - Vascular Access
- 30.3.1 Interventional Cardiology - Noncoronary Cardiac Intervention - Aortic Valve Intervention
- 31.2 Cardiovascular Surgery - Valves
- 31.3 Cardiovascular Surgery - Valves

Essential reading

- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 3286002854.
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.4.3 POST-PROCEDURAL MANAGEMENT

Objectives

- To lifelong follow-up patients submitted to BAV in ACHDS

Knowledge

- To know the signs, work-up and treatment of procedural complications
- To acknowledge the development and treatment of residual aortic stenosis or aortic regurgitation following BAV of AoS
- To learn the importance of monitoring clinical status, left ventricular size and function, aortic valve function

Skills

- To monitor and diagnose procedural complications in the post-procedural period
- To understand the principles for life-time follow-up of patients with AoS, including the risk of IE

Attitudes

- The commitment to work with non-invasive cardiologists and paediatricians during a lifelong follow-up of patients with PVS

ESC topic List

- 3.4 Echocardiography - Valvular Heart Disease
- 3.7 Echocardiography - Congenital Heart Disease
- 4.4 Cardiac Computed Tomography (CT) - Valvular Heart Disease
- 4.7 Cardiac Computed Tomography (CT) - Congenital Heart Disease
- 5.4 Cardiac Magnetic Resonance (CMR) - Valvular Heart Disease
- 5.7 Cardiac Magnetic Resonance (CMR) - Congenital Heart Disease
- 5.9 Cardiac Magnetic Resonance (CMR) - Flow Imaging
- 8.3 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Valvular Heart Disease
- 8.10 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Congenital Heart Disease
- 20 to 20.3.99 Valvular Heart Disease
- 20.1 Valvular Heart Disease - Pathophysiology and Mechanisms
- 20.2 Valvular Heart Disease - Epidemiology, Prognosis, Outcome
- 20.3.1-3 Valvular Heart Disease - Diagnostic Methods - Imaging - Cardiac Magnetic Resonance (CMR)
- 20.3.2 Valvular Heart Disease - Diagnostic Methods - Invasive Haemodynamic Assessment
- 20.4.2.1 Valvular Heart Disease - Treatment - Intervention - Aortic Valve Stenosis

- 20.4.3 Valvular Heart Disease - Treatment - Surgery
- 20.6.1 Valvular Heart Disease - Clinical - Aortic Valve Stenosis
  20.6.10 Valvular Heart Disease - Clinical - Rheumatic Heart Disease
  21.5 Infective Endocarditis – Prevention
- 25.6.2 Congenital Heart Disease and Paediatric Cardiology - Clinical - Adult Congenital Heart Disease (ACHD)
- 30.2.2 Interventional Cardiology - Percutaneous Coronary Intervention (PCI) - Vascular Access
- 30.3.1 Interventional Cardiology - Noncoronary Cardiac Intervention - Aortic Valve Intervention
- 31.2 Cardiovascular Surgery - Valves
- 31.3 Cardiovascular Surgery - Congenital Heart Disease

Essential reading

- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 3286002854.
- 2021 ESC/EACTS Guidelines for the management of valvular heart disease[11]

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.5 Balloon dilatation and stenting of coarctation of the aorta (CoA)

8.8.5.1 DIAGNOSIS, TIMING OF INTERVENTION AND PRE-PROCEDURAL PLANNING

Objectives

- To understand the clinical signs and findings of CoA
- To know the indications for intervention in CoA
- To use imaging modalities to plan catheter-based intervention in CoA

Knowledge

- Principles of epidemiology, pathophysiology, and clinical features of CoA
- Indications for intervention in CoA in ACHD

Skills

- To perform and interpretate non-invasive (echocardiography, MSCT, CMR) and invasive diagnostic techniques
- To balance benefits and risks of surgical and catheter-based treatment of CoA

Attitudes

- The commitment to work in a HT with cardiovascular surgeons, anaesthetists, imagers, non-invasive cardiologists, and paediatricians
- To assess and balance the procedural risks and whether these outweigh the potential benefits

ESC Topic List

- 3.7 Echocardiography – Congenital Heart Disease
- 4.7 Cardiac Computed Tomography (CT) - Congenital Heart Disease
- 5.7 Cardiac Magnetic Resonance (CMR) - Congenital Heart Disease
- 8.10 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Congenital Heart Disease
- 20.4.2.99 Valvular Heart Disease - Treatment - Intervention - Intervention, Other
- 20.6.99 Valvular Heart Disease - Clinical - Clinical, Other
- 25.1 Congenital Heart Disease and Paediatric Cardiology - Pathophysiology and Mechanisms
- 25.2 Congenital Heart Disease and Paediatric Cardiology - Epidemiology, Prognosis, Outcome
- 25.3.1.1 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods Imaging – Echocardiography
- 25.3.1.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods Imaging - Cardiac Computed Tomography (CT)
- 25.3.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods Invasive Haemodynamic Assessment
- 25.4.3 Congenital Heart Disease and Paediatric Cardiology - Treatment – Intervention
- 25.4.4 Congenital Heart Disease and Paediatric Cardiology - Treatment - Surgery
- 25.6.2 Congenital Heart Disease and Paediatric Cardiology - Clinical - Adult Congenital Heart Disease (ACHD)
- 30.1 Interventional Cardiology - Invasive Imaging and Functional Assessment
- 30.99 Interventional Cardiology - Interventional Cardiology, Other

Essential reading

- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 32860028[54]
- The PCR-EAPCI Percutaneous Interventional Cardiovascular Medicine Textbook Volume. III, Part II, chapter "Coartation of the Aorta"

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.5.2 INTERVENTION AND POTENTIAL COMPLICATIONS

Objectives

- To safely perform balloon dilatation and stenting of CoA

Knowledge

- Anatomy and techniques of vascular access as well as use of closure devices
- Principles, benefits and risks of balloon dilatation and stenting of CoA
- To acknowledge the main interventional settings and procedural steps of balloon dilatation and stenting of CoA
- To know the frequency and clinical impact of the peri-procedural complications, as well as how to handle them

Skills

- To gain vascular access and use closure devices
- To select and size the balloon for each patient
- To bail-out in case of vascular complications

Attitudes

- The commitment to work in a HT with cardiovascular surgeons, anaesthetists, imagers, non-invasive cardiologists, and paediatricians
- To build a structured approach on risk-assessment for balloon sizing and compliant properties
- To assess and balance the procedural risks and whether these outweigh the potential benefits

ESC topic List

- 3.7 Echocardiography – Congenital Heart Disease
- 4.7 Cardiac Computed Tomography (CT) – Congenital Heart Disease
- 5.7 Cardiac Magnetic Resonance (CMR) - Congenital Heart Disease
- 8.10 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Congenital Heart Disease
- 20.4.2.99; Valvular Heart Disease - Treatment - Intervention - Intervention, Other
- 25.6.2 Congenital Heart Disease and Paediatric Cardiology - Clinical - Adult Congenital Heart Disease (ACHD)
- 20.6.99 Valvular Heart Disease - Clinical - Clinical, Other
- 25.1 Congenital Heart Disease and Paediatric Cardiology - Pathophysiology and Mechanisms
- 25.2 Congenital Heart Disease and Paediatric Cardiology - Epidemiology, Prognosis, Outcome
- 25.3.1.1 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods Imaging – Echocardiography

- 25.3.1.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods Imaging - Cardiac Computed Tomography (CT)
- 25.3.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods Invasive Haemodynamic Assessment
- 25.4.3 Congenital Heart Disease and Paediatric Cardiology - Treatment - Intervention
- 25.4.4 Congenital Heart Disease and Paediatric Cardiology - Treatment - Surgery
- 25.6.2 Congenital Heart Disease and Paediatric Cardiology - Clinical - Adult Congenital Heart Disease (ACHD)
- 30.1 Interventional Cardiology - Invasive Imaging and Functional Assessment
- 30.99 Interventional Cardiology - Interventional Cardiology, Other

Essential reading

- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 3286002854.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

8.8.5.3 POST-PROCEDURAL MANAGEMENT

Objectives

- To lifelong follow-up patients submitted to balloon dilatation and stenting of CoA

Knowledge

- To know the signs, work-up and treatment of procedural complications
- To acknowledge the importance of monitoring blood pressure and treating hypertension in patients with CoA
- To understand the importance of associated cardio-vascular lesions (e.g., bicuspid aortic valve, ascending aorta aneurysm, cerebral aneurysms) in patients with CoA

Skills

- To monitor and diagnose procedural complications in the post-procedural period
- To understand the principles for life-time follow-up of patients with CoA

Attitudes

- The commitment to work with non-invasive cardiologists and paediatricians during a lifelong follow-up of patients with CoA

ESC Topic List

- 3.7 Echocardiography – Congenital Heart Disease
- 4.7 Cardiac Computed Tomography (CT) - Congenital Heart Disease
- 5.7 Cardiac Magnetic Resonance (CMR) - Congenital Heart Disease
- 8.10 Cross-Modality and Multi-Modality Imaging Topics - Imaging of Congenital Heart Disease
- 20.4.2.99 Valvular Heart Disease - Treatment - Intervention - Intervention, Other
- 20.6.99 Valvular Heart Disease - Clinical - Clinical, Other
- 25.1 Congenital Heart Disease and Paediatric Cardiology - Pathophysiology and Mechanisms
- 25.2 Congenital Heart Disease and Paediatric Cardiology - Epidemiology, Prognosis, Outcome
- 25.3.1.1 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods Imaging - Echocardiography
- 25.3.1.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods Imaging - Cardiac Computed Tomography (CT)
- 25.3.2 Congenital Heart Disease and Paediatric Cardiology - Diagnostic Methods Invasive Haemodynamic Assessment
- 25.4.3-4 Congenital Heart Disease and Paediatric Cardiology - Treatment - Intervention
- 25.4.4 Congenital Heart Disease and Paediatric Cardiology - Treatment – Surgery
- 25.6.2 Congenital Heart Disease and Paediatric Cardiology - Clinical - Adult Congenital Heart Disease (ACHD)
- 30.1 Interventional Cardiology - Invasive Imaging and Functional Assessment
- 30.99 Interventional Cardiology - Interventional Cardiology, Other

Essential reading

- 2020 ESC Guidelines for the management of adult congenital heart disease. Eur Heart J. 2021 Feb 11;42(6):563-645. doi: 10.1093/eurheartj/ehaa554. PMID: 3286002854.

Level of competence recommendation

- See Figure 6 (condensed LoC) and Diagram LoC 8.1-8.5

Aortic module

AORTIC VALVE DISEASE
LoC 8.1-8.5

Mitral/Tricuspid module

EAPCI

EAPCI European Association of Percutaneous Cardiovascular Interventions

9 Conclusion

The Percutaneous Valvular and Structural Heart Disease Interventions Core Curriculum of the European Association of Percutaneous Cardiovascular Interventions (EAPCI) provides guidance for training centres and trainees.
It describes the knowledge, skills, and attitudes that define competency levels required from newly trained interventional cardiologists performing structural heart disease interventions. They should train within multidisciplinary teams, managing adult patients from diagnosis to follow-up, developing selective skills in either aortic and/or mitral/tricuspid areas. Their education may be complemented by competencies in other domains such as adult congenital heart disease, left atrial appendage occlusion, pulmonary thromboembolism, paravalvular regurgitation, septal ablation or septal defects.
The Core Curriculum promotes excellence and universal training in ESC countries, forming the cornerstone of future certifications for patient protection.

10 Conflict of Interest statement

Eustachio Agricola has received speaker honorary compensation from GE Healthcare, all outside the current topic. Amat-Santos has received speaker honorary and advisory board compensation from Boston Scientific, Meril Life, Medtronic, and Abbott Vascular. Andreas Baumbach has received Institutional Research Support from Biotronik and honoraria from, Faraday, Pi-Cardia and Meril. Daniel Blackman has acted as a consultant, advisory board member, and speaker, for Abbott Vascular, Edwards Lifesciences, and Medtronic. Nikos Bonaros has received speaker's honoraria from Edwards Lifesciences and Medtronic as well as Research Grants from Edwards Lifesciences and Corcym. Martin Czerny is consultant to Terumo Aortic, Medtronic, NEOS and Endospan. Ole De Backer received research grants, speaker and consulting fees from Abbott, Boston Scientific, and Medtronic. Pierre Deharo has received honoraria from Boston Scientific, Abbott, Asahi, Medtronic and Novartis. Philip Lurz has received institutional fees and research grants from Abbott Vascular, Edwards Lifesciences, and ReCor, honoraria from Edwards Lifesciences, Abbott Medical, Innoventric, ReCor and Boehringer Ingelheim and has stock options with Innoventric. Rik Hermanides has received compensation from companies outside the current topic. Stefan James has received institutional research support from Edwards, Medtronic and proctoring fees from Medtronic. Francis Joshi has received honoraria and advisory board compensation from Boston Scientific and travel support from Millbrook Medical. Petr Kala declares that he has received consultant and

speakers fees from Boston Scientific, Edwards Lifesciences, Sanofi, Novartis, Servier, participated in advisory boards from Boston Scientific, Abbott, Novartis, Servier, and received research support from Bayer, Novartis and Amgen. Nicole Karam has received consultant fees from Abbott, Medtronic, Edwards Lifesciences and Boston. Andre Luz has received consultant fees from Abbott Vascular. Julinda Mehilli has received speaker honorary compensation from Astra Zeneca, Boston Scientific, Daiichi Sankyo and Shock Wave. Darren Mylotte has received research grants from Boston Scientific, and speaker ' honorary / advisory board compensation from Medtronic, Microport, and Boston Scientific. Rutger-Jan Nuis has received research grant support from Vifor Pharma and consulting fees from Edwards Lifesciences, Abbott, Boston Scientific. Valeria Paradies declares research grant from Abbott Vascular to the Institution and speaker fees from Abbott Vascular and Boston Scientific. Radoslaw Parma has received speaker fees from Edwards Lifescience. Andreas Rück declares institutional research and educational grants from Boston Scientific and Edwards Lifesciences, and personal speakers and consultancy fees from Boston Scientific, Abbott, Edwards Lifesciences and Anteris. Thomas Pilgrim reports research, travel or educational grants to the institution without personal remuneration from Biotronik, Boston Scientific, and Edwards Lifesciences and speaker fees and consultancy fees to the institution from Biotronik, Boston Scientific, Edwards Lifesciences, Abbott, Medtronic, Biosensors, and Highlife. Giuseppe Tarantini has received speaker honorary/advisory board compensation from Edwards Lifescience, Boston Scientific, Medtronic, Abbott, Philips, Microport. Didier Tchetche is consultant for Abbottt, Boston Scientific, Edwards LifeSciences and Medtronic. Anselm Uebing has received advisory board compensation from Medtronic. Nicolas Van Mighem has received reserach grant support from Abbott VAscular, Boston Scientific, Medtronic, Astra Zeneca, Daiichi Sankyo and scientific advisory fees from Anteris, JenaValve, Amgen, Siemens, Pie Medical, Abbott Vascular, Boston Scientific, Medtronic, Astra Zeneca, Daiichi Sankyo. Marleen van Wely has received proctoring fees from Abbott Vascular and speaking fees from Boston Scientific. Verena Veulmans has received consulting fees, travel expenses, or study honoraria from Medtronic, Edwards Lifesciences, and Boston Scientific. The other authors have no conflicts of interest to declare.

11 Funding statement

The other authors declare no funding. The Clinical Practice Guidelines (CPG) committee from the European Society of Cardiology formally approved the document.

12 Abbreviations

ACC	American College of Cardiology
ACE	inhibitors angiotensin-converting enzyme inhibitors
ACS	acute coronary syndrome
ACHD	adult congenital heart disease
AF	atrial fibrillation
AI	artificial intelligence
AHA	American Heart Association
AMI	acute myocardial infarction
AMU	acute medical unit
AOR	Aortic
AR	aortic regurgitation
ARC	Academic Research Consortium
AoMTC	aortic, mitral and tricuspid
AoS	Aortic stenosis
ASD	atrial septal defect
BARC	Bleeding Academic Research Consortium
BAV	balloon aortic valvuloplasty
BMC	alloon mitral commissurotomy
BMS	bare metal stent
BPA	balloon pulmonary angioplasty
BTHC	butyryl-tri-hexyl citrate
BVF	bioprosthetic valve failure
CABG	coronary artery bypass graft
CAVI	caval valve implantation
CAD	coronary artery disease
CARDS	Cardiology Audits and Registration Data Standards
CAS	carotid artery stenting
CC	Core Curriculum
CCU	coronary care unit
CDIs	catheter-directed interventions
CEC	clinical events committee
CHD	congenital heart disease
CIHF	chronic ischaemic heart failure
CIN	contrast-induced nephropathy
CPG	Clinical Practice Guidelines

CKD	chronic kidney disease
CMR	cardiac magnetic resonance
CoA	coarctation of the aorta
COPD	chronic obstructive pulmonary disease
COT	cusp overlap technique
CS	cardiogenic shock
CTO	chronic total occlusion
CTEPH	chronic thromboembolic pulmonary hypertension
CTEPH	chronic thromboembolic pulmonary hypertension
DAPT	dual antiplatelet therapy
DCM	dilated cardiomyopathy
DEB	drug-eluting balloon
DORV	double outlet right ventricle
D-TGA	VSD transposition of the great arteries with ventricular septal defect
DSA	digital subtraction angiography
EACVI	European Association of Cardiovascular Imaging
EAPCI	European Association of Percutaneous Cardiovascular Interventions
EAS	European Atherosclerosis Society
EBSC	European Board for the Specialty of Cardiology
ECMO	extracorporeal capillary membrane oxygenator
ESC	European Society of Cardiology
ECG	electrocardiogram
EMB	endomyocardial biopsy
E2E	edge-to-edge
EORP	EURObservational Research Programme
EPA	Entrustable Professional Activities
ESH	European Society of Hypertension
ETC	Education and Training Committee
EVAR	endovascular aneurysm repair (or endovascular aortic repair)
Fr	French (size)
FFR	fractional flow reserve
GUCH	grown-up congenital heart disease
GDMT	guideline-directed medical therapy
HCM	hypertrophic cardiomyopathy
HF	heart failure
HFpEF	heart failure with preserved ejection fraction
HFrEF	heart failure with reduced ejection fraction
HT	heart team

IAP	invasive arterial pressure
IC	interventional cardiologist
ICD	implantable cardioverter-defibrillator
ICE	intra-cardiac echocardiography
ICH	intracerebral haemorrhage
ICU	intensive care unit
IE	infectious endocarditis
iFR	instantaneous wave-free ratio
IFU	instruction for use
IMR	index of microcirculatory resistance
ISR	in-stent restenosis
IVUS	intravascular ultrasound
LAAO	left atrial appendage occlusion
LM	left main
LoC	levels of competence
LVEF	left ventricle ejection fraction
MCE	myocardial contrast echocardiography
MCS	mechanical circulatory support
MR	mitral regurgitation
MRA	magnetic resonance angiography
MS	mitral stenosis
MSCD	myocardial stem cell delivery
MSCT	multi slice computed tomography
MTC	mitral and tricuspid disease
MV	mitral valve
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
NTF	Nuclear Task Force
OCT	optical coherence tomography
OFDI	optical frequency domain imaging
OHCA	out-of-hospital cardiac arrest
OTW	over the wire
PAD	peripheral artery disease
PCI	percutaneous coronary intervention
PCR	Paris Course on Revascularisation

PERT	Pulmonary Embolism Response Team
PFO	patent foramen ovale
POBA	plain old balloon angioplasty
POT	proximal optimisation technique
PPI	proton pump inhibitor
PMR	primary mitral regurgitation
PPM	patient prosthesis mismatch
PPVI	percutaneous pulmonary valve implantation
PROM	patient-reported outcome measures
PREM	patient-reported experience measures
PTE	pulmonary thromboembolism
PVR	pulmonary valve regurgitation
PVS	pulmonary valve stenosis
PTA	percutaneous transluminal angiography
PVD	peripheral vascular disease
PVL	paravalvular regurgitation
QA/QI	quality assessment and quality improvement
QCA	quantitative coronary angiography
RA	refractory angina
RASS	renin-angiotensin-aldosterone system
RBBB	right bundle branch block
RCT	randomized clinical trials
RFC	renal frame count
RFR	relative flow reserve
RVOT	right ventricular outflow tract
SAVR	surgical aortic valve replacement
SDAIC	EAPCI scientific documents and initiatives committee
SHD	structural heart disease
STEMI	ST-segment elevation myocardial infarction
SVD	Structural valve degeneration
SVG	saphenous vein graft
SYNTAX	synergy between percutaneous coronary intervention with TAXUS and cardiac surgery
SMR	secondary mitral regurgitation
SOP	standard operating procedures
TASH	trans coronary ablation of septal hypertrophy
TAVI	transcatheter aortic valve implantation
TCC	EAPCI training and certification committee

TOE	transoesophageal echocardiography
TEER	transcatheter edge-to-edge repair
TTE	transthoracic echocardiography
TEVAR	thoracic endovascular aortic/aneurysm repair
THV	transcatheter heart valve
TIMI	Thrombolysis In Myocardial Infarction
ToF	Tetralogy of Fallot
TMTCI	transcatheter or mixed interventions
TMVI	transcatheter mitral valve implant
TMVR	transcatheter mitral valve repair
TPVI	transcatheter pulmonary valve interventions
TR	tricuspid regurgitation
TV	tricuspid valve
WG CVS	Cardiovascular Surgery Working Group
VARC	Valve Academic Research Consortium
VIR	valve-in-ring
VIV	valve-in-valve
VHD	valvular heart disease
VSD	ventricular septal defect

13 References

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