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Title: EAPCI Core Curriculum for Percutaneous Cardiovascular Interventions (202): Committee for Education and Training European Association of Percutaneous Cardiovascular Interventions (EAPCI) A branch of the European Society of Cardiology.

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EAPCI Core Curriculum for Percutaneous Cardiovascular Interventions (2020):

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A branch of the European Society of Cardiology

Short Title: EAPCI Core Curriculum for Percutaneous Cardiovascular Interventions (2020)

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Abstract

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

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

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

List of Abbreviations and Acronyms

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

DCM	Dilated Cardiomyopathy
DEB	Drug Eluting Balloon
DSA	Digital Subtraction Angiography
EAPCI	European Association of Percutaneous Cardiovascular Interventions
EAS	European Atherosclerosis Society
EBSC	European Board for the Specialty of Cardiology
ECG	Electrocardiogram
EMB	Endomyocardial Biopsy
ESC	European Society of Cardiology
ESH	European Society of Hypertension
ETC	Education and Training Committee
EVAR	Endovascular Aneurysm Repair (or Endovascular Aortic Repair)
F	French (size)
FFR	Fractional Flow Reserve
GUCH	Grown-Up Congenital Heart
HCM	Hypertrophic CardiomyopathyHypertrophic Cardiomyopathy
HF	Heart Failure
IC	Interventional Cardiologist
ICH	Intra Cerebral Haemorrhage
iFR	instantaneous Instantaneous Wave-Free Ratio
IMR	IndexIndex of Microcirculatory ResistanceResistance
ISR	In-Stent Restenosis
IVUS	Intra-Vascular Ultrasound
LAAO	Left Atrial Appendage Occlusion
LM	Left Main
MCE	Myocardial Contrast Echocardiography
MRA	Magnetic Resonance Angiography
MSCD	Myocardial Stem Cell Delivery
MSCT	Multi Slice Cardiac Tomography

MTC	Mitral and Tricuspid Disease
MVARC	Modified Valve Academic Research Consortium
NARC	Non-Adherence Academic Research Consortium
NIRS-IVUS	Near-Infrared Spectroscopy-IVUS
NSTE-ACS	Non-ST-Segment Elevation Acute Coronary Syndrome
NSTEMI	Non-ST-Segment Elevation Myocardial Infarction
OCT	Optical Coherence Tomography
OFDI	Optical Frequency Domain Imaging
OHCA	Out of Hospital Cardiac Arrest
OTW	Over the Wire
PCI	Percutaneous Coronary Intervention
PCR	Paris Course on Revascularization
PE	Pulmonary Embolism
PFO	Patent foramen ovale
POBA	Plain Old Balloon Angioplasty
POT	Proximal Optimization Technique
PPI	Proton Pump Inhibitor
PPVI	Percutaneous Pulmonary Valve Implantation
PTA	Percutaneous Transluminal Angiography
PVD	Peripheral Vascular Disease
PVL	Paravalvular Leaks
QA/QI	Quality Assessment and Quality Improvement
QCA	Quantitative Coronary Angiography
RA	Refractory Angina
RASS	Renin-Angiotensin-Aldosterone System
RBBB	Right Bundle Branch Block
RFC	Renal Frame Count
RFR	Relative Flow Reserve
RVOT	Right Ventricular Outflow Tract

STEMI	ST-segment Elevation Myocardial Elevation Myocardial Infarction
SVG	Saphenous Vein Graft
SYNTAX	Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery
TASH	Transcoronary Ablation of Septal Hypertrophy
TAVI	Transcatheter Aortic Valve Implantation
TEE	Trans-Esophageal Echocardiography
TEVAR	Thoracic Endovascular Aortic/Aneurysm Repair
TIMI	Thrombolysis In Myocardial Infarction
TMTCI	Transcatheter or Mixed Interventions
TMVI	Transcatheter Mitral Valve Intervention
TMVR	Transcatheter Mitral Valve Replacement
VARC 2	Valve Academic Research Consortium 2
VHD	Valvular Heart Disease
VSD	Ventricular Septal Defect

Introduction

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

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

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

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

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

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

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

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

The EAPCI ETC Committee launched the project under the auspices of Professors Michael Haude and Andreas Baumbach. A total of 10 groups consisting of 2 to 3 interventional cardiologists each, developed, circulated and improved the document under the direction of the successive Chair and co-chair of the ETC, Professors Dariusz Dudek, Eric Van Belle and Doctor Rui Campante Teles. The document was revised by the Chair and Co-Chair of the ETC, Prof Eric Van Belle and Doctor Rui Campante Teles as well as the current EAPCI President, Professor Andreas Baumbach and President Elect, Professor Dariuz Dudek.
The 2020 Core Curriculum underwent a thorough review process based on the template of the review of the ESC guidelines and of the EAPCI Textbook in Percutaneous Interventional Cardiovascular Medicine. The document does not include minimum or optimal numbers of procedures to be undertaken, and does not address periodic evaluation or revalidation. It defines the clinical, patient-oriented, training of the IC. The structure of the current Core Curriculum has been drastically modified as compared to the previous version and evolved from the "2013 Core Curriculum of the general cardiologist" to follow the current ESC recommendations for Core Curriculums. In most subject areas, there was a wide if not unanimous consensus among the task force members on the training required for the IC of the future. The document recommends that acquisition of competence requires at least 2 years of training in interventional cardiology, in addition to 4 years devoted to cardiology.
The first part of the curriculum covers general aspects of training and is followed by a comprehensive description of the specific components in 54 chapters. Each of the chapters includes statements of the objectives, and is further subdivided into the required knowledge, skills, behaviours, and attitudes.

The clinical field of interventional cardiology

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

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

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

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

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

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

Concomitantly these fields are continuously expanding and, in certain cases, a very specific training to master a procedure or technique is required. Help from a proctor is recognized as advantageous or an appropriate referral for a more skilled centre might be advisable, especially in certain areas

that, depending on the individual and centre, require a particular expertise, namely complex coronary interventions, stroke, PVD, grown-up congenital heart (GUCH) disease, mitral or tricuspid valve disease, left atrial appendage occlusion (LAAO), etc.

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

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

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

General aspects of training in the specialty

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Learning objectives

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

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

Categories and levels of competence

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

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

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

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

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

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

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

Table 3: Level of competence translating into interventional cardiology skills

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

PCI in bifurcation lesions	Performance as first operator without supervision	IV
PCI in LM	Performance as first operator without supervision	IV
PCI in CTO	Performance as second operator and/or with direct, proactive supervision	II
PCI with rotablator	Performance as second operator and/or with direct, proactive supervision	II
Invasive physiology (FFR, iFR, RFR and others)	Performance as first operator without supervision	IV
OCT/OFDI	Supervision at a distance and/or *post hoc*	IV
IVUS	Supervision at a distance and/or *post hoc*	IV
Endomyocardial biopsy	No performance, even with direct supervision. Observation is recommended	I
Use of percutaneous mechanical haemodynamic support	Performance with reactive supervision, i.e., on request and quickly available	III
Balloon aortic valvuloplasty	Performance as second operator and/or with direct, proactive supervision	II
TAVI	Performance as second operator and/or with direct, proactive supervision	II
Balloon mitral valvuloplasty	Performance as second operator and/or with direct, proactive supervision	II
Transcatheter mitral valve repair	No performance, even with direct supervision. Observation is recommended	I
Transcatheter mitral valve implantation	No performance, even with direct supervision. Observation is recommended	I
Transcoronary ablation of septal hypertrophy	No performance, even with direct supervision. Observation is recommended	I
Transcatheter pulmonary valve interventions	No performance, even with direct supervision. Observation is recommended	I
Left atrial appendage occlusion	Performance as second operator and/or with direct, proactive supervision	II
Atrial septal defect closure or patent *foramen ovale* closure	Performance as second operator and/or with direct, proactive supervision	II
Closure of ventricular septal defect	No performance, even with direct supervision. Observation is recommended	I
Percutaneous treatment of paravalvular leaks	No performance, even with direct supervision. Observation is recommended	I

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

Requirements for training institutions and trainers

Requirements for training institutions

- General aspects

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

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

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

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

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

1) Active clinical research program and/or involvement in clinical trials is mandatory for both types of centres.

2) Number of trainees per Institution should not exceed number of faculty members/trainers.

3) Heart-Team meetings, including participation by clinical cardiologists, interventional operators, and cardiothoracic surgeons should be planned regularly (i.e. weekly or bimonthly).

4) Regular database - electronic database of diagnostic and interventional procedures regularly audited by the National Interventional Society is recommended to ensure centre quality.

5) Performance measures report of institution (periodic at least annual): In hospital mortality in acute, elective PCI and diagnostic catheterisation.

6) Regular "quality assessment and quality improvement" (QA/QI) program including radiation safety program.

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

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

paravalvular leak closure, etc) are recommended. The presence of a Heart team is mandatory.

- A center may develop other programmes for peripheral interventions (stroke, carotid stenting, aorta, peripheral limb), treatment of adult congenital heart disease, performance of septal ablation for hypertrophic cardiomyopathy, etc.

Table 4: Characteristics and Requirements of Training Centers

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

- Procedural Volumes and Public metric reporting

It has been established that the procedural volumes of centres has a significant impact on the availability of training opportunities and on performance measures and intervention outcomes, but numbers are insufficient to define the quality of a centre and their ability to train interventional

fellows. Public reporting of centre training program, procedural volumes and clinical outcomes are advisable to guide trainee choice of the training centre. While the present document does not make recommendations on specific procedural volumes, training centres should comply with local standards according to national regulation bodies, including minimal procedural volumes.

Requirements for trainers

- General aspects and levels of competence

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

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

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

- Number of Trainers and their expertise

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

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

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

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

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