

Curriculum and syllabus for interventional cardiology subspecialty training in Europe

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Foreword

I am pleased to announce a new and important step forward in the definition of a common programme for interventional cardiology training in Europe. A meeting of the nucleus members of the WG 10 and the chairmen of the national interventional societies held in Stockholm during the ESC Congress in 2005 nominated a committee to finalise a preliminary proposal for a Curriculum and Syllabus I. This has been circulating and improved over the last 2 years and is based on feed-back received during various meetings held during the EuroPCR, as well as the ESC congresses in Vienna and Munich. The committee included experts in education such as: Professor Mills, member of the education committee of the ESC and author of the ESC Curriculum and Syllabus for General Cardiology; Dr Rolf Michels, representing as well the Union for European Medical Specialists (UEMS), Professor Jean-Luc Dubois-Randé, the promoter in France of what is today the only fully active national programme within Europe for interventional cardiology training; Professor Germano Di Sciascio, the education delegate of the WG10 Nucleus. After 2 days of hard work in Paris and London – coordinated and assisted by Dr Joanna Ortolí from the European Heart House – I am pleased to present here on behalf of this prestigious panel of experts the final approved document. This curriculum, however, will remain merely a vain proposal unless it is endorsed and promoted by the national interventional and general cardiology societies and is adapted to the different and specific

characteristics of current cardiology training in each individual European country. We hope that the publication here and on the website will help this process, stimulating discussion on this important achievement of the WG 10 – an achievement which will be officially presented during a special meeting at EuroPCR 2006 in Paris, kindly organised by Professor Marco.

CURRICULUM

Background

Ensuring both quality of patient care, and clinical excellence in interventional cardiology is of the utmost importance. In most European countries, cardiology training is constituted by a period of training in internal medicine (1-2 years) and 3-4 years training in Cardiology, covering the different invasive and non invasive fields. The ability to perform diagnostic coronary angiography and right and left cardiac catheterisation is still part of the general training for all Cardiologists in most European countries, with a minimum number of procedures often indicated in the curriculum of trainees in general cardiology. Interventional cardiology is the most frequent method of coronary revascularisation but the general training in cardiology rarely offers more than the opportunity to assist a more senior operator to perform angioplasty procedures.

The absence of regulations to determine the level of experience and knowledge in this field, has allowed new Cardiology Specialists to

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start, or be involved in interventional programmes without formal training. Now that free movement of Specialists is allowed in the European Community, it is essential that a certified, uniform, training programme exists, before cardiologists practice procedures which carry a potential risk.

Rationale & aims of this curriculum

The intention of this curriculum is to identify an educational process for specialists in interventional cardiology in Europe.

Completion of a formal, two-years programme training must include:

- Cardiovascular anatomy and physiology
- Vascular biology and pathology
- Pathophysiology (with clinical applications: intracoronary imaging, QCA...)
- Pharmacology (including anti-thrombotic and thrombolytic therapy, contrast agents)
- Radiology imaging and safe use of radiation
- Patient selection, indications, and limitations
- Interventional device design and performance
- Clinical management and strategy, pre- and post- procedure

Completion of the training programmes will deliver international credibility, and professional legitimacy to the candidate. Acquired knowledge and skills should be maintained by accredited continuing medical education (CME) activities.

Structure of the training programme

Basic training in cardiology (including internal medicine) must be completed before the subspecialty training in interventional cardiology is undertaken.

Learning objectives for the subspecialty of interventional cardiology

- a. Appropriately select patients for percutaneous coronary revascularisation and identify the optimal timing for the procedure, applying evidence based medicine and current guidelines to the individual patient needs and characteristics, with optimal and cost-effective use of the available resources.
- b. Be able to understand, explain and discuss the individual options of medical, percutaneous or surgical treatment with patients, patient relatives, referring physicians, other cardiologists, cardiac surgeons.
- c. Acquire the theoretical knowledge and practical skills to perform coronary angioplasty procedures in adults as an independent primary operator.
- d. Plan pre-procedural, intra- procedural and post- procedural patient management with particular emphasis on adjunctive pharmacological treatment, selection of vascular access, control of haemostasis and prevention of bleeding complications, prevention of allergic reactions and renal insufficiency.
- e. Identify the optimal strategy of interventional treatment including device and technique selection, development of alternative plans in case of failure of the initially chosen approach, and handling of unexpected complications.
- f. Plan long- term clinical follow up including secondary prevention and pharmacological treatment.

Learning methods

APPRENTICE LEARNING

Apprenticeship learning is the mainstay of the training process in interventional cardiology. Candidates will be required to be involved in procedure planning, assessment of indications and contraindications, specific establishment of the individual patient risks based on clinical and angiographic characteristics.

The trainee should:

1. Handle patient admission to the ward, obtain informed consent, prescribe pre-procedure drug therapy, and organise appropriate non-invasive testing.
2. Perform supervised angioplasty procedures with progressive increase in the level of involvement based on incremental operator experience and case complexity. The trainee must discuss the procedure with his/her educational supervisor, who will also ensure appropriate tutorship in the catheterisation laboratory.
3. The trainee must be involved in post procedural management including timely preparation of the report, monitoring of the patient's status with special attention to the complications at the catheter entry site, heart and renal failure, bleeding and recurrent myocardial ischemia. The trainee should participate in the selection of the pharmacological treatment before, during and after the procedure based on established protocols and after discussion with the supervisor.
4. The trainee must participate in the cardiology night and weekend on-call with the aim to optimise exposure to acute interventional treatment in the setting of acute myocardial infarction and other emergency cardiology conditions.
5. Every trainee must be exposed to techniques of intravascular imaging and functional assessment of lesion severity (intravascular ultrasound, intra coronary pressure measurement).

Typically the **two year programme** is **divided into four semesters** and should include activities in the ward and in the Catheterisation Laboratory, divided as follows:

1. **1st semester:** the trainee mainly prepares the patient for the intervention, including diagnostic angiography, and assists the supervisor or another experienced interventionalist performing the angioplasty procedure.
2. **2nd semester:** the trainee starts working as primary operator for simple angioplasties under close supervision and assists in the most complex angioplasty procedures (bifurcations, thrombus containing lesions, chronic occlusions, diffuse disease, severe calcifications, etc).
3. **3rd semester:** the trainee performs simple angioplasty procedures as independent operator, with the supervisor still available to plan the procedure, judge the results and advise in case of complications. The trainee will start performing complex procedures under closer supervision.
4. **4th semester:** if the trainee has developed appropriate competencies, he/she will work as primary and independent operator in both simple and complex coronary interventional procedures. During stages 3 and 4 the trainee may undertake elective/advanced training in peripheral vascular, valvular and congenital interventions.

FORMAL LEARNING

Formal learning will be organised at the European level by the Working Group of Interventional Cardiology, at the national level by the national societies of interventional cardiology, at the local level by the accredited institution or university. The training program must ensure that trainees have the required cognitive knowledge base of all the subjects included in the Syllabus.

Trainees will be required to attend at least **30 full days (240 hours) in 2 years of accredited formal sessions** locally, nationally or abroad. Formal learning should include attendance at study days and post graduate courses, national and international courses in Interventional Cardiology, including live courses.

Distance learning through journals, textbooks and the Internet should be part of the training process. Attendance at journal clubs and conferences on specific new techniques should be encouraged and certified.

All trainees must be exposed by the training programme to research in interventional cardiology. Participation as co-investigator in single centre or multi centre trials, handling data collection or participation in the analysis, presentation of results and investigators' meetings must be part of the training programme.

A statistical background sufficient to allow independent interpretation of results is a recommended component of training.

Trainees will be required to provide documentation of attendance at accredited formal training courses. Copies should be maintained in the records of the trainee (logbooks).

The interventional cardiology training programme must include:

- regular cardiac catheterisation conferences to present clinical data, non-invasive imaging results (scintigraphy, cardiac MR, multislice CT), haemodynamic measurements and angiographic images of patients selected for intervention
- multi-specialist medical surgical conference
- meetings to review the results of simple and complex procedures
- morbidity and mortality meetings.

Trainees must have knowledge of peripheral arterial anatomy, and – if part of the centre interventional programme

- participate in revascularisation procedures for:
 - carotid stenoses,
 - subclavian stenoses,
 - renal artery stenoses,
 - iliac artery stenoses
 - other vascular procedures, such as abdominal aortic aneurysm.

Assessment methods

The following methods will be used to assess the trainee, and should not be considered in isolation but as complementary techniques:

Formal training

Trainees will be required to provide documentation of attendance at accredited formal training courses. Copies should be maintained in the records of the trainee (logbooks).

Procedural logbook

All trainees will maintain a continuous record of their catheter lab based procedures. It should be clear whether the trainee was second, primary or sole operator for the case.

The trainee's log book must follow the template of the CARDS data standards for interventional cardiology, as recommended by the European Society of Cardiology (ESC). In particular the database must indicate whether the case was elective, urgent or emergency. The log book must provide details of lesion complexity and type of device used and complications encountered.

The trainee will have performed at least 200 procedures as first or only operator, from which one third should have been emergency or ACS procedures.

The procedure log book will be reviewed and signed off on a monthly basis by the Training Director

Directly Observed Procedural Skill Assessment

Directly Observed Procedural Skill assessment is an established assessment method, which must be employed at regular intervals during the 2 year programme. Ideally this should be performed by an experienced, independent trainer who observes the trainee performing an interventional procedure. In practice it is expected that the assessor will come from within the training centre.

Learning Practical Skills Outside the Catheter Lab: Simulators

Simulators have the advantage to provide objective reproducible evidence of manual skills. Currently they are of limited availability and are expensive, but have the potential to be used as an internationally standardised and complementary assessment method.

In the foreseeable future simulators may become an important assessment tool in interventional cardiology.

Appraisal from the Programme Director

Final appraisal must be signed by the programme director involving all consultants supervising the trainee.

The appraisal should take into consideration observations from other team members (surgeons, cardiologists, senior cath lab nurses, chief radiographer and cardiac technicians as well as junior staff members, Cardiology Registrars in training).

The Programme Director should testify that the trainee can perform adequate revascularisation procedures as independent operator and deliver post procedural care. Analytical evaluation of the complexity of the interventions performed as primary or secondary operator should be included, with particular attention to the incidence of complications, their cause and competent handling.

- The final judgement should report the trainee's ability to interact with cath lab staff and colleagues, attention to minimise patient risk and discuss complex procedures with more expert colleagues, ability to make independent appropriate choices and cope with emergency situation.
- Knowledge of devices, drugs and material, handling of x-ray and other cath lab equipment, attention to achieve results with minimal contrast injections/x-ray exposure to the patients should also be considered in the final training assessment.

In case the final judgement is not positive the estimated duration and characteristics of the additional training considered sufficient to achieve the ability to work as independent operators should be clearly specified.

Examination

This exam will be held at the end of the training and consist of 2 parts: the first section will test theoretical knowledge, covering all items included in the Syllabus. The second will use clinical cases to appraise practical experience. The format in both sections will be MCQs. The Working Group of the ESC will regularly organise examination of candidates who have entered or completed a training programme following this Curriculum. The format of the examination will be as follows:

Theoretical section

100 MCQs in 120 minutes. Each question will have 5 answer stems and there will be only 1 correct response.

Case studies

This will consist of 50 questions based around 10-20 case studies. Each answer will have 5 possible answers and only 1 will be correct.

Organisation of the training

Entry requirements for cardiologists

Applicants for the subspecialty training in interventional cardiology must have successfully completed an approved programme of training in cardiology including a common trunk in internal medicine. The cardiology programme must have been at least three years in duration and must document basic experience in all the other cardiology subspecialties, including: echocardiography, non invasive imaging (radionuclide techniques, CMR, etc), coronary care and intensive care units, electrophysiology and pacing, adult congenital heart disease, chronic heart failure treatment, preventive cardiology.

Selection

Proficiency in the cardiac catheterisation laboratory showing manual skills and accurate reporting of angiograms will be considered in the selection process for interventional cardiology, but no specific experience in interventional cardiology is required to join this programme.

In countries where a period of advanced training in invasive diagnostic catheterisation and interventional cardiology is part of the cardiology specialist training, this attendance will be considered in the selection process and may lead to a modification in the duration and characteristics of the training programme.

Non-European specialists who compete for a post in an interventional cardiology subspecialty programme must provide evidence of a training process in internal medicine and cardiology adequate to provide the same knowledge and experience of the other European approved training specialists and in particular should document their ability to manage acute cardiological conditions.

Requirements for training centre and training supervisors

Training centres should fulfil the following technical and staffing requirements. The implementation of these requirements should be confirmed by the national societies for Interventional Cardiology.

CARDIAC CATHERISATION LABORATORY

The training centre should have an independent interventional cardiology unit, allowing the trainee to follow the patient from the beginning to the completion of the 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.

The presence of a programme of peripheral interventions, treatment of adult congenital heart disease, performance of septal ablation for hypertrophic cardiomyopathy and valvuloplasty, are useful adjuncts to the centre qualification. An electronic database of diagnostic and interventional procedures regularly audited by the national interventional society is desirable in order to ensure that the number of types of interventions required according to the training scheme occur.

PROCEDURE VOLUME

The interventional cardiology programme should perform at least 800 coronary angioplasties per year including acute coronary syndromes and primary angioplasty for acute myocardial infarction. These requirements are highly desirable but exceptional cases can be considered of highly skilled groups with smaller annual procedural volume or not able to practice acute interventions because of poor departmental or country organisation of service.

PROGRAMME DIRECTOR AND SUPERVISORS

Most of the interventions should be performed by permanent medical staff and at least two supervisors must be available, with an experience of at least 1,000 coronary interventions and more than five years experience mainly dedicated to interventional cardiology.

The programme Directors must be responsible for the interventional unit and should ensure that the trainee shares his time between:

- Performance and supervision of diagnostic coronary angiography.
- Planning and performance of coronary revascularisation fulfilling the goal of at least 200 interventions as primary operator.

The supervisor must also ensure that the trainee attends the formal training courses and is involved in the research and educational activities of the department.

Advanced training

The following procedures should not be part of the core curriculum but should be considered as an “optional” part of the training programme. The supervisor of the training process should separately indicate whether the trainee has achieved enough experience and proficiency to perform them as primary operators.

- A. Mitral and aortic valvuloplasty (in the future percutaneous valve repair might be included)
- B. Closure of atrial septal defects and patent foramen ovale (possibly including closure of post MI ventricular septal defects and perivalvular leaks)
- C. Septal alcoholisation for hypertrophic cardiomyopathy
- D. Carotid stenting

- E. Renal stenting
- F. Iliac stenting
- G. Subclavian stenting
- H. Other peripheral vascular procedures

SYLLABUS Specific Programme Content

Basic Science

- a. **Anatomy and physiology:** cardiac, vascular and coronary artery anatomy, including anatomical variants and frequent congenital abnormalities; basic circulatory physiology, myocardial blood flow regulation, myocardial physiology and metabolism.
- b. **Vascular biology,** including the processes of vasoreactivity, plaque formation, vascular injury and healing, restenosis, SVG atherosclerosis, cardiac allograft vasculopathy.
- c. **Function of progenitor cells** and their possible role in angiogenesis and myogenesis.
- d. **Haematology,** including platelet function and aggregation, clotting cascade, and fibrinolysis.
- e. **Coronary anatomy and physiology,** including
 - Classification of coronary segments and lesion characteristics;
 - Assessment of lesion severity, intracoronary pressure and flow velocity measurement, fractional flow reserve (FFR);
 - Assessment of collateral circulation.

Pharmacology

- a. Biologic effects and appropriate use of vasoactive drugs, antiplatelet agents, thrombolytics, anticoagulants, antiarrhythmics, inotropic agents, and sedatives.
- b. Biologic effects and appropriate use of angiographic contrast agents, including prevention of renal dysfunction and allergic reactions.
- c. Atherosclerosis prevention in PCI candidates focusing on optimal care of hypertension, dyslipidemia, diabetes and smoking cessation.

Imaging

- a. **Radiation physics, radiation risks and injury, and radiation safety,** including glossary of radiological terms, methods to control radiation exposure for patients, physicians, and technicians.
- b. **Specific imaging techniques in interventional cardiology,** such as quantitative angiography and intravascular ultrasonography.
- c. **Principles of cardiac computed tomography,** potential role for non-invasive coronary imaging.
- d. **Digital archiving and tele-communication** of angiographic images.

Indications for treatment and patient selection

- a. **Indications for elective cardiac catheterisation and related catheter-based interventions** in management of ischaemic and valvular heart disease, in accordance with the ESC guidelines and evidence based medicine.
- b. **Indications for urgent catheterisation** and management of acute myocardial infarction, including differentiation between patients

who require primary or rescue angioplasty, coronary bypass surgery or conservative treatment.

- c. **Indications for mechanical support devices in the management of haemodynamically compromised patients** (intra-aortic balloon pump etc.)
- d. **Present indications for surgical re-vascularisation in coronary artery disease**

Procedural techniques

- a. **Vascular access** including principles of femoral, radial, and brachial procedures, closure techniques, detection and treatment of complications.
- b. **Appropriate catheter selection** to achieve optimal opacification and support.
- c. Selection of optimal projections for lesion visualisation and treatment.
- d. **Knowledge of angioplasty material** and proper selection of guidewires, balloon catheters, and stents.
- e. **Knowledge of types and characteristics of bare metal and drug-eluting stents** including post-implantation pharmacological treatment and their risk of thrombosis and restenosis.
- f. **Classification, mechanisms, and therapy of in-stent restenosis.**
- g. **Knowledge of ancillary interventional techniques,** including
 - Therapeutic: anti-embolic protection with filters and occlusive balloons, rotablator, laser, atherectomy and thrombectomy devices.
 - Diagnostic: intravascular ultrasound, Doppler and intracoronary pressure measurement
- e. **Indications for mitral, aortic, and pulmonary valvuloplasty** in management of valvular disorders, including factors that differentiate patients who require surgical commissurotomy or valve repair or replacement.
- f. **Indication for catheter-based interventions** in management of congenital heart disease in adults, such as closure of intracardiac defects (ASD, PFO, VSD, PDA).
- g. **Indications for septal alcoholisation** in obstructive hypertrophic cardiomyopathy

Management of complications of percutaneous intervention

- a. **Mechanical complications,** such as coronary dissection, spasm, perforation, "slow/no reflow", cardiogenic shock, left main trunk dissection, cardiac tamponade including pericardiocentesis, peripheral vessel occlusion, and retained components.
- b. **Thrombotic and haemorrhagic complications** associated with percutaneous intervention or drugs.

Miscellaneous

- a. Peripheral angiography and angioplasty including essential radiological anatomy, indications and principles of carotid, subclavian, renal and iliac stenting.
- b. Ethical issues and risks associated with diagnostic and therapeutic techniques.
- c. Statistics, epidemiologic data, and economic issues related to interventional procedures.