

Core curriculum for the heart rhythm specialist: executive summary

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Heart rhythm (HR) management is rapidly developing as a subspecialty within cardiology, and it is imperative to promote and ensure sufficient and homogeneous training and qualification amongst professionals in Europe. This has led the European Society of Cardiology, through the European Heart Rhythm Association (EHRA), to organize a European Core Curriculum for the HR specialist through the following: definition of the scope of the HR speciality (Syllabus), development of minimum standards and objectives for training in HR management (Curriculum), development of a model to certify HR professionals and teaching units (Accreditation), and development of a Registry for European HR accredited professionals and teaching units and its activity (Registries). The duration of the training period should be of a minimum of 2 years following general cardiology training. During this period, the trainee must develop the required knowledge, practical skills, behaviours, and attitudes to manage HR patients. The trainee must be involved in a minimum number of different procedures and achieve specified levels of competence. The training centre should be integrated within a full-service cardiology department. Assessment of the trainee and the training programmes should include reports by the training programme supervisor and the national society HR organizations, a logbook of procedures, written examinations, and assessment of professionalism. The EHRA presently requires the trainee to pass the EHRA accreditation exams (invasive EP and cardiac pacing and ICDs). Continuous learning and practice are required to maintain standards and practice and because substantial changes may occur in clinical practice or the health-care environment.

Keywords Accreditation • Arrhythmia • Curriculum • Education • Electrophysiology • Heart rhythm

Introduction

Heart rhythm (HR) management is rapidly developing as a subspecialty within cardiology that is devoted to the diagnosis and the treatment of cardiac rhythm disorders. More than 50 000 catheter ablations are performed every year in Europe.¹ In addition, device implantation for arrhythmia treatment, sudden death prevention, and cardiac resynchronization are performed in more than 200 000 patients in Europe per year.¹ The increase in the indications and the number of all of these procedures depicts the present scenario by emerging indications, an increasing number

of invasive procedures, and the establishment of new practising units and professionals. Nevertheless, these procedures require cardiologists with comprehensive knowledge of HR disorders and who are trained in cardiovascular catheter manipulation, heart electrical signal recording and interpretation, and device implantation and follow-up to ensure both patient safety and quality.^{2,3} Thus, it appears to be imperative to promote and ensure sufficient and homogeneous training and qualification in HR management among these professionals in Europe.

In addition, the European Council of Ministers adopted a recommendation on the development and implementation of

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systems on 30 September 1997 to improve the quality and homogeneity of Health Care Services. The recommendation stated that *quality systems must be publicly controlled through objective external evaluation* by independent organizations. Although training and accreditation programmes are conducted both nationally and regionally, co-ordination at the European level is needed.

These reasons supported the commitment of the European Society of Cardiology (ESC), through the European Heart Rhythm Association (EHRA), in organizing such a European system together with the Registries of European certified units, professionals, and activities. A European programme in this field will be of utmost interest and will represent a harmonized and uniform way to ensure high standards of excellence. Thus, the general aim is to organize a European Core Curriculum for the HR specialist associated with an Accreditation System to certify professional practice through the following objectives:

1. Definition of the scope of the HR speciality (Syllabus).
2. Development of a minimum standards and objectives recommendation for training in HR management (Core Curriculum).
3. Development of an Accreditation model for European HR professionals and teaching units (Accreditation).
4. Development of a Registry for European HR accredited professionals and teaching units and its activity (Registries).

This document describes the EHRA system. The reader should note that the recommendations, text, and tables included in this executive summary represent a succinct summary of the more extensive ones that are included in the full-text document. Readers are strongly encouraged to refer to the full-text document.⁴

Definitions and glossary

Accreditation

Accreditation is a process resulting in a diploma/certificate indicating proficiency. This applies to individuals, institutions, and laboratories. Different terms have been often used and confused with accreditation including authorization, inspection, and homologation. Accreditation signifies granting credit or recognition, or proving certitude. It is voluntary and motivational, and its objective is the improvement of quality. It is performed in health centres, which already have the appropriate authorization from the corresponding official organization to carry out a certain activity and, therefore, are already operational.

Heart rhythm specialist

A cardiologist with specific knowledge, training, skills, and attitudes for the study, management, research, and teaching of the HR disorders.

Cardiac electrophysiology

Cardiac electrophysiology (EP) is the field of cardiology related to the study and management of HR physiology and disorders. It includes both invasive and non-invasive techniques. Invasive cardiac EP is the discipline that involves the study, diagnosis,

treatment, and prevention of cardiac arrhythmias through recording electrical activity, stimulation, and the controlled creation of endocardic and epicardic lesions in the heart and its principal vessels through electro-catheters, which are generally introduced by the percutaneous vascular route. Knowledge of the management of HR implantable devices, as one of the diverse diagnostic and therapeutic approaches for HR disorder management, is also required for proficiency in this speciality.

Heart rhythm implantable devices: pacemakers, defibrillators, and others

Heart rhythm implantable devices are those that are designed for implantation in the human body for the study, diagnosis, prevention, or management of HR disorders. The most frequent HR implantable devices are pacemakers (PMs), implantable cardioverter-defibrillators (ICDs), and devices for cardiac resynchronization therapy (CRT). Proficiency in this discipline requires also a basic knowledge about invasive and non-invasive cardiac EP.

Summarized syllabus

The subspecialty syllabus is the comprehensive index of the present knowledge in the HR subspecialty, which includes knowledge in both invasive cardiac EP and cardiac rhythm implantable devices. For formal aspects, the knowledge base of the HR subspecialty will consider all data and information related to it that has been made public and are currently available as published work in international peer-reviewed journals. Nevertheless, summarized syllabuses for the HR specialist in general and for invasive cardiac EP and HR implantable devices in particular have practical interest and are presented in this section.

Syllabus for the heart rhythm specialist

1. Normal and abnormal anatomy of the heart and the conduction system
2. Normal and abnormal general physiology and heart EP, including ion channels, cellular EP, autonomous system influences, and the basic mechanisms of rhythm disorders, syncope, and sudden death
3. Arrhythmic disorders (epidemiology, genetics, pathophysiology, clinical features and diagnosis, prognosis and risk evaluation, treatment, prevention, ESC guidelines)
 - 3.1 Sinus node and atrial impulse formation and conduction disorders
 - 3.2 Atrioventricular (AV) nodal and His–Purkinje conduction disorders
 - 3.3 Atrial and thoracic vein ectopy and tachycardias
 - 3.4 Atrial flutter
 - 3.5 Atrial fibrillation
 - 3.6 Junctional and AV node ectopy and tachycardias
 - 3.7 Accessory pathway-mediated tachycardias
 - 3.8 Ventricular ectopy and tachycardias
 - 3.9 Ventricular fibrillation
 - 3.10 Autonomic disorders (carotid sinus hypersensitivity, neurocardiogenic syncope, and other)

4. Arrhythmogenic diseases and syndromes (epidemiology, genetics, pathophysiology, clinical features and diagnosis, prognosis and risk evaluation, treatment, prevention, ESC guidelines)
 - 4.1 Ischaemic cardiomyopathy
 - 4.2 Non-ischaemic cardiomyopathies
 - 4.2.1 Idiopathic dilated cardiomyopathies
 - 4.2.2 Hypertrophic cardiomyopathies
 - 4.2.3 Right ventricular arrhythmogenic cardiomyopathies
 - 4.2.4 Neuromuscular cardiomyopathies
 - 4.2.5 Valvular-related cardiomyopathies
 - 4.2.6 Congenital diseases
 - 4.2.7 Other (Chagas disease, etc.)
 - 4.3 Channelopathies and other inherited syndromes
 - 4.3.1 Long and short QT syndromes
 - 4.3.2 Brugada syndrome
 - 4.3.3 Catecholaminergic polymorphic ventricular tachycardia
 - 4.3.4 Congenital conduction disorders
 - 4.3.5 Other
 - 4.4 Other situations leading to rhythm disorders
5. Diagnostic procedures and techniques in heart rhythmology and clinical EP (rationale, materials and equipment, techniques and procedures, complications, result interpretation, indications and contraindications, ESC guidelines)
 - 5.1 Clinical evaluation (history and physical examination)
 - 5.2 Electrocardiography (ECG)
 - 5.2.1 Conventional 12-lead ECG
 - 5.2.2 ECG monitoring (Holter, event monitoring, implantable event and loop monitoring)
 - 5.2.3 Heart rate variability and baroreflex sensitivity
 - 5.2.4 Signal-averaged ECG
 - 5.2.5 T-wave and micro-T-wave alternants
 - 5.2.6 Body surface mapping
 - 5.3 ECG–pharmacological tests
 - 5.3.1 Type I drugs for His–Purkinje system challenge
 - 5.3.2 Type I drugs for Brugada ECG unmasking
 - 5.3.3 Adrenaline for congenital long QT syndrome unmasking
 - 5.3.4 Adrenaline/atropine for sinus node dysfunction
 - 5.3.5 Adenosine/ATP for sinus node and AV node dysfunction
 - 5.3.6 Other
 - 5.4 Exercise tests
 - 5.5 General knowledge in imaging techniques (fluoroscopy, echocardiography, magnetic resonance imaging, computed tomography, nuclear imaging, angiograms, and other)
 - 5.6 Autonomic nervous system evaluation
 - 5.6.1 Carotid sinus massage
 - 5.6.2 Supine to orthostatism for orthostatic hypotension evaluation
 - 5.6.3 Tilt testing
 - 5.6.4 Other
 - 5.7 Transoesophageal electrical evaluation
 - 5.8 Invasive EP studies

- 5.9 Other
6. Therapies in heart rhythmology and clinical EP (rationale, material and equipment, techniques and procedures, side effects and complications, results, indications and contraindications, ESC guidelines)
 - 6.1 Physical and autonomous system manoeuvres
 - 6.2 Resuscitation and life support
 - 6.3 Drugs with antiarrhythmic effects
 - 6.4 Drugs for associated rhythm problems (anticoagulants, vasodilators, and other)
 - 6.5 Transient electrical stimulation
 - 6.5.1 Transcutaneous
 - 6.5.2 Transoesophageal
 - 6.5.3 Intracardiac percutaneous
 - 6.6 Cardioversion and defibrillation
 - 6.7 Invasive EP-guided therapies
 - 6.8 Percutaneous catheter ablation
 - 6.9 Implantable HR devices (PMs, ICDs, CRTs, and other)
 - 6.10 General knowledge of cardiac and antiarrhythmic surgery
 - 6.11 Other
7. Professional, legal, ethical, and socio-economical aspects

The specific syllabuses for invasive cardiac EP and for HR implantable devices are presented in the full-text document.⁴

General learning objectives

Individual training in HR management should have a solid background in all aspects of general medicine, which can provide the basis for specialized arrhythmia care. A dedicated training period following general cardiology training⁵ is also required. At the same time, individuals in the field require a sound understanding of the research principles and mechanisms, including study design and statistical principles. In addition, a thorough knowledge of the principles of clinical ethics and clinical and research governance is required. Patients with cardiac arrhythmias are a particularly vulnerable group and understanding cardiac arrhythmia abnormality can be a significant challenge for the lay person. Thus, development of patient communication and ‘people’ skills is highly important. Finally, administration of clinical practices requires a broad set of administrative skills. The individual responsible for service management needs to equip him/herself with an understanding of the basic management principles, including management skills, such as the ability to successfully ‘people-manage’, write business plans, perform audits, negotiate the purchase of consumables and equipment, and undertake appraisal. The main learning objectives to achieve in the different areas of HR management together with the knowledge, the practical skills, the behaviour, and the attitudes the trainee should have achieved at the end of the training period are presented in tables in the full-text document.⁴

Training requirements and plan

This section details the minimal requirements of the training programme for HR specialists. Following this training programme, the trainee will entitle recognition of theoretical and practical

competency in invasive EP and HR management device implantations and follow-up. At the end of the training programme, the trainee should be able to treat independently patients with HR disorders.

Training duration

The duration of the training period should be of a minimum of 2 years. During this period, the trainee must be involved in all aspects of HR management, including the research and educational activities of the teaching department. The trainee should not only fulfil the criteria concerning the procedure numbers, but should also undergo a final evaluation. Such an evaluation has been developed by the EHRA, which presently requires the trainee to take and pass the EHRA accreditation exams (invasive EP and cardiac pacing and ICDs) in order to register as an HR specialist in this association. Finally, the programme director should provide a written statement concerning the ability of the trainee to treat patients with cardiac arrhythmias at the end of the training period.

Trainee requirements

The trainee should be a registered cardiologist or should fulfil the requirements of a general cardiologist set in the core curriculum of the ESC in order to enter the programme accordingly.

Training plan

The trainee should follow a structured teaching programme and the learning objectives detailed in the previous section. The programme must be comprehensive and completion of the training in one centre is recommended. The training plan should include clinical activities and practical training together with theoretical educational activities, and research activities and education. During the training period, trainees should attend and participate in weekly meetings reviewing topics and discussing patients, indications, results, and procedural-related complications. In addition, the trainee should attend at least one official international subspecialty meeting of a scientific society in the field. The trainee must be involved in research activities in the HR field and should present at least one scientific abstract at a national or international meeting in the field during the training period.

During the 2-year training period, the trainee should participate in the HR training programme for at least 80% of the working hours (based on full-time employment). During the training

period, dedication to the different clinical activities should be distributed as follows:

1. Outpatient clinic: 10% of the training period.
2. Device (ICDs, CRT, and PMs) follow-up: 10% of the training period.
3. Device (ICDs, CRT, and PMs) implantations: 10% of the training period.
4. Invasive EP: 40% of the training period.

Based on a 2-year training period (assuming that basic cardiology training is completed), training should be distributed into different periods which are detailed in the full-text document.⁴

Indicative number of procedures

This section details the minimum number of procedures recommended to be performed by the trainee during the training period. In addition, the levels of competence (I to III) expected for a given area of a subject matter are provided with the same definitions used in the ESC Core Curriculum for the General Cardiologist⁵ and are complementary to them.

The trainee should review at least 1000 12-lead ECGs during the training period in addition to the >1000 that he or she should have had reviewed during the Cardiology speciality training. In addition, the trainee should gain basic knowledge (level of competence I) in ECG-based techniques, including T-wave alternant analysis, body surface potential mapping, and heart rate variability. The trainee should also be familiar (level of competence I) with surgery for HR disorders. The recommended procedural numbers and the levels of competence for the rest of the HR procedures are presented in *Tables 1* and *2*.

Training centre and trainer requirements

Formal training in HR management must be carried out in a centre that is recognized and accredited by an official organization, such as the EHRA, as an HR subspecialty training centre. The training centre should be integrated within a full-service cardiology department, which includes an interventional unit, a cardiac imaging department, a heart-failure unit, and a cardio-surgical unit. The institution must be a training centre for general cardiologists and a recognized centre (by the health authorities or according to national laws) for performing all arrhythmia and device-related procedures with the

Table 1 Minimum recommended procedural numbers and levels of competence in non-invasive techniques to be achieved by the HR specialist during training

Technique	Number	Level of competence	Comments
Holter ECG monitoring (external)	50	III	
ECG event recording	5	III	
Pharmacological test, autonomic system manoeuvres, and tilt test	25	III	
Pacemaker follow-up/programming	250	III	
ICD follow-up/programming	100	III	
CRT follow-up/programming	50	III	

Table 2 Minimum recommended procedural numbers and levels of competence in invasive techniques to be achieved by the HR specialist during training

Technique	Number	Level of competence	Comments
Diagnostic invasive electrophysiological studies (as a standalone procedure or prior to an ablation procedure)	200	III	50 as the primary operator
Percutaneous catheter ablation	150	III	35 as the primary operator
Transseptal catheterization	10	III	5 as the primary operator
Pacemaker implantation	50	III	30 as the primary operator
ICD implantation	30	III	15 as the primary operator
CRT implantation	20	III	10 as the primary operator

only exception of arrhythmia surgery. The centre must have access to at least one dedicated and state-of-the-art equipped EP catheterization laboratory, it must record procedural-related data, and it must have a complication registration system.

The training centre must employ at least two fully trained, advisable HR specialists, who should be recognized (accredited) by the EHRA. Both of them must be actively involved in the field of HR management for at least 70% of the time (based on a full-time employment). The programme supervisor should be a fully trained HR specialist recognized by the EHRA and who has at least 5 years of experience in the field. In addition, the training programme staff should be active in clinical research related to the field of HR management.

Clinical practice activities: procedures and numbers

The training centre should perform PM, ICD, and CRT device implantation and replacement, invasive electrophysiological procedures, and catheter ablation of the following arrhythmias on a regular basis: accessory pathway-mediated tachycardias, AV nodal re-entrant tachycardia/junctional tachycardia, ectopic atrial tachycardia, atrial flutter from the right and the left atrium, atrial fibrillation, AV conduction ablation, and ventricular tachycardia (idiopathic and in patients with structural heart disease).

The training centre should perform yearly at least 250 invasive electrophysiological diagnostic procedures, 200 catheter ablation procedures, 200 PM implantations/replacements, 50 ICDs implantations/replacements, and 20 CRTs implantations/replacements.

Educational activities

The training centre should organize regular theoretical educational activities on a weekly basis.

Research activities

A training centre should maintain a minimum level of scientific activity and interest in HR, which could be endorsed by the presentation of at least three related scientific communications at an EHRA recognized official subspecialty congress and the publication of at least one scientific article related to HR in a journal with an objective 'impact factor' during the previous 3 years.

Certifying as a training centre

Training centres should comply with the National Quality insurance programme. The National Working Group on Arrhythmias should endorse the training centre and trainers.

Training assessment

Assessment of the trainee and the training programmes is essential, both to guarantee a minimum level of knowledge and practical competence of the trainee and to promote continuous improvement of the training programmes. The assessment methods should include reports by the training programme supervisor and the national society HR organizations, a log book of procedures, written examinations, and assessment of professionalism.⁶

In addition, the assessment process should include an appeal procedure, as an additional quality control of the system provided by their participants, and a revocation procedure for accredited professionals or centres that act incompetently or in an unsatisfactory manner. This assessment process should aim to develop a certification or accreditation system (see glossary) for HR specialists, not to delimit the legal capacity of professional training in this field of Cardiology, but for objective certification of the qualification of training personnel and training centres, with the guarantee of required quality from a strictly professional and technical point of view.

The EHRA has undertaken the task of assessment and accreditation of centres and professionals by verifying the candidates' credentials, log books and merits, evaluating and verifying the centre and the candidates' professional competence, and implementing and holding accreditation examinations. The centres and candidates who pass the assessment process successfully are entitled to a diploma/certificate indicating training excellence and proficiency, respectively, which will be endorsed and accredited by the EHRA. The first EHRA's Accreditation exams for invasive EP and for implantable devices were held in 2005 and the first EHRA's Accreditation titles were issued in 2006.⁷

A more detailed description of training assessment, reaccreditation, revocation, and the composition and role of the Accreditation Committee can be found in the full-text document.⁴

Continuous medical education and maintaining competence

Continuous learning and practice are required to maintain standards and practice and because substantial changes may occur in clinical practice or the healthcare environment. Training seminars and international specialist conferences must be attended (at least two per year). Continued practice may indicate 16 h/week working in the subspecialty field. Continued learning may indicate 200 continuous medical education credits over a 5-year period in the field of HR management.

Therefore, accreditation as an HR specialist is time limited and will require individuals to go through a process of reaccreditation and recertification. The time period before reaccreditation is required will be 10 years or if considered advisable by the Accreditation Committee, whenever a suitable electronic platform is available. Reaccreditation requires submission and validation of evidence of continued learning and practice within the subspecialty.

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