TRAINING IN CARDIAC ELECTROPHYSIOLOGY AND PACING

A Policy statement for training and practice of cardiac electrophysiology and pacing issued by the board of the Egyptian Society of Cardiology

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On behalf of the board of the Egyptian Society of Cardiology

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I. Background and Objectives

Clinical cardiac electrophysiology is one of the most rapidly growing subspecialties of cardiovascular medicine. Advancement in technology provides more effective and safer management options for arrhythmia patients. Catheter ablation procedures have emerged as an effective tool to tackle simple and complex arrhythmias like atrial fibrillation and scar-related ventricular tachycardia. The tremendous evolution in cardiac rhythm management devices including pacemakers, implantable loop recorders (ILR), cardiac resynchronization therapy (CRT) and implantable cardiovertor defibrillators (ICDs); has offered therapeutic solutions to life-threatening cardiac arrhythmias and advanced heart failure. Given the wide spectrum of cardiac rhythm problems dealt by the modern cardiac electrophysiologist, a well-organized training program in cardiac electrophysiology would be highly appreciated.

The objectives of this document would be:

1. To advance the standard of care delivered to arrhythmia patients in Egypt providing the best possible service that matches international standards and guidelines.
2. To standardize the required credentials and training to practice cardiac electrophysiology and pacing among Egyptian centers and departments of Cardiology.
3. To ascertain the essential relationship between appropriate credentials and complete training on one hand and the privilege to practice cardiovascular medical subspecialties on the other.
4. To encourage harmonization of practice patterns in different cardiovascular centers in Egypt. Eventually, setting the stage to acquire uniform database allowing national multi-center registries and research activities.

II. Qualifications, credentials, requirements and certification

1- Trainees

A. Candidates for training in cardiac electrophysiology and pacing should be dedicated specialists in cardiovascular medicine. They should have complete education, comprehensive knowledge and full training in clinical Cardiology including basic sciences, pathophysiology, diagnosis and management of congenital, valvular, myocardial, coronary and vascular heart diseases covering all subjects included in the core syllabus in cardiovascular medicine (section III). Candidates should have obtained one of the following degrees in cardiovascular medicine:

i. MD in cardiovascular medicine in one of the departments of Cardiology in Egyptian Universities.
ii. Master degree in cardiovascular medicine in one of the departments of Cardiology in Egyptian Universities.
iii. The Egyptian fellowship in cardiovascular medicine from the board of medical education and fellowship, Ministry of health.
B. Candidates should have completed their training in a department of Cardiology supervised by professors/consultants with a doctorate degree in cardiovascular medicine.

C. Candidates should have completed a program of dedicated training in cardiovascular electrophysiology and pacing as detailed in the following passages including performance of the required number of procedures (section V).

D. Candidates should submit an application endorsed by the recommendation, approval and signature of two professors/consultants with an MD degree in cardiovascular medicine and either 10 years of experience in cardiac electrophysiology and pacing or the performance of 1000 diagnostic/interventional EP procedure and 500 device implant.

2- The trainers

A. The program director:

The director of invasive cardiology should be a full professor/consultant in Cardiology with an MD degree in cardiovascular medicine. He should be a recognized expert having either 10 years of experience in cardiac electrophysiology and pacing or the performance of 1000 diagnostic/interventional EP procedure and 500 device implant.

B. Other faculty members:

Other trainers should have an MD degree in cardiovascular medicine and 5 years of postgraduate experience in cardiac electrophysiology and pacing. The rest of the faculty should include experienced members in echocardiography, interventional cardiology, congenital and valvular heart diseases.

3- The training institution/department

This should be a fully equipped and staffed department specialized in cardiovascular medicine. It should have a coronary care unit, inpatient ward, non-invasive diagnostic equipments, imaging facilities, facilities for performing diagnostic and interventional catheterization, congenital heart disease and preventive Cardiology programs.

The institution/department should be run by specialists in cardiovascular medicine and experts in Cardiology subspecialties who are properly certified with Masters and MD degrees in cardiovascular medicine.

It should carry a regular Cardiology conference for the discussion of cases before and after invasive procedures and it should also produce research work in cardiovascular medicine.
4- Certification for practice of cardiac electrophysiology and pacing

A certificate offered by the Egyptian Society of Cardiology and the Egyptian Medical Syndicate for independent practice in cardiac electrophysiology and pacing will be offered to specialists in Cardiovascular Medicine upon completion of the following requirements:

i. Obtaining a Master/MD degree in cardiovascular medicine from one of the cardiology departments in Egyptian universities or an Egyptian fellowship in cardiovascular medicine from the board of medical education and fellowship, Ministry of Health.

ii. Completion of level 2 and 3 training in Cardiac electrophysiology and pacing as detailed below (section V).

III. Core syllabus in Cardiovascular medicine

1. Global burden of cardiovascular disease:
   • Economic, social and demographic transitions
   • Rate of changed of epidemiologic transition
   • Current worldwide variations in the global burden of cardiovascular disease
   • Global trends in cardiovascular disease
   • Regional trends in risk factors

2. History and physical examination of the cardiovascular system:
   • Cardinal symptoms of heart disease
   • The history in specific forms of heart disease
   • Assessing cardiovascular disability
   • Physical examination of the heart and circulation
   • The general physical examination
   • The cardiac examination

3. Electrocardiography
   • Fundamental principles
   • Recording electrodes and leads
   • Clinical electrocardiographic lead systems
   • The electrical axis
   • The normal electrocardiogram
   • The abnormal electrocardiogram
   • Clinical issues in electrocardiographic interpretation

4. Exercise stress testing:
   • Exercise physiology
5. Echocardiography:
   • Principles of cardiac ultrasonography:
     o Principles of ultrasound physics and instrumentation
     o The Doppler principle
     o The anatomical echocardiographic examination
     o Examination and appearance of the normal heart
     o Quantification of the ventricular performance
     o Principles of the Doppler examination
     o Additional imaging formats and techniques
     o Contrast echocardiography
   • Clinical application of echocardiography in:
     o Acquired valvular heart disease
     o Evaluation of prosthetic heart valves
     o Congenital heart disease
     o Disease of the pericardium
     o Cardiomyopathies
     o Hypertrophic cardiomyopathy
     o Ischemic heart disease
     o Diseases of the aorta
     o Cardiac masses and tumors

6. Cardiovascular imaging:
   • The chest radiograph in cardiovascular disease
   • Nuclear cardiology
   • Cardiovascular magnetic resonance
   • Computed tomography of the heart
   • Relative merits of cardiac diagnostic techniques

7. Cardiac catheterization:
   • Indications for diagnostic cardiac catheterization.
   • Technical aspects of cardiac catheterization:
     o Catheterization laboratory protocol
8. Mechanisms of cardiac contraction and relaxation:
   • Microanatomy of contractile cells and proteins
   • Calcium ion influxes in cardiac contraction – relaxation cycle
   • Beta adrenergic signal system
   • Cholinergic and nitric oxide signaling
   • Contractile performance of intact heart
   • Effects of ischemia and reperfusion on contraction and relaxation

9. Heart failure:
   • Assessment of normal and abnormal cardiac function
   • Pathophysiology of heart failure
   • Clinical aspects of heart failure, pulmonary oedema, high output heart failure
   • Drugs in the treatment of heart failure
   • Management of heart failure
   • Assisted circulation in the treatment of heart failure
   • Heart transplantation

10. Cardiac arrhythmias:
    • Genesis of cardiac arrhythmias: electrophysiological consideration
    • Genetics of cardiac arrhythmias
    • Diagnosis of cardiac arrhythmias
    • Therapy for cardiac arrhythmias
    • Cardiac pacemaker and cardioverter defibrillators
    • Specific arrhythmias: diagnosis and treatment
    • Cardiac arrest and sudden cardiac death
11. Hypotension and syncope
12. The vascular biology of atherosclerosis
13. Risk factors of atherothrombotic disease
14. Systemic hypertension therapy
15. Lipoprotein disorder and cardiovascular disease
16. Diabetes mellitus, the metabolic syndrome, and atherosclerotic vascular disease
17. Nutrition and cardiovascular disease
18. Primary and secondary prevention of coronary heart disease
19. Comprehensive rehabilitation of patients with cardiovascular disease
20. Myocardial ischemia and infarction:
   • Coronary blood flow and myocardial ischemia
   • Approach to the patient with chest pain
   • ST elevation myocardial infarction: pathology, pathophysiology and clinical features
   • ST elevation myocardial infarction: management
   • Primary percutaneous coronary intervention in the management of acute myocardial infarction
   • Unstable angina and non ST elevation myocardial infarction
   • Chronic coronary artery disease

22. Percutaneous coronary and valvular intervention.
   • Balloon percutaneous transluminal coronary angioplasty.
   • Coronary atherectomy.
   • Catheter-based thrombolysis and mechanical thrombectomy.
   • Distal embolic protection devices.
   • Total occlusion-crossing devices.
   • Coronary stents
   • Clinical outcomes and complication of percutaneous coronary intervention
   • Radiation brachytherapy for instent restenosis
   • Vascular closure devices
   • Anticoagulation during percutaneous coronary intervention
   • Pharmacological approaches to restenosis
   • Drug-eluting stents
   • Indications for percutaneous coronary interventions
   • Options for medical therapy or coronary revascularization
   • Percutaneous valvuloplasty
   • Training standards and proficiency in interventional cardiology

23. Diseases of the aorta
24. Peripheral arterial diseases
25. Endovascular treatment of non-coronary obstructive vascular disease
26. Congenital heart disease:
   • Anatomy and embryology
   • Pathological consequences of congenital cardiac lesions
   • Evaluation of patients with congenital heart diseases
   • Specific cardiac deficits
   • Adult congenital heart diseases
27. Valvular heart disease:
   • Mitral stenosis
   • Mitral regurgitation
   • Mitral valve prolapse syndrome
   • Aortic stenosis
   • Aortic regurgitation
   • Tricuspid, pulmonic and multivalvular disease
   • Prosthetic cardiac valves
28. Infective endocarditis
29. The cardiomyopathies
30. Myocarditis
31. Cardiovascular abnormalities in HIV infected individuals
32. Toxins and the heart
33. Primary tumors of the heart
34. Pericardial disease
35. Traumatic heart disease
36. Pulmonary embolism
37. Pulmonary hypertension
38. Sleep disorders and cardiovascular disease
39. Principles of cardiovascular molecular biology and genetics:
   • Principles of cell biology and cell cycle
   • The genetic code: DNA, RNA and protein
   • Principle and techniques of molecular biology
   • Principles of molecular genetics
   • Genetic modification of mice to study human cardiovascular disease
   • Gene and cell based therapies
40. Genetics and cardiovascular disease:
   • Genetic factors in disease
   • Cardiovascular disorders associated with chromosome aberrations
   • Congenital heart diseases
   • Cardiomyopathies
   • Disorders of connective tissue
- Inborn errors of metabolism that affect the cardiovascular system
- Neuromuscular disorders
- Cardiac tumors
- Disorders of the circulation
- Genetic factors predisposing to atherosclerosis
- Abnormal regulation of blood pressure

41. Myocardial regeneration

42. Cardiovascular disease in the elderly

43. Cardiovascular disease in women

44. Pregnancy and cardiovascular disease

45. Cardiovascular disease in athletes

46. Medical management of the patient undergoing cardiac surgery

47. Anesthesia and non-cardiac surgery in patient with heart disease

48. Heart disease in various populations

49. Endocrine disorders and cardiovascular disease

50. Hemostasis, thrombosis, fibrinolysis and cardiovascular disease

51. Rheumatic fever

52. Rheumatic disease and the cardiovascular system

53. The patient with cardiovascular disease and cancer

54. Psychiatric and behavioral aspects of cardiovascular disease

55. Neurological disorders and cardiovascular disease

56. Interface between renal disease and cardiovascular illness

57. Cardiovascular manifestations of autonomic disorders

58. Economics and cardiovascular disease

59. Clinical decision-making in cardiology

60. Measurement and improvement of quality of cardiovascular care

61. The principles of cardiovascular drug therapy

62. Care of patients with end-stage heart disease

IV. Core syllabus in Cardiac Electrophysiology and pacing

The core syllabus in cardiac electrophysiology and pacing should comply with guidelines provided by international societies (European Heart Rhythm Association 2009 and Heart Rhythm Society 2011) and should cover the following topics:

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
V. Curriculum for training in cardiac electrophysiology and pacing

The curriculum for training in cardiac electrophysiology and pacing and the post-training examination are the same applied and conducted for several years in the department of cardiovascular medicine, Ain-Shams University. The post-training examination includes both a theoretical part and a practical part. (For further information, refer to Prof. Mervat Aboul-Maaty Nabih). The training program involves the following levels:

Level 1 (3 months – Cardiac arrhythmia and EP core)

Basic knowledge:

- Basic electrocardiographic knowledge and interpretation
- Diagnosis and management of bradyarrhythmias and tachyarrhythmias
- Electrocardiographic manifestations of arrhythmias
- Indications for and limitations of electrophysiologic studies
- Ability to interpret basic intracardiac recordings such as AH, HV intervals
- Differentiation of a supraventricular and ventricular tachycardia
- Use of antitachycardia pacing to terminate tachyarrhythmias
- Proper use of antiarrhythmic agents, including drug interactions and proarrhythmic potential
- Appropriate indications for catheter ablation procedures
- Fundamentals of cardiac pacing
- Recognizing normal and abnormal pacemaker function
- Indications for temporary and permanent pacing and the implantation of ICDs
- Pacing modes
- Understanding basic techniques for interrogation, programming, and surveillance of pacemakers and ICDs.
- Indications and limitations of biventricular pacing in patients with congestive heart failure
- Indications and technique of elective and emergency cardioversions

Procedures:

- Exposure to and interpretation of noninvasive techniques related to the diagnosis and management of patients with cardiac arrhythmias including ambulatory electrocardiographic monitoring, event recorders, ILRs and exercise testing for arrhythmia assessment and tilt-table testing

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• Insertion, management, and follow-up of temporary pacemakers including measurement of pacing and sensing thresholds and recording of intracardiac electrograms (minimum of 10)
• Delivering elective and emergency cardioversions (minimum of 10)

Level 2 (6 months – Advanced non-invasive EP management)

Essential knowledge:

• Thorough knowledge and demonstration of proficiency in Level 1 items.
• Competency in interpretation of invasive electrophysiologic study data, and complex arrhythmia electrocardiograms

Procedures:

• Demonstration of proficiency in the performance and interpretation of noninvasive tests related to the evaluation of arrhythmia patients
• Interrogation, interpretation and programming of all types of bradycardia pacing, biventricular pacing, and ICD systems (minimum of 100 patients)
• Competency in temporary pacing and cardioversion

Level 3 (18 months – Clinical invasive cardiac EP)

Essential knowledge:

• Mastering the scientific background behind invasive EP procedures including catheter placement, programmed electrical stimulation, endocardial mapping, catheter ablation, and interpretation of data during the study. A thorough knowledge of possible complications and their management is mandatory
• Extensive knowledge of ICD/CRT indications, contradictions, and management of complications; an understanding of drug– and pacemaker–ICD interactions; and a thorough knowledge of ICD programming and management of ICD malfunction and postoperative complications

Procedures:

• Performance of at least 150 electrophysiologic studies and/or ablation procedures
• Implantation of a minimum of 75 antiarrhythmic devices (30 as a primary operator) including left ventricular lead implantation procedures
• Performance of ICD defibrillation threshold testing and managing high defibrillation thresholds
• Performance of at least 10 trans-septal catheterization procedures

VI. Auditing and quality assurance

The credentials committee with the Egyptian Society of Cardiology will assign officers from each institution for implementation and quality assurance of the training program.

Members of the credentials committee and the members of the Egyptian medical syndicate will assume auditing responsibilities and will report their findings to the committee and to the participating centers.

VII. Future directions

The practice patterns, recommendations and guidelines are always changing with the appearance of innovations, new trials and evidence. This will reflect on future modifications of this document.