

Curriculum

FNB Fellowship



Cardiac Electrophysiology

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I. INTRODUCTION

National Board of Examinations in Medical Sciences is offering a 2 year post doctorate residential course (Fellowship) in field of Cardiac Electrophysiology. The fellow of Cardiac Electrophysiology can practice in the field of electrophysiology.

II. PROGRAM GOAL AND OBJECTIVES

The trainee in Clinical Cardiac Electrophysiology should acquire broad knowledge in all aspects of arrhythmology, including but not limited to bradyarrhythmias, tachyarrhythmias, syncope, non-invasive and invasive diagnostic electrophysiology, and interventional electrophysiology including catheter ablation and device implantation. The trainee should have sufficient knowledge of basic electrophysiology to understand current theories of the mechanisms of cardiac dysrhythmias and the rationale for both pharmacologic and nonpharmacologic therapy.

III. TEACHING & TRAINING ACTIVITIES

The fundamental components of the teaching programme should include:

Case presentations and discussion:	Once a week
Seminar:	Once a week
Journal club:	Once a week
Grand round presentation (By rotation all departments and subspecialties)	Once a week
Faculty lecture teaching:	Once a month
Clinical Audit:	Once a Month
One poster presentation and one oral presentation in a state or National conference	At least once during the training period

The training program would focus on acquiring knowledge, skills and attitudes which are essential components of education and delivery of high quality patient care. The training can be theoretical, clinical and practical in all aspects of the delivery of rehabilitative care, including methodology of research and teaching.

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- 1. Theoretical:** The theoretical knowledge would be imparted through faculty lectures, discussions, journal clubs, symposia and seminars. The students will be exposed to recent advances through discussion in journal clubs. These are necessary in view of an inadequate exposure to the subject in the undergraduate curriculum.
 - 2. Symposia:** Trainees would be required to present a minimum of 12 topics based on the curriculum in a period of two years to the combined class of teachers and students. A free discussion would be encouraged in these symposia. The topics of the symposia would be given to the trainees with the dates for presentation by the teacher.
 - 3. Clinical:** The trainee would be attached to a faculty member to be able to learn methods of history taking, examination, making a diagnosis and anaesthetic management.
 - 4. Bedside:** The trainee would work up cases, learn management of cases by discussion with faculty members in the department.
 - 5. Journal Clubs:** This would be once a week academic exercise. A list of suggested Journals is given towards the end of this document. The candidate would summarize and discuss the scientific article critically. A faculty member will suggest the article and moderate the discussion, with participation by other faculty members and residents. The contributions made by the article in furthering the scientific knowledge, its clinical implications and limitations, if any, will be highlighted.

IV. SYLLABUS

- Structural and Molecular Bases of Ion Channel Function, and Biophysics of Various Cardiac channels Including but not limited to all types of Na⁺, K⁺, Ca⁺⁺, membrane pump and exchangers, gap junctions and intracardiac signaling
- Intermolecular Interactions and pharmacology of cardiac ion channels including but not limited to pharmacology of Sodium channels, Potassium channels, L and T type of Calcium channels, and drug induced channelopathies
- Biological Pacing

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- Mechanism of Cardiac cell depolarization and repolarization
 - Action potential, ionic mechanism and curve
 - Refractory periods (effective refractory period and functional refractory period)
 - Mechanism of arrhythmogenesis
 - Automaticity and its regulation in health and disease, enhanced automaticity as a mechanism for arrhythmogenesis
 - Triggered activity – early and delayed depolarizations
 - Reentry – types, mechanism, and clinical implications including Macroreentry, microreentry, atrial reentry, nodal reentry, AV reentry, bundle branch reentry, phase 2 reentry, spiral wave reentry and scar related reentry
 - Rotors and spiral waves in heart
 - Neural control of cardiac electrical activity, including adrenergic and cholinergic signaling and effects on cardiac ion channels
 - Molecular genetics and pharmacogenomics of arrhythmias and effect on drug therapies
 - Inheritable diseases of Sodium channel, potassium channel and intracellular calcium regulation
 - Supraventricular Arrhythmias: Mechanism, Features, and management of
 - Atrioventricular Nodal Reentrant Tachycardia (AVNRT) and variants
 - Atrioventricular Reentrant Tachycardia (AVRT) and variants
 - Wolf Parkinson White syndrome (WPW)
 - Mahaim Tachycardia
 - Paroxysmal Junctional Reciprocating Tachycardia
 - Junctional tachycardia
 - Focal Ectopic atrial tachycardias
 - Atrial Flutter

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- Atrial Fibrillation Mechanism, features, and management including Radiofrequency and cryoablation
 - Ventricular Arrhythmias: Mechanism, Features, and Management of
 - Ventricular tachycardia in structurally normal heart including Outflow tract tachycardias, and Fascicular tachycardias
 - Ventricular tachycardia in patients with coronary artery disease
 - Ventricular tachycardia in patient with Dilated cardiomyopathy including bundle branch reentry VT
 - Arrhythmogenic right ventricular cardiomyopathy
 - Ventricular arrhythmias in patients with hypertrophic cardiomyopathy
 - Ventricular tachycardia in heart failure
 - The Brugada Syndrome
 - Ventricular tachycardia in patients after congenital heart surgery
 - Long QT and Short QT syndrome
 - Catecholaminergic Polymorphic Ventricular Tachycardia
 - Andersen-Tawil syndrome
 - Timothy Syndrome
 - Idiopathic Ventricular Fibrillation
 - Drug induced ventricular tachycardia
 - Sudden cardiac death
 - Arrhythmias in neurological and systemic disorders
 - Electrocardiogram (ECG): Formation, identification of various arrhythmias, localizations and interpretation
 - Differential diagnosis of Wide QRS tachycardia
 - Long and Short RP tachycardias
 - Parasystole
 - Localization of VPCs
 - Localization of various arrhythmias

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- T wave alternans
 - Diagnostic evaluation of cardiac arrhythmias
 - Use of ELRs and Implantable loop recorders (ILR)
 - Exercise induced arrhythmias
 - Head up Tilt table testing
 - Autonomic testing
 - Assessment of syncope
 - Sudden cardiac death in Athletes
 - Arrhythmias in pediatrics
 - Sleep disordered breathing and arrhythmia
 - Anatomy of heart relevant for cardiac electrophysiology
 - Catheter Ablation Therapy
 - Technologies of catheter ablation including Radiofrequency, Cryoablation, pulsed field ablation, laser ablation
 - Radiofrequency Ablation: biophysics of lesion formation
 - Atrial Substrate ablation in AF
 - Pulmonary Vein Isolation
 - Catheter ablation of Supraventricular arrhythmias
 - Catheter ablation of Ventricular arrhythmias in structurally normal heart
 - Catheter ablation of ventricular arrhythmias in presence of Scar
 - Catheter ablation of arrhythmias in pediatric and congenital heart disease patients
 - Pacemaker therapies
 - Implantation of permanent pacemaker
 - Science and Technique of conduction system pacing
 - Pacemaker programming and troubleshooting

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- Implantable Cardioverter and Defibrillator (ICD)
 - Technical and clinical aspects
 - Implantation of ICDs
 - Science and technique of implanting Subcutaneous defibrillators
 - ICD programming and troubleshooting
 - Cardiac Resynchronization therapies
 - Technical and clinical aspects
 - Implanting of CRTs
 - Science and technique of Resynchronization optimization
 - CRT programming and trouble shooting
 - **Electrophysiology Lab (The fellow is posted at least for 3 days a week in the invasive EP lab)**
 - Learn indications for invasive electrophysiologic testing
 - Learn techniques of catheter placement and manipulation
 - Learn techniques of intra-cardiac recording
 - Learn techniques of programmed intra-cardiac stimulation as a method of arrhythmia induction and termination and to assess mechanisms of arrhythmias (resetting and entrainment)
 - Learn strategies to map abnormal rhythms using 2D and 3D mapping systems
 - Learn methods of catheter ablation for treatment of rhythm disturbances
 - Learn methods of external cardioversion using direct current shocks
 - Learn use of conscious sedation for prolonged studies
 - **Pacemaker (PM)/Implantable Cardioverter Defibrillator (ICD) Lab**
 - Learn indications for pacemaker implantation
 - Learn surgical skills required for implantation of PM

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- Learn lead placement skills
 - Learn principles of pacemaker function including pacing and sensing threshold evaluation with emphasis on acute measurements
 - Learn principles of pacemaker function including pacing and sensing threshold evaluation with emphasis on acute measurements
 - Learn principles of cardioverter/defibrillator function including pacing and sensing threshold evaluation, defibrillation threshold testing, and anti-tachycardia pacing therapies
 - Learn principles and techniques of Conduction System pacing
 - Learn pacemaker troubleshooting
 - Gain experience with lead extraction
 - Learn conscious sedation techniques for PM implantation
- **Pacemaker and CIED Clinic (The fellow is posted in the Device outpatient clinic at least for one day per week)**
 - Learn PM chronic evaluation and troubleshooting
 - Learn methods of trans-telephonic follow-up of PMs
 - Learn electrocardiography of pacemaker rhythms
 - Learn CRT/ICD chronic evaluation and troubleshooting
 - Learn electrocardiography of pacemaker rhythms
 - To understand and evaluate conduction system pacing
- **Outpatient Arrhythmia Clinic**
 - Learn appropriate use of diagnostic tests including:
 - Event recorders
 - Holter Monitors
 - Signal-averaged electrocardiogram
 - Tilt Table Testing

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- Invasive electrophysiologic testing
 - MRI/CT scan of the heart
 - Gain exposure to a variety of arrhythmia patients in an ambulatory setting to assess response to therapy and to monitor for problems

- **In-patient consultation service**

- Learn appropriate use of diagnostic tests including:
 - Event recorders
 - Holter Monitors
 - Signal-averaged electrocardiogram
 - Tilt Table Testing
 - Invasive electrophysiologic testing
 - MR/CT scan of the heart
- Gain exposure to variety of arrhythmia patients in an acute setting to initiate therapy, assess response to therapy and to monitor for problems

- **Research Experience**

- Gain exposure to clinical research projects
- Review current literature in Journal conferences
- Participate in weekly Cardiology Research Conference
- To do at least one clinical research project as for publication

- **In-patient services**

The patients on the Electrophysiology Service include patients admitted from Outpatient, same day admit electrophysiologic procedures, patients admitted through the emergency department, or patients transferred directly from other departments and outside hospitals. Fellows are also responsible for performing inpatient electrophysiology consults. The fellow's responsibilities include, but are not limited to, performing histories and physicals on admissions or consults, appropriate documentation in the electronic medical record, communication with patient families, coordination of consultations or procedures, and managing the

discharge process including the discharge summary on selected patients. Later in the training experience, the fellow will assume responsibility for running the service, including assisting the associate providers, with back up from the attending electrophysiologist.

- **Call frequency**

Clinical electrophysiology fellows serve as first call for post-ablation and post-device implant patients. Timely evaluations are done by the electrophysiology fellow on call and supervised directly by the consultant. Fellows provide device troubleshooting and programming services every day.

V. COMPETENCIES

- **Clinical Competencies**

- To be able to describe, understand the mechanisms, and determine appropriate diagnostic and treatment strategies of all types of supraventricular arrhythmias, ventricular arrhythmias, arrhythmias commonly encountered in patients with or without cardiovascular disease and post cardiac surgery patients, atrial fibrillation, scar related ventricular arrhythmias.
- To be able to determine appropriate diagnostic and treatment strategies for symptoms such as palpitations, near syncope, syncope and aborted sudden cardiac death.
- To be able to describe, understand the mechanism, and determine appropriate diagnostic and treatment strategies for various types of brady-arrhythmias.
- To Summarize history and physical exam findings in a cogent presentation, both verbal and written.
- To Develop and execute patient management plans.

- **Medical Knowledge competencies**

- By the end of the fellowship program, the fellow will acquire a basic working knowledge of the common acute and chronic medical conditions that an EP specialist sees.
- The fellow will understand the differential diagnosis of brady-arrhythmias and both narrow and wide-complex tachyarrhythmias.
- The fellow will understand the electrophysiological effects, indications, contraindications, and potential adverse/proarrhythmic effects of antiarrhythmic drugs.
- The fellow will understand the indications, contraindications, and potential complications of implantation or extraction of implantable cardiac devices, including permanent pacemakers, implantable cardioverter defibrillators, biventricular pacemakers and ICD's, and implantable loop recorders.
- The fellow will understand the indications, contraindications, and potential complications of common tests and procedures such as electrophysiologic study, percutaneous catheter ablation, and tilt table testing.
- The fellow will demonstrate an understanding of the common acute and chronic medical problems encountered by an EP consultant.

Awarding the fellowship certificate: Prerequisites

- **Competencies in Electrophysiology Lab**

- Demonstrate competence in catheter ablation procedures, including post-diagnostic testing. Each fellow must perform a minimum of 100 ablation procedures including ablation for atrial fibrillation and ventricular tachycardia.
- Demonstrate competence in device implantation, including a minimum of 25 ICD implantations, 50 dual-chamber pacemaker implantations, and 25 CRT implantations.
- Demonstrate competence in various mapping techniques, such as activation sequence mapping and entrainment mapping.

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- Demonstrate understanding of recording techniques, including amplifiers, filters, and signal processors.
 - Demonstrate understanding of programmed electrical stimulation techniques to determine conduction times and refractory periods, and to initiate and terminate tachyarrhythmias.
 - Demonstrate understanding of radiation of physics, and safety related to the use of x- ray imaging equipment.
 - Demonstrate understanding of the biophysics of catheter ablation including factors affecting lesion formation, covering a variety of modalities (solid electrode, irrigated electrode, cryoablation).
 - Demonstrate understanding of sterile operating room techniques, multiple techniques for vascular access and creating pockets for pulse generators.
 - Demonstrate understanding of how to troubleshoot implantable device malfunction with external programmers.
- **Clinical Cardiac Electrophysiology fellows must perform a minimum number of the following procedures:**
 - EP diagnostic studies (standalone or as part of EPS+RFA) –100 intra-cardiac procedures as assistant or primary operator in at least 50 patients, with an average of three or more EP diagnostic/interventional catheter procedures per week as primary assisting operator
 - Catheter ablations — 100, of which at least 50 percent are supraventricular, including atrioventricular nodal reentrant tachycardia, accessory pathway-mediated tachycardia 25 percent as 3D mapping and ablation techniques, atrial flutter, atrial fibrillation and ventricular tachycardia ablation
 - Pacemakers — 50 implants as primary operator; 100 follow-up visits
 - Implantable cardioverter defibrillator (ICD) — 25 implants as assistant or primary operator; minimum 50 follow-up visits
 - Cardiac resynchronisation therapy (CRT) - 25 implants as assistant or primary operator; minimum 50 follow-up visits

- **Competence -Clinics**

- Demonstrate competence in the evaluation and management of outpatients with supraventricular tachycardias including atrial fibrillation; patients requiring acute or chronic anticoagulation; ventricular tachyarrhythmias including congenital and acquired long QT syndrome; and patients with syncope.
- Demonstrate competence in prevention of tachyarrhythmias, including primary prevention of sudden death.
- Demonstrate care of patients before and after an electrophysiology procedure.
- Demonstrate care in monitoring of patients with permanent pacemakers of all types and ICDs of all types. This skill set includes device interrogation and programming.
- Demonstrate competence in testing that is relevant to arrhythmia diagnosis and treatment.
- Demonstrate knowledge of the scientific method of problem solving and evidence-based decision making.
- Demonstrate competence in understanding the indications for and complications from invasive electrophysiologic procedures. This includes demonstrating competence in obtaining informed consent on patients undergoing these procedures.
- Demonstrate knowledge of basic electrophysiology that is relevant to clinical practice, including but not limited to determinants of the normal cardiac rhythm (ionic currents), determinants of normal conduction, mechanisms of tachyarrhythmias and various modulators such as autonomic tone and
- ischemia, and the cellular electrophysiologic effects of various classes of antiarrhythmic drugs.
- Demonstrate knowledge of the epidemiology and genetic basis for various dysrhythmia syndromes.
- Demonstrate knowledge of the various antiplatelet agents and anticoagulants and their role in the management of the CCEP patient.

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- Demonstrate knowledge of basic pharmacokinetics and pharmacodynamics.
 - Demonstrate knowledge of the engineering aspects of pulse generator design, and the engineering aspects of electrical sensing and stimulation relevant to implantable cardiac rhythm devices.
 - Demonstrate knowledge of the pathophysiology and differential diagnosis for the various types of SVT, polymorphic VT, and monomorphic VT.
 - Understand the test characteristics (for example predictive value) of advanced electrocardiographic methods of risk stratification.
 - Demonstrate knowledge on how to interpret the results of non-invasive and invasive tests, such as Holter monitoring, signal-averaged electrocardiography, exercise treadmill testing for arrhythmia evaluation, invasive electrophysiologic testing, and remote monitoring of implantable cardiac devices.
 - Demonstrate understanding of the differences in pathophysiology and similarities in treatment for neurocardiogenic syncope, orthostatic hypotension, and POTS syndrome.
 - Demonstrate understanding of the value of diagnostic tests for the assessment of syncope, including tilt table tests, ambulatory ECG monitoring, and electrophysiologic testing.

Titles for academic presentation

The number of minimum seminar presentations and EP tracings presentation will be 10 per year each. Additional topics are covered, though not limited, via didactic and journal club session as listed:

- Cardiac Preexcitation Syndromes
- Defibrillation and cardioversion
- Noninvasive electrophysiologic testing for device follow-up
- Cardioversion of atrial fibrillation
- Normal cardiac conduction
- Atrioventricular nodal reentrant tachycardia
- Electrocardiographic recognition and diagnosis of wide complex
- Catheter ablation
- Permanent pacemakers

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- Carotid sinus hypersensitivity: recognition, indications for pacemaker
 - Atrial fibrillation
 - Atrial flutter
 - Pediatric arrhythmic issues
 - Long QT syndromes
 - Signal averaged electrocardiography: theoretical rationale, indications, interpretation
 - Monophasic action potential recording
 - Techniques for evaluation of sympathetic and parasympathetic nervous system

VI. LOG BOOK

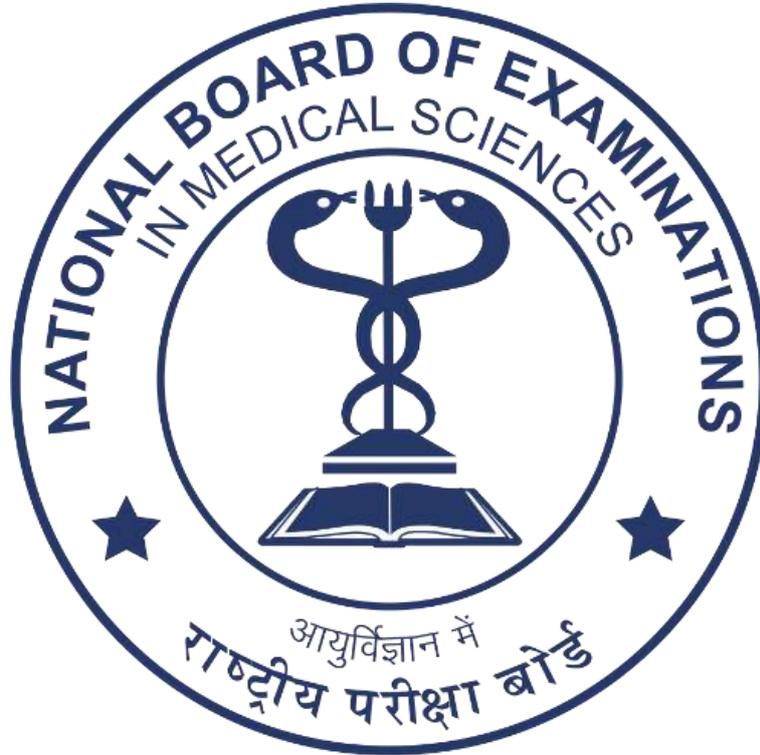
A candidate shall maintain a log book of operations (assisted / performed) during the training period, certified by the concerned post graduate teacher / Head of the department / senior consultant. This log book shall be made available to the board of examiners for their perusal at the time of the final examination.

The log book should show evidence that the before mentioned subjects were covered (with dates and the name of teacher(s) The candidate will maintain the record of all academic activities undertaken by him/her in log book.

1. Personal profile of the candidate
2. Educational qualification/Professional data
3. Record of case histories
4. Procedures learnt
5. Record of case Demonstration/Presentations
6. Every candidate, at the time of practical examination, will be required to produce performance record (log book) containing details of the work done by him/her during the entire period of training as per requirements of the log book. It should be duly certified by the supervisor as work done by the candidate and countersigned by the administrative Head of the Institution.
7. In the absence of production of log book, the result will not be declared.

VII. RECOMMENDED TEXTBOOKS AND JOURNALS

- From Cell to Bedside by Douglas P Zipes
- Clinical arrhythmology and electrophysiology : Braunwald companion by Issa, Miller, Zipes
- Catheter Ablation of Cardiac Arrhythmias: A practical approach by Huwang
- Clinical Cardiac Electrophysiology - Techniques and Interpretations - M. Josephson
- Ellenbogen - Clinical Cardiac Pacing, Defibrillation and Resynchronization Therapy



आयुर्विज्ञान में राष्ट्रीय परीक्षा बोर्ड
स्वास्थ्य एवं परिवार कल्याण मंत्रालय, भारत सरकार
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