

- i. ordering, receiving and unpacking radioactive materials safely and performing the related radiation surveys;
  - ii. calibrating dose calibrators and diagnostic instruments and performing checks for proper operation of survey meters;
  - iii. calculating and safely preparing patient dosages;
  - iv. using administrative controls to prevent the misadministration of by-product material;
  - v. using procedures to contain spilled by-product material safely and using proper decontamination procedures; and
  - vi. eluting technetium-99m from generator systems, measuring and testing the eluate for molybdenum-99 and alumina contamination and processing the eluate with reagent kits to prepare technetium-99m-labeled radiopharmaceuticals; and
3. 500 h of supervised clinical experience under the supervision of an authorized user that includes
- i. examining patients and reviewing their case histories to determine their suitability for radioisotopic diagnosis, limitations or contraindications;
  - ii. selecting the suitable radiopharmaceuticals and calculating and measuring the dosages;
  - iii. administering dosages to patients and using syringe radiation shields;
  - iv. collaborating with the authorized user in the interpretation of radioisotope test results; and
  - v. patient follow-up; or
- c. Has successfully completed a 6-month training program in nuclear medicine that has been approved by the Accreditation Council for Graduate Medical Education and that included classroom and laboratory training, work experience and supervised clinical experience in all the topics identified in paragraph b of this section.

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## Task Force 6: Training in Specialized Electrophysiology, Cardiac Pacing and Arrhythmia Management

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Clinical cardiac electrophysiology and cardiac pacing have matured significantly and are merging into a common cardiac subspecialty discipline. Today, complex cardiac arrhythmias are managed by cardiologists and cardiac surgeons with special expertise in cardiac electrophysiology, the use of implantable pacemakers and cardioverter-defibrillators and the application of other interventional techniques and treatments. Nonpharmacologic therapy also includes electrophysiologic mapping and subsequent catheter or surgical ablation as standard treatment for certain tachyarrhythmias. Many new antiarrhythmic agents with diverse mechanisms of action are often used therapeutically alone or in conjunction with implantable multiprogrammable arrhythmia control devices (pacemakers and implantable cardioverter-defibrillators).

In 1986, Task Force VI, Training in Cardiac Pacing, and Task Force VII, Training in Arrhythmias and Specialized Electrophysiologic Studies and Interventions, were published

separately as a result of the Bethesda Conference 17 on adult cardiology training. The present task force combines these two closely related disciplines to reflect the current merging of science, art and practice of clinical cardiac electrophysiology.

### General Standards and Environment

#### *General Standards, Facilities and Faculty*

Three organizations, the American College of Cardiology (ACC), American Heart Association (AHA) and The North American Society of Pacing and Electrophysiology (NASPE), have recently addressed training requirements and guidelines for pacemaker implantation (1), guidelines for use of implantable cardioverter-defibrillators in cardiovascular practice (2), training requirements for permanent pacemaker selection, implantation and follow-up (3) and teaching objectives for fellowship programs in clinical electrophysiology (4,5). The

training recommendations for these three organizations are congruent and address new technologies, faculty and facility requirements, as well as practice standards.

It is strongly recommended that trainees who desire admission to the American Board of Internal Medicine (ABIM) examination for certification in Cardiovascular Diseases and those who seek admission to the Clinical Cardiac Electrophysiology (CCEP) Examination for certification of added qualifications in clinical cardiac electrophysiology be certain to obtain specific requirements from the ABIM.

The cardiac arrhythmia aspects of a cardiology training program should meet the published recommendations and requirements regarding facilities and faculty (5). Training must take place in an Accreditation Council for Graduate Medical Education (ACGME) approved training program. The intensity of training and the required teaching resources may vary according to the level of training provided. Facilities should be adequate to ensure a safe, sterile and effective environment for invasive electrophysiologic studies and implantation of arrhythmia control devices. Faculty should include specialists who are skilled in the medical and surgical aspects of pacing and electrophysiology. The faculty may be heterogeneous; however, at least one faculty member must be board certified by the ABIM in clinical cardiac electrophysiology (or its equivalent), and the same or another faculty member must be recognized as an expert in pacing for accrediting advanced levels of training in each respective area.

### Levels of Training

**Level 1.** Within the cardiology core training program, level 1 should be at least 2 months of clinical rotation designed for cardiology trainees to acquire knowledge and experience in the diagnosis and management of bradyarrhythmias and tachyarrhythmias. The cardiology trainee should learn the indications for and limitations of electrophysiologic studies, the appropriate use of pharmacologic and nonpharmacologic therapeutic options and the proper and appropriate use of antiarrhythmic agents, including drug interactions and proarrhythmic potential. The level 1 trainee should be exposed to noninvasive and invasive techniques related to the diagnosis and management of patients with cardiac arrhythmias that include ambulatory electrocardiographic (ECG) monitoring, event recorders, exercise testing for arrhythmia assessment, tilt table testing, signal-averaged electrocardiography, invasive electrophysiologic testing and implantation of cardiac arrhythmia control devices. These requirements are in addition to the basic ECG training as addressed in Task Force 2 and would require an additional minimum of 2 months.

Electrocardiographic manifestations of arrhythmias should be taught on a regular basis during formal ECG conferences. Additional experience in heart rhythm disorders and clinical correlations can be obtained from didactic sessions and conferences; however, they must be supplemented by rotation on an arrhythmia consultation service, during which time the trainee should gain first-hand experience as a consultant in

arrhythmia management. Arrhythmias associated with congenital heart disease, cardiac and noncardiac surgical patients and the pre- and post-cardiac transplantation patient are important components of the arrhythmia core training. The level 1 cardiology trainee experience should also include learning the fundamentals of cardiac pacing; recognizing normal and abnormal pacemaker function; and knowing indications for temporary and permanent pacing, pacing modes and the general approach to programming and surveillance of pacemakers and implantable cardioverter-defibrillators.

The cardiology trainee should also be formally instructed in and gain experience with 1) the insertion, management and follow-up of temporary pacemakers (6); 2) measuring pacing and sensing thresholds and recording electrograms for management of patients with temporary pacemakers; and 3) indications and techniques for elective and emergency cardioversions (7). Insertion of a minimum of 10 temporary pacemakers and performance of at least eight elective cardioversions is required. These experiences can be obtained throughout the 24-month clinical training period.

**Level 2.** All candidates for level 2 training must meet all training requirements under level 1. Level 2 training consists of a minimum of 6 months of training as a noninvasive cardiac arrhythmia specialist with advanced competency and proficiency in the diagnosis, treatment and longitudinal care of patients with complex arrhythmias. Level 2 trainees should meet all level 1 requirements and, in addition, should obtain advanced training in normal and abnormal cardiac electrophysiology and mechanisms of arrhythmias and proficiency in the performance and interpretation of noninvasive diagnostic procedures (ambulatory ECG monitoring, event recording, telephone ECG transmission, signal-averaged electrocardiography, tilt table testing, heart rate variability and other tests of the autonomic nervous system). Level 2 trainees should also acquire knowledge of basic and clinical pharmacology of antiarrhythmic agents and proficiency in their use. Of special importance for the level 2 trainee is the acquisition of skills and experience for managing inpatients and outpatients with complex cardiac arrhythmias, including programming and follow-up management of all types of bradycardia pacing systems. The trainee is expected to function as the primary programming operator who interrogates, interprets, prescribes and reprograms in at least 100 patients. The trainee at this level must also acquire advanced expertise in temporary pacing, transesophageal atrial pacing, cardioversion, interpretation of invasive electrophysiologic study data and complex arrhythmia ECG interpretation. Although the level 2 trainee must have significant exposure to invasive electrophysiology, implantable cardioverter-defibrillators and the surgical aspects of arrhythmia control device implantation, level 2 training will not qualify him or her to perform these invasive procedures. The level 2 trainee has the option of obtaining additional training in the surgical aspects of pacemaker implantation or may choose the additional training required for invasive cardiac electrophysiology, or both, as described under level 3.

**Level 3.** This level of training is designed for the individual who wishes to specialize in invasive diagnostic and therapeutic cardiac electrophysiology (clinical cardiac electrophysiology)

**Table 1.** Cardiac Arrhythmia and Electrophysiology Curriculum Training Summary

Level	Curriculum/Skills	Time Requirement	Optional Training in Device Implantation
1	Cardiac arrhythmia and electrophysiology core	2 mo (in addition to Task Force 2 training requirements)	No
2	Advanced noninvasive arrhythmology	6 mo	Yes: In addition to 6 mo of noninvasive emphasis, another 6 mo for a total of 12 mo is required for pacemaker implantation training
3	Clinical invasive cardiac electrophysiology (meets the ABIM CCEP Examination requirements)	1 yr	Yes: A total of 1 yr beyond the 3-yr cardiology training program is required. If surgical aspects of device implantation are desired, a total of 12 mo within the 4 yr will need to be devoted to these disciplines

ABIM = American Board of Internal Medicine; CCEP = Clinical Cardiac Electrophysiology.

(8). Requirements of levels 1 and 2 must be fully met. Clinical cardiac electrophysiology training will include a minimum of 4 years of training in clinical cardiology and electrophysiology. Two years of training must be in clinical cardiology and 2 years in electrophysiology, 1 year of which may be research related, or 3 years of training in clinical cardiology followed by a dedicated fourth year of training in clinical cardiac electrophysiology. The appropriate use, safe performance and judicious interpretation of these complex procedures requires highly specialized training and competence and cannot be completed in a 3-year training program. Further, an advanced knowledge base in basic clinical cardiac electrophysiology and pharmacology must provide a sound foundation for the acquisition of technical abilities and cognitive skills in management of patients with complex arrhythmias.

To complete level 3, in addition to level 1 and 2 requirements, trainees should perform at least 100 electrophysiologic procedures as the primary operator or as an assistant involved with the acquisition and analysis of the data. Electrophysiologic procedures should cover the total spectrum of arrhythmias, both supraventricular and ventricular tachyarrhythmias, as well as bradyarrhythmias. At least 50 of these procedures should be in patients with supraventricular tachyarrhythmias. Expertise in catheter placement, programmed electrical stimulation, endocardial mapping, catheter ablation and interpretation of data must be assured by the electrophysiology program director. The endocardial mapping experience should include at least 15 cases of left heart mapping using the retrograde aortic approach. If expertise in transseptal catheterization is required, training should be by an individual at the training

institution with expertise in the technique. Experience with at least 10 transseptal catheterization procedures is suggested as minimal required training. Participation in a minimum of 50 catheter ablations, including ablation and modification of the atrioventricular (AV) node, AV accessory pathways, atrial flutter and atrial and ventricular tachycardia is required. The trainee in electrophysiology requires implantable cardioverter-defibrillator experience that includes assisting with the primary device implantation with electrophysiologic testing at the time of implantation and with follow-up assessment. This experience will include at least 50 device evaluations (combined implantation and follow-up). Although the level 3 trainee must have significant exposure to the management and follow-up of implantable cardioverter-defibrillator pacemaker implantation, he or she will not necessarily be trained in the surgical aspects of these procedures (Table 1).

### *Optional Training in Device Implantation (Applicable to Level 2 or Level 3)*

Level 2 and 3 trainees may choose to obtain additional training in the surgical aspects of device implantation. This device implantation training may be obtained concurrently or sequentially with level 2 or level 3, respectively. Training for the surgical implantation of permanent bradycardia pacing systems can be obtained in both levels 2 and 3, whereas training in the surgical implantation of implantable cardioverter-defibrillators can be obtained in level 3 only. Training in the surgical aspects of device implantation should not take place without the supporting training of level 2 or level 3 training, or both.

For those cardiology trainees who elect to obtain proficiency in the surgical aspects of transvenous bradycardia device implantation (pacemakers), previous or concurrent level 2 training is required. The pacemaker implantation training must include developing expertise in permanent atrial and ventricular lead placement, threshold testing and programming of devices, principles of surgical asepsis, surgical techniques of implantation and management of implant-related complications. Individuals receiving qualifying training in pacemaker implantation must participate as the primary operator (but under direct supervision) in at least 50 primary implantations of transvenous pacemakers and 20 pacemaker system revisions or replacements. At least half of the implantations should involve dual-chamber pacemakers. The trainee must also participate in the follow-up of at least 100 pacemaker patient visits and acquire proficiency in advanced pacemaker electrocardiography, interrogation and programming of complex pacemakers. Level 2 training (6 months) with the option of training in pacemaker implantation (6 months) requires a total of 1 year of advanced training beyond the cardiology core level 1. This may be obtained within a 3-year cardiology program if 1 of the 3 years is dedicated to acquiring pacemaker implantation skills plus related management and follow-up skills. This training does not meet the ABIM requirements for admission to the CCEP Examination.

The trainee pursuing a career in cardiac electrophysiology as addressed under level 3 also has the option of obtaining expertise in the surgical aspects of pacemaker or transvenous

implantable cardioverter-defibrillator implantation, or both. The same amount of surgical experience with bradycardia pacemaker implantation is required and may be supplemented with surgical training for implantable cardioverter-defibrillator implantation. If the level 3 trainee chooses this option, he or she must participate as the primary implanter (under direct supervision) in at least 20 implantable cardioverter-defibrillator system implantations as well as the management and follow-up skills addressed under level 3. The trainee must also participate in the surgical replacement or revision of at least 10 implantable cardioverter-defibrillator systems and follow-up of at least 50 implantable cardioverter-defibrillator patient visits. Level 3 training with the option of pacemaker or implantable cardioverter-defibrillator implantation, or both, requires a minimum of 1 year of dedicated clinical cardiac electrophysiology and device implantation training beyond the 3-year cardiology program.

### *Evaluation, Competency and Privileges*

The program director should maintain adequate records of each individual's training experiences and performances of various procedures for appropriate documentation for levels 1, 2 and 3. The trainees should also maintain records of participation in the form of a logbook containing clinical information, procedure performed and outcome of procedures, including any complications encountered.

Competency examinations in electrocardiography and other self-assessment programs are available through the ACC. Training directors and trainees are encouraged to utilize the resources. The ACGME has recently published the essential components of a specialized program for training in clinical cardiac electrophysiology. The ABIM provides a special examination for additional certification in clinical cardiac electrophysiology. Information concerning the training requirements for admission to the examination can be obtained from the ABIM; NASPE also has a written examination of special

competency in device therapy, but it does not provide certification.

Subsequent privileges to perform invasive procedures should be primarily granted on the basis of the technical expertise acquired in the training program, the documented training and the recommendations of the directors of electrophysiology/pacing programs.

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## Task Force 7: Training in Cardiovascular Research

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All cardiology training should be carried out in institutions in which the opportunity to participate in research is available. The training site should be one that will provide an atmosphere of intellectual inquiry and support of the investigational process.

*It is important that every cardiovascular trainee participate directly in research.* Cardiology is a dynamic clinical field where rapid transfer of knowledge from basic and clinical research to clinical care will continue to occur. This pattern will only accelerate in the future. Cardiovascular research is defined in