

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

Endorsed by the Heart Rhythm Society

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The following training statement, "Task Force 6: Training in Specialized Electrophysiology, Cardiac Pacing, and Arrhythmia Management," is the result of a close collaboration between the American College of Cardiology (Adult Cardiovascular Medicine Core Cardiology Training [COCATS] Task Force 6) and the Heart Rhythm Society. This Task Force 6 Report is 1 of 13 COCATS 3 Task Force Reports, which encompass training recommendations for the fellowship programs in adult cardiovascular medicine and are published in their entirety in the January 22, 2008, issue of the *Journal of the American College of Cardiology* (J Am Coll 2008;51:374-80).

This document has been endorsed by the Board of Trustees of the American College of Cardiology and the Heart Rhythm Society.

Clinical cardiac electrophysiology and cardiac pacing have merged into a common cardiac subspecialty discipline. Complex cardiac arrhythmias are managed by physicians with special expertise in cardiac electrophysiology, the use of cardiac implantable electrical devices (CIEDs), and the application of other interventional ablative techniques and pharmacologic treatments. Cardiac implantable electronic devices is a term used to encompass implantable cardioverter-defibrillators (ICDs), pacemakers, cardiac resynchronization therapy (CRT) devices, implantable hemodynamic monitors (IHMs), and implantable loop recorders (ILRs). For purposes of this document, IHMs and ILRs, while legitimately considered CIEDs, are excluded, and implantation numbers for these should not be considered as satisfying minimum training requirements.

The current Task Force is charged with updating previously published adult clinical cardiac electrophysiology training guidelines (1-4) based on changes in the cardiac electrophys-

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iology field since the last revision (4). The number of procedures recommended for each level is a consensus based on published guidelines and competency statements and assumes training by an appropriately trained mentor and documentation of satisfactory completion of such training by the program director. The number of procedures and duration of training are summarized in Tables 1 and 2.

General Standards and Environment Facilities and Faculty

Three organizations—the American College of Cardiology (ACC), the American Heart Association (AHA), and the Heart Rhythm Society (HRS)—have addressed training requirements and guidelines for permanent pacemaker selection, implantation, and follow-up (5,6); guidelines for the implantation and follow-up of ICDs in cardiovascular practice (7,8); guidelines for training in catheter ablation procedures (9,10); and teaching objectives for fellowship programs in clinical electrophysiology (11,12). The training recommendations for these 3 organizations are congruent and address new technologies, faculty, and facility requirements, as well as practice. 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 CCEP be certain to obtain specific requirements from the ABIM (13,14).

The cardiac arrhythmia aspects of a cardiology training program should meet the published recommendations and requirements regarding facilities and faculty (9,10). In order for trainees to be eligible for admission to the CCEP examination of the ABIM, training must take place in an Accreditation Council for Graduate Medical Education (ACGME)-approved training program (13). 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. In addition, faculty should be knowledgeable about the risks to the patient and to medical per-



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 months (in addition to Task Force 2 training requirements) | No |
| 2 | Advanced noninvasive arrhythmia management | 6 months | Yes: In addition to 6 months of noninvasive emphasis, another 6 months for a total of 12 months is required for pacemaker implantation training |
| 3 | Clinical invasive cardiac electrophysiology (meets the American Board of Internal Medicine CCEP Examination requirements) | 1–2 years (12–24 months) | Yes: A total of 1 year beyond the 3-year cardiology training program is required. If surgical aspects of CIED implantation are desired, a total of 12 months will need to be devoted to this discipline. |

CCEP = Clinical Cardiac Electrophysiology; CIED = cardiac implantable electrical device.

sonnel from radiation exposure. Faculty responsible for training must be board certified in CCEP or possess equivalent qualifications. In addition, there must be a minimum of 2 key clinical CCEP faculty members, including the program director. In programs with a total of more than 2 residents enrolled, a ratio of such faculty to residents of at least 1:1 must be maintained (13).

Levels of Training

Level 1

Within the cardiology core training program, Level 1 should comprise at least 2 months of CCEP rotation designed for cardiology trainees to acquire knowledge and experience in the diagnosis and management of bradyarrhythmias and tachyarrhythmias. Level 1 trainees still need to meet the requirements necessary for proper training in electrocardiography. Every cardiology trainee should learn the indications for and limitations of electrophysiologic studies, the ability to interpret intracardiac recordings such as AH, HV intervals and basic activation sequences during tachycardia, differentiation of a supraventricular and ventricular tachycardia, and the use of antitachycardia pacing to terminate tachyarrhythmias. Level 1 trainees should learn the proper use of antiarrhythmic agents, including drug interactions and proarrhythmic potential. In addition, Level 1 trainees should learn the appropriate indications for catheter ablation procedures. 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 monitoring (see the Task Force 2 recommendations), event recorders, ILRs, exercise testing for arrhythmia assessment, tilt-table testing, invasive electrophysiologic studies, and implantation of cardiac arrhythmia control devices. The electrocardiographic manifestations of arrhythmias should be taught on a regular basis during formal electrocardiogram (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 asso-

ciated with congenital heart disease and exposure to cardiac and noncardiac surgical procedures are important components of the arrhythmia core training.

The Level 1 cardiology trainee's experience should also include learning the fundamentals of cardiac pacing, recognizing normal and abnormal pacemaker function, indications for temporary and permanent pacing and the implantation of ICDs (4), pacing modes, and understanding basic techniques for interrogation, programming, and surveillance of pacemakers and ICDs. Trainees should learn the indications and limitations of biventricular pacing in patients with congestive heart failure.

The cardiology trainee should be formally instructed in and gain experience with the insertion, management, and follow-up of temporary pacemakers (4); measurement of pacing and sensing thresholds and recording of intracardiac electrograms

Table 2 Core cardiac arrhythmia and electrophysiology curriculum training

| Level | Minimal Number of Procedures | Cumulative Duration of Training (Months) |
|-------|---|--|
| 1 | 10 temporary pacemakers 10 cardioversions | 2 |
| 2 | 100 CIED interrogations/ programming | 6 |
| 3 | 150+ EP cases 75 ablations 30–50 atrial fibrillation ablations 10+ trans-septal procedures 75 CIEDs (25 ICD, 25 dual-chamber devices, 25 CRT devices) 30 CIED revisions/replacements 200 CIED interrogations/ programming (100 ICDs, 100 pacemakers) | 12–24 |

CIED = cardiac implantable electrical device; CRT = cardiac resynchronization therapy; EP = electrophysiology; ICD = implantable cardioverter-defibrillator.

for management of patients with temporary pacemakers; and indications and techniques for elective and emergency cardioversions (15). Temporary pacemaker and cardioversion exposure can be performed in other venues such as the cardiac catheterization laboratory or the critical care setting. Insertion of a minimum of 10 temporary pacemakers and performance of at least 10 elective cardioversions are required. The cardiology trainee should be formally instructed in and gain experience with the application of and use of transcutaneous pacing systems. These experiences can be obtained throughout the cardiovascular clinical training period.

Level 2

Some trainees in cardiology may wish to acquire advanced training in the management of arrhythmias but not undertake training in all aspects of cardiac electrophysiology. Level 2 trainees should meet all Level 1 training requirements and should obtain advanced training in normal and abnormal cardiac electrophysiology and mechanisms of arrhythmias. Level 2 training consists of a minimum of 6 months of training in noninvasive arrhythmia management techniques designed to develop advanced competence and proficiency in the diagnosis, treatment, and longitudinal care of patients with complex arrhythmias. Exposure and proficiency in the performance and interpretation of other noninvasive tests related to the evaluation of patients who have arrhythmias should be part of the training. Level 2 trainees should have a thorough knowledge of the basic and clinical pharmacology of antiarrhythmic agents and demonstrate 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, biventricular pacing, and ICD systems. The trainee is expected to function as the primary programming operator who interrogates, interprets, prescribes, and reprograms devices in at least 100 patients. The trainee at this level must also acquire advanced competency in temporary pacing, cardioversion, interpretation of invasive electrophysiologic study data, and complex arrhythmia electrocardiograph interpretation.

Although the Level 2 trainee must have significant exposure to invasive electrophysiology, ICDs, and the surgical aspects of arrhythmia control device implantation, Level 2 training by itself does not qualify the trainee 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 (16). Requirements of Levels 1 and 2 must be fully met. Prior procedure volume during

Level 1 and Level 2 training is cumulative and counts towards the overall numbers to reach Level 3 training.

Clinical cardiac electrophysiology training includes a minimum of 4 years of training in clinical cardiology and electrophysiology. Current ACGME requirements specify a 3-year training program in general cardiology, which consists of a core 24-month clinical program and an additional 12 months, which may involve research and/or elective time in electrophysiology. A dedicated fourth year of training in CCEP after 3 years is required. The appropriate use, safe performance, and judicious interpretation of these complex procedures require highly specialized training and competence. Although CIED and invasive cardiac electrophysiology training including ablation is usually done concomitantly, sequential training is also acceptable as long as all of the requirements of training in this document are met. Furthermore, an advanced knowledge base in basic CCEP and pharmacology must provide a sound foundation for the acquisition of technical abilities and cognitive skills in the management of patients with complex arrhythmias.

To complete Level 3, in addition to Level 1 and 2 requirements, trainees should perform at least 150 electrophysiologic procedures and "be a primary operator and analyze 100 to 150 initial diagnostic studies. At least 50 to 75 of these procedures should involve patients with supraventricular arrhythmias. Because therapy with antiarrhythmic devices forms a major part of current electrophysiology practice, the trainee should also have been a primary operator during more than 25 electrophysiological evaluations of implantable antiarrhythmic devices" (17).

Electrophysiologic procedures should cover the total spectrum of arrhythmias, both supraventricular and ventricular tachyarrhythmias as well as bradyarrhythmias. Given the complexity of the field and the growing amount of information and new procedures, it is common for trainees to extend training for an additional year or more to gain advanced expertise in specific procedures, such as ischemic ventricular tachycardia, ablation of patients with congenital heart disease, and atrial fibrillation ablation procedures and lead extractions. This type of advanced training can also be achieved during a post-training mentored practice.

Expertise in catheter placement, programmed electrical stimulation, endocardial mapping, catheter ablation, and interpretation of data must be ensured by the electrophysiology program director. The endocardial mapping experience should include some exposure to left heart mapping by the retrograde aortic approach. Training in trans-septal catheterization should be provided by an individual at the training institution with expertise in the technique. Experience with at least 10 trans-septal catheterization procedures is suggested as minimal required training. Participation in a minimum of 75 catheter ablations, including ablation and modification of the atrioventricular (AV) node, AV accessory pathways, atrial flutter, and atrial and ventricular tachycardia, is required (17). To gain expertise in atrial fibrillation ablation requires additional expertise in catheter

manipulation and integration of knowledge related to 3-dimensional mapping systems. Given the rapid evolution of new mapping technologies, it is unlikely that the trainee will be exposed to all mapping technologies as part of their training. Trainees should be exposed to tools for definition of intracardiac anatomy, such as intravascular ultrasound, cardiovascular magnetic resonance, and computed tomography scans. No numeric guidelines have been established for training in atrial fibrillation ablation, but it is anticipated that the Level 3 trainee should participate in 30 to 50 mentored atrial fibrillation ablations, and data suggest that experience in 100 atrial fibrillation ablation procedures will minimize adverse effects (18).

Level 3 training in electrophysiology requires ICD experience that includes assisting with the primary device implantation, with electrophysiologic testing at the time of implantation, and with follow-up assessment. The trainee in electrophysiology also requires experience in left ventricular lead implantation procedures. The ICD implant exposure includes assisting with the device implantation, threshold, and defibrillation threshold (DFT) testing at the time of implant and follow-up. Full Level 3 recommendations for the implantation of CIEDs are explained in detail in the following text.

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. The CIED implantation training may be obtained concurrently or sequentially with Level 2 or Level 3 training, respectively. For those cardiology trainees who elect to obtain proficiency in the surgical aspects of transvenous CIED implantation previous or concurrent Level 2 training is required. The CIED training must include development of expertise in permanent atrial right and left ventricular lead and ICD 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 CIED implantation must participate as the primary operator (under direct supervision) in at least 75 CIED initial primary implantations. Primary implantations should include at least 25 ICD, 25 dual-chamber, and 25 CRT (either pacing or defibrillation) devices. Thorough ICD implant evaluation including ventricular fibrillation induction and defibrillation testing for a minimum of 25 implants is a necessary part of this training. Thirty CIED revisions or replacements, including at least 10 ICD revisions as the primary operator, is also a necessary requisite of this level of training. The trainee must also participate in the follow-up of at least 200 CIED patient visits and acquire proficiency in advanced pacemaker electrocardiography, interrogation, and programming of complex pacemakers. Of the follow-up visits, at least 100 should be in ICD and 100 in pacemaker patients. 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. As part of the training regarding implantable pacemakers, exposure to the indications, implantation techniques, and follow-up of implantable loop recorders is desirable.

The trainee pursuing a career in CCEP as addressed under Level 3 also has the option of obtaining expertise in the surgical aspects of pacemaker or transvenous ICD implantation, or both. The same amount of surgical experience with bradycardia pacemaker implantation is required and may be supplemented with surgical training for ICD implantation (15). If the Level 3 trainee chooses this option, he or she must participate as the primary implanter (under direct supervision) in at least 25 ICD system implantations, as well as possess the management and follow-up skills addressed under Level 3. The Level 3 trainee wishing to become proficient in implantation of biventricular pacing or defibrillating systems requires the aforementioned training and involvement in implantation and follow-up of 25 biventricular systems (5). He or she should be proficient at interpreting data gained from noninvasive tools, such as echocardiography, used in the evaluation of resynchronization therapies. Pacemaker lead extraction is a specialized procedure that requires special training but is not an obligate part of training for CCEP examination eligibility. Physicians being trained in lead extraction should perform a minimum of 20 lead extractions as the primary operator under the direct supervision of a qualified training physician (19).

Level 3 trainees for ICD implantation must have an extensive knowledge of ICD indications, contradictions, and management of complications; an ability to determine defibrillation thresholds and manage high defibrillation thresholds; an understanding of drug- and pacemaker-ICD interactions; and a thorough knowledge of ICD programming and management of ICD malfunction and post-operative complications. Level 3 training with the option of pacemaker or ICD implantation or both requires a minimum of 1 year of dedicated CCEP and device implantation training beyond the 3-year cardiology program. In addition, Level 3 trainees must have an extensive knowledge of left ventricular lead indications, contraindications, and management of biventricular malfunctions and interactions, as well as post-operative complications. It has been advocated that physicians training in congestive heart failure/transplantation could pursue an additional year of training to achieve Level 2 and Level 3 competency in implantable devices by meeting all of the above COCATS training requirements (20). It is recommended that Level 3 fellowship training for ICD implantation follow the aforementioned COCATS requirements.

Evaluation, Competence, and Privileges

The program director should maintain adequate records of each individual's training experiences and performance 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.

The ACC, AHA, and HRS have formulated a clinical competence statement on invasive electrophysiology studies, catheter ablation, and cardioversion (17). Self-assessment programs and competence examinations in electrocardiography are available through the ACC and other organizations. Training directors and trainees are encouraged to utilize these resources.

The ACGME has published the essential components of a specialized program for training in CCEP. The ABIM provides a special examination for additional certification in CCEP. Information concerning the training requirements for admission to the examination can be obtained from the ABIM; such requirements include 1 additional year of training in an ACGME-accredited electrophysiology program. Subsequent privileges to perform invasive procedures should be granted primarily 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.

The Heart Rhythm Society strongly recommends the COCATS Task Force 6 training requirements for CIEDs. As the Society's 2004 Clinical Competency Statement on Training Pathways for Implantation of Cardioverter Defibrillators and Cardiac Resynchronization Devices (21) and the 2005 Addendum (22) sunsets in October 2008, the Society recommends that physicians who wish to incorporate CIED implantation and follow-up into their clinical practice meet the training requirements described in this document and passage of the International Board of Heart Rhythm Examiners' (IBHRE) Examination of Special Competency in Cardiac Pacing and Cardioversion Defibrillation for the Physician (23) and or the American Board of Internal Medicine CCEP Examination (for those who complete a CCEP fellowship, which demonstrate knowledge essential to the practice of heart rhythm management).

This is a revision of the 2006 document that was written by Gerald V. Naccarelli, MD, FACC—Chair; Jamie B. Conti, MD, FACC; John P. DiMarco, MD, PhD, FACC; and Cynthia M. Tracy, MD, FACC (Heart Rhythm Society Representative).

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Appendix 1

Author Relationships with Industry—ACCF 2008 Recommendations for Training in Adult Cardiovascular Medicine Core Cardiology Training (COCATS 3)—Task Force 6: Training in specialized Electrophysiology, Cardiac Pacing, and Arrhythmia Management

| Name | Consultant | Research Grant | Scientific Advisory Board | Speakers' Bureau | Steering Committee | Stock Holder | Other |
|--------------------------|---|---|--|---|--------------------|--------------|-------|
| Dr. Jamie B. Conti | None | <ul style="list-style-type: none"> ● Guidant ● Medtronic ● St. Jude Medical | <ul style="list-style-type: none"> ● St. Jude Medical | None | None | None | None |
| Dr. John P. DiMarco | <ul style="list-style-type: none"> ● Guidant ● Medtronic ● Novartis ● St. Jude Medical | <ul style="list-style-type: none"> ● Guidant ● Medtronic ● Sanofi-Aventis | None | <ul style="list-style-type: none"> ● Guidant | None | None | None |
| Dr. Gerald V. Naccarelli | <ul style="list-style-type: none"> ● AstraZeneca ● Boehringer-Ingelheim ● Cardiofocus ● GlaxoSmithKline ● Guidant ● Medtronic ● Sanofi-Aventis U.S. Pharmaceuticals ● Proctor & Gamble ● Reliant Pharmaceuticals ● Wyeth Pharmaceuticals ● Zention | <ul style="list-style-type: none"> ● Boehringer-Ingelheim ● Cardiome ● Guidant ● Medtronic ● Sanofi-Aventis ● Wyeth Pharmaceuticals | None | None | None | None | None |
| Dr. Cynthia M. Tracy | None | None | None | None | None | None | None |

This table represents the relationships of committee members with industry that were reported by the authors as relevant to this topic. It does not necessarily reflect relationships with industry at the time of publication.

Appendix 2

Peer Reviewer Relationships with Industry—ACCF 2008 Recommendations for Training in Adult Cardiovascular Medicine Core Cardiology Training (COCATS 3)—Task Force 6: Training in Specialized Electrophysiology, Cardiac Pacing, and Arrhythmia Management

| Name* | Affiliation | Consultant | Research Grant | Scientific Advisory Board | Speakers' Bureau | Steering Committee | Stock Holder | Other |
|------------------------|---|--|--|---------------------------|--|--------------------|---|-------|
| Dr. Rick A. Nishimura | <ul style="list-style-type: none"> ● Official—Board of Trustees | None | None | None | None | None | None | None |
| Dr. Stuart A. Winston | <ul style="list-style-type: none"> ● Official—Board of Governors | None | None | None | None | None | None | None |
| Dr. Anne B. Curtis | <ul style="list-style-type: none"> ● Organizational—Heart Rhythm Society | <ul style="list-style-type: none"> ● Biosense ● Medtronic ● St. Jude Medical ● Webster | <ul style="list-style-type: none"> ● Medtronic | None | <ul style="list-style-type: none"> ● Boston Scientific ● Medtronic ● St. Jude Medical | None | None | None |
| Dr. Dwight W. Reynolds | <ul style="list-style-type: none"> ● Organizational—Heart Rhythm Society | None | None | None | None | None | None | None |
| Dr. Peter R. Kowey | <ul style="list-style-type: none"> ● Content—Electrophysiology Committee | None | None | None | None | None | None | None |
| Dr. Richard L. Page | <ul style="list-style-type: none"> ● Content—Electrophysiology Committee | None | None | None | None | None | None | None |
| Dr. Claudio D. Schuger | <ul style="list-style-type: none"> ● Content—Electrophysiology Committee | <ul style="list-style-type: none"> ● Stereotaxis | <ul style="list-style-type: none"> ● Guidant ● Medtronic | None | None | None | <ul style="list-style-type: none"> ● St Jude Medical | None |

This table represents the relationships of peer reviewers with industry that were reported by the authors as relevant to this topic. It does not necessarily reflect relationships with industry at the time of publication.

*Names are listed in alphabetical order with each category of review.