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Preamble

Since the 1995 publication of its Core Cardiovascular Training Statement (COCATS), the American College of Cardiology (ACC) has played a central role in defining the knowledge, experiences, skills, and behaviors expected of all clinical cardiologists upon completion of training. Subsequent updates have incorporated major advances and revisions—both in content and structure—including, most recently, a further move toward competency (outcomes)-based training, and the use of the 6-domain competency structure promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and the American Board of Medical Specialties (ABIM). A similar structure has been used by ACC to describe and endorse the American Board of Internal Medicine (ABIM). The 6-domain competency structure was developed to promote the alignment of general medical competencies with those expected of cardiovascular specialists and to guide ongoing improvement of fellowship training programs.

Whereas COCATS has focused on general clinical cardiology, ACC Advanced Training Statements define selected competencies that go beyond those expected of all cardiologists
and require training beyond a standard 3-year cardiovascular disease fellowship. This includes sub-specialties for which there is an ABIM added-qualification designation, such as clinical cardiac electrophysiology (CCEP). The Advanced Training Statements also describe key experiences and outcomes necessary to maintain or expand competencies during practice.

The ACC Competency Management Committee oversees the development and periodic revision of the cardiovascular training and competency statements. A key feature of competency-based training and performance is an outcome-based evaluation system. Although specific areas of training may require a minimum number of procedures or duration of training time to ensure adequate exposure to the range of clinical disorders and to effectively evaluate the trainee, it is the objective assessment of proficiency and outcomes that demonstrates the trainee’s achievement of competency. Such evaluation tools may include in-training examinations, direct observation, procedure logbooks, simulation, conference presentations, and multisource (360°) evaluations, among others. For practicing physicians, these tools may also include professional society registry or hospital quality data, peer-review processes, and patient satisfaction surveys. A second feature of a competency-based training program is the recognition that learners develop some competency components at different rates. For multiyear training programs, assessment of selected representative curricular milestones during training can identify learners or areas that require additional focused attention.

The recommendations in the ACC cardiovascular training statements are based on available evidence, and where evidence is lacking, reflect expert opinion. The writing committee consists of a broad range of members representing ACC, the American Heart Association (AHA), and the Heart Rhythm Society (HRS), identified because they perform ≥1 of the following roles: cardiovascular training program directors; EP training program directors; early-career experts; general cardiologists; EP specialists representing both the academic and community-based practice settings as well as small, medium, and large institutions; specialists in all aspects of CCEP, including catheter ablation, device management, antiarrhythmic drug therapy, lead extraction, and left atrial appendage occlusion/ligation; physicians experienced in training and working with the ACGME/Residency Review Committee as well as the ABIM examination writing committee; physicians experienced in defining and applying training standards according to the 6 general competency domains promulgated by the ACGME and the American Board of Medical Specialties and endorsed by the ABIM; and nurses. This writing committee met the College’s disclosure requirements for relationships with industry or other entities (RWI) of writing committee members or peer reviewers of the document, each individual is required to disclose all current healthcare-related relationships, including those existing 12 months before initiation of the writing effort. The ACC Competency Management Committee reviewed these disclosures to identify products (marketed or under development) pertinent to the document topic. On the basis of this information, the writing committee was constituted to ensure that the Chair and a majority of members have no relevant RWI. Authors with relevant RWI were not permitted to draft initial text or vote on recommendations or curricular requirements to which their RWI might apply. RWI was reviewed at the start of all meetings and conference calls and updated as changes occurred. The RWI of authors and peer reviewers relevant to this document are disclosed in Appendixes 4 and 5, respectively. To ensure transparency, comprehensive healthcare-related disclosure information, including RWI not pertinent to this document, is posted online. Disclosure information for the ACC Competency Management Committee is also available online, as is the ACC disclosure policy for document development.

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1. Introduction
1.1. Document Development Process
1.1.1. Writing Committee Organization
The writing committee consisted of a broad range of members representing ACC, the American Heart Association (AHA), and the Heart Rhythm Society (HRS), identified because they perform ≥1 of the following roles: cardiovascular training program directors; EP training program directors; early-career experts; general cardiologists; EP specialists representing both the academic and community-based practice settings as well as small, medium, and large institutions; specialists in all aspects of CCEP, including catheter ablation, device management, antiarrhythmic drug therapy, lead extraction, and left atrial appendage occlusion/ligation; physicians experienced in training and working with the ACGME/Residency Review Committee as well as the ABIM examination writing committee; physicians experienced in defining and applying training standards according to the 6 general competency domains promulgated by the ACGME and the American Board of Medical Specialties and endorsed by the ABIM; and nurses. This writing committee met the College’s disclosure requirements for relationships with industry as described in the Preamble.

1.1.2. Document Development and Approval
The writing committee convened by conference call and e-mail to finalize the document outline, develop the initial draft, revise the draft based on committee feedback, and ultimately approve the document for external peer review. In addition, the committee conducted a survey of EP training program directors to obtain additional insight into procedural numbers to consider in writing committee deliberations.
The document was reviewed by 9 official representatives from the ACC, AHA, and HRS, as well as by 26 additional content reviewers, including CCEP training program directors, resulting in 417 peer review comments. The list of peer reviewers, affiliations for the review process, and corresponding RWI is included in Appendix 6. Comments were reviewed and addressed by the writing committee. A member of the ACC Competency Management Committee served as lead reviewer to ensure a fair and balanced peer review resolution process. Both the writing committee and the ACC Competency Management Committee approved the final document to be sent for organizational approval. The governing bodies of the ACC, AHA, and HRS approved the document for publication. This document is considered current until the ACC Competency Management Committee revises or withdraws it from publication.

1.2. Background and Scope
The original 1995 ACC recommendations for training in adult cardiology evolved from a Core Cardiology Training Symposium.1 After several iterations, COCATS 42 focuses on trainee outcomes that require delineation of specific components of competency within the subspecialty, definition of the tools necessary to assess training, and establishment of milestones documenting the trainee’s progression toward independent competency. Ultimately, the goal is for the trainee to develop the professional skill set to be able to evaluate, diagnose, and treat patients with acute and chronic cardiovascular disturbances.

The COCATS 4 document includes individual task force reports that address subspecialty areas in cardiology, each of which is an important component in training a fellow in cardiovascular disease. Task Force 11 of that document addresses training in arrhythmia diagnosis and management, cardiac pacing, and EP3 and updated previous standards for general cardiovascular training for fellows enrolled in cardiovascular fellowship programs. It addresses faculty, facilities, equipment, and ancillary support. It also addresses training components, including didactic, clinical, and hands-on experience, and the number of procedures and duration of training. Importantly, the COCATS 4 Task Force 11 report did not provide specific guidelines for advanced CCEP training.

This document focuses on training requirements for advanced training in adult CCEP. For training standards related to pediatric EP, readers should refer to the SPCTPD/ACC/AAP/AHA Training Guidelines for Pediatric Cardiology Fellowship Programs Task Force 4: Pediatric Cardiology Fellowship Training in Electrophysiology4 and to Recommendations for Advanced Fellowship Training in Clinical Pediatric and Congenital Electrophysiology: a Report From the Training and Credentialing Committee of the Pediatric and Congenital Electrophysiology Society.5

1.2.1. Evolution of CCEP
Training in CCEP has become more complex as the clinical specialty has matured. The use of cardioactive drugs, implantation and use of cardiac implantable electronic devices (CIEDs) and left atrial appendage occlusion devices, and performance of invasive catheter ablation procedures for arrhythmia management have reached a level of sophistication that necessitates a re-evaluation of the training curriculum.

The ABIM requires 3 years of cardiology fellowship training before fellows may sit for the certification examination in cardiovascular medicine. Previously, it had required an additional year of training in CCEP for eligibility to take the certification examination in EP. It is now clear that CCEP demands a skill level to diagnose and treat patients with cardiac arrhythmias and conduction disorders that can no longer be attained in a single year of training. Two years of advanced training are now required to achieve the experience necessary to become a competent, independent expert in CCEP.

1.2.2. Levels of Training
COCATS 4 Task Force 11 was charged with updating previously published standards for training fellows in cardiovascular medicine and establishing consistent training criteria across all aspects of cardiology including advanced training in CCEP.3 For the cardiovascular fellowship, the following 3 levels of training have been delineated for training in arrhythmia diagnosis and management, cardiac pacing, and EP:

- **Level I training**, the basic training required of trainees to become competent consultant cardiologists, is required of all fellows in cardiology, and can be accomplished as part of a standard 3-year training program in general cardiology.
- **Level II training**, refers to additional training in ≥1 area that enables some cardiologists to perform or interpret specific procedures or render more specialized care for patients with certain conditions. Level II training in selected areas may be achieved by some trainees during the standard 3-year cardiovascular fellowship, depending on their career goals and use of elective rotations. Level II EP training during the general fellowship can provide the knowledge and skills needed for the fellow to provide specialized arrhythmia and CIED management, including implantation, interrogation and programming of pacemakers and implantable loop recorders (ILRs), and interrogation and programming of other CIEDs.
- **Level III training**, the primary focus of this document, requires additional training and experience beyond the cardiovascular fellowship for the acquisition of specialized knowledge and experience in performing, interpreting, and training others to perform specific procedures or render advanced, specialized care for specific procedures at a high level of skill. Level III training is required of individuals seeking subspecialty board certification in CCEP. Trainees in CCEP are expected to have completed Level I training in all areas of general cardiovascular medicine before beginning their CCEP fellowship.

1.2.3. Methods for Determining Procedural Numbers
As noted in the COCATS 4 Task Force 11 report,3 the recommended number of procedures performed and interpreted by trainees under faculty supervision has been developed on the basis of published studies and guidelines, competency statements, and the experience and opinions of the members of the writing group. In addition, the writing committee
surveyed CCEP training program directors to gain additional insight into procedural volumes. Of 100 directors of ABIM-recognized training programs, 33 responded. The procedural volumes suggested in this document were determined to be the minimum numbers sufficient to provide trainees with exposure to a variety and spectrum of complexity of clinical case material and to give supervising faculty sufficient opportunity to evaluate the competency developed by each trainee. The numbers of procedures that should be performed and/or interpreted successfully to achieve competence (see Section 4.2) are intended as general guidance, based on the educational needs and progress of typical CCEP trainees in typical programs. Those considering these volume figures should bear in mind the fundamental nature of educational milestones—that proficiency and outcomes, rather than length of exposure or the exact number of procedures performed, are the dominant requirements. Flexibility is inherent to this concept, and the ACGME mandates that all programs establish milestones for the acquisition of various competencies by trainees during the course of fellowship training.

2. General Standards

2.1. Faculty

Engaged faculty who are committed to teaching EP are the most important resource for a successful CCEP training program. Faculty must include specialists who are knowledgeable about basic and clinical aspects of EP, including anatomy, physiology, and pathophysiology of arrhythmias; both noninvasive and invasive diagnostic strategies and tests; and therapeutic options, including device-based therapies, medical management, and catheter ablation. The most recent ACGME Program Requirements for Graduate Medical Education in CCEP require a single designated program director and at least 1 additional key clinical faculty member. Each of the key clinical faculty members should be currently certified in CCEP by the ABIM. Furthermore, it is recommended that the number of ABIM-certified EP faculty equal or exceed the number of trainees enrolled in the training program. In addition to subject knowledge, faculty should be active both clinically and academically in the field of EP; should have experience and/or undergo professional training in teaching and mentoring; and must have sufficient time to fulfill the teaching, mentoring, and administrative responsibilities required for participation as active faculty in the CCEP training program.

2.2. Facilities

Facilities must include dedicated areas for both outpatient care and hospital-based treatment. An outpatient area that allows for longitudinal management of patients with arrhythmia problems is essential for complete training. In the hospital environment, a dedicated area that provides a safe and sterile environment for performing invasive electrophysiological procedures is necessary. The “Heart Rhythm Society Expert Consensus Statement on Electrophysiology Laboratory Standards: Process, Protocols, Equipment, Personnel, and Safety” provides general recommendations for the EP laboratory. In addition to physical space and facilities, the teaching environment must include a systems-based practice that allows for effective communication between the outpatient and inpatient environments and among different specialists. Facilities must also have systems or mechanisms in place that continuously evaluate quality and clinical outcomes.

2.3. Equipment

EP laboratories that provide a safe environment for invasive EP studies require imaging capabilities such as fluoroscopy and equipment for recording electrical and hemodynamic signals. In addition, specialized equipment, including alternative imaging methods (eg, intracardiac echocardiography), advanced 3-dimensional mapping systems, ablation energy sources, CIED programmers, and extraction tools, is often necessary for safe and maximally-effective care of patients within the EP laboratory. Appropriate resuscitation equipment must be immediately available. In addition to facilities recommendations, the HRS Expert Consensus Statement on Electrophysiology Laboratory Standards: Process, Protocols, Equipment, Personnel, and Safety provides detailed recommendations on equipment necessary for performing invasive EP studies and placing CIEDs. Equipment and technology in the EP laboratory will continue to evolve rapidly, and a mechanism must be present that allows assessment and integration of important new technologies. In addition to equipment physically located within the EP suite, access to equipment and technologies outside of the EP suite, such as transesophageal echocardiography and advanced imaging (eg, computed tomography [CT] scanning, cardiovascular magnetic resonance [CMR]), is essential for successful training in EP.

2.4. Ancillary Support

Adequate EP training requires interaction among many different specialties within the healthcare environment. Communication with, and access to, cardiologists who have advanced training in interventional cardiology, echocardiography and advanced imaging, and heart failure are critical. In addition, interaction with and availability of anesthesiologists and cardiothoracic surgeons are important for safe performance of some advanced EP procedures. Physicians from other fields of medical and surgical practice should be available for consultation, and access to other healthcare professionals, including genetic counselors, pharmacists, dieticians, occupational therapists, physical therapists, social workers, and biomedical engineers, is required.

3. Training Components

3.1. Didactic Program

Didactic instruction may take place in a variety of formats, including lectures, conferences, journal club, grand rounds, clinical case presentations, electrocardiogram (ECG) and electrogram review conferences, and patient safety or quality improvement conferences. Topics for discussion include genetics; anatomy; neural innervation; pathology; molecular, cellular, whole-animal and human EP; radiation safety; imaging; specific arrhythmia mechanisms; and patient-centered care. Didactic sessions and case reviews are important mechanisms for training in the interpretation of complex surface
and intracardiac electrograms and in the evaluation and management of hospitalized patients and outpatients with cardiac arrhythmias. The latter includes the interpretation of ambulatory monitoring and CIED data critical for patient management. Hands-on use of simulators is an emerging platform to assist in the training of electrophysiologists, particularly in areas such as lead extraction, lead placement, trans-septal puncture, catheter ablation procedures, and preparation for infrequent emergencies such as cardiac perforation and tamponade.\(^8,9\) The same requirements for frequency of didactic instruction in general cardiology training are recommended for Level III training in CCEP.\(^3\) Moreover, it is expected that the CCEP trainees embark on a lifelong journey of education and learning that does not end with the completion of the fellowship, especially as new technologies and procedures are developed.

### 3.2. Clinical Experience

Level III trainees are required to have completed Level I training. Level II training can be completed before or in conjunction with Level III training. In either situation, Level III training cannot start until 3 years of cardiovascular training have been completed. Level III training requires robust clinical experiences in the outpatient and inpatient consultation settings and in the EP laboratory. In each of these clinical arenas, trainees assist in patient care in a supervised setting that provides for patient-centered education in all aspects of arrhythmia management. During a portion of clinical training, the Level III trainee is expected to act as a first-line consultant in arrhythmia management with appropriate on-site attending backup. In this capacity, the Level III trainee is expected to gather accurate, essential information from all sources, including medical interviews, physical examination, records, device interrogation, and diagnostic/therapeutic procedures; make informed recommendations about preventive, diagnostic, and therapeutic options and interventions that on the basis of clinical judgment, scientific evidence, and patient preferences; develop, negotiate, and implement patient management plans; and perform competently the diagnostic and therapeutic procedures considered essential to the practice of CCEP.

### 3.3. Hands-On Procedural Experience

Hands-on experience is essential for training in arrhythmia and CIED management. Level III training in CCEP requires a robust experience in the EP laboratory performing diagnostic and therapeutic EP procedures and device implantation and programming (permanent pacemakers, implantable cardioverter-defibrillators [ICDs], and cardiac resynchronization therapy [CRT] devices). The number of procedures that need to be completed during the 24 months of CCEP training is summarized in Section 4.2.

Level III trainees require experience in performing diagnostic EP studies and standard ablation procedures including ablation of atrioventricular (AV) nodal re-entrant tachycardia, atrial flutter, atrial tachycardia, accessory pathways (APs), the AV node, and ventricular arrhythmias (VAs). They also require experience in endocardial mapping including exposure to left heart mapping by the retrograde aortic and trans-septal approaches. Performance of procedures such as atrial fibrillation (AF) ablation, ablation of left-sided APs, and placement of left atrial appendage occlusion devices/ligation requires training in trans-septal catheterization. Ablation of AF, atrial tachycardia, premature ventricular complexes, and ventricular tachycardia (VT) requires additional expertise in catheter manipulation, delivery of ablative energy, and integration of knowledge related to 3-dimensional mapping systems and supporting modalities, such as intracardiac echocardiograms, CMR, and CT scans.

To gain skills in CIED implantation, the trainee should have adequate supervised experience performing this procedure (see Section 4.2). CIED lead extraction is a specialized procedure that requires special training but is not required to qualify for CCEP examination eligibility. Level III training in ICD implantation requires an extensive knowledge of ICD indications and contraindications, and of management of complications; an ability to assess patients for their risk of elevated defibrillation thresholds (DFTs), determine DFTs when appropriate, and manage high DFTs; an understanding of drug- and pacemaker-ICD interactions; and a thorough knowledge of ICD programming, management of ICD malfunction, and postoperative complications. Level III trainees must have an extensive knowledge of left ventricular lead indications and contraindications, management of biventricular pacemaker malfunctions and interactions, and postoperative complications.\(^10\)

Cardiac EP is a rapidly evolving field, and the ongoing introduction of new technology can be expected. These new technologies include leadless pacing systems, left atrial appendage exclusion devices, renal denervation procedures, implantable hemodynamic and pressure monitors, and novel methods for arrhythmia mapping. Therefore, although specific requirements for trainees in these new technologies cannot be stipulated, Level III trainees will be expected to attain the same minimum number of supervised procedures recommended for practicing electrophysiologists in the future. In addition, the increase in the number of left ventricular assist devices and the growth of the adult with congenital heart disease population introduce specific, unquantifiable patient-based complexities. Performance of procedures in these special populations may be limited to certain centers that expose trainees to a larger number of these patients.

### 3.4. Diagnosis and Management of Emergencies and Complications

The nature of procedures performed in the practice of CCEP raises the real possibility of potential complications that range from minor to major, including those that are immediate and life threatening. It is critical that the Level III trainee be proficient at recognizing potential complications for each type of procedure being performed and understand safeguards that must be in place to minimize risk. In addition, the Level III trainee must become proficient at managing acute iniprocedural complications as well as postprocedural complications. Potential complications include death, vascular disruption (eg, at an access site or during lead extractions), pulmonary emboli, respiratory compromise, stroke, infection (either device-related or not device-related), cardiac perforation...
with effusion and/or tamponade, hemothorax, pneumothorax, venous thromboses (both those related to CIED implantation and those that are not device related), phrenic nerve paralysis, atrial esophageal fistula (following AF ablation), and air embolism. The Level III trainee must be proficient at managing those complications that can be treated by the electrophysiologist, as well as understanding when additional support is needed from cardiothoracic surgery, interventional cardiology, or anesthesiology. The Level III trainee is expected to follow institutional requirements for reporting complications, present and discuss them at patient safety or quality improvement conferences, and learn from such experiences.

3.5. Diagnosis and Management of Rare Clinical Conditions and Syndromes
A large number of hereditary conditions can be associated with cardiac arrhythmias, and the Level III trainee must be familiar with inherited ion channel disorders such as long QT syndrome, Brugada syndrome, short QT syndrome, and catecholaminergic polymorphic VT as well as with inherited cardiomyopathies that have arrhythmic manifestations including hypertrophic cardiomyopathy, arrhythmogenic right ventricular dysplasia/cardioiomyopathy, myotonic dystrophy, other muscular dystrophies, and other types of cardiomyopathies. In addition, numerous autoimmune and inflammatory disorders have potential electrophysiological manifestations. The Level III trainee shall develop clinically applicable knowledge of the basic and clinical sciences that underlie these disorders and apply this knowledge in patient care. The Level III trainee is not expected to be expert in the complete management of patients with these conditions and syndromes but must be able to use information technology or other available methodologies, including consultation with genetic counselors, clinical geneticists, and experts in these conditions, to diagnose and manage affected patients.

3.6. Research and Scholarly Activity
All trainees are expected to carry out scholarly activities and/or research during Level III training in CCEP. Level III training in CCEP may include structured activities designed to support careers in cardiovascular investigation. However, not all Level III CCEP trainees are expected to follow this route. During Level III training, the trainee is expected to work with a mentor(s) to develop areas of scholarly achievement. Scholarly activity may include original clinical, basic science, or translational research; quality improvement activities; presentation at institutional, local, regional, or national meetings; and publication of original articles, reviews, chapters, or case reports. In addition, a scholarly approach to answering clinical questions and enhancing patient care through conducting literature reviews should be promoted throughout the fellowship years. Trainees should be encouraged to develop and maintain habits of self-learning, particularly through regular reading of cardiology and CCEP journals and attending appropriate scholarly meetings. Progress in research and scholarly training is assessed by the program director and instructors through evaluation tools such as direct observation, reviewing presentations and manuscripts, and overseeing research activities.

4. Training Requirements
4.1. Development and Evaluation of Core Competencies
Training and requirements in CCEP address the 6 general competencies promulgated by the ACGME and American Board of Medical Specialties and endorsed by the ABIM. These competency domains are: medical knowledge, patient care and procedural skills, practice-based learning and improvement, systems-based practice, interpersonal and communication skills, and professionalism. The ACC has used this structure to define and depict the components of the clinical competencies for cardiology. The curricular milestones for each competency and domain also provide a developmental roadmap for fellows as they progress through various levels of training and serve as an underpinning for the ACGME reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs.

Table 1 delineates each of the 6 competency domains, as well as their associated curricular milestones for training in CCEP. Included in the table are examples of evaluation tools suitable for assessing competence in each domain. It is expected that all trainees will achieve the Level III competencies listed in the table. In addition, selected Level III competency components designated with an asterisk (ie, “III*”) require additional training beyond the requirements for every trainee. These additional competencies may be obtained during or after the standard CCEP fellowship, depending on the trainee’s career focus and the training opportunities available at the trainee’s CCEP fellowship program. It is recognized that not all CCEP programs have sufficient volume of lead extraction and/or epicardial VT ablation procedures, for example, to adequately train ≥1 CCEP trainee in these skills within a 24-month fellowship. The milestone interval (12 months, 24 months, or additional months) indicates the stage by which the typical trainee will achieve a particular competency. In recognition of the fact that programs may vary with respect to the sequence of clinical experiences provided to trainees, the time at which various competencies are achieved may also vary. Moreover, although the competency components included in this table should be achieved by all trainees and are appropriate areas for assessment, not every component need be individually assessed in every trainee. Rather, as with all educational activities, assessment is a sampling process that should be tailored to the needs of the individual trainee and program.

4.2. Number of Procedures and Duration of Training
The minimum number of interventional procedures recommended for the 2-year Level III CCEP fellowship training is the consensus formed by review and consideration of published literature applicable to this topic,12–18 previously published competency statements,19,20 COCATS,19,21,22 policies of the ACGME and the ABIM,21 results from a 2015 survey of CCEP training program directors, practice guidelines,24–27 expert consensus documents,26–32 a policy statement33 relevant to the practice regarding indications and contraindications
# Table 1. Competency Components and Curricular Milestones for Level III Training in Clinical Cardiac Electrophysiology

<table>
<thead>
<tr>
<th>Competency Component: Medical Knowledge</th>
<th>Milestones (Months)</th>
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<tbody>
<tr>
<td><strong>Pathophysiological Basis of Cardiac Arrhythmias/Basic Electrophysiology</strong></td>
<td>12 24 Add</td>
</tr>
<tr>
<td>1. Know normal cardiac anatomy, including the anatomy of the conduction system.</td>
<td>III</td>
</tr>
<tr>
<td>2. Know basic cardiac electrophysiology.</td>
<td>III</td>
</tr>
<tr>
<td>3. Know the mechanisms of cardiac arrhythmias, including the relationship between cardiac arrhythmias and structural heart disease (including congenital heart disease), sympathetic as well as parasympathetic tone, myocardial ischemia/infarction, and drugs.</td>
<td>III</td>
</tr>
<tr>
<td>4. Know the physiology and pathophysiology of the atrioventricular conduction system and the types and associated clinical manifestations of accessory pathways.</td>
<td>III</td>
</tr>
<tr>
<td>5. Know the genetic basis of arrhythmias, including genetically-based ion channel abnormalities and inherited cardiomyopathies.</td>
<td>III</td>
</tr>
<tr>
<td>6. Know the epidemiology of arrhythmias.</td>
<td>III</td>
</tr>
<tr>
<td>7. Know the influence of acquired structural or congenital heart disease in causing cardiac arrhythmias and its effect on clinical decision-making about arrhythmia risk and management.</td>
<td>III</td>
</tr>
<tr>
<td>8. Know the systemic disorders and metabolic abnormalities associated with arrhythmias and conduction abnormalities.</td>
<td>III</td>
</tr>
</tbody>
</table>

**Diagnostic Tests**

<table>
<thead>
<tr>
<th>Noninvasive Diagnostic Tests</th>
<th>Milestones (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Know the role and method of interpreting ECGs obtained during sinus rhythm, exercise, and cardiac arrhythmias in the evaluation of patients with known or suspected cardiac arrhythmias.</td>
<td>III</td>
</tr>
<tr>
<td>10. Know the methods to interpret surface ECG for the differential diagnosis of cardiac arrhythmias.</td>
<td>III</td>
</tr>
<tr>
<td>11. Know the indications for event monitors/recorders and Holter monitors/recorders and the methods to interpret the results.</td>
<td>III</td>
</tr>
<tr>
<td>12. Know the indications for tilt table tests, the methods to perform a tilt table test, and the methods to interpret the results.</td>
<td>III</td>
</tr>
<tr>
<td>13. Know the role of exercise stress testing, with or without imaging, in the evaluation and management of patients with cardiac arrhythmias.</td>
<td>III</td>
</tr>
<tr>
<td>14. Know the role of transthoracic and transesophageal echocardiography in the management of patients with cardiac arrhythmias.</td>
<td>III</td>
</tr>
<tr>
<td>15. Know the role of transesophageal echocardiography and intracardiac echocardiography in guiding trans-septal puncture and ablation near key anatomic structures and monitoring for the development of a pericardial effusion.</td>
<td>III</td>
</tr>
<tr>
<td>16. Know the role of advanced imaging (computed tomography, magnetic resonance imaging, and positron emission tomography) in the evaluation and management of patients with cardiac arrhythmias.</td>
<td>III</td>
</tr>
<tr>
<td>17. Know the electrophysiological basis of various electrocardiographic parameters such as signal-averaged electrocardiography.</td>
<td>III</td>
</tr>
<tr>
<td>18. Know the methods to interpret tracings and other information downloaded from pacemakers, defibrillators, and implanted loop monitors with respect to both arrhythmias and heart failure management.</td>
<td>III</td>
</tr>
<tr>
<td>19. Know the indications for referring patients for sleep apnea evaluation.</td>
<td>III</td>
</tr>
</tbody>
</table>

**Invasive Electrophysiological Testing**

<table>
<thead>
<tr>
<th>Milestones (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20. Know the techniques of, indications for, contraindications, and potential complications of invasive electrophysiological studies.</td>
</tr>
<tr>
<td>21. Know the principles of obtaining vascular access, multielectrode catheter placement, electrogram recording, and stimulation.</td>
</tr>
<tr>
<td>22. Know the invasive laboratory recording techniques, including the principles of amplifiers, filters, and signal processors.</td>
</tr>
<tr>
<td>23. Know the principles of advanced 3-dimensional mapping systems, including anatomical chamber reconstruction, image integration, and creation and interpretation of electroanatomical activation and voltage maps.</td>
</tr>
<tr>
<td>24. Know the principles of radiation safety and of electrical safety (related to fluoroscopy and other equipment used in the laboratory) in the performance of electrophysiology studies, ablation, or device therapy.</td>
</tr>
<tr>
<td>25. Know the characteristics of unipolar and bipolar intracardiac electrocardiographic signals.</td>
</tr>
<tr>
<td>26. Know the methods of programmed electrical stimulation, the role of provocative drug testing/stimulation, and the characteristic findings in patients with and without arrhythmias or conduction disturbances.</td>
</tr>
<tr>
<td>27. Know the pacing protocols to evaluate sinus node and atrioventricular node function and to induce supraventricular and ventricular arrhythmias, including use of entrainment.</td>
</tr>
<tr>
<td>28. Know the predictive value and limitations of invasive electrophysiological studies in patients with various arrhythmias and clinical syndromes.</td>
</tr>
</tbody>
</table>

**Nondevice Therapies**

<table>
<thead>
<tr>
<th>Antiarrhythmic Medications</th>
<th>Milestones (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>29. Know the indications, contraindications, and clinical pharmacology of antiarrhythmic drugs and sympathetic and parasympathetic agonists and antagonists.</td>
<td>III</td>
</tr>
<tr>
<td>30. Know the clinical pharmacokinetics and pharmacodynamics of antiarrhythmic medications.</td>
<td>III</td>
</tr>
</tbody>
</table>

(Continued)
### Table 1. Continued

<table>
<thead>
<tr>
<th>Competency Component: Medical Knowledge</th>
<th>Milestones (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31. Know the adverse effects of antiarrhythmic drugs, including drug–drug and drug–device interactions and proarrhythmia potential.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Catheter Ablation</strong></td>
<td></td>
</tr>
<tr>
<td>32. Know the biophysics of radiofrequency, cryoablation, and other ablation energy sources that become available.</td>
<td>III</td>
</tr>
<tr>
<td>33. Know the indications and contraindications for catheter ablation of all types of cardiac arrhythmias.</td>
<td>III</td>
</tr>
<tr>
<td>34. Know the complications associated with catheter ablation of all types of cardiac arrhythmias.</td>
<td>III</td>
</tr>
<tr>
<td>35. Know the methods to minimize the risks of complications of catheter ablation.</td>
<td>III</td>
</tr>
<tr>
<td>36. Know the methods to manage complications that occur during catheter ablation.</td>
<td>III</td>
</tr>
<tr>
<td>37. Know the relative benefits and risks associated with radiofrequency ablation, cryoablation, and other ablation technologies that become available.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Surgical Ablation</strong></td>
<td></td>
</tr>
<tr>
<td>38. Know the pathophysiological basis of arrhythmia surgery.</td>
<td>III</td>
</tr>
<tr>
<td>39. Know the techniques, indications for, and complications associated with surgical treatment of cardiac arrhythmias, including surgical atrial fibrillation ablation.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Implantable Devices</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Pacemakers</strong></td>
<td></td>
</tr>
<tr>
<td>40. Know the indications for implantation of a cardiac pacemaker and the methods to select the appropriate pacemaker type for a particular patient.</td>
<td>III</td>
</tr>
<tr>
<td>41. Know the complications associated with placement of a cardiac pacemaker and the methods to manage those complications.</td>
<td>III</td>
</tr>
<tr>
<td>42. Know the methods to interrogate, program, and troubleshoot cardiac pacemakers, including the use of remote monitoring and interrogation.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Implantable Defibrillators</strong></td>
<td></td>
</tr>
<tr>
<td>43. Know the indications for implantation of an implantable cardioverter-defibrillator for primary and secondary prevention of sudden cardiac death.</td>
<td>III</td>
</tr>
<tr>
<td>44. Know the methods for selecting the appropriate implantable cardioverter-defibrillator type (including subcutaneous implantable cardioverter-defibrillators) for a particular patient.</td>
<td>III</td>
</tr>
<tr>
<td>45. Know the complications associated with implantation of an implantable cardioverter-defibrillator and the methods to manage them.</td>
<td>III</td>
</tr>
<tr>
<td>46. Know the methods to interrogate, program, and troubleshoot implantable cardioverter-defibrillators including the use of remote interrogation.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Resynchronization Therapy</strong></td>
<td></td>
</tr>
<tr>
<td>47. Know the indications for cardiac resynchronization therapy.</td>
<td>III</td>
</tr>
<tr>
<td>48. Know the complications associated with placement of a cardiac resynchronization therapy device and the methods to manage those complications.</td>
<td>III</td>
</tr>
<tr>
<td>49. Know the theories and methodology of optimization of cardiac resynchronization therapy as well as the methods to interrogate, program, and troubleshoot cardiac resynchronization therapy.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Implantable Loop Monitors</strong></td>
<td></td>
</tr>
<tr>
<td>50. Know the indications for and complications of implantable loop monitors and the methods to interpret the recordings.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Left Atrial Appendage Occlusion/Ligation</strong></td>
<td></td>
</tr>
<tr>
<td>51. Know the indications for left atrial appendage occlusion and appendage ligation.</td>
<td>III</td>
</tr>
<tr>
<td>52. Know the techniques of and complications associated with left atrial appendage occlusion and appendage ligation.</td>
<td>III</td>
</tr>
<tr>
<td>53. Know the methods to manage the complications associated with left atrial appendage occlusion and appendage ligation.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Lead Management</strong></td>
<td></td>
</tr>
<tr>
<td>54. Know the indications for lead extraction and management strategies for infected devices.</td>
<td>III</td>
</tr>
<tr>
<td>55. Know the complications of lead extraction and the methods to manage them.</td>
<td>III</td>
</tr>
<tr>
<td>56. Know the methods for diagnosing and managing lead failure.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Arrhythmia Types and Syndromes</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Bradyarrhythmias and Heart Block</strong></td>
<td></td>
</tr>
<tr>
<td>57. Know the pathophysiological basis of sinus node dysfunction and heart block.</td>
<td>III</td>
</tr>
<tr>
<td>58. Know the differential diagnosis and approach to diagnosis of patients with heart block, acquired and congenital.</td>
<td>III</td>
</tr>
</tbody>
</table>

(Continued)
59. Know the methods to diagnose and manage sinus node dysfunction and heart block, acquired and congenital. III

Atrial Fibrillation and Atrial Flutter

60. Know the pathophysiological basis of atrial fibrillation and atrial flutter. III
61. Know the methods to diagnose atrial fibrillation and atrial flutter. III
62. Know the methods to assess the risk of stroke and bleeding in patients with atrial fibrillation and atrial flutter. III
63. Know the indications for, complications of, and contraindications to anticoagulation. III
64. Know the pharmacology of anticoagulant drugs, including reversal of actions. III
65. Know when and how to prescribe and monitor anticoagulant drugs. III
66. Know when and how to prescribe rate control medications. III
67. Know when to recommend ablation of the atrioventricular node for rate control. III
68. Know when and how to prescribe antiarrhythmic medications for rhythm control strategies. III
69. Know the indications and techniques for electrical and pharmacological cardioversion. III
70. Know the techniques, risks, and benefits of catheter and surgical ablation of atrial fibrillation and atrial flutter. III
71. Know the methods to manage the complications associated with catheter ablation of atrial fibrillation and atrial flutter. III

Other Supraventricular Tachycardias

72. Know the pathophysiological basis of atrial tachycardia, junctional tachycardia, atrioventricular nodal re-entrant tachycardia, and accessory pathway-mediated tachycardia and associated risks of each arrhythmia, including sudden cardiac death, heart failure, and stroke. III
73. Know the methods to stratify risk of sudden death in patients with pre-excitation. III
74. Know the methods to diagnose atrial tachycardia, junctional tachycardia, atrioventricular nodal re-entrant tachycardia, and accessory pathway-mediated tachycardia. III
75. Know when and the methods to recommend drug therapy for patients with atrial tachycardia, junctional tachycardia, atrioventricular nodal re-entrant tachycardia, and accessory pathway-mediated tachycardia. III
76. Know the indications for, techniques of, and complications associated with catheter ablation for treatment of patients with atrial tachycardia, junctional tachycardia, atrioventricular nodal re-entrant tachycardia, and accessory pathway-mediated tachycardia. III
77. Know the methods to manage the complications associated with catheter ablation of atrial tachycardia, junctional tachycardia, atrioventricular nodal re-entrant tachycardia, and accessory pathways. III

Inherited Arrhythmia Syndromes and Genetic Testing

78. Know the pathophysiological basis of arrhythmias that occur in patients with an inherited arrhythmia syndrome cardiomyopathy. III
79. Know the genetic basis of inherited arrhythmia syndromes cardiomyopathy. III
80. Know the methods to diagnose inherited arrhythmia syndromes cardiomyopathy, including the roles and limitations of genetic testing in diagnosis and family screening. III
81. Know the methods to manage patients with inherited arrhythmia syndromes. III
82. Know the indications for pharmacotherapy, ablation, cardiac sympathetic denervation, and device therapy for the treatment of patients with an inherited arrhythmia syndrome cardiomyopathy. III

Ventricular Arrhythmias and Sudden Cardiac Death

83. Know the definition and magnitude of the problem of sudden cardiac arrest/death, the methods to manage acute episodes, and the methods to evaluate and treat survivors. III
84. Know the pathophysiological basis of ventricular arrhythmias, including premature ventricular contractions, nonsustained ventricular tachycardia, torsades de pointes, sustained ventricular tachycardia, ventricular fibrillation, pulseless electrical activity, and heart block asystole. III
85. Know the pathophysiological basis of and the acute and long-term approach to management of patients with aborted sudden cardiac death. III
86. Know the methods of diagnosing and managing patients with premature ventricular contractions, nonsustained ventricular tachycardia, torsades de pointes, ventricular tachycardia, ventricular fibrillation, pulseless electrical activity, and heart block asystole. III
87. Know when and the methods to recommend drug therapy for patients with ventricular arrhythmias. III
88. Know the indications and techniques for electrical and pharmacological cardioversion and defibrillation. III
89. Know the indications for, techniques for, and complications associated with catheter ablation of ventricular arrhythmias. III
90. Know the methods for determining sudden cardiac death risk and when to advise implantation of an implantable cardioverter defibrillator in patients with or at risk for development of ventricular arrhythmias. III

Table 1. Continued

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<td>72. Know the pathophysiological basis of atrial tachycardia, junctional tachycardia, atrioventricular nodal re-entrant tachycardia, and accessory pathway-mediated tachycardia and associated risks of each arrhythmia, including sudden cardiac death, heart failure, and stroke. III</td>
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<tr>
<td>75. Know when and the methods to recommend drug therapy for patients with atrial tachycardia, junctional tachycardia, atrioventricular nodal re-entrant tachycardia, and accessory pathway-mediated tachycardia. III</td>
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<td>76. Know the indications for, techniques of, and complications associated with catheter ablation for treatment of patients with atrial tachycardia, junctional tachycardia, atrioventricular nodal re-entrant tachycardia, and accessory pathway-mediated tachycardia. III</td>
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<tr>
<td>77. Know the methods to manage the complications associated with catheter ablation of atrial tachycardia, junctional tachycardia, atrioventricular nodal re-entrant tachycardia, and accessory pathways. III</td>
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<td>81. Know the methods to manage patients with inherited arrhythmia syndromes. III</td>
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<td>82. Know the indications for pharmacotherapy, ablation, cardiac sympathetic denervation, and device therapy for the treatment of patients with an inherited arrhythmia syndrome cardiomyopathy. III</td>
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<td>84. Know the pathophysiological basis of ventricular arrhythmias, including premature ventricular contractions, nonsustained ventricular tachycardia, torsades de pointes, sustained ventricular tachycardia, ventricular fibrillation, pulseless electrical activity, and heart block asystole. III</td>
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<td>85. Know the pathophysiological basis of and the acute and long-term approach to management of patients with aborted sudden cardiac death. III</td>
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<tr>
<td>86. Know the methods of diagnosing and managing patients with premature ventricular contractions, nonsustained ventricular tachycardia, torsades de pointes, ventricular tachycardia, ventricular fibrillation, pulseless electrical activity, and heart block asystole. III</td>
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<tr>
<td>87. Know when and the methods to recommend drug therapy for patients with ventricular arrhythmias. III</td>
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<td>88. Know the indications and techniques for electrical and pharmacological cardioversion and defibrillation. III</td>
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Table 1. Continued

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<tr>
<th>Competency Component: Medical Knowledge</th>
<th>Milestones (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>91. Know the methods to assess sudden death risk in athletes.</td>
<td>III</td>
</tr>
<tr>
<td>92. Know the methods to diagnose and manage ventricular arrhythmias in athletes.</td>
<td>III</td>
</tr>
</tbody>
</table>

**Syncope**

93. Know the differential diagnosis of syncope.                                                       | III                 |
94. Know the methods for determining the cause of syncope, including the role of the clinical history, ECG, noninvasive arrhythmia monitoring, cardiac imaging, electrophysiology testing, and tilt table testing.   | III                 |
95. Know the methods for treating patients with syncope, including vasovagal syncope and syncope resulting from cardiac arrhythmias. | III                 |

**Palpitations and Paroxysmal Supraventricular Tachycardias**

96. Know the differential diagnosis of patients presenting with palpitations and the corresponding methods for diagnosis and treatment. | III                 |
97. Know the differential diagnosis of patients with paroxysmal supraventricular tachycardia and the corresponding methods for diagnosis and treatment. | III                 |

**Evaluation Tools:** direct observation, chart-stimulated recall, multisource evaluation, and conference presentation.

<table>
<thead>
<tr>
<th>Competency Component: Patient Care and Procedural Skill</th>
<th>Milestones (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Skill to perform a comprehensive clinical evaluation (consultation) for patients with manifest or suspected cardiac arrhythmias or conduction disturbance and to establish an appropriate evaluation and management plan in both outpatient and inpatient settings.</td>
<td>III</td>
</tr>
<tr>
<td>2. Skill to evaluate and manage patients in the intensive care and postoperative electrophysiology procedural and surgical care units.</td>
<td>III</td>
</tr>
</tbody>
</table>

**Diagnostic Tests**

**Noninvasive Diagnostic Tests**

3. Skill to appropriately utilize and perform noninvasive testing in the evaluation and management of patients with arrhythmias. | III                 |
4. Skill to appropriately utilize electrocardiography in the evaluation and management of patients with cardiac arrhythmias and inherited arrhythmia syndromes. | III                 |
5. Skill to appropriately utilize and perform exercise stress testing in the evaluation and management of patients with arrhythmias. | III                 |
6. Skill to appropriately utilize transthoracic and transesophageal echocardiography in the evaluation and management of patients with arrhythmias. | III                 |
7. Skill to appropriately utilize and perform intracardiac echocardiography in the evaluation and management of patients with arrhythmias. | III                 |
8. Skill to appropriately utilize advanced imaging (cardiovascular computed tomography, cardiovascular magnetic resonance, and positron emission tomography) in the evaluation and management of cardiac arrhythmias. | III                 |

**Invasive Electrophysiological Evaluation**

9. Skill to place sheaths in the femoral, internal jugular, subclavian, axillary, and cephalic veins using anatomic landmarks and ultrasound imaging. | III                 |
10. Skill to place sheaths in the femoral arteries using anatomic landmarks and ultrasound imaging. | III                 |
11. Skill to place and manipulate electrode catheters in the atria, ventricles, coronary sinus, His bundle area, aortic root, and pulmonary artery. | III                 |
12. Skill to accurately measure and assess conduction intervals and refractory periods during programmed electrical stimulation. | III                 |
13. Skill to use intracardiac recordings to determine activation sequence mapping and to interpret the responses to pacing techniques including entrainment. | III                 |
14. Skill to use advanced 3-dimensional mapping systems, including anatomical chamber reconstruction, image integration, and electroanatomical activation and voltage maps in the management of patients with cardiac arrhythmias. | III                 |
15. Skill to appropriately utilize and monitor sedation during procedures.                                 | III                 |
16. Skill to identify patients in whom general anesthesia should or should not be considered for electrophysiology and device procedures. | III                 |
17. Skill to recognize and manage procedural complications, including vascular complications, cardiac perforation/tamponade, pneumothorax, lead dislodgements, and pocket complications (eg, bleeding, infection). | III                 |
18. Skill to appropriately select patients for electrophysiology procedures and effectively carry out preprocedural, intraprocedural, and postprocedural management and follow-up. | III                 |

(Continued)
Table 1. Continued

<table>
<thead>
<tr>
<th>Competency Component: Patient Care and Procedural Skill</th>
<th>Milestones (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>19. Skill to integrate the findings from invasive electrophysiological testing with clinical and other testing results in</td>
<td>III</td>
</tr>
<tr>
<td>the management of patients with arrhythmias or conduction disturbances.</td>
<td></td>
</tr>
<tr>
<td>20. Skill to apply diagnostic pacing maneuvers to distinguish among different forms of supraventricular tachycardia and in</td>
<td>III</td>
</tr>
<tr>
<td>assessment of ventricular tachycardia.</td>
<td></td>
</tr>
<tr>
<td>21. Skill to perform and interpret invasive electrophysiological testing in patients with all forms of arrhythmias, including</td>
<td>III</td>
</tr>
<tr>
<td>AV nodal re-entrant tachycardia, atrial tachycardia or flutter, atrioventricular node or accessory pathway abnormalities, and</td>
<td></td>
</tr>
<tr>
<td>ventricular arrhythmias.</td>
<td></td>
</tr>
</tbody>
</table>

Nondevice Therapies

Antiarrhythmic Medications

22. Skill to prescribe antiarrhythmic drug therapy for treatment of patients with cardiac arrhythmias. III
23. Skill to monitor patients being treated with antiarrhythmic drug therapy. III
24. Skill to manage patients with a pro-arrhythmic response to antiarrhythmic drug therapy or side effects to antiarrhythmic drugs. III

Catheter Ablation

25. Skill to carry out ablation therapy in patients with atrioventricular nodal re-entrant tachycardia, atrial tachycardia, typical atrial flutter, and accessory pathway–mediated arrhythmias. III
26. Skill to carry out ablation therapy in patients with atrial fibrillation. III
27. Skill to carry out ablation therapy in patients with atypical atrial flutter. III
28. Skill to carry out ablation therapy in patients with idiopathic premature ventricular contractions and/or ventricular tachycardia arising from right ventricular outflow tract. III
29. Skill to carry out ablation therapy in patients with idiopathic premature ventricular contractions and/or ventricular tachycardia arising from sites other than the right ventricular outflow tract. III
30. Skill to identify appropriate candidates for and assess risk/benefit of epicardial approach to ventricular tachycardia ablation. III
31. Skill to carry out epicardial ventricular tachycardia ablation. III
32. Skill to introduce sheaths and catheters into the left atrium via a patent foramen ovale or trans-septal puncture to perform mapping and ablation. III
33. Skill to access the aortic root and/or left ventricle using a retrograde aortic approach. III
34. Skill to utilize magnetic resonance imaging, computed tomography, and intracardiac echocardiography to facilitate invasive electrophysiology testing, intracardiac mapping, and catheter ablation. III
35. Skill to effectively perform ablation for scar-based atrial and ventricular arrhythmias. III
36. Skill to perform invasive electrophysiology studies and ablation therapy in adult patients with repaired or unrepaired congenital heart disease. III*
37. Skill to recognize and manage patients who experience a complication during and/or following catheter ablation. III
38. Skill to minimize the risks of complications associated with catheter ablation. III

Surgical Ablation

39. Skill to identify patients likely to benefit from surgical treatment of cardiac arrhythmias. III
40. Skill to follow patients who have undergone surgical treatment of a cardiac arrhythmia. III

Implantable Devices

Pacemakers

41. Skill to appropriately select, implant, test, interrogate, program, and follow pacemakers. III
42. Skill to identify and manage complications associated with pacemaker implantation. III

Implantable Cardioverter-Defibrillators

43. Skill to appropriately select, implant, test, interrogate, program, and follow implantable cardioverter-defibrillator devices in clinic and remotely. III
44. Skill to identify and manage complications associated with placement of implantable cardioverter-defibrillators. III
45. Skill to identify appropriate patients for, and to implant, subcutaneous implantable cardioverter-defibrillators. III

Resynchronization Therapy

46. Skill to appropriately select, implant, test, interrogate, program, and follow cardiac resynchronization therapy devices. III
47. Skill to identify and manage complications associated with cardiac resynchronization therapy device implantation. III

Implantable Loop Recorders

48. Skill to implant implantable loop recorders. III

(Continued)
Table 1. Continued

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<tr>
<th>Competency Component: Patient Care and Procedural Skill</th>
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</tr>
</thead>
<tbody>
<tr>
<td>49. Skill to interrogate and follow patients who have undergone implantable loop recorder implantation.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Left Atrial Appendage Occlusion/Ligation</strong></td>
<td></td>
</tr>
<tr>
<td>50. Skill to perform placement of a left atrial appendage closure device, including recognition and management of complications.</td>
<td>III*</td>
</tr>
<tr>
<td>51. Skill to perform left atrial appendage ligation using a percutaneous approach, including recognition and management of complications.</td>
<td>III*</td>
</tr>
<tr>
<td>52. Skill to identify patients who are candidates for surgical left atrial appendage ligation and to follow these patients following the procedure.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Lead Management</strong></td>
<td></td>
</tr>
<tr>
<td>53. Skill to identify anatomic lead location on the basis of fluoroscopic or x-ray image.</td>
<td>III</td>
</tr>
<tr>
<td>54. Skill to perform lead extraction.</td>
<td>III*</td>
</tr>
<tr>
<td>55. Skill to manage patients with lead failure.</td>
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</tr>
<tr>
<td>57. Skill to diagnose and manage patients with bradyarrhythmias, including sinus node dysfunction, asystole, and heart block.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Atrial Fibrillation and Atrial Flutter</strong></td>
<td></td>
</tr>
<tr>
<td>58. Skill to diagnose and manage patients with atrial fibrillation, including anticoagulation and rate and rhythm control.</td>
<td>III</td>
</tr>
<tr>
<td>59. Skill to perform electrical and pharmacological cardioversion.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Other Supraventricular Arrhythmias</strong></td>
<td></td>
</tr>
<tr>
<td>60. Skill to diagnose and manage patients with supraventricular tachycardia, including with pharmacological therapy and catheter ablation.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Inherited Arrhythmia Syndromes and Genetic Testing</strong></td>
<td></td>
</tr>
<tr>
<td>61. Skill to diagnose, manage, or refer patients with an inherited arrhythmia syndrome cardiomyopathy to physicians/programs who have this expertise.</td>
<td>III</td>
</tr>
<tr>
<td>62. Skill to know when to order genetic testing.</td>
<td>III</td>
</tr>
<tr>
<td>63. Skill to interpret the results of genetic testing with the assistance of a genetic counselor.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Ventricular Arrhythmias and Sudden Cardiac Death</strong></td>
<td></td>
</tr>
<tr>
<td>64. Skill to evaluate and manage patients at risk for sudden cardiac arrest or aborted sudden cardiac arrest.</td>
<td>III</td>
</tr>
<tr>
<td>65. Skill to evaluate and manage patients with ventricular arrhythmias, including premature ventricular contractions, nonsustained ventricular tachycardia, torsades de pointes, sustained ventricular tachycardia, and ventricular fibrillation.</td>
<td>III</td>
</tr>
<tr>
<td>66. Skill to perform electrical and pharmacological cardioversion and defibrillation.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Syncope</strong></td>
<td></td>
</tr>
<tr>
<td>67. Skill to evaluate and manage patients with syncope.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Palpitations and Paroxysmal Supraventricular Tachycardias</strong></td>
<td></td>
</tr>
<tr>
<td>68. Skill to evaluate and manage patients with palpitations and paroxysmal supraventricular tachycardia.</td>
<td>III</td>
</tr>
<tr>
<td><strong>Evaluation Tools:</strong> chart-stimulated recall, clinical and patient safety and quality improvement conference presentation, direct observation, multisource evaluation, and logbook, simulation.</td>
<td></td>
</tr>
</tbody>
</table>

**Competency Component: Systems-Based Practice**

<table>
<thead>
<tr>
<th>Milestones (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 24 Add</td>
</tr>
<tr>
<td>1. Use hospital data and available registries to assess appropriateness, performance, and safety of implanted devices.</td>
</tr>
<tr>
<td>2. Work effectively with hospital electrophysiology laboratory staff to enhance safety and efficiency while controlling cost.</td>
</tr>
<tr>
<td>3. Incorporate risk/benefit analysis and cost considerations in diagnostic and treatment decisions.</td>
</tr>
<tr>
<td>4. Work as part of a multidisciplinary team to provide safe and effective transitions of care within and across healthcare systems.</td>
</tr>
<tr>
<td><strong>Evaluation Tools:</strong> chart-stimulated recall, direct observation, and multisource evaluation.</td>
</tr>
</tbody>
</table>

**Competency Component: Practice-Based Learning and Improvement**

<table>
<thead>
<tr>
<th>Milestones (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 24 Add</td>
</tr>
<tr>
<td>1. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.</td>
</tr>
<tr>
<td>2. Know how to conduct literature searches and apply results to clinical care.</td>
</tr>
</tbody>
</table>

(Continued)
of these procedures, and the experience and opinions of the members of the writing group. Recommended procedural numbers are summarized in Table 2. The previously published procedural numbers from the American training documents and from international societies and organizations are summarized in Table 3. It is expected that the training is directed by an appropriately trained and board-certified mentor in an ACGME–accredited program as defined in Section 2.1. The satisfactory completion of such training is documented by the program director.

As indicated in Section 1.2.3, the procedural volumes in this document are based on a judgment about the minimum experience required to provide most trainees with a sufficient variety of clinical situations and to allow faculty enough opportunity to evaluate the trainee’s emerging competency. The numbers of procedures necessary to achieve competence should be interpreted as approximate, based on the educational needs and progress of typical trainees in typical programs. Proficiency and outcomes, rather than length of exposure or the exact number of procedures performed, are the dominant criteria for evaluation of competency in the context of educational milestones. In addition, absolute mastery of all aspects of EP is not likely to be achieved on the basis of the fellowship experience alone. For common and straightforward procedures, mastery can occur, but for very complex or infrequently-performed procedures, lower levels of proficiency are anticipated for new graduates. Realistically, full proficiency in advanced techniques may develop only after additional years of experience, as indicated in Table 1.

Significant overlap exists in the rapidly growing fields of interventional EP and CIED procedures; however, there are differences in the acquisition of technical abilities and cognitive skills with respect to different types of arrhythmias and diagnostic and therapeutic interventions. For instance, the technical skills needed for ablation of AF are substantial. These include performance of trans-septal puncture and cannulation of the left atrium; precise manipulation of the catheter for mapping and ablation; identification of the pulmonary vein ostia; adjustment of the energy used for ablation; and the appropriate use of fluoroscopy, radiographic contrast imaging, 3-dimensional mapping systems, and/or intracardiac echocardiography. Concepts related to pacing maneuvers and entrainment are especially important for characterizing the mechanisms of supraventricular arrhythmias or VAs and for determining the point of origin, the location of the AP, and/or the critical zone of conduction. All are important to the success of ablation. CIEDs share many common implantation techniques and requisite knowledge for management; however, defibrillation and antitachycardia pacing testing, cannulation of the coronary sinus for CRT, lead extraction for defective or infected devices, or programming and management of pacemakers versus ICDs require different skills. Training programs vary in expertise, technology available, and procedural volumes; nevertheless, trainees are expected to develop proficiencies and be well-versed in most EP–related interventional procedures upon completion of a 2-year fellowship. For these reasons, the recommendations for procedural numbers are categorized by supraventricular tachycardia (SVT), atrial flutter and macro–re-entrant AT; AF; VA; CIED implantation, CIED interrogation and programming, and lead extraction. It is recognized that not all trainees will receive training in all aspects of clinical EP and device implantation and management. The core components of EP training that are required of all trainees, as well as those components of EP training that are considered elective and, as a result, are not required to complete a CCEP training program, are presented in Table 1. The proficiencies that are not required for all CCEP trainees include epicardial VT ablation, lead extraction, atrial appendage occlusion/ligation, and catheter
Table 2. Recommendations for Minimum Procedural Volume to Achieve and Demonstrate Competence in Clinical Cardiac Electrophysiology

<table>
<thead>
<tr>
<th>Procedures</th>
<th>Numbers*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic electrophysiology studies (which can be performed with catheter ablation procedures)</td>
<td>175</td>
</tr>
<tr>
<td>Catheter ablation procedures</td>
<td>160</td>
</tr>
<tr>
<td>SVT (not including atrial fibrillation or flutter)</td>
<td>50</td>
</tr>
<tr>
<td>Focal AT</td>
<td>5</td>
</tr>
<tr>
<td>AVN</td>
<td>5</td>
</tr>
<tr>
<td>AVNRT</td>
<td>25</td>
</tr>
<tr>
<td>AVRT/AP</td>
<td>15</td>
</tr>
<tr>
<td>Atrial flutter/macro–re-entrant AT</td>
<td>30</td>
</tr>
<tr>
<td>Isthmus dependent atrial flutter</td>
<td>20</td>
</tr>
<tr>
<td>Nonisthmus dependent/complex macro–re-entry atrial arrhythmias</td>
<td>10</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>50</td>
</tr>
<tr>
<td>VT/PVC ablation</td>
<td>30</td>
</tr>
<tr>
<td>Idiopathic VT/PVCs</td>
<td>20</td>
</tr>
<tr>
<td>VT/PVCs in patients with SHD</td>
<td>10</td>
</tr>
<tr>
<td>CIED procedures</td>
<td></td>
</tr>
<tr>
<td>CIED implantation</td>
<td>100</td>
</tr>
<tr>
<td>Pacemakers</td>
<td>40†</td>
</tr>
<tr>
<td>ICDs</td>
<td>60†</td>
</tr>
<tr>
<td>CRT pacemakers or ICDs</td>
<td>25‡</td>
</tr>
<tr>
<td>CIED replacement/revision</td>
<td>30</td>
</tr>
<tr>
<td>CIED interrogation/programming</td>
<td>200</td>
</tr>
<tr>
<td>CIED interrogation/programming, pacemakers</td>
<td>100</td>
</tr>
<tr>
<td>CIED interrogation/programming, ICDs</td>
<td>100</td>
</tr>
<tr>
<td>Remote device interpretation§</td>
<td>50</td>
</tr>
<tr>
<td>Lead extraction procedure(s) (with one or more leads implanted &gt;=12 months previously)</td>
<td>30</td>
</tr>
<tr>
<td>Tilt table tests</td>
<td>5</td>
</tr>
</tbody>
</table>

*Actual numbers that should be performed and/or interpreted successfully to achieve competence are intended as general guidance, based on the educational needs and progress of typical CCEP trainees.
†Of which at least 20 should be dual chamber.
‡Also count as pacemaker or implantable cardioverter-defibrillator implants.
§The remote interrogations can be included as CIED interrogation/programming number requirements.

Ablation of atrial arrhythmias and VAs in patients with complex congenital heart disease.

Each trainee should perform at least 175 electrophysiological procedures for arrhythmia evaluation. These can be performed in conjunction with catheter ablation procedures. Over the 2-year CCEP fellowship, at least 160 ablation procedures should be performed, with at least 50 of these being supraventricular ablation procedures. These ablations should include 5 focal ATs, 5 AV node ablations, 25 AV nodal re-entrant tachycardias, and 15 AV re-entrant tachycardias and other less common SVTs, including sinus node re-entrant tachycardia and junctional tachycardia. The role of the trainee should either be to function as the primary hands-on operator or to perform programmed electrical stimulation and analyze the diagnostic components of the procedure. Expertise in catheter placement, programmed electrical stimulation, endocardial mapping, catheter ablation, and interpretation of data must be ensured by the CCEP faculty and training program director. The endocardial mapping experience should include left heart mapping by either the retrograde aortic or trans-septal approach for APs. Training in trans-septal catheterization for performance of AF ablation and for ablation of arrhythmias originating from the left atrium or involving left APs is required. These numbers should not be regarded as strict requirements but rather as a general framework of the depth and breadth of exposure that trainees should obtain during their training. Earlier data from multicenter surveys suggest that procedural complications were significantly associated with procedural volumes. From the Multicenter European Radiofrequency Survey, complication rates of 4.6% were reported from centers with ≥100 cases/year, compared with 5.6% from centers performing ≤50 cases/year. From a 1994 survey from the North American Society of Pacing and Electrophysiology, a 1.5% complication rate was reported from centers performing ≥50 cases/year, whereas complications occurred in 3.2% of patients from centers performing ≤20 cases/year. The success rate of AF ablation was related to the operator’s experience.

The patient population with typical atrial flutter and other macro–re-entrant AT is growing, primarily related to increasing surgical and ablation procedures in the atria. Each trainee should participate in mapping and ablation of at least 30 of these arrhythmias. Achieving competence in programmed electrical stimulation with cognitive skills in identifying the arrhythmia circuit using both activation and entrainment mapping, determining appropriate sites for ablation, and demonstrating conduction block across re-entry circuit sites post-ablation is expected. Integration of knowledge related to 3-dimensional mapping systems and re-entrant mechanisms is required. Although it is unlikely that trainees will be exposed to all mapping technologies during their 2 years of training given the rapid evolution of new mapping technologies, trainees should be exposed to tools for definition of intracardiac anatomy, such as intravascular ultrasound, CMR, CT, and advanced mapping systems. Of the 30 procedures, at least 20 typical atrial flutters and 10 other macro–re-entrant ATs are expected. It is anticipated that post-graduate education will continue after the 2 training years.

AF ablation is the most commonly performed catheter ablation procedure today. The procedure is complex, requiring technical ability and dexterity, an in-depth understanding of anatomical relationships, and integration of cognitive skills. Each trainee should participate in at least 50 AF ablation cases. Although the standardization of the technical approach continues to evolve,25,26,31 improved outcomes have been associated with centers that perform at least 100 ablation procedures annually.12,16-18 Complications are also related to procedural volumes. Data from the National Inpatient Sample13 showed that procedural complication rates were significantly lower among operators performing ≥50 AF ablations/year compared with ≤25 cases/year. Lower complication rates occurred in...
Table 3. History of Societal Recommendations for Training to Achieve Competence in Clinical Cardiac Electrophysiology

<table>
<thead>
<tr>
<th>Source</th>
<th>Studies</th>
<th>Ablation</th>
<th>SVT</th>
<th>Atrial Flutter/ET</th>
<th>Macro-Re-Entrant AT</th>
<th>Atrial Fibrillation</th>
<th>Ventricular Arrhythmia</th>
<th>CIED</th>
<th>Programming</th>
<th>CIED</th>
<th>Implantation</th>
<th>Pacemaker</th>
<th>ICD</th>
<th>CRT</th>
<th>Replacement/Revision</th>
<th>Lead Extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACP/ACC/AHA 1994*</td>
<td>100</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>ACC/AHA 2008**</td>
<td>150</td>
<td>50–75</td>
<td>NS</td>
<td>30–50</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>COCATS 1995†</td>
<td>100</td>
<td>50</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>50</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>COCATS 2008‡</td>
<td>150</td>
<td>75</td>
<td>NS</td>
<td>30–50</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>200</td>
<td>75†</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>30</td>
<td>20</td>
<td>20</td>
<td>NS</td>
</tr>
<tr>
<td>ACGME 2016§</td>
<td>150–175</td>
<td>75</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>25</td>
<td>NS</td>
<td>25†</td>
<td>25</td>
<td>25</td>
<td>30</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>NS</td>
</tr>
<tr>
<td>ABIM 2014¶</td>
<td>150</td>
<td>75</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>British Cardiac Society 1995‖</td>
<td>70</td>
<td>50</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>CCS/CHRS 2011§</td>
<td>100–150</td>
<td>50</td>
<td>10–20§</td>
<td>30–50</td>
<td>10–20</td>
<td>NS</td>
<td>NS</td>
<td>75</td>
<td>NS</td>
<td>25</td>
<td>15</td>
<td>20</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>EHRA 2009¶</td>
<td>200 (50)</td>
<td>150 (35)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>50 (30)</td>
<td>30 (15)</td>
<td>20 (10)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

*Including ablation. †25 dual-chamber CIEDs are required. ‡Dual chamber. §Macro-re-entrant AT. ‖Scar-dependent. ¶Total procedures (as the primary operator).

ABIM indicates American Board of Internal Medicine; ACC, American College of Cardiology; ACGME, Accreditation Commission for Graduate Medical Education; ACP, American College of Physicians; AHA, American Heart Association; CCS, Canadian Cardiovascular Society; CHRS, Canadian Heart Rhythm Society; COCATS, Core Cardiovascular Training Statement; EHRA, European Heart Rhythm Association; EP, electrophysiology; ICD, implantable cardioverter-defibrillator; n, number; NS, not specified; other abbreviations as in Table 2.

hospitals that performed at least 100 cases/year compared with those that performed <50 cases/year.

Fellowship training on ablation of VAs is important. Each trainee should participate in at least 30 ablation procedures for VA. Ablation of VAs requires a wide spectrum of technical skills and understanding of anatomy, as it may require mapping of right ventricular and left ventricular endocardium, the great vessels including the aortic root and venous structures, and/or the epicardium. The substrate for re-entrant VT occurs in both ischemic and nonischemic heart disease. Due to the wide spectrum of VA location and substrate, it is recommended that experience should include 20 VAs of the idiopathetic type and 10 VAs in patients with structural heart disease. In addition to developing expertise in electroanatomic mapping, fellows must have exposure to the advanced ablation delivery systems. Due to the thickness of the ventricular myocardium, technical proficiency in accessing epicardial space and positioning catheters in cardiac venous vasculature is of value in selected cases. Becoming expert in these evolving techniques is not required of all EP trainees and, if desired, may necessitate that the trainee obtain additional training in centers specializing in these procedures.

CIED training must include development of expertise in permanent atrial and right and left ventricular pacemaker lead placement and ICD lead placement, threshold testing and programming of devices, understanding of CIED infections, 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 100 CIED initial primary implantations, of which 25 should be CRT device implantations. Primary implantations should include at least 40 pacemakers (20 dual chamber), 60 ICDs (20 dual chamber), and 25 CRT devices (either pacing or defibrillation). Thirty CIED revisions or replacements are also required. The trainee must also participate in the follow-up of at least 200 CIED patient visits and acquire proficiency in advanced CIED electrocardiography, interrogation, and device programming. Of the follow-up visits, at least 100 should be in ICD and 100 in pacemaker patients. Interpretation of at least 50 remote device monitoring recordings is required. As part of the training regarding CIEDs, exposure to the indications, implantation techniques, and follow-up of loop recorders is desirable.

CIED lead extraction is a specialized procedure that requires special training. Physicians being trained in lead extraction should perform at least 30 lead extraction procedures under the direct supervision of a skilled and experienced physician in this procedure. Each of these 30 procedures should involve removal of ≥1 lead that had been implanted for 12 months or longer.

Tilt table testing is useful for the evaluation of syncope and for the understanding of the physiology or pathophysiology of vasovagal response and orthostatic intolerance. During the CCEP fellowship, a trainee should conduct at least 5 tilt table tests.

4.3. Diagnostic Testing

4.3.1. Noninvasive Diagnostic Tests

Numerous tests are available to evaluate the electrophysiological properties of the heart. Although learning the fundamentals of ECG is part of the basic knowledge requirements for general cardiology, promulgating a deeper understanding of the electrophysiological fundamentals that are manifest in ECG recordings is critical in electrophysiological training. A series of
professional multisocietal documents provides information on standardized interpretation and reporting of the surface 12-lead ECG. Similarly, although evaluation of ambulatory ECG monitoring is part of the basic cardiology curriculum, a more nuanced interpretation is a critical skill for electrophysiologists and often provides insight into arrhythmia mechanism. For certain groups, such as athletes, additional and more focused electrocardiographic education and knowledge are required. Ambulatory ECG monitoring techniques have evolved rapidly over the past decade, and the electrophysiologist must understand the relative benefits of different monitoring technologies with particular focus on the cost, benefit, and recommended duration of different monitoring periods. Some specialized tests including the signal-averaged ECG, T-wave alternans, body surface mapping, tilt table testing, and autonomic testing may not be in widespread clinical use. However, understanding the electrophysiological basis for these tests remains an essential component of EP training, particularly in estimating the risk of sudden cardiac arrest/death in selected patients.

Tilt table testing and treadmill testing can provide valuable information for patients with orthostatic or exercise-related symptoms or arrhythmias. In addition to provocative tests designed to evaluate electrophysiological properties of the heart in different conditions, EP training must include a discussion of the full range of cardiovascular stress testing techniques. For example, stress testing used to identify the presence of significant coronary artery disease is often important for evaluating the relationship between ischemia and arrhythmia development in individual patients. Stress testing is also important in determining the presence of exercise-related arrhythmias.

Finally, noninvasive tests that allow imaging of the heart have emerged as a critically important component of EP training because of the close relationship between cardiac anatomy and electrophysiological abnormalities. An understanding of the application of techniques such as echocardiography (transthoracic, transesophageal, and intracardiac), cardiovascular CT, CMR imaging, and nuclear studies in the setting of arrhythmias is essential.

4.3.2. Invasive Electrophysiological Evaluation
Understanding the indications, risks, and performance of invasive EP studies is a fundamental aspect of advanced training in EP. The CCEP trainee should be able to describe the indications for invasive EP evaluation, perform and interpret a comprehensive EP study, create and interpret an electroanatomic map, and integrate these findings into a formal diagnosis and treatment plan including an ablation strategy when indicated. This includes basic knowledge of recording techniques such as principles of amplifiers, filters, signal processing, mapping techniques, and radiation safety. It also includes the ability to independently perform the appropriate selection of catheters; proper placement; mastery of appropriate pacing protocols; and the ability to induce, terminate, and evaluate the mechanisms of SVTs and VAs.

4.4. Arrhythmia Types and Syndromes
4.4.1. Pathophysiological Basis of Cardiac Arrhythmias/Basic Electrophysiology
The “HRS Policy Statement: Clinical Cardiac Electrophysiology Fellowship Curriculum: Update 2011” was developed by EP fellowship directors as a compendium of the basic information necessary for the practicing electrophysiologist. The curriculum recommended in this document provides a useful framework for developing a CCEP fellowship curriculum and emphasizes the importance of understanding basic EP (under both normal conditions and disease states) and cardiac anatomy. Important anatomic concepts identified by the document include an understanding of anatomy of the heart with a particular focus on tissues responsible for the normal heart beat (the sinus node, AV node, His bundle and branches), as well as an understanding of the anatomy of the cardiac vascular system, great vessels, and autonomic nervous system. Basic EP understanding requires comprehensive knowledge of the resting membrane potential and action potential for different cardiac tissues as well as an understanding of the molecular, cellular, and tissue basis for heart arrhythmias. In addition to knowledge of arrhythmias in an individual patient, EP training also requires an understanding of arrhythmias at a population level, including overall incidence and prevalence and strategies that can be employed to treat arrhythmias in groups of people.

As emphasized by Table 1, EP abnormalities can develop in specific conditions such as genetic disorders, congenital heart disease, metabolic abnormalities, and systemic diseases. Competency in EP requires an understanding of arrhythmia issues that develop in these and other conditions.

4.4.2. Inherited Arrhythmia Syndromes and Genetic Testing
Heart rhythm specialists are often involved in the initial diagnosis of patients with inherited arrhythmia syndromes and, in many cases, may manage patients with these conditions longitudinally. The trainee must understand the pathophysiological basis of arrhythmias that occur in patients with an inherited arrhythmia syndrome, the ECG findings and other diagnostic features of the syndromes, and the prognosis. The trainee should know the appropriate indication for and limitations of genetic testing and family screening and be familiar with the role of genetic counseling both prior to obtaining genetic tests and in interpreting the test results. The trainee must know the methods to manage these patients including: 1) risk stratification for sudden cardiac death; 2) the indications, efficacy, and limitations of pharmacotherapy; 3) the role of cardiac sympathetic denervation; 4) the indications for device therapy; and 5) recommendation of activity levels, exercise, and participation in competitive sports appropriate to the risks of the inherited disease state.

4.4.3. Bradyarrhythmias
Bradyarrhythmias can be broadly classified as those resulting from abnormal automaticity (usually due to sinus node dysfunction), and those resulting from AV block. EP training should include instruction on the epidemiology, natural history, etiology, anatomy, pathophysiology, and treatment options for both sinus node dysfunction and AV block. For sinus node dysfunction, the different clinical manifestations (eg. sinus pause or exit block, bradycardia-tachycardia syndrome, chronotropic incompetence), the strengths and limitations of different diagnostic strategies (both invasive and noninvasive), and appropriate use of pacing therapy must be understood. Management of AV block requires an
understanding of different clinical manifestations, diagnostic clues and strategies for identifying the anatomic site of block (AV node versus infranodal), the importance of associated conditions (eg, the patient with AV block due to sarcoidosis, the patient with AV block and neuromuscular disease), and appropriate use of CIED therapy (single- versus dual-chamber pacing, special programming algorithms to minimize ventricular pacing, CRT, and defibrillator capabilities).

### 4.4.4. Palpitations and Paroxysmal SVTs
Heart rhythm specialists are frequently involved in the initial or ongoing diagnosis of individuals with unspecified palpitations including suspected paroxysmal SVT. Trainees should understand the differential diagnosis of palpitations, including sustained versus nonsustained arrhythmias, atrial arrhythmias versus VAs, and arrhythmic versus nonarrhythmic etiologies. Trainees should develop approaches for evaluating patients with palpitations and suspected arrhythmias, including appropriately selecting diagnostic modalities such as ECG, ambulatory monitors, exercise stress testing, and EP testing. Trainees should understand the indications for treatment of palpitations and paroxysmal SVT at various stages of diagnosis, including observation, lifestyle modification, medications, and catheter ablation.

### 4.4.5. Supraventricular Tachycardias
The trainee must understand the mechanisms and methods of initiation of different SVTs including ATs, AV nodal re-entrant tachycardia, AF-mediated tachycardias, and junctional tachycardias. The trainee must be able to perform and interpret pacing and mapping techniques to differentiate various forms of SVT including pacing maneuvers and interpretation of drug effects as well as physical maneuvers. The trainee must also gain knowledge in the role and selection of pharmacological therapy to treat SVTs. Knowledge of the techniques, indications, and risks of catheter ablation of SVT must also be acquired. This includes experience with 3-dimensional mapping techniques; techniques for retrograde and trans-septal access; and understanding the underlying anatomy, potential complications, and methods to avoid complications.

### 4.4.6. AF and Atrial Flutter
Comprehensive knowledge of the epidemiology, anatomy, and multifactorial pathophysiology of AF and atrial flutter is essential for CCEP training. It is now evident that patients with atrial arrhythmias represent a diverse group with significant differences in underlying mechanisms and symptoms. It is important that trainees understand the relationship among sleep apnea, obesity, and AF as the relationship concerns both etiology as well as management decisions. The electrophysiologist must have a clear understanding of the natural history of atrial arrhythmias; potential consequences of increased risk for outcomes such as stroke, dementia, cardiomyopathy, heart failure, sudden death, and hospitalizations; and the likelihood of 1 of these adverse outcomes in an individual patient. In particular, the trainee should be familiar with the important and extensive evidence base for the association of atrial arrhythmias and increased risk of stroke and proven therapeutic strategies that can reduce stroke risk in many patients. For oral anticoagulant therapy, an understanding of the individual patient at risk and the different mechanisms and pharmacology of the specific agents that can reduce stroke risk is essential. In addition, appropriate application of this information to an individual patient is essential because the electrophysiologist is often asked to provide a nuanced opinion on best anticoagulant management in difficult cases in patients who are not well represented in clinical trials.

Atrial arrhythmias can be treated with either a rate control or rhythm control strategy. Electrophysiologists must have a comprehensive knowledge of the risks, benefits, and limitations of rate control and rhythm control strategies and be able to explain the risks, benefits, and alternatives to patients and their caregivers in a clear and balanced manner. Initial and serial evaluation of AF will often require diagnostic tests to evaluate arrhythmia burden, adequacy of rate control, and identification of associated cardiac and noncardiac diseases or problems. The best diagnostic strategy often varies from patient to patient. In deciding on a treatment plan, the electrophysiologist must understand and consider different drug therapies, catheter ablation procedures, and surgical options. The mechanisms of action, metabolism, risks, and pharmacology of both rate control and rhythm control medications are an important part of the core curriculum for EP training. The electrophysiologist must be aware of the risks, benefits, and potential adverse outcomes of catheter ablation, surgical procedures, and device therapy in patients with AF. EP training should emphasize the importance of individualized patient-centered care and longitudinal care over extended periods of time. In addition, treatment options for AF are evolving rapidly, and an effective EP training program must have a mechanism to integrate these changes into teaching and clinical practice.

### 4.4.7. VAs and Sudden Cardiac Death
Advanced training in EP includes the development of a comprehensive understanding of the epidemiology, etiology, and mechanisms of VAs and management of patients with VAs or who are at risk for sudden death due to VT and ventricular fibrillation. This includes an understanding of the definition and magnitude of the problem of sudden cardiac death. Trainees must understand the pathophysiological basis and diagnostic and management approaches to patients with VAs, including ventricular premature complexes, nonsustained VT, torsades de pointes, sustained VT, and ventricular fibrillation as well as management of patients resuscitated from and at risk for sudden cardiac death. The trainee must also know how to manage VAs in a broad range of patient populations, including athletes.

Topics that must be mastered include the pathophysiological and genetic basis of inherited arrhythmia syndromes such as long QT syndrome; short QT syndrome; catecholaminergic polymorphic VT; and J-wave syndromes, including Brugada syndrome and early repolarization. The trainee must also understand the concepts of arrhythmia pathophysiology, risk stratification, and management. This will include the assessment and management of patients with cardiomyopathies of either ischemic or nonischemic origin, or other cardiomyopathies, such as hypertrophic cardiomyopathy, arrhythmogenic right ventricular cardiomyopathy, sarcoidosis, amyloidosis, and other infiltrative cardiomyopathies. Trainees should understand when to refer a patient/family to a cardiac geneticist and/or an inherited heart disease center for further evaluation and management. The
trainee should also understand the significance of congenital heart disease in causing cardiac arrhythmias and risk of sudden death, including the effect on clinical decision making for patient management. There must be a rigorous understanding of the pivotal ICD trials for both primary and secondary prevention of sudden cardiac death. Trainees must understand the principles of arrhythmia genesis and understand potential proarrhythmic effects due to drugs, autonomic influences, myocardial ischemia, and electrolyte abnormalities.

The trainee must learn to direct and carry out appropriate testing to diagnose and risk stratify patients. This includes directing diagnostic testing such as imaging (transthoracic and transesophageal echocardiography, CT, and CMR) for the presence of structural heart disease, exercise testing, and coronary angiography. The trainee must also understand the appropriate use of genetic testing, including family testing for inherited arrhythmia syndromes and cardiomyopathies, and be able to interpret results with the assistance of a genetic counselor. Additionally, the trainee must understand the indications for and be able to interpret other noninvasive testing (ie, signal-averaged ECG, short- and long-term ECG monitoring, provocative pharmacological testing) and carry out invasive arrhythmia testing when appropriate (ie, programmed stimulation).

Management of VAs must be mastered in both the acute and chronic settings and tailored to the patient’s individual clinical needs and type of VA. This includes the use of drugs (antiarrhythmic and sympathetic/parasympathetic modulators) with an understanding of their pharmacodynamic and pharmacokinetic effects and the potential for drug–drug and drug–device interactions in the treatment of patients with premature ventricular complexes, nonsustained VT, torsades de pointes, VT, and ventricular fibrillation. The trainee must understand the indications for cardiac sympathetic denervation in primary arrhythmia syndromes cardiomyopathies. The trainee must also understand the indications for, technique of, and complications associated with catheter ablation for treatment of patients with premature ventricular complexes, nonsustained VT, VT, and ventricular fibrillation triggers. The trainee must also know when to advise implantation of an ICD following the assessment of sudden cardiac death risk in patients with VAs and various cardiac diseases.

4.4.8. Syncope
The trainee must acquire the medical knowledge and clinical skills to diagnose and manage patients with syncope. This will include knowledge of the differential diagnosis; approach to diagnosis; and approach to treatment, including risk stratification of patients with syncope.

The trainee will gain an understanding of the classifications of syncope, including vasovagal or neurally-mediated syncope,47 and syncope due to a cardiac arrhythmia, including bradyarrhythmias (sinus bradycardia, AV block) and tachyarrhythmias (SVT and VT). This understanding also includes an appreciation of whether the syncope patient is at risk for sudden cardiac death, such as in the setting of structural heart disease or an inherited arrhythmia syndrome. The trainee will also learn how to evaluate patients with a thorough history, physical examination, and ECG interpretation and to direct appropriate testing for possible structural heart disease or inherited arrhythmia syndrome when indicated. Additionally, the trainee will know the indications for other diagnostic modalities such as short- and long-term ECG monitoring (including ILRs), tilt table testing, and invasive electrophysiological testing.

The trainee must learn to manage patients with neurally-mediated syncope (ie, vasovagal syncope), including the use of lifestyle measures, pharmacological therapies, nonpharmacological interventions (eg, lower-body compression garments), and the appropriate indications for permanent pacing. The trainee will also learn how to manage patients with syncope due to cardiac arrhythmias, including the indications for permanent pacing for bradyarrhythmias, and the use of pharmacological therapy and ablation for specific tachyarrhythmias. The trainee must have an understanding of unusual causes of syncope and also know the causes of postural intolerance, such as postural orthostatic tachycardia syndrome, dysautonomia, and orthostatic hypotension. Finally, the trainee must understand how to identify patients at risk for sudden cardiac death for which an ICD or other therapies may be indicated.

4.5. Nondevice Therapies

4.5.1. Antiarrhythmic Medications
The CCEP trainee should know and understand basic concepts for therapeutic drug delivery of antiarrhythmic medications including pharmacokinetic and pharmacodynamic properties. The trainee should have a thorough understanding of the indications, contraindications, and dosages of commonly used antiarrhythmic medications, including knowledge of drug–drug and drug–device interactions, as well as an understanding of how drug effects and toxicities can differ in specific populations of patients depending on their age, sex, renal function, and drug metabolism. The trainee should also have an understanding of how to follow patients for development of drug side effects and toxicities.

4.5.2. Catheter Ablation
Catheter ablation is an important component of advanced fellowship training in CCEP, allowing effective treatment for many cardiac arrhythmias. The trainee should acquire a thorough understanding of the basic biophysics of radiofrequency, cryoablation, and other ablative energy sources, including the factors that influence how to modify variables that affect ablation lesion size and safety. This includes an in-depth understanding of how to recognize and prevent complications from catheter ablation.

4.5.3. Surgical Ablation
The electrophysiologist must be able to evaluate and manage patients who undergo surgical ablation for arrhythmias. Surgical ablation is currently most commonly performed for the treatment of AF, usually in the context of concomitant cardiac surgery.12 As the management options for patients with AF have expanded over the past decade, surgical ablation options for AF have also broadened to include stand-alone surgical procedures as well as hybrid approaches in which catheter ablation and EP testing are performed in the same setting or at a later date. Surgical ablation may also be utilized for the treatment of VT.
The trainee must know the pathophysiological basis of arrhythmia surgery. This includes an understanding of the surgical approaches that involve the creation of linear lesion sets in the left and right atria to achieve pulmonary vein isolation. A variety of energy sources may be utilized, and the trainee should have an understanding of the biophysics of the available energy sources. The trainee must also know the indications, techniques, and potential complications associated with surgical treatment of cardiac arrhythmias. The trainee must develop the skill to identify patients likely to benefit from surgical treatment of a cardiac arrhythmia and to follow patients after surgery. This includes an understanding of the comparative advantages and disadvantages of different lesion sets and energy sources, including the potential for collateral damage. The trainee should understand both the intraprocedural and standalone surgical options for the management of the left atrial appendage. The trainee must understand the potential for lesion gaps that place the patient at risk for atrial flutter, which may require subsequent catheter ablation.

4.6. Implantable Devices
The electrophysiologist implants a variety of CIEDs, which include ILRs, permanent pacemakers, subcutaneous ICDs, standard ICDs, and CRT devices (pacemaker or defibrillator). Specific requirements are outlined in the following text and include knowledge of the indications for each device and the skills to perform the implantation safely and manage any complications that may arise. The trainee must acquire the skills for procedural planning. This includes preprocedural assessment of hemodynamics, sedation risks, and anticoagulation management. Other preprocedural considerations include venous access and device pocket location (ie, right versus left, prepectoral versus subpectoral). The trainee must also learn to recognize venous or cardiac anomalies (encompassing congenital and postsurgical abnormalities) that may affect procedural techniques, including lead positioning and the need for an epicardial pacing system. The trainee must acquire the procedural skills to implant single- or dual-chamber pacemakers safely, which includes the appropriate use of antibiotic therapy and other procedural measures to avoid infection, hemodynamic collapse, significant bleeding, pneumothorax, or cardiac perforation. The trainee must also be proficient in the safe use of anticoagulants, procedural sedation, techniques to minimize radiation exposure, and techniques to handle suboptimal venous access. Additionally, the trainee must learn to recognize potential complications quickly and be able to initiate appropriate therapy.

The trainee must also acquire all of the programming skills that relate to a particular CIED, including the ability to interrogate (encompassing remote interrogation), program, and troubleshoot devices and direct patient management. Knowledge of the bioengineering aspects of implantable devices and how these devices may be affected by environmental factors is also necessary. The trainee should also be able to manage the CIED patient who may be exposed to environmental electromagnetic interference. Management includes surgical procedures, radiation therapy, and referring the patient for magnetic resonance imaging. The trainee should also be familiar with global systems of device safety monitoring, the practitioner’s role in supporting these safety systems, and protocols to manage patients with devices or leads that are on recall or advisory. The trainee must be able to review interrogations in both the clinic and remote monitoring settings, including having the ability to distinguish VAs from SVTs. Finally, trainees will learn how to manage patients with end-of-life considerations, including decisions about not replacing a device when appropriate.

4.6.1. Pacemakers
The trainee will acquire the knowledge and skills needed for permanent pacing. These include knowledge of the indications for implantation, such as the appropriate device type (single versus dual chamber versus CRT) and the skills to implant and manage patients with permanent pacemakers. The trainee must also attain proficiency in pacemaker programming both at the time of implant and at follow-up. These programming skills should include choice of pacing modes, understanding of timing intervals (including AV delay, blanking, and refractory periods), management of rate response algorithms and sensors, mode switching algorithms, use of auto capture, and programming skills to maintain battery longevity and minimize ventricular pacing for non–CRT pacing systems. Programming skills should also include an understanding of the biophysics of pacing and of the technology of pacing leads and generators. The trainee will also become proficient in troubleshooting pacemaker performance and devising an appropriate management plan, including having the ability to diagnose and determine the root cause for problems such as loss of capture and inappropriate sensing, and to recognize the potential for a pacemaker malfunction or inappropriate lead position based on ECG. Troubleshooting also includes the ability to identify pseudo-malfunction due to vendor-specific pacing algorithms (eg, algorithms that switch between AAI and DDD modes) and other problems such as distinguishing electromagnetic interference from lead fracture or malfunction.

4.6.2. Implantable Cardioverter-Defibrillators
Multiple large clinical trials have demonstrated that ICDs are effective in primary and secondary prevention of sudden death and reduction of total mortality in select populations. Trainees must thoroughly understand the results from clinical trials and registry data as well as how to incorporate professional guidelines with patient-specific factors (including comorbidities and anticipated psychosocial impact of ICDs) to select appropriate ICD candidates. Trainees should gain expertise in selecting the appropriate ICD device, including lead selection and evaluation for subcutaneous ICDs. Technical proficiency in device implantation is required and encompasses laboratory safety (including proper use of diagnostic radiation and electrosurgical instruments), surgical asepsis, sedation strategies, anticoagulation strategies, surgical site/pocket management, vascular entry (including situations with limited or anomalous venous access), lead implantation, lead evaluation (including sensing assessment, threshold testing, and anatomic location by fluoroscopy), and defibrillation testing (including understanding defibrillation waveforms and defibrillation probability curves). It is also important to understand the role of DFT testing, when not to perform DFT testing, and how to use alternate lead configurations and/or device programming to manage patients with a high DFT. The operator must understand ICD-related complications, including how to prevent,
identify, and manage these complications both intraoperatively and long term. Knowledge is required of interrogating and programming ICDs from various manufacturers, both in-person and remotely, including reviewing diagnostic data; analyzing intracardiac electrograms; distinguishing SVTs from VAs; designing long-term follow-up programs; minimizing ventricular pacing if appropriate; performing noninvasive programmed stimulation; troubleshooting; and optimally programming ventricular tachyarrhythmia detection, discrimination, and termination algorithms (to minimize inappropriate shocks and favor antitachycardia pacing over shocks for VT termination). The trainee must understand drug–device and environment–device (electromagnetic) interactions.

4.6.3. Resynchronization Therapy

Multiple large clinical trials have demonstrated that cardiac resynchronization improves quality of life, cardiac performance, and survival in select populations. Trainees must thoroughly understand the results from clinical trials and registry data as well as the recommendations from professional societies; this includes awareness of variables that potentially modify the anticipated response to CRT to reduce the probability of selecting nonresponders. The trainee should develop technical proficiency in CIED implantation, with specific additional skills for CRT, including detailed knowledge of cardiac venous anatomy and expertise in lead placement in the coronary sinus system. The operator must understand CRT-related complications, including how to prevent, identify, and manage these complications both intraoperatively and long term. When anatomy precludes transvenous left ventricular lead placement, the trainee should be familiar with alternative left ventricular lead placement, including the epicardial approach. Trainees should be skilled in managing patients with heart failure and understand how to evaluate, follow-up, and optimize device programming (including AV and interventricular timing) using ECG analysis, device-based algorithms, echocardiography, and/or alternative imaging modalities.

4.6.4. Implantable Loop Recorders

ILRs are increasingly used to detect sporadic arrhythmias. Trainees should thoroughly understand the indications for and considerations in recommending an ILR. The trainee should develop technical proficiency in implanting and explanting ILRs, including monitoring and managing potential complications. Knowledge is required of interrogating and programming ILRs in-person and remotely; this includes correct electrogram analysis and rhythm determination.

4.6.5. Left Atrial Appendage Occlusion/Ligation

Surgical and percutaneous left atrial appendage occlusion represents an emerging alternative strategy to systemic anticoagulation for reducing risk of thromboembolism and stroke in patients with AF. Trainees should be knowledgeable regarding the rationale, indications, technical approach, risks, and complications associated with different left atrial appendage occlusion/ligation strategies. They should be able to identify potential candidates for percutaneous or surgical left atrial appendage occlusion/ligation. Trainees should understand how to manage patients following left atrial appendage occlusion/ligation, including managing anticoagulant and/ or antithrombotic therapy, and evaluating device efficacy long-term. For trainees seeking to perform appendage occlusion procedures, additional technical expertise is required (in some instances as part of a multidisciplinary team), including proficiency in placing and possibly revising the occlusion device; recognizing and managing complications (including expertise in managing pericardial space complications); and interpreting advanced imaging modalities, including CT scanning, fluoroscopy, cine with contrast, and echocardiography.

4.6.6. Lead Management

Trainees should be knowledgeable about strategies to prevent lead- and device-related complications, including during CIED implantation, revision, and generator replacement. Heart rhythm specialists should understand the basic design of leads. Trainees should learn how to track the performance of a wide variety of leads from different manufacturers, monitor individuals with leads under advisory, and diagnose and manage lead failure. Trainees should thoroughly understand the indications for lead extraction and know how to manage patients undergoing extraction perioperatively including those with device infection and/or requiring subsequent CIED therapy. For trainees seeking to perform transvenous lead extraction, additional expertise is required in the technical aspects of the procedure, including exposure as the primary operator to various venous entry sites, extraction tools, and techniques under the direct supervision of an appropriately trained physician. The operator must understand potential complications of lead extraction, including how to prevent, identify, and manage these complications as part of a multidisciplinary extraction team.

5. Evaluation of Proficiency

Evaluation tools in EP include direct observation by instructors, case logs, conference and case presentations, multisource evaluations, trainee portfolios, and simulation. Self-assessment programs are available through the ACC and HRS. Training directors and trainees are encouraged to incorporate these resources in the course of training. Following completion of CCEP training, trainees will be eligible to take the ABIM Board Certification Examination in EP.

Judgement, case management, and bedside and procedural skills must be evaluated in every trainee. Quality of care and follow-up; reliability; judgment or decisions or actions that result in complications; interaction with other physicians, patients, and laboratory support staff; initiative; and the ability to make appropriate decisions independently should be considered. Trainees should maintain records of participation and advancement in the form of a Health Insurance Portability and Accountability Act–compliant electronic database or logbook that meets ACGME reporting standards and summarizes pertinent clinical information (number of cases, diagnoses, disease severity, outcomes, and disposition) for each encounter.

Under the guidance of the program director, faculty should record and verify each trainee’s experiences, assess performance, and document satisfactory achievement. The program director is responsible for confirming experience and competence and reviewing the overall progress of individual trainees with the Clinical Competency Committee to ensure achievement of selected training milestones and identify areas in which additional focused training may be required.
6. Maintenance of Competency

As indicated in the competency table, there are a number of evaluation tools to ensure achievement of the knowledge, skills, and behaviors required for successful completion of CCEP fellowship. It is also important to ensure that learning is a lifelong process and that the core CCEP competencies are maintained over the course of a career. A number of mechanisms can aid in this regard; traditionally, this has included formal ABIM maintenance of EP certification. Individual practitioner outcomes, quality metrics, and peer review can also be important components of demonstration of competency.

For successful graduation from an accredited CCEP training program, a minimum number of various EP procedures has been suggested. Similarly, minimum annual numbers and a blend of procedures have been proposed for assurance of continued competence. It is important to recognize that there is a growing subspecialization career focus within EP, in which some highly skilled practitioners limit the scope of their clinical activity to pacemaker and defibrillator implantation and follow-up, whereas others focus their efforts on complex ablation, and still others do more straightforward ablations (not those that are complex) but have little continuing experience in implantable device work. Thus, although maintenance of some CCEP competencies is an expectation for all clinical cardiac electrophysiologists, the maintenance of other CCEP competencies—and the evaluation tools to assess them—can be career-focused.

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Key Words: AHA Scientific Statements ◼ cardiac arrhythmias ◼ cardiac electrophysiology ◼ cardiac electrophysiology testing ◼ cardiac resynchronization therapy ◼ catheter ablation ◼ clinical competence ◼ fellowship training ◼ implantable defibrillators ◼ lead extraction ◼ pacemakers

### Appendix 1. Author Relationships With Industry and Other Entities (Relevant)—2015 ACC/AHA/HRS Advanced Training Statement on Clinical Cardiac Electrophysiology (A Revision of the ACC/AHA 2006 Update of the Clinical Competence Statement on Invasive Electrophysiology Studies, Catheter Ablation, and Cardioversion)

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ACC indicates American College of Cardiology; AHA, American Heart Association; DSMB, data safety monitoring board; and HRS, Heart Rhythm Society.

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†No financial benefit.

ABIM indicates American Board of Internal Medicine; ACPC, Adult Congenital and Pediatric Cardiology; AIG, Assembly of International Governors; BOG, Board of Governors; BOT, Board of Trustees; CMC, Competency Management Committee; CV, Cardiovascular; EP, Electrophysiology; UCSF, University of California, San Francisco; other abbreviations as in Appendix 1.

### Appendix 3. Abbreviation List

- ABIM = American Board of Internal Medicine
- ACC = American College of Cardiology
- ACGME = Accreditation Council for Graduate Medical Education
- AF = atrial fibrillation
- AHA = American Heart Association
- AP = accessory pathway
- AV = atrioventricular
- CCEP = clinical cardiac electrophysiology
- CIED = cardiac implantable electronic devices
- CMR = cardiovascular magnetic resonance
- COCATS = Core Cardiovascular Training Statement
- CRT = cardiac resynchronization therapy
- CT = computed tomography
- DFT = defibrillation threshold
- ECG = electrocardiogram
- EP = electrophysiology
- HRS = Heart Rhythm Society
- ICD = implantable cardioverter-defibrillator
- ILR = implantable loop recorder
- RWI = relationships with industry
- SVT = supraventricular tachycardia
- VA = ventricular arrhythmia
- VT = ventricular tachycardia


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