

COMPETENCE AND TRAINING STATEMENT

2017 ACC/HRS Lifelong Learning Statement for Clinical Cardiac Electrophysiology Specialists



A Report of the ACC Competency Management Committee

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PREAMBLE

Since publication of its first Core Cardiovascular Training Statement (COCATS) in 1995, the American College of Cardiology (ACC) has defined the knowledge, experiences, skills, and behaviors expected of clinical cardiologists. Subsequent revisions have moved toward competency (outcomes)-based training based on the 6-domain competency structure promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and the American Board of Medical Specialties, and endorsed by the American Board of Internal Medicine (ABIM). The 6 domains include: medical knowledge, patient care and procedural skills, systems-based practice, practice-based learning and

improvement, professionalism, and interpersonal and communication skills. The ACC has taken a similar approach to describe the aligned general cardiology lifelong learning competencies that practicing cardiologists are expected to maintain. Many hospital systems now use the 6-domain structure as part of medical staff privileging, peer review, and professional competence assessments.

Whereas COCATS focuses on general clinical cardiology, ACC Advanced Training Statements define selected competencies beyond those expected of all cardiologists and that require training beyond a standard 3-year cardiovascular disease fellowship. This includes those disciplines for which there is an ABIM added-qualification designation, such as clinical cardiac electrophysiology (CCEP). The Advanced Training Statements describe key experiences and outcomes necessary to maintain or expand competencies during practice, and these are supplemented by additional lifelong learning statements that address the commitment to sustaining and enriching competency over the span of a career.

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 to ensure adequate exposure to the range of clinical disorders and effectively evaluate the trainee, the objective assessment of proficiency and outcomes demonstrates the achievement of competency. Evaluation tools include examinations, direct observation, procedure logbooks, simulation, conference presentations, and multisource (360°) evaluations, among others. For practicing physicians, these tools also include professional society registry or hospital quality data, peer-review processes, and patient satisfaction surveys.

The recommendations in the ACC cardiovascular training statements are based on available evidence and, where evidence is lacking, reflect expert opinion. All documents undergo a rigorous process of peer review and public comment. Recommendations are intended to guide the assessment of competence of cardiovascular care providers beginning independent practice, as well as those undergoing periodic review to ensure that competence is maintained.

The Advanced Training Statement on CCEP addresses the added competencies required of sub-specialists who focus on diagnosis and management of patients with cardiac arrhythmias and conduction disturbances at a high level of skill. The document complements the basic training in cardiac electrophysiology required of all trainees during the standard 3-year cardiovascular fellowship. The training requirements and clinical

competencies designated in the Advanced Training Statement focus on the core competencies reasonably expected of all clinical cardiac electrophysiologists and identify aspects that go beyond the core expectations. These additional competencies may be achieved by some clinical cardiac electrophysiologists either during formal fellowship training or through subsequent training experiences. It should be emphasized that physicians with advanced training and experience in CCEP should maintain a strong foundation in the competencies expected of all clinical cardiologists designated in the [Lifelong Learning Statement for General Clinical Cardiologists](#), including but not limited to the knowledge and skills applicable to cardiologists whose careers focus on CCEP.

This Lifelong Learning Statement complements the Advanced Training Statement on CCEP by focusing on the competencies expected of practicing cardiac electrophysiologists throughout their careers. It also recognizes those competencies that exceed standard expectations and may be achieved and maintained by some cardiac electrophysiologists based on their specific training and practice focus. This document provides examples of appropriate measures for assessing competence in the context of lifelong learning.

The work of the writing committee was supported exclusively by the ACC without commercial support. Writing committee members volunteered their time to this effort. Conference calls of the writing committee were confidential and attended only by committee members. To avoid actual, potential, or perceived conflict of interest arising as a result of relationships with industry (RWI) or other entities of members of the writing committee or peer reviewers of the document, each individual was 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. Based on this information, the writing committee was selected 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. Relevant RWI for authors is disclosed in [Appendix 1](#). To ensure transparency, comprehensive RWI for authors, including RWI not pertinent to this document, is posted [online](#). Peer reviewers, along with their employment information and affiliation in the review process, are shown in [Appendix 2](#). There are no RWI restrictions for participation in peer review, in the interest of encouraging comments from a

variety of constituencies to ensure that broad viewpoints inform final document content. Reviewers are required, however, to disclose all healthcare-related RWI and other entities, and their disclosure information 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 15 members across the United States representing the ACC and the Heart Rhythm Society (HRS), identified because they fit into ≥ 1 of the following roles/categories: cardiovascular training program directors; CCEP training program directors; early-career through mid- and later-career specialists; general cardiologists; CCEP specialists representing both the academic and community-based practice settings as well as small, medium, and large institutions; specialists directing CCEP laboratories; specialists in all aspects of CCEP, including catheter ablation, device management, antiarrhythmic drug therapy, lead extraction, and left atrial appendage management; members working with ABIM and the ACGME; 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 specializing in cardiac implantable electronic devices. The writing committee met the College's disclosure requirements for RWI 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.

The document was reviewed by 5 official representatives from the ACC and HRS, as well as by 29 additional content reviewers ([Appendix 2](#)). The document was simultaneously posted for public comment from July 21, 2017 to August 7, 2017. A total of 235 comments were submitted on the document. 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 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

In 2010, the ACC began an ambitious initiative to delineate: 1) the core clinical competencies essential for trainees to attain during a 3-year cardiovascular fellowship (COCATS 4) (1); and 2) the aligned competencies that patients and accrediting bodies can reasonably expect clinical cardiologists in practice to acquire, maintain, or enhance through lifelong learning throughout their career (2,3). Key features of this outcomes-based curriculum include the 6-domain structure promulgated by the ACGME and the American Board of Medical Specialties, and endorsed by the ABIM. The cardiovascular competencies provide a structure for the ACC learning pathways and underpin all ACC educational activities.

The lifelong learning competencies for general cardiologists were published in 2016 and incorporated the new curricular competency format aligned with the COCATS 4 training milestones (3). Although the COCATS 4 and lifelong learning competencies are similar, they are not identical, reflecting the impact of practice focus and patterns on expectations of competency. Similarly, an advanced training statement on CCEP was published in 2015 (4) and this document now represents the corresponding lifelong learning competencies for CCEP specialists in practice. The aggregated lifelong learning competencies collectively underlie the Entrustable Professional Activities that patients and the public can reasonably expect all competent clinical cardiologists, including subspecialists, to be able to perform (Table 1). This 2017 document represents the first lifelong learning competencies specific to a subspecialty of cardiovascular medicine.

1.2.1. CCEP Lifelong Learning Competencies

The lifelong learning competencies for CCEP are organized using the 6 domains promulgated by ACGME/American Board of Medical Specialties and endorsed by the ABIM (Table 2). Section 2 focuses on clinical competencies, encompassing both the medical knowledge and the patient care and procedural skills competencies related to CCEP identified in Table 3, as well as the professional behavior competencies that pertain to CCEP, describing competencies for systems-based practice, practice-based learning and improvement, interpersonal and communication skills, and professionalism. Section 3

TABLE 1 Entrustable Professional Activities for Subspecialists in Cardiovascular Disease

- **Cardiovascular Consultation**—evaluate, diagnose, and develop treatment plans for patients with known or suspected cardiovascular disease, or who are at risk of developing cardiovascular disease.
- **Acute Cardiac Care**—manage patients with acute cardiac conditions.
- **Chronic Cardiovascular Disease Management**—manage patients with chronic cardiovascular diseases.
- **Cardiovascular Testing**—appropriately utilize cardiovascular diagnostic testing.
- **Disease Prevention and Risk Factor Control**—implement disease prevention and risk factor control measures, addressing comorbidities.
- **Team-Based Care**—work effectively to promote and coordinate interdisciplinary, patient-centered care.
- **Lifelong Learning**—engage in lifelong learning to maintain and enhance knowledge and skills.

Reprinted from COCATS 4 Introduction (5).

of the document focuses on leadership and administrative competencies that pertain to CCEP specialists.

1.2.1.1. Distinction Between Competencies Expected of All CCEP Specialists and Those Required Based on the Focus of Practice

Table 3 distinguishes competency components expected of all CCEP specialists (left column) from those expected of selected CCEP specialists based on background, specialized knowledge, skills, experience, and practice focus (right column). This distinction is particularly relevant to the patient care competencies, which may require clinicians to obtain certain skills and experience beyond the traditional CCEP training period to be considered competent for independent practice. This distinction recognizes the breadth of experiences and practice styles in electrophysiology. Some physicians may specialize in a particular aspect of electrophysiology such as genetic arrhythmias or atrial fibrillation ablation. Others may adopt a less-invasive practice as they enter or continue throughout their career.

TABLE 2 ACGME Core Competencies

- **Patient Care** that is compassionate, appropriate, and effective for treating health problems and promoting health.
- **Medical Knowledge** about established and evolving biomedical, clinical, and cognate (e.g., epidemiological and social-behavioral) sciences and the application of this knowledge to patient care.
- **Practice-Based Learning and Improvement** that involves investigation and evaluation of their own patient care, self-appraisal, and assimilation of scientific evidence, and improvements in patient care.
- **Interpersonal and Communication Skills** that result in effective information exchange and teaming with patients, their families, and other health professionals.
- **Professionalism** as manifested by a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population.
- **Systems-Based Practice** as manifested by actions that demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value.

These minimum general competencies were endorsed by the ACGME in February 1999 (www.acgme.org). All Residency Review Committees and Institutional Review Committees were to include this minimum language in their respective Program and Institutional Requirements by June 2001. The definitions are available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3043418/>.

ACGME indicates Accreditation Council for Graduate Medical Education.

1.2.2. Research and Scholarly Activity

The topic areas in **Table 3** define the core clinical competencies for practicing CCEP specialists. Scholarly activity and clinical research are also important in lifelong learning and professional competency. All physicians should have the skills to assess new research findings and appropriately incorporate new diagnostic and treatment modalities in patient care. In addition, physicians should utilize a scholarly approach to evaluate evidence, address clinical questions, and enhance outcomes through literature review, including at the point of

care. They should use a systematic approach to critically appraise high-quality evidence from a variety of sources to apply a patient-centered approach to optimizing care and outcomes across all settings. Physicians should maintain and enhance knowledge through regular reading of peer-reviewed journals and other sources of reliable information, and through attending scientific meetings and professional congresses. Referral of patients for participation in well-designed clinical trials is encouraged for both academic and nonacademic cardiologists.

2. CLINICAL COMPETENCIES

TABLE 3 Lifelong Learning Competencies for Clinical Cardiac Electrophysiology Specialists

MEDICAL KNOWLEDGE		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
Pathophysiological Basis of Cardiac Arrhythmias/Basic Electrophysiology			
1.	Know normal cardiac anatomy, including the anatomy of the conduction system.	X	
2.	Know basic cardiac electrophysiology, including the currents that drive the action potential.	X	
3.	Know the pathophysiological effects of cardiac arrhythmias.	X	
4.	Know the principles of cardiac impulse propagation and repolarization.	X	
5.	Know the physiology and pathophysiology of the atrioventricular conduction system, the types and associated clinical manifestations of atrioventricular nodal pathways, accessory pathways, and the ECG features of accessory atrioventricular pathways as well as variant pathways.	X	
6.	Know the mechanisms of cardiac arrhythmias including re-entry, triggered activity, and abnormal automaticity, as well as associated triggers such as ischemia, changes in autonomic tone, and drugs.	X	
7.	Know the genetic basis of arrhythmias, including genetically-based ion channel abnormalities and inherited cardiomyopathies, as well as pathophysiology of drug-induced channel malfunction.	X	
8.	Know the epidemiology of arrhythmias.	X	
9.	Know the influences of acquired structural or congenital heart disease in causing cardiac arrhythmias.	X	
10.	Know the principles of cardiac implantable device-mediated proarrhythmia.	X	
11.	Know the systemic disorders and metabolic abnormalities associated with arrhythmias and conduction abnormalities.	X	
Diagnostic Tests			
Noninvasive Diagnostic Tests		All	Practice Focus
12.	Know the methods to interpret surface ECG for the differential diagnosis of cardiac arrhythmias.	X	
13.	Know the indications for ambulatory ECG recordings and the methods to interpret the results.	X	
14.	Know the methods to interpret intracardiac electrogram tracings and other information downloaded from pacemakers, defibrillators, and implanted loop recorders with respect to both arrhythmias and heart failure management.	X	
15.	Know the indications for exercise stress testing, with or without imaging, in the evaluation and management of patients with cardiac arrhythmias.	X	
16.	Know the indications for noninvasive provocative drug testing and exercise testing in the diagnosis and risk assessment of genetic arrhythmia syndromes such as long QT and Brugada syndrome.	X	
17.	Know the influences of modifiable risk factors such as obesity, sleep apnea, and hypertension on arrhythmias and indications for referring patients for additional testing and treatment.	X	

TABLE 3 Lifelong Learning Competencies, continued

MEDICAL KNOWLEDGE		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
18.	Know the indications for transthoracic and transesophageal echocardiography in the management of patients with cardiac arrhythmias.	X	
19.	Know the indications for advanced imaging (cardiovascular computed tomography, cardiovascular magnetic resonance, and positron emission tomography) in the evaluation and management of patients with cardiac arrhythmias.	X	
20.	Know the indications for tilt-table testing and the methods to perform tilt-table testing and interpret the results.	X	
Invasive Electrophysiological Testing		All	Practice Focus
21.	Know the techniques, indications, contraindications, and complications of invasive electrophysiology studies.	X	
22.	Know the principles of obtaining vascular access, multielectrode catheter placement, electrogram recording, and stimulation.	X	
23.	Know the indications for transesophageal echocardiography and intracardiac echocardiography in guiding intracardiac procedures and their associated complications.	X	
24.	Know the general concepts of filters, amplifiers, and signal processors as related to invasive electrophysiological testing.	X	
25.	Know the principles of advanced 3-dimensional mapping systems, including anatomical chamber reconstruction, image integration, and creation and interpretation of electroanatomic activation and voltage/substrate maps.	X	
26.	Know the principles of radiation, electrical, and fire safety in the performance of electrophysiology studies, ablation, or device therapy.	X	
27.	Know the biophysical basis for generation of unipolar and bipolar electrograms, as well as their roles in the diagnosis and treatment of arrhythmias.	X	
28.	Know the methods of programmed electrical stimulation, the roles of provocative drug testing/stimulation, and the characteristic findings in patients with and without arrhythmias or conduction disturbances.	X	
29.	Know pacing protocols to evaluate sinus node and atrioventricular node function and to induce and characterize supraventricular and ventricular arrhythmias, including use of entrainment, activation, and scar-based mapping.	X	
30.	Know the predictive values and limitations of invasive electrophysiology studies in patients with various arrhythmias and clinical syndromes.	X	
Nondevice Therapies			
Antiarrhythmic Medications		All	Practice Focus
31.	Know the indications, contraindications, and clinical pharmacology of antiarrhythmic drugs and sympathetic and parasympathetic agonists and antagonists.	X	
32.	Know the clinical pharmacokinetics and pharmacodynamics of antiarrhythmic medications.	X	
33.	Know the adverse effects of antiarrhythmic drugs, including drug-drug and drug-device interactions and proarrhythmic potential.	X	
Anticoagulant Medications		All	Practice Focus
34.	Know the indications, contraindications, and clinical pharmacology of anticoagulant medications.	X	
35.	Know the clinical pharmacokinetics and pharmacodynamics of anticoagulant medications.	X	
36.	Know the adverse effects of anticoagulant medications, including drug-drug interactions, and methods to reverse effects in the setting of bleeding.	X	

TABLE 3 Lifelong Learning Competencies, continued

MEDICAL KNOWLEDGE		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
Catheter Ablation			
37.	Know the indications, contraindications, expected outcomes, and complications associated with catheter ablation for cardiac arrhythmias.	X	
38.	Know the special considerations for cardiac ablation in adults with congenital heart disease.		X
Surgical Ablation		All	Practice Focus
39.	Know the indications, contraindications, expected outcomes, and complications associated with surgical ablation, including hybrid procedures, for cardiac arrhythmias.	X	
Implantable Devices			
Pacemakers and Implantable Cardioverter-Defibrillators		All	Practice Focus
40.	Know the indications for implantation and testing of a cardiac pacemaker and the methods to select the appropriate pacemaker type and leads for a particular patient for transvenous, epicardial, and leadless technologies, including following any heart valve surgery or intervention.	X	
41.	Know the complications associated with implantation of a cardiac pacemaker and methods to manage those complications for transvenous, epicardial, and leadless technologies.	X	
42.	Know the methods to interrogate, program, and troubleshoot cardiac pacemakers, including the use of remote monitoring.	X	
43.	Know the methods to test for potential interactions of pacing systems with separately implantable electrical devices.	X	
44.	Know the indications for implantation and programming of an implantable cardioverter-defibrillator for primary and secondary prevention of sudden cardiac death.	X	
45.	Know the methods to select the appropriate implantable cardioverter-defibrillator type and leads for a particular patient for both transvenous and subcutaneous technologies.	X	
46.	Know the complications associated with implantation and testing of an implantable cardioverter-defibrillator and the methods to manage them for both transvenous and subcutaneous technologies.	X	
47.	Know the methods to interrogate, program, and troubleshoot implantable cardioverter-defibrillators, including the use of remote monitoring.	X	
48.	Know the methods for perioperative management of cardiac implantable devices during noncardiac surgery and other procedures.	X	
49.	Know the role of a selective conduction system pacing lead.	X	
50.	Know the indications for defibrillation threshold testing.	X	
Resynchronization Therapy		All	Practice Focus
51.	Know the indications for cardiac resynchronization therapy.	X	
52.	Know the complications associated with implantation of a cardiac resynchronization therapy device and the methods to manage those complications.	X	
53.	Know the methods to interrogate, program, optimize, and troubleshoot cardiac resynchronization devices.	X	
Implantable Loop Recorders		All	Practice Focus
54.	Know the indications for, and complications and follow-up of, implantable loop recorders and the methods to interpret the recordings.	X	
55.	Know the methods to interrogate, program, and troubleshoot implantable loop recorders, including the use of remote monitoring.	X	

TABLE 3 Lifelong Learning Competencies, continued

MEDICAL KNOWLEDGE		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
Noninvasive Device Therapy			
56.	Know the indications for, and complications and follow-up of, wearable defibrillators.	X	
Left Atrial Appendage Management		All	Practice Focus
57.	Know the indications, contraindications, and complications associated with left atrial appendage management.	X	
58.	Know the methods to perform appendage occlusion and manage complications of this procedure.		X
Lead Management		All	Practice Focus
59.	Know the methods for diagnosing and managing lead failure.	X	
60.	Know the indications and complications of lead extraction, including the risks/benefits when managing lead failure and infected cardiac implantable electronic devices.	X	
61.	Know the methods to perform lead extraction and manage complications of this procedure.		X
Arrhythmia Types and Syndromes			
Bradyarrhythmias and Atrioventricular Block		All	Practice Focus
62.	Know the pathophysiological basis of sinus node dysfunction and atrioventricular block.	X	
63.	Know the methods to diagnose and manage sinus node dysfunction and atrioventricular block (acquired and congenital).	X	
Atrial Fibrillation and Atrial Flutter		All	Practice Focus
64.	Know the pathophysiological basis of atrial fibrillation and atrial flutter.	X	
65.	Know the methods to diagnose atrial fibrillation and atrial flutter.	X	
66.	Know the methods to assess the risk of stroke and bleeding in patients with atrial fibrillation and atrial flutter.	X	
67.	Know when to prescribe oral anticoagulation in the setting of atrial fibrillation and flutter.	X	
68.	Know when to prescribe rate control medications and the methods for dosing.	X	
69.	Know when to recommend ablation of the atrioventricular node for rate control.	X	
70.	Know when to prescribe antiarrhythmic medications for rhythm control strategies and the methods for dosing.	X	
71.	Know the indications and techniques for electrical and pharmacological cardioversion.	X	
72.	Know the indications and principles of catheter and surgical ablation of atrial fibrillation and atrial flutter.	X	
73.	Know the methods to recognize and manage the post-procedural complications associated with catheter ablation of atrial fibrillation and atrial flutter.	X	
Other Supraventricular Tachycardias		All	Practice Focus
74.	Know the pathophysiological basis of and the methods to distinguish atrial tachycardia, junctional tachycardia, atrioventricular nodal re-entrant tachycardia, and accessory pathway-mediated tachycardia and the associated risks of each arrhythmia.	X	
75.	Know both invasive and noninvasive methods for risk stratification of sudden death in patients with pre-excitation.	X	
76.	Know the indications for and selection of drug therapy for patients with atrial tachycardia, junctional tachycardia, atrioventricular nodal re-entrant tachycardia, and accessory pathway-mediated tachycardia.	X	

TABLE 3 Lifelong Learning Competencies, continued

MEDICAL KNOWLEDGE		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
77.	Know the indications and principles of catheter ablation for treatment of patients with atrial tachycardia, junctional tachycardia, atrioventricular nodal re-entrant tachycardia, and accessory pathway-mediated tachycardia.	X	
78.	Know the methods to recognize and manage the post-procedural complications associated with catheter ablation of atrial tachycardia, junctional tachycardia, atrioventricular nodal re-entrant tachycardia, and accessory pathways.	X	
79.	Know the symptoms and criteria for diagnosis of inappropriate sinus tachycardia and postural orthostatic tachycardia syndrome and how to distinguish from other supraventricular tachycardias, such as atrial tachycardia.	X	
80.	Know the methods to diagnose and manage patients with inappropriate sinus tachycardia and postural orthostatic tachycardia syndrome.	X	
Inherited Arrhythmia Syndromes and Genetic Testing		All	Practice Focus
81.	Know the pathophysiological and genetic basis of arrhythmias that occur in patients with an inherited arrhythmia syndrome/cardiomyopathy.	X	
82.	Know the methods to diagnose inherited arrhythmia syndromes, including the roles and limitations of genetic testing and importance of family screening.	X	
83.	Know the methods to manage patients with inherited arrhythmia syndromes, including the indications for genetic counseling, pharmacotherapy, ablation, cardiac sympathetic denervation, and device therapy.		X
Arrhythmogenic Cardiomyopathies		All	Practice Focus
84.	Know the methods to diagnose and manage arrhythmogenic cardiomyopathies, including infiltrative diseases such as sarcoidosis and amyloidosis, and the appropriate imaging and laboratory testing.	X	
Ventricular Arrhythmias and Sudden Cardiac Death		All	Practice Focus
85.	Know the definition and magnitude of the problem of sudden cardiac arrest/death.	X	
86.	Know the pathophysiological basis, diagnosis, and management of patients with ventricular arrhythmias, including premature ventricular complexes, nonsustained ventricular tachycardia, <i>torsades de pointes</i> , sustained ventricular tachycardia, and ventricular fibrillation.	X	
87.	Know the pathophysiological basis, diagnosis, and management of patients with pulseless electrical activity and atrioventricular block/asystole.	X	
88.	Know acute and long-term management strategies for patients with aborted sudden cardiac arrest.	X	
89.	Know when to recommend drug therapy for patients with ventricular arrhythmias and the choice of antiarrhythmic drugs for particular patients.	X	
90.	Know the indications and techniques for electrical and pharmacological cardioversion and defibrillation.	X	
91.	Know the indications, contraindications, and complications associated with catheter ablation of ventricular arrhythmias, including epicardial ablation.	X	
92.	Know the methods to perform catheter ablation of ventricular arrhythmias, including epicardial ablation.		X
93.	Know the methods to recognize and manage the post-procedural complications associated with catheter ablation of ventricular arrhythmias.	X	
94.	Know the methods to determine sudden cardiac death risk and the indications for implantable cardioverter-defibrillators in patients with sustained ventricular arrhythmias or at risk for development of sustained ventricular arrhythmias.	X	
95.	Know the methods to assess sudden death risk and manage ventricular arrhythmias in athletes.	X	
96.	Know the utility of hemodynamic support for ventricular arrhythmias during complex ablations.	X	

TABLE 3 Lifelong Learning Competencies, continued

MEDICAL KNOWLEDGE		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
Syncope			
97.	Know the differential diagnosis of syncope.	X	
98.	Know the methods to determine the cause of syncope, including the role of the clinical history, ECG, noninvasive arrhythmia monitoring, implantable loop recorder, cardiac imaging, electrophysiology testing, and autonomic and tilt-table testing.	X	
99.	Know the methods to treat patients with syncope, including vasovagal syncope and syncope resulting from cardiac arrhythmias.	X	
PATIENT CARE AND PROCEDURAL SKILLS		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
Patient Consultation and Management			
1.	Skill to perform a comprehensive clinical evaluation (consultation) for patients with manifest or suspected cardiac arrhythmias or conduction disturbances and to establish an appropriate evaluation and management plan in both outpatient and inpatient settings.	X	
Diagnostic Tests			
Noninvasive Diagnostic Tests		All	Practice Focus
2.	Skill to appropriately utilize and interpret electrocardiography and ambulatory monitoring in the evaluation and management of patients with suspected cardiac arrhythmias and inherited arrhythmia syndromes.	X	
3.	Skill to appropriately utilize and interpret exercise stress testing in the evaluation and management of patients with arrhythmias.	X	
4.	Skill to appropriately utilize the results of transthoracic and transesophageal echocardiography in the evaluation and management of patients with arrhythmias.	X	
5.	Skill to appropriately utilize the results of advanced imaging (cardiovascular computed tomography, cardiovascular magnetic resonance, and positron emission tomography) in the evaluation and management of cardiac arrhythmias.	X	
Invasive Electrophysiological Testing		All	Practice Focus
6.	Skill to appropriately select patients for electrophysiology testing.	X	
7.	Skill to place sheaths in the central venous system using anatomic landmarks and/or ultrasound imaging.	X	
8.	Skill to place sheaths in the femoral arteries using anatomic landmarks and/or ultrasound imaging.	X	
9.	Skill to place sheaths in the epicardial space.		X
10.	Skill to place and manipulate electrode catheters in the right atrium, right ventricle, coronary sinus, and His bundle area.	X	
11.	Skill to accurately measure and assess conduction intervals and refractory periods during programmed electrical stimulation.	X	
12.	Skill to use intracardiac recordings to determine activation sequence and to interpret the responses to pacing techniques including entrainment.	X	
13.	Skill to appropriately perform intracardiac echocardiography in the evaluation and management of patients with arrhythmias.		X
14.	Skill to use advanced 3-dimensional mapping systems, including anatomical chamber reconstruction, image integration, and electroanatomic activation and voltage maps, in the management of patients with cardiac arrhythmias.		X
15.	Skill to appropriately utilize and monitor sedation during procedures.	X	

TABLE 3 Lifelong Learning Competencies, continued

PATIENT CARE AND PROCEDURAL SKILLS		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
16.	Skill to identify patients in whom general anesthesia should be considered for electrophysiology procedures.	X	
17.	Skill to maintain appropriate hemodynamics of the patient during invasive electrophysiological procedures.	X	
18.	Skill to minimize and recognize procedural complications.	X	
19.	Skill to integrate the findings from invasive electrophysiological testing with clinical and other testing results in the management of patients with arrhythmias or conduction disturbances.	X	
20.	Skill to apply diagnostic pacing maneuvers to distinguish among different forms of supraventricular tachycardia and in assessment of ventricular tachycardia.	X	
21.	Skill to limit radiation exposure to the patient and the staff.	X	
Nondevice Therapies			
Antiarrhythmic Medications		All	Practice Focus
22.	Skill to prescribe and monitor antiarrhythmic drug therapy for treatment of patients with cardiac arrhythmias.	X	
23.	Skill to manage patients with a proarrhythmic response to antiarrhythmic drug therapy or side effects to antiarrhythmic drugs.	X	
Anticoagulant Medications		All	Practice Focus
24.	Skill to prescribe and monitor the appropriate anticoagulant medication or reversal agent, if available, for a particular patient or situation.	X	
25.	Skill to manage perioperative anticoagulation in patients who have been taking anticoagulant medications.	X	
Catheter Ablation		All	Practice Focus
26.	Skill to perform ablation therapy in patients with atrioventricular nodal re-entrant tachycardia, atrial tachycardia, cavotricuspid isthmus-dependent atrial flutter, and accessory pathway-mediated arrhythmias.		X
27.	Skill to perform ablation therapy in patients with atrial fibrillation.		X
28.	Skill to perform ablation therapy in patients with noncavotricuspid isthmus-dependent atrial flutter.		X
29.	Skill to identify appropriate candidates for and assess risk/benefit of epicardial approach to ventricular tachycardia ablation.	X	
30.	Skill to perform ablation therapy in patients with idiopathic premature ventricular complexes and/or ventricular tachycardia.		X
31.	Skill to recognize patients who experience a complication during and/or following catheter ablation.	X	
32.	Skill to perform epicardial ventricular tachycardia ablation.		X
33.	Skill to introduce sheaths and catheters into the left atrium via a patent foramen ovale or trans-septal puncture to perform mapping and ablation.		X
34.	Skill to access the aortic root, great vessels, and/or left ventricle using a retrograde aortic or transseptal approach.		X
35.	Skill to utilize cardiovascular magnetic resonance, cardiovascular computed tomography, and/or intracardiac echocardiography to facilitate invasive electrophysiology testing, intracardiac mapping, and catheter ablation.		X
36.	Skill to perform ablation for scar-based atrial and ventricular arrhythmias.		X
37.	Skill to perform invasive electrophysiology studies and ablation therapy in adult patients with repaired or unrepaired congenital heart disease.		X
38.	Skill to manage patients who experience a complication during and/or following catheter ablation.		X

TABLE 3 Lifelong Learning Competencies, continued

PATIENT CARE AND PROCEDURAL SKILLS		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
Surgical Ablation			
39.	Skill to recognize complications in patients who have undergone surgical treatment of cardiac arrhythmias.	X	
40.	Skill to obtain and interpret intraoperative maps of cardiac arrhythmias.		X
Implantable Devices			
Pacemakers and Implantable Cardioverter-Defibrillators		All	Practice Focus
41.	Skill to appropriately select, interrogate, program, and follow pacemakers and implantable cardioverter-defibrillators in clinic and remotely.	X	
42.	Skill to implant and test pacemakers (including leadless) and implantable cardioverter-defibrillators (including subcutaneous).		X
43.	Skill to implant pacemakers and implantable cardioverter-defibrillators in adult patients with congenital heart disease.		X
44.	Skill to selectively pace the conduction system or perform targeted cardiac stimulation.		X
45.	Skill to identify and manage complications associated with pacemaker and cardioverter-defibrillator implantation.	X	
46.	Skill to evaluate and manage patients with all cardiac implantable electronic devices who have been referred for a cardiovascular magnetic resonance study.	X	
47.	Skill to identify patients in whom general anesthesia should be considered for cardiac implantable electronic device procedures.	X	
48.	Skill to identify appropriate patients for subcutaneous implantable cardioverter-defibrillators.	X	
49.	Skill to pace-terminate arrhythmias at the bedside.	X	
50.	Skill to manage cardiac implantable electronic devices intraoperatively and perioperatively.	X	
51.	Skill to tunnel cardiac implantable electronic device leads.		X
52.	Skill to manage compromised or occluded vascular access, including venoplasty.		X
53.	Skill to remove and replace pacemaker and implantable cardioverter-defibrillator pulse generators.		X
54.	Skill to perform defibrillation testing.		X
Resynchronization Therapy		All	Practice Focus
55.	Skill to appropriately select, interrogate, program, and assess response while following cardiac resynchronization therapy devices.	X	
56.	Skill to implant and test cardiac resynchronization therapy devices at the time of implantation.		X
57.	Skill to identify complications associated with cardiac resynchronization therapy device implantation.	X	
58.	Skill to minimize and manage complications associated with cardiac resynchronization therapy device implantation.		X
Implantable Loop Recorders		All	Practice Focus
59.	Skill to insert implantable loop recorders.	X	
60.	Skill to interrogate and manage patients who have undergone implantable loop recorder placement.	X	
61.	Skill to explant implantable loop recorders.	X	

TABLE 3 Lifelong Learning Competencies, continued

PATIENT CARE AND PROCEDURAL SKILLS		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
Left Atrial Appendage Management			
62.	Skill to identify patients for whom left atrial appendage management is appropriate.	X	
63.	Skill to place a left atrial appendage occlusion device, including recognition and management of complications.		X
Lead Management		All	Practice Focus
64.	Skill to identify anatomic lead location on the basis of fluoroscopic or x-ray image.	X	
65.	Skill to manage patients with lead failure in the outpatient setting.	X	
66.	Skill to manage patients with a cardiac implantable electronic device infection.	X	
67.	Skill to perform lead extraction.		X
68.	Skill to perform peripheral and/or coronary sinus venoplasty.		X
69.	Skill to perform snaring techniques.		X
Arrhythmia Types and Syndromes			
Bradyarrhythmias and Atrioventricular Block		All	Practice Focus
70.	Skill to diagnose and manage patients with bradyarrhythmias, including sinus node dysfunction, atrioventricular block, and ventricular asystole.	X	
Atrial Fibrillation and Atrial Flutter		All	Practice Focus
71.	Skill to diagnose and manage patients with atrial fibrillation and flutter, including use of anticoagulation and rate and rhythm control.	X	
72.	Skill to perform electrical and pharmacological cardioversion and manage complications.	X	
Inherited Arrhythmia Syndromes and Genetic Testing		All	Practice Focus
73.	Skill to recognize an inherited arrhythmia syndrome/cardiomyopathy and/or to refer patients to physicians/programs who have this expertise.	X	
74.	Skill to manage patients with inherited arrhythmia syndromes/cardiomyopathies.		X
75.	Skill to interpret the results of genetic testing.		X
76.	Skill to discuss lifestyle modifications and sports participation in patients with inherited arrhythmia syndromes.	X	
Ventricular Arrhythmias and Sudden Cardiac Death		All	Practice Focus
77.	Skill to evaluate and manage patients at risk for sudden cardiac arrest.	X	
78.	Skill to evaluate and manage patients with ventricular arrhythmias, including premature ventricular complexes, nonsustained ventricular tachycardia, <i>torsades de pointes</i> , sustained ventricular tachycardia, and ventricular fibrillation.	X	
79.	Skill to perform electrical and pharmacological cardioversion and defibrillation and manage complications.	X	
Syncope		All	Practice Focus
80.	Skill to evaluate and manage patients with syncope.	X	
81.	Skill to differentiate and manage patients with autonomic dysfunction.		X
Other Conditions Associated With Cardiac Arrhythmias		All	Practice Focus
82.	Skill to evaluate arrhythmias in patients with conditions such as sarcoidosis, myocarditis, and other systemic diseases.	X	

TABLE 3 Lifelong Learning Competencies, continued

SYSTEMS-BASED PRACTICE		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
1.	Use hospital data and available registries to assess appropriateness, performance, and safety of procedures in the management of arrhythmia patients.	X	
2.	Use device databases to manage device advisories and device follow-up.	X	
3.	Work effectively with the multidisciplinary electrophysiology team to enhance safety and efficiency while managing cost.	X	
4.	Incorporate risk/benefit analysis and cost considerations in diagnostic and treatment decisions, including the adoption of new technologies.	X	
5.	Work as part of a multidisciplinary team to provide safe and effective transitions of care within and across healthcare systems.	X	
PRACTICE-BASED LEARNING AND IMPROVEMENT		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
1.	Identify one's own knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.	X	
2.	Skill to conduct literature searches, interpret data, and apply results to clinical care.	X	
3.	Develop the practice of lifelong learning, including regular review of cardiology and clinical cardiac electrophysiology journals, updated practice guidelines, consensus documents, and appropriate use criteria, as well as attending appropriate scholarly meetings.	X	
4.	Learn and improve via feedback and performance audit.	X	
PROFESSIONALISM		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
1.	Practice within the scope of personal expertise and technical skills.	X	
2.	Demonstrate sensitivity to patient preferences and end-of-life decisions.	X	
3.	Accept responsibility and follow through on tasks.	X	
4.	Demonstrate high ethical standards, including the recognition and management of overt and subtler potential conflicts of interest, when making diagnostic or therapeutic decisions.	X	
5.	Skill to enhance occupational health and safety through minimizing radiation exposure and reducing risk of chronic spine injury.	X	
INTERPERSONAL AND COMMUNICATION SKILLS		All CCEP Specialists	Selected CCEP Specialists Based on Practice Focus
1.	Communicate effectively with patients, families, and interprofessional teams across a broad range of cultural, ethnic, and socioeconomic backgrounds including those from underserved communities.	X	
2.	Engage in shared decision-making with patients, including options for diagnosis and treatment.	X	
3.	Provide test results and interpretations to healthcare providers and patients in a timely fashion.	X	

ECG indicates electrocardiogram.

3. LEADERSHIP AND ADMINISTRATIVE COMPETENCIES

In addition to clinical competency, CCEP specialists are expected to function effectively as leaders in allied efforts to ensure high-quality care and promote individual and population health. Some of these activities and attributes fall outside the realm of clinical knowledge and skill and instead involve administrative roles in clinical practice, hospitals, health systems, professional societies, or other organizations. Specific competencies expected of all general cardiologists and cardiovascular specialists including those whose careers involve greater involvement in administrative, managerial, or advocacy positions are delineated in Table 24 of the 2016 ACC Lifelong Learning Competencies for General Cardiologists (3).

4. MAINTENANCE OF COMPETENCE AND ASSESSMENT TOOLS

Continuing practice of CCEP requires ongoing maintenance of competency beyond original training. The requirements for training as a specialist in CCEP are delineated in the 2015 Advanced Training Statement on CCEP, including the specific competencies required to achieve competence as well as recommendations for minimum procedural volume to demonstrate competence in CCEP (4). As practitioners continue in their careers beyond initial training, it is recognized that many practice opportunities and challenges will exist. As such, prescribing specific numerical requirements to any particular procedure is problematic, as patterns of practice vary from individual to individual as well as during the lifelong practice of CCEP. However, the CCEP specialist should be familiar with the literature that has related improved outcomes with specific procedural volume and, where appropriate, use these data to guide assessment of procedural skills (6-15).

In addition, there are a number of ways that CCEP specialists can maintain competency and expand lifelong learning in the course of practice and assess their own professional needs for education and performance improvement. Objective evaluation of competence in the practice setting can be challenging, but can be achieved through a number of assessment tools and learning resources that are available for this purpose and applicable to all CCEP specialists. These include:

- Demonstrate successful completion of a dedicated CCEP training program.

- Obtain ABIM certification following completion of CCEP training.
- Maintain certification with participation in a Maintenance of Certification process.
- Participate in ongoing Continuing Medical Education programs.
- Participate in Quality of Care Measures in hospital databases and national registries (e.g., ACC's National Cardiovascular Data Registry) including procedure-specific registries where they apply.
- Experts in particular aspects of CCEP (e.g., device implantation or atrial fibrillation ablation) should perform an adequate annual volume to maintain skills and, where possible, provide their results for open scrutiny in the appropriate national databases.
- For new technologies and procedures, obtain adequate training through coursework, proctoring, and simulation laboratories.

Importantly, there is a growing subspecialization career focus within CCEP, 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 device-related procedures. Thus, although maintenance of some CCEP competencies is an expectation for all clinical cardiac electrophysiologists, the maintenance of select CCEP competencies and the evaluation tools to assess them can be career focused.

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REFERENCES

1. Williams ES, Halperin JL, Fuster V. ACC 2015 core cardiovascular training statement (COCATS 4) (revision of COCATS 3): a report of the ACC Competency Management Committee. *J Am Coll Cardiol*. 2015;65:1721-3.
2. Calkins H, Awtry EH, Bunch TJ, et al. COCATS 4 task force 11: training in arrhythmia diagnosis and management, cardiac pacing, and electrophysiology. *J Am Coll Cardiol*. 2015;65:1854-65.
3. Williams ES, Halperin JL, Arrighi JA, et al. 2016 ACC lifelong learning competencies for general cardiologists: a report of the ACC Competency Management Committee. *J Am Coll Cardiol*. 2016;67:2656-95.
4. Zipes DP, Calkins H, Daubert JP, et al. 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). *J Am Coll Cardiol*. 2015;66:2767-802.
5. Halperin JL, Williams ES, Fuster V. COCATS 4 introduction. *J Am Coll Cardiol*. 2015;65:1724-33.
6. Al-Khatib SM, Lucas FL, Jollis JG, Malenka DJ, Wennberg DE. The relation between patients' outcomes and the volume of cardioverter-defibrillator implantation procedures performed by physicians treating Medicare beneficiaries. *J Am Coll Cardiol*. 2005;46:1536-40.
7. Curtis AB, Ellenbogen KA, Hammill SC, et al. Clinical competency statement: training pathways for implantation of cardioverter defibrillators and cardiac resynchronization devices. *Heart Rhythm*. 2004;1:371-5.
8. Curtis JP, Luebbert JJ, Wang Y, et al. Association of physician certification and outcomes among patients receiving an implantable cardioverter-defibrillator. *JAMA*. 2009;301:1661-70.
9. Deshmukh A, Patel NJ, Pant S, et al. In-hospital complications associated with catheter ablation of atrial fibrillation in the United States between 2000 and 2010: analysis of 93 801 procedures. *Circulation*. 2013;128:2104-12.
10. Freeman JV, Wang Y, Curtis JP, Heidenreich PA, Hlatky MA. Physician procedure volume and complications of cardioverter-defibrillator implantation. *Circulation*. 2012;125:57-64.
11. Kirkfeldt RE, Johansen JB, Nohr EA, Jorgensen OD, Nielsen JC. Complications after cardiac implantable electronic device implantations: an analysis of a complete, nationwide cohort in Denmark. *Eur Heart J*. 2014;35:1186-94.
12. Krahn AD, Lee DS, Birnie D, et al. Predictors of short-term complications after implantable cardioverter-defibrillator replacement: results from the Ontario ICD database. *Circ Arrhythm Electrophysiol*. 2011;4:136-42.
13. Tracy CM, Akhtar M, DiMarco JP, et al. American College of Cardiology/American Heart Association 2006 update of the clinical competence statement on invasive electrophysiology studies, catheter ablation, and cardioversion: a report of the American College of Cardiology/American Heart Association/American College of Physicians Task Force on Clinical Competence and Training developed in collaboration with the Heart Rhythm Society. *J Am Coll Cardiol*. 2006;48:1503-17.
14. Wazni O, Epstein LM, Carrillo RG, et al. Lead extraction in the contemporary setting: the LExCon study: an observational retrospective study of consecutive laser lead extractions. *J Am Coll Cardiol*. 2010;55:579-86.
15. Wilkoff BL, Love CJ, Byrd CL, et al. Transvenous lead extraction: Heart Rhythm Society expert consensus on facilities, training, indications, and patient management. *Heart Rhythm*. 2009;6:1085-104.

KEY WORDS ACC/HRS Competency Statement, cardiac arrhythmias, cardiac electrophysiology, cardiac electrophysiology testing, cardiac resynchronization therapy, catheter ablation, clinical competency, implantable defibrillators, lead extraction, lifelong learning, maintenance of competence, pacemakers

**APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—2017
 ACC/HRS LIFELONG LEARNING STATEMENT FOR CLINICAL CARDIAC ELECTROPHYSIOLOGY
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Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
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*Significant relationship.

†No financial benefit.

ACC = American College of Cardiology; CCEP = clinical cardiac electrophysiology; DSMB = data and safety monitoring board; HRS = Heart Rhythm Society.

APPENDIX 2. PEER REVIEWER INFORMATION—2017 ACC/HRS LIFELONG LEARNING STATEMENT FOR CLINICAL CARDIAC ELECTROPHYSIOLOGY SPECIALISTS

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ACC = American College of Cardiology; AHA = American Heart Association; CCEP = clinical cardiac electrophysiology; EP = electrophysiology; and HRS = Heart Rhythm Society.

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

CCEP = clinical cardiac electrophysiology

COCATS = Core Cardiovascular Training Statement

HRS = Heart Rhythm Society

RWI = relationships with industry