ACC 2015 Core Cardiovascular Training Statement (COCATS 4) (Revision of COCATS 3)

A Report of the ACC Competency Management Committee

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‖‖Dr. Lauer participated in this work as part of his official Federal duties. However, the opinions expressed in this paper do not necessarily reflect the official positions of the NHLBI, the NIH, or the U.S. Department of Health and Human Services.

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COCATS 4 Introduction[1]

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1. Evolution of Training Recommendations for Specialists in Adult Cardiovascular Medicine

Recommendations for training in adult cardiovascular medicine were first published in the *Journal of the American College of Cardiology* in 1995 as a consensus statement emanating from the Core Cardiology Training Symposium (COCATS) held at Heart House in Bethesda, Maryland the previous year (1). The term “COCATS” has since been used when referring to the American College of Cardiology (ACC) curriculum recommendations for fellowship programs and has come to designate the Core Cardiology Training Statement (rather than the symposium). The 1995 recommendations were contained in 10 Task Force reports covering overall training in clinical cardiology and specialized areas of cardiovascular medicine. As advances in cardiovascular science and technology evolved, training recommendations were revised extensively in 2002 and published as “COCATS 2” (2). In that iteration, the 10 original Task Force reports were updated and additional reports were developed that addressed training recommendations in the areas of vascular medicine, catheter-based peripheral vascular interventions, and cardiovascular magnetic resonance imaging. Subsequent evolution necessitated further revisions, and training recommendations for cardiac electrophysiology and cardiac computed tomography were first published in 2006 as an update to COCATS 2 (3) and then as a full revision (COCATS 3) in 2008 (4). As in previous COCATS documents, the terms “fellow” and “trainee” are used interchangeably, as are “cardiovascular medicine” and “cardiology.”

2. Oversight of Postgraduate Education for Specialists in Cardiovascular Medicine

Regulatory oversight of training in internal medicine and its subspecialties is provided by the Accreditation Council for Graduate Medical Education (ACGME) and its Internal Medicine Residency Review Committee. The ACGME establishes both common and subspecialty-specific program requirements regarding training duration, institutional infrastructure, faculty leadership and clinician educators, and training environment and safety, as well as the minimum requirements for program content. Whereas the ACGME accredits training programs, the American Board of Internal Medicine (ABIM) certifies individuals as specialists in Cardiovascular Disease. Successful

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completion of training in a program with ACGME accreditation is a requirement to sit for the ABIM Cardiovascular Disease certifying exam. Although ACGME, ABIM, and ACC represent independent organizations, their alignment on training standards is important; and COCATS has been an important contributor to the development of the training requirements for Cardiovascular Disease. COCATS provides additional curricular content detail beyond the ACGME minimum requirements for general cardiovascular disease to define progressive levels of skill and competency in designated areas.

Over the past several years, there has been a progressive move toward competency-based training, the key characteristic of which is evaluation focused on specific learner outcomes. The central requirements of such training are to delineate the specific components of competency within the subspecialty, define the tools necessary to assess training, and establish milestones that should be met as fellows progress toward independence. This evolution is manifested in COCATS 4, including the overarching 6-domain structure (Table 1) promulgated by the ACGME/American Board of Medical Specialties (ABMS) and endorsed by ABIM (5).

Table 1. 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 involve investigation and evaluation of a fellow's 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) and 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 = Accreditation Council for Graduate Medical Education.

These competencies should be interpreted, developed, and evaluated in the context of subspecialty training, recognizing that more basic competencies in these domains will or should have been acquired during residency training in internal medicine, a prerequisite for cardiovascular fellowship. Furthermore, maintenance of core competencies over the course of one's professional career is as important as initial competency acquisition.

Each COCATS Task Force Report that follows covers a specific field of competency in cardiovascular disease, includes curricular content (milestones) within each domain, and lists potential evaluation tools. It is important to emphasize several points regarding the competency tables that accompany each Task Force Report. First, each curricular milestone need not be independently evaluated or documented by a formal outcome measure; rather, representative components may be assessed, or in some cases assessed in aggregate. Second, the curricular milestones underpin the more global ACGME/ABIM reporting milestones (6); the ACC will also provide tools to facilitate mapping of the relevant curricular competencies that support achievement of the more global ACGME/ABIM reporting milestones. This is intended to help training program directors respond to this reporting requirement. Third, the 12-, 24-, 36-month designations that appear in each competency table are intended as a roadmap for a typical fellow, helping evaluators determine whether an individual fellow is progressing on-track toward independent competency. Training programs vary widely in their sequencing of educational experiences, and fellows vary in the pace at which they achieve competency. The time estimates are simply examples and may, therefore, not apply to all programs or trainees. Variability is expected and acceptable, as long as programs provide mechanisms to assess the development of key competencies over time. A supplement to this document gathers all of the tables in a compendium (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF1_Competency_Tables_Supplement.pdf).

The aggregated competencies described in COCATS 4 form the basis for the overarching Entrustable Professional Activities (EPAs) of our profession; namely, those activities that patients and the public expect all competent clinical cardiologists can perform (Table 2).

Table 2. Entrustable Professional Activities for Subspecialists in Cardiovascular Disease

- **Cardiovascular Consultation –** evaluate, diagnose, and develop treatment plans for patients with known, suspected, or 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 testing
- **Disease Prevention and Risk Factor Control** – implement disease prevention and risk factor control measures, addressing comorbidities
- **Team-Based Care** – work effectively to promote patient-centered interdisciplinary team-based care
- **Lifelong Learning –** engage in lifelong learning

Some human resource professionals draw a distinction between the terms “competence” and “competency,” using “competence” to describe the actions necessary to perform a function optimally (concerned with effect and output rather than effort and input), and “competency” to describe the behaviors that lie behind optimum performance, such as critical thinking and analytical skills (describing what individuals bring to the profession). Because performance requires a combination of behavior, attitude, and action, the 2 terms are used interchangeably in the Task Force reports.

3. Revision of Training Components Since Earlier Iterations of COCATS

This iteration of COCATS contains a number of structural changes in the cardiovascular curriculum since the recommendations issued in 2008. There is a substantially stronger focus on ambulatory, consultative, and longitudinal care, reflecting a commitment to patient-centric education in clinical cardiology. The intent is that training of the cardiologist as a consultant with a longitudinal commitment to the care of the patient be pervasive throughout the 3-year general cardiology fellowship. The curriculum also includes a requirement that continuity clinics be integrated with service rotations in specialized fields such as heart failure, congenital heart disease, geriatric cardiology, and arrhythmias to encompass training in this context.

Two task force reports address areas of training not covered in previous editions of COCATS: critical care cardiology and multimodality noninvasive cardiovascular imaging, although the latter was addressed as a separate publication in 2009 (7). A third report expands considerably on the pursuit of research and scholarly activity during fellowship training. This revision emphasizes the importance of active participation in research and scholarly activities and outlines a variety of approaches and formats to meet this important academic requirement for cardiology trainees in the context of a commitment to lifelong learning.

This revision of COCATS incorporates the training recommendations for the 4 basic noninvasive imaging modalities – echocardiography (COCATS Task Force 5), nuclear cardiology (COCATS Task Force 6), cardiac computed tomography (COCATS Task Force 7), and cardiovascular magnetic resonance (COCATS Task Force 8)—which are introduced in a new section on multimodality imaging (COCATS Task Force 4). Each was written by individual writing groups and represents a revision of a previously published document, except for multimodality imaging, which includes the Chairs of the Task Forces for each component imaging modality and experts in multimodality imaging. In the previous training paradigm, fellows often rotated through these laboratories as individual silos of imaging technologies, with individual conferences and separate didactic teaching offerings attached to each modality. The 2008 Training Statement on Multimodality Noninvasive Cardiovascular Imaging indicated that novel methods of training (e.g., allowing concurrent training and consolidating curricula among modalities) could allow fellows to develop higher-level expertise in more than 1 modality in a 3-year fellowship (7). It is increasingly important to utilize multimodality imaging principles in conferences and didactic sessions and to critically discuss the benefits and limitations of various imaging techniques for a given clinical indication.

As described in the echocardiography (COCATS Task Force 5) report, competence in both transesophageal echocardiography and contrast echocardiography is necessary to achieve Level II training (defined in Section 5); basic competence in stress echocardiography can be achieved in Level II training, but additional training beyond Level II is recommended for full competence and independence in this technique.

The need for core training in procedural techniques, such as electrocardiography, ambulatory monitoring, and conventional exercise stress testing, is clearly defined, with the expectation that trainees will develop increasing sophistication in the application of these techniques over the course of the 36-month fellowship. Training in interventional cardiology as described in the COCATS Task Force 10 report is limited to formal training programs in the United States that satisfy the basic standards developed by the ACGME and are accredited by the ACGME. This Level III training must be achieved during a fourth year of dedicated fellowship experience.

The Task Force 11 report indicates more specific procedural time and case volume to gain expertise in cardiac implantable electronic device management. Training in heart failure and transplantation as outlined in the Task Force 12 report has been revised relative to the 1995 and 2002 reports. Level III training in heart failure acknowledges the requirements of the United Network for Organ Sharing for heart transplant physicians. Level III heart failure training will require at least 1 additional year of training in advanced heart failure and transplantation.

4. Migration to a Competency-Based Curriculum

COCATS 4 utilizes the 6 general competency domains promulgated by the ACGME/ABMS (Table 1) to define the core competencies in clinical cardiology and structures the curriculum for training to achieve them. The ACC has also adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs and developed tools to assist physicians in assessing, enhancing, and documenting competencies.

Each Task Force report includes a table delineating the competency domains and associated curricular milestones for training. The milestones are categorized into Level I, Level II, and Level III training (defined below) and indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical trainee should achieve the designated level of competence. The tables also describe potential evaluation tools for assessing competence in each domain. Level I competencies may be achieved at earlier or later time points. Although these tables delineate key competency components, they are not comprehensive, and the full spectrum of competency components required of Level I-trained cardiologists is embodied in the task force reports that together delineate the training requirements and scope of curriculum.

It is vital to the excellence of a training program that faculty help trainees develop clinical skills and supervise, guide, and critique performance and interpretation of procedures. Although the Task Force reports provide, in some cases, minimum numbers of procedures that should be completed with acceptable outcomes to achieve levels of training, performance and interpretation of a given number of procedures is neither synonymous with satisfactory completion nor sufficient to define adequate training. The numbers of procedures performed and/or interpreted have been developed to be consistent with volume recommendations found in the ACC/American Heart Association practice guidelines, ACC/American Heart Association /American College of Physicians clinical competence statements, expert consensus statements, and other relevant consensus documents, when available; however, the specified volumes of tests or procedures performed and/or interpreted successfully to achieve competence are intended as general guidance based on the educational needs and progress of typical trainees. When duration of exposure or volume of procedures or cases has been suggested, specified numbers should be considered approximate. The objectives are to ensure exposure to a sufficient breadth of clinical material and pathology and provide faculty sufficient opportunity to evaluate competency in a given area. Similarly, approximate timeframes are guides to facilitate scheduling, reflecting the periods required by the typical trainee to gain requisite knowledge, skills, and experience in each subdiscipline. Given the complexity and time constraints of training programs, many of the requirements in time and case numbers in various procedures may be satisfied concurrently. Examples include training in stress testing during rotations in echocardiography or nuclear cardiology and experience in cardiovascular magnetic resonance or cardiac computed tomography interpretation during other imaging rotations.

5. Structure and Levels of Training

The ABIM subspecialty board on cardiovascular disease requires 3 years of cardiology fellowship training. Additional training beyond the standard 3-year general cardiology fellowship is required to sit for certification examinations in clinical cardiac electrophysiology, interventional cardiology, advanced heart failure and transplant cardiology, and adult congenital heart disease. As outlined in this document, additional years of training are also recommended for trainees who desire advanced expertise in specialized areas, those who want dedicated time for basic and/or clinical research training, or both. In this revision of COCATS, recommendations for such advanced training experiences are proposed relative to the discipline of cardiovascular medicine being addressed.

Throughout the task force reports, training is defined in terms of the following levels:

- **Level I –** The basic training required of all trainees to be competent consultant cardiologists. This can be accomplished during a standard 3-year training program in general cardiology.

- **Level II** – This refers to the additional training in 1 or more areas that enables some cardiologists to perform or interpret specific diagnostic tests and procedures or render more specialized care for specific patients and conditions. This level of training is recognized only for those areas in which a nationally accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training may be achieved by some trainees in selected areas during the standard 3-year general cardiology fellowship, depending on the trainee's career goals and use of elective periods.

- **Level III** – This level of training requires additional experience beyond the general cardiology fellowship to acquire specialized knowledge and competencies in performing, interpreting, and training others to perform specific procedures or for the trainee to render advanced, specialized care at a high level of skill. Level III training cannot generally be obtained during the standard 3-year general cardiology fellowship and requires additional exposure in a program that meets requirements delineated in Advanced Training Statements (formerly in Clinical Competence Statements) and developed for each specialized field of endeavour. Advanced (Level III) trained faculty should be available to participate in training Level I fellows in cardiac catheterization, interventional cardiology, and cardiac electrophysiology, but are not required for Level I training in other fields.

The emphasis of COCATS is on Level I training—delineating competencies that all cardiology fellows must acquire during the standard fellowship that follows residency training in internal medicine. Level II training is defined for fields in which specific competencies can be undertaken during about 6 months of the 3-year training period (depending upon the career focus of trainees) and measured by a standardized qualifying instrument such as a subspecialty examination. Level II training is not available or described for fields lacking this criterion. Level III training is described only in broad terms to provide context for trainees and clarify that these advanced competencies are not covered during the general cardiology fellowship and require an additional period of training and designation by an independent accrediting board, often coupled with a certifying examination. The advanced training requirements required to achieve Level III competency will be addressed in subsequent, separately published clinical competence and advanced training statements. The Steering Committee and Task Forces recognize that implementation of these changes in training requirements will occur incrementally over time.

A summary of the various clinical rotations is depicted conceptually in Figure 1. It is important to emphasize that the intent of this diagram is to illustrate relationships among and potential overlaps across the various clinical and educational experiences during fellowship training rather than the specific sequence or duration of rotations. Trainees vary with respect to the length of time spent in each area of study based upon prior experience, aptitude, career goals, and interests. Training in cardiovascular medicine involves the acquisition of specialized skills and capabilities in specific technologies as well as experiences in longitudinal care and scholarly activity that are pervasive across virtually the entire fellowship period. For the typical fellow, approximately half a year during the standard 3-year fellowship could be allocated to pursuits aligned with the individual's choice for subsequent advanced training. The individual Task Force reports that include sections on Level III training provide information about ancillary fields upon which fellows may choose to focus during general cardiology training to better prepare them for advanced training in their area of interest.

The rapid evolution of cardiovascular science and cardiovascular medicine requires that all training programs have an experienced faculty, adequate facilities, and a rich assortment of didactic offerings for fellows. Specific components are addressed in each task force report. Case-based conferences are vital to train fellows and develop their skills in evidence-based decision-making. Self-learning is emphasized, and Internet-based, online educational programs, many of which are interactive, play an increasingly important role in learning during fellowship and beyond. Such didactic activities are outlined throughout the task force reports. In most clinical rotations, emphasis should be placed on evidence-based practice guideline recommendations, standards for recording clinical data, and appropriate use criteria for diagnostic and therapeutic procedures.

The COCATS Steering Committee, Task Force chairs and members, and ACC recognize the need to assist trainees, faculty, and program directors with the transition from the historical curriculum that was based on exposure time and case volume to the current competency-based model. Also recognized is the related need for faculty development tools to facilitate the assessment of competency among fellows in training. The developers of COCATS are additionally aware of other challenges facing fellowship programs during this transitional period related to ACGME/ABIM milestone reporting requirements, and the writing groups allow for flexibility in implementation as long as the emphasis on competency-based learning is preserved.

6. Evaluation of Competency and Reporting of Educational Milestones

A key characteristic of competency- and curricular milestone-based training is integration with outcomes-based evaluations. Evaluation of competence is an integral, continuous, and critical part of the educational process for the cardiology fellow across the spectrum of training. Evaluation tools include a variety of modalities, such as direct observation by instructors, in-training examinations, procedure logbooks, conference and case presentations, multisource evaluations, trainee portfolios, simulation, and self-reflection. Case management, judgment, and interpretive and technical skills must be evaluated regularly in every trainee and discussed with the trainee at least twice annually. Quality of care and follow-up; reliability; judgment, decisions, or actions that result in complications; interaction with other physicians, patients, and laboratory support staff; initiative; and the ability to make appropriate independent decisions should be considered.

The ACGME distinguishes levels of advancement in each of the general competencies using milestones that describe a developmental progression from early learner status through advancing or improving competency, readiness for unsupervised practice, and at the pinnacle, aspirational achievement by learners. The program must develop an evaluation system that accurately determines each fellow's progression along this developmental continuum. Mechanisms should be incorporated so that fellows who perform suboptimally or exhibit critical deficiencies can be counseled and provided with opportunities for corrective action. Likewise, fellows who are progressing appropriately should be challenged to excel. With the curricular competency milestones, the ACC provides a schema for evaluating the trainee's progressive competency development over the course of the training program. This curricular milestone framework facilitates specific feedback to trainees as they progress through training.

As much as possible, methods for evaluation and documentation of competence have been standardized across the various task force reports. An optimum training environment includes bidirectional evaluations, in which faculty evaluate and provide positive or negative feedback to trainees and trainees evaluate faculty. The program director should review these evaluations with the trainee and faculty individually and collectively at group meetings addressing the curriculum and training environment with both fellows and faculty. Fellows and faculty should be formally evaluated after each rotation; timely evaluations better enable trainees to process and incorporate feedback into their learning objectives. By using a competency- and curricular milestone-based framework, the ACC has identified specific observable behaviors that, ideally, are easier to evaluate. In addition to easing evaluation, this format should also aid in providing more specific feedback to trainees as they progress through multiple levels of training.

Evaluation may be accomplished using a variety of modalities on a daily basis. It should include the aforementioned tools but may include other innovative evaluation methods as available. Overall clinical progress and deficiencies should also be assessed for each trainee at least twice annually by the training program's Clinical Competency Committee and reported with recommendations to the cardiology fellowship program director. Evaluations are ultimately the responsibility of the fellowship program director and should be performed at least twice annually for each fellow using a variety of evaluation tools.

7. Composition of the Task Forces and Integration of Training Recommendations

As knowledge in cardiovascular medicine continues to expand, training must keep pace. This report represents a consensus, having been created using the overall format of the previous COCATS documents. Individual task forces were empaneled to address each component of training in cardiology and structured similarly to include the following members: representatives of the ACC and key cardiovascular subspecialty organizations for a given field of study, a cardiovascular training program director who is not a subspecialist in the subject of the particular report, a training program director in the particular field, an early-career cardiologist practicing in the field who has completed fellowship training within 5 to 8 years, experienced specialists practicing in both academic and community-based practice settings, and physicians experienced in developing and applying training standards according to the core competencies structure promulgated by the ACGME/ABMS.

The writing groups reviewed the 2008 COCATS 3 Task Force reports and made revisions, additions, and deletions based on data from the literature and expert opinion. Major changes in curricular content most often related to evolution of subspecialty areas in cardiology and widespread acceptance of emerging technologies in clinical practice. Collectively, the task force reports reflect a broad effort to establish consistent training criteria across all aspects of cardiology.

8. Document Review and Endorsement

COCATS 4 was peer reviewed by 55 external peer reviewers, culminating in over 900 comments that were addressed by authors. The entire document was peer reviewed by the ACC Competency Management Committee, the Cardiology Training and Workforce Committee, and a member of the ACC Board of Trustees and the ACC Board of Governors. A member of the ACC Competency Management Committee served as lead reviewer to ensure a fair and balanced peer review resolution process. Individual task force reports were reviewed by the following ACC councils: Task Force report 2 – Prevention of Cardiovascular Disease Section Leadership Council; Task Force reports 3 and 11 – Electrophysiology Section Leadership Council; Task Force reports 4 to 8 – Imaging Section Leadership Council; Task Force report 9 – Peripheral Vascular Disease Section Leadership Council; Task Force report 10 – Interventional Section Leadership Council; Task Force report 12 – Heart Failure and Transplant Section Leadership Council; and Task Force report 15 – Academic Cardiology Section Leadership Council. Representatives from several organizations also reviewed the document: Introduction and Task Force reports 1 and 9 – the ABIM; Task Force report 5 – the American Society of Echocardiography; Task Force reports 6 and 7 – the American Society of Nuclear Cardiology; Task Force report 7 – the Society of Cardiovascular Computed Tomography and the Society of Atherosclerosis Imaging and Prevention; Task Force reports 7, 9, and 10 – the Society for

Cardiovascular Angiography and Interventions; Task Force report 8 – the Society for Cardiovascular Magnetic Resonance; Task Force report 9 – the Society for Vascular Medicine; Task Force report 11 – the Heart Rhythm Society; and Task Force report 12 – the Heart Failure Society of America. The American Heart Association reviewed the entire document. All reviewers and their affiliations in the review process and employment information can be found in the appendix containing peer reviewer disclosure information in each report.

Following peer review, the revised document was posted for public comment from December 20, 2015 to January 6, 2016, resulting in 34 additional comments from an array of reviewers from both the community-based and academic practice settings, cardiovascular training program directors, sub-subspecialty training program directors, early-career professionals (in practice less than 8 years), fellows in training, and government employees. The authors addressed these comments to finalize the document.

All individual COCATS reports were approved by the respective Task Forces, the COCATS Steering Committee, and the ACC Competency Management Committee, and subsequently ratified by the ACC Board of Trustees. Endorsement by participating societies is reflected in each Task Force report. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

9. Author Affiliations

The Steering Committee is grateful for the time and effort devoted to this COCATS revision by the Task Force members and reviewers who provided valuable input. Staff of the American College of Cardiology provided superb support to the COCATS 4 effort, and their contributions are recognized with appreciation.

The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiology training statement; however employment and affiliation information for authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_Intro_Comprehensive_RWI_Supplement.pdf).

Key Words: ACC Training Statement ▪ COCATS ▪ fellowship training ▪ clinical competence.

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—ACC 2015 COCATS 4 INTRODUCTION

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_Intro_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELEVANT RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES—ACC 2015 COCATS 4 INTRODUCTION

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ABIM = American Board of Internal Medicine, ACC = American College of Cardiology, ACPC = Adult Congenital/Pediatric Cardiology, AHA = American Heart Association, ASE = American Society of Echocardiography, ASNC = American Society of Nuclear Cardiology, HFSA = Heart Failure Society of America, PVD =

Peripheral Vascular Disease, SCAI = Society for Cardiovascular Angiography and Interventions, SCMR = Society for Cardiovascular Magnetic Resonance, and SVM = Society for Vascular Medicine.

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

COCATS = Core Cardiovascular Training Statement

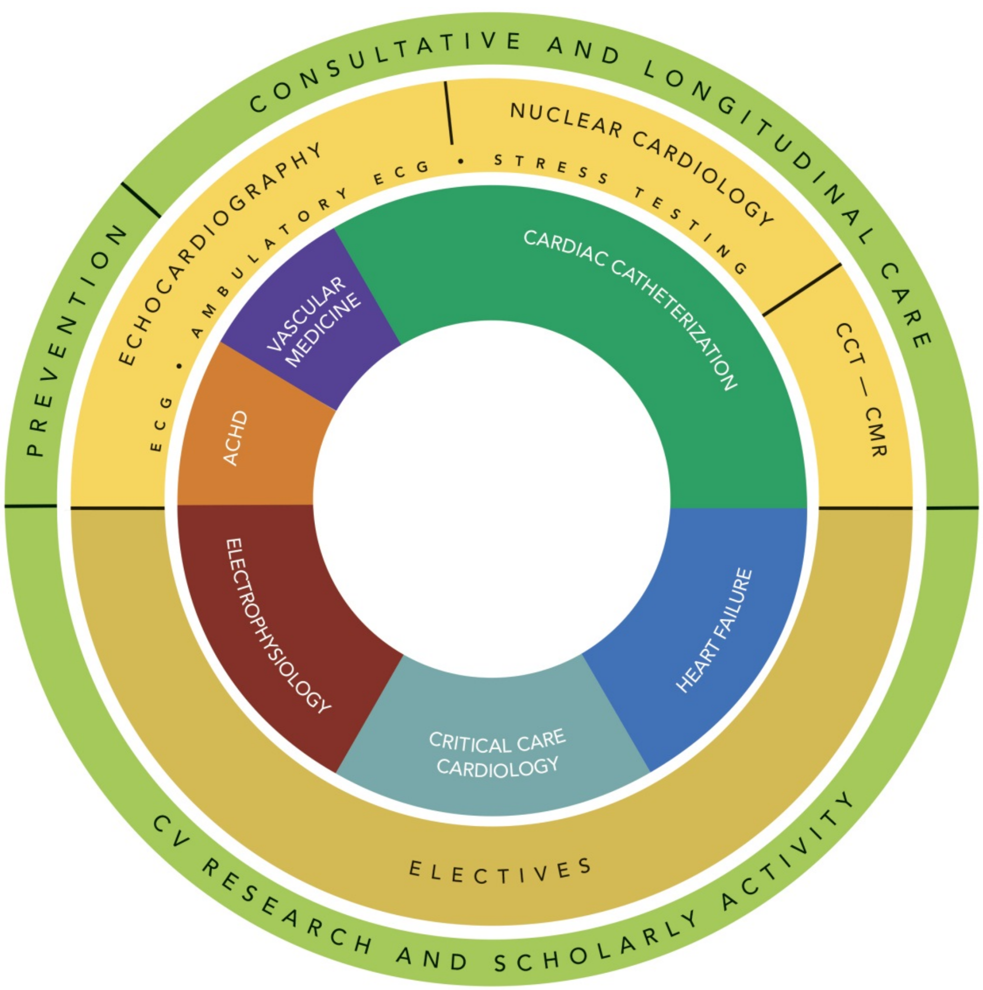

Figure 1. The COCATS curriculum for Level I training in cardiovascular medicine. This schematic summarizes the components of training during the standard 3-year cardiovascular fellowship. The various clinical rotations are depicted in a conceptual format to illustrate relationships and potential overlap across the various educational experiences rather than the sequence or duration of rotations. Basic experiences in the acute hospital setting typically occur mainly during the first 24 months, though in some cases, some experiences may be deferred to the third year. Exposure to noninvasive diagnostic testing modalities typically occurs at various points throughout the fellowship as trainees develop the ability to integrate the information generated by these modalities into patient care with increasing sophistication. The outer ring of the diagram denotes longitudinal experiences that pervade the entire fellowship training period. These include consultative, ambulatory, and longitudinal patient care, and integration of disease prevention strategies into patient management. Proportionate time frames indicated for each experience represent those required by the typical fellow to acquire the required competencies but should be considered approximate. Depending on available resources and particular characteristics of some training programs and the background, skills, and career goals of individual trainees, it may be possible to combine certain components of training or to develop certain competencies concurrently with others. Elective time may be devoted to additional training in 1 or more areas selected on the basis of the individual trainee's needs and career goals. This additional exposure will enable some trainees to gain Level II competence to perform or interpret certain procedures or render more specialized care for specific patients and conditions. Time allocated to research and scholarly activity may be scheduled continuously or at specific points in the 36-month fellowship depending on the trainee's prior experience, rate of progress, and professional objectives.

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COCATS 4 Task Force 1: Training in Ambulatory, Consultative, and Longitudinal Cardiovascular Care[2]

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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The writing committee was selected to represent the American College of Cardiology (ACC) and included a cardiovascular training program director; a member of the ACC Competency Management Committee; a cardiologist early in his career as well as specialists representing both the academic and community-based practice settings; as well as physicians, including a staff physician from the American Board on Internal Medicine (ABIM), experienced in defining and applying training standards according to the 6 general competency domains promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialties (ABMS), and endorsed by the ABIM. The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiology training statement. Employment and affiliation information for authors and peer reviewers is provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF1_Comprehensive_RWI_Supplement.pdf).

1.1.2. Document Development and Approval

The writing committee developed the document, approved it for review by individuals selected by the ACC and representing ABIM, and addressed the comments. The document was revised and posted for

[2] The American College of Cardiology requests that this document be cited as follows: Fuster V, Halperin JL, Williams ES, Cho NR, Iobst W, Mukherjee D, Vaishnava P. COCATS 4 task force 1: training in ambulatory, consultative, and longitudinal care. J Am Coll Cardiol. 2015;••:••••–••••.

public comment from December 20, 2015 to January 6, 2015. Authors addressed additional comments to complete the document. The final document was approved by the Task Force, COCATS Steering Committee, and ACC Competency Management Committee, and ratified by the ACC Board of Trustees in March, 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

The Task Force was charged with updating previously published standards for training fellows in general clinical cardiology enrolled in ACGME-certified fellowships (1) on the basis of the following factors: 1) changes that have occurred in the field since 2008 and as part of a broader effort to establish consistent training criteria across all aspects of cardiology, and 2) the evolving framework of competency-based medical education described by the ACGME Outcomes Project and the 6 general competencies endorsed by ACGME and ABMS. This document does not provide specific guidelines for training in advanced cardiovascular subspecialty areas but, where appropriate, identifies opportunities to obtain advanced training.

The background and overarching principles governing fellowship training are provided in the Introduction to COCATS, and readers should become familiar with this foundation before considering the details of training in ambulatory, consultative, and longitudinal cardiovascular care. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally over time.

For most areas of adult cardiovascular medicine, 3 levels of training are delineated:

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 during a standard 3-year training program in general cardiology.

Level II training refers to the additional training in 1 or more areas that enables some cardiologists to perform or interpret specific diagnostic tests and procedures or render more specialized care for specific patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training in selected areas may be achieved by some trainees during the standard 3-year general cardiology fellowship, depending on the trainees' career goals and use of elective rotations.

Level III training requires additional experience beyond the general cardiology fellowship to acquire specialized knowledge and competencies in performing, interpreting, and training others to perform specific procedures and rendering advanced, specialized care at a high level of skill. Level III training typically requires training beyond the standard 3-year general cardiology fellowship.

Most cardiac care occurs in the ambulatory setting. Although hospital-based care is increasingly directed at acutely ill patients or those undergoing invasive procedures, the importance of training and competence in the longitudinal care of ambulatory patients, including in disease prevention and management, has been increasingly emphasized. Anticipating reallocation of health resources toward ambulatory care, an expanded commitment to training in outpatient care for all cardiology trainees is required, regardless of a trainee's field of interest or subspecialization. Training in ambulatory, consultative, and longitudinal care is a bedrock of cardiovascular fellowship upon which all subspecialized, advanced, and procedure-oriented training is based. Accordingly, a single level of training is delineated for this aspect of cardiology fellowship, with the expectation that the principles delineated in this report should pervade all other aspects of cardiovascular training. The approximate numbers of cases, procedures, and experiences recommended are based on published guidelines, competency statements, and the opinions of the members of the writing group. Training should be directed by appropriately prepared mentors in an ACGME-accredited program and satisfactory completion of training must be documented by the program director on the recommendation of a competency committee. The variety and types of encounters and the scope of training required by the typical fellow are summarized in Section 4.

Training to become a general or specialized physician should prepare the trainee to provide high-quality care, which the Institute of Medicine defines as effective, efficient, equitable, safe, timely, and patient-centered. The specific training necessary to become a competent cardiovascular specialist should address prevention of adverse events such as myocardial infarction, stroke, or premature death from disease of the heart or blood vessels. Training should facilitate cardiovascular health and foster wellbeing across the lifespan, healthy aging, and event- and intervention-free survival. Hence, a key attribute of this aspect of training is the establishment of relationships with patients that span several years.

Experience in ambulatory, consultative, and longitudinal care should incorporate 3 general approaches: 1) acquisition of key skills through practical exposure and clinical practice, 2) participation in consultative cardiology, and 3) a formal curriculum that emphasizes the pathophysiological mechanisms and core knowledge of cardiovascular diseases. Cardiologists should embrace novel and evolving areas such as clinical applications of genetics, mechanical cardiac assist devices, remote monitoring, and transplantation and immunotherapy; become facile in managing or co-managing patients with congenital heart disease, pulmonary hypertension, age-related disorders, and dementia; and apply preventive strategies that promote health and longevity.

As a highly trained medical subspecialist, the modern cardiologist must serve as an effective member of the professional healthcare team. In many cases, the cardiologist will assume the role of team leader. At other times, the delivery of high-quality, patient-centered care will require that the cardiologist defer to the expertise of other members of the team. Negotiating these multiple roles requires skill as a communicator, competence with emerging technology, and effective collaboration with all healthcare professionals. On an interpersonal level, the cardiologist must acknowledge mistakes when they occur, learn from them and redirect a course of action to optimize outcomes, engender trust by exhibiting benevolence, avoid or divulge material conflicts, and motivate and inspire patients and colleagues. A lifelong commitment to mastery and maintenance of these skills and to learning is essential to both providing high quality, patient-centric, ambulatory, consultative, and longitudinal care and assuming a leadership role in directing cardiovascular patient management.

2. General Standards

In published guidelines for ambulatory, consultative, and longitudinal cardiovascular care that are organized around individual disease states or cardiovascular procedures, the ACC and American Heart Association have promulgated congruent recommendations that address faculty, facility requirements, emerging technologies, and practice. We also recommend strongly that candidates for certification in cardiovascular diseases review the specific requirements of the ABIM.

2.1. Faculty

Faculty should include specialists who are able to provide integrated assessment of cardiovascular risk and are knowledgeable and skilled in the principles of bedside clinical examination; differential diagnosis; electrocardiography; chest X-ray; echocardiography; stress testing; ambulatory rhythm and electrophysiological monitoring; cardiovascular development and aging; hypertension evaluation and management; dyslipidemia; abnormalities of glucose metabolism; congenital and valvular heart disease; evaluation, staging, and management of cardiac failure; cardiac arrhythmia diagnosis and management; and clinical applications of genetics and cardiovascular pharmacology . Faculty must also have a thorough understanding of the attitudes and proficiencies required of trainees to ensure acquisition of the additional ACGME/ABMS general competencies of systems-based practice, practice-based learning and improvement, interpersonal and communication skills, and professionalism as they pertain to the delivery of cardiovascular care. A minimum of 2 key clinical faculty members, including the program director, must be board-certified in cardiovascular disease or possess equivalent qualifications based on training in a similar environment for a similar length of time, and must have expertise in the requisite skills and at least 5 years of clinical experience beyond fellowship training. Programs must also maintain at least a 1:1.5 ratio of qualified faculty to enrolled trainees.

2.2. Facilities

Facilities should be sufficient to ensure an environment suitable for safe and effective ambulatory patient care, and include a patient reception area; clean, orderly, private examination rooms with sinks; examination gowns; gloves; sphygmomanometers; ophthalmoscopes and related equipment; consultation rooms with seating for the physician, patient, and at least 1 additional person such as a member of the patient's family, which can be used for or in addition to a place for case review and discussion between the trainee and faculty preceptor; and workstations with computer terminals for access to the Internet and medical records. In addition, there should be accessible facilities for outpatient laboratory evaluations, including blood specimen collection for transmittal to a certified clinical laboratory and the standard and specialized equipment for performing the routine diagnostic procedures delineated in Section 2.3. The facility should be capable of accommodating common cardiovascular emergencies either onsite or at a nearby institutional facility to which a patient in distress can be readily transported under direct and continuous physician or nursing supervision.

2.3. Equipment

Clinic or ambulatory care facilities require equipment for measuring blood pressure and trans-cutaneous oxygen saturation and for electrocardiography, with access to chest X-ray, echocardiography, ambulatory cardiac rhythm monitoring, and exercise stress testing. An electronic or paper-based medical record system must be available that meets federal data security requirements yet can be accessed by authorized caregivers at all times for the purposes of both data entry and retrieval at—but not limited to—the point of care.

2.4. Ancillary Support

Ancillary support should be available to facilitate appointment scheduling and follow-up; manage clinical and financial records; retrieve laboratory and other clinical reports; enable telephone communications between patients and providers (e-mailing optional); provide clean, prepared examining and consultation rooms; and properly contain, control, and remove medical waste.

3. Training Components

3.1. Didactic Program

Didactic instruction may take place in a variety of formats, including but not limited to lectures, conferences, journal clubs, grand rounds, clinical case presentations, and patient safety or quality improvement conferences. A formal curriculum should include, in addition to the evaluation and management of patients across the full spectrum of cardiovascular diseases, relevant non-cardiovascular disease topics commonly complicated by cardiovascular disease to which the trainee might otherwise have been less exposed. Among the topics to consider are acute and chronic pulmonary disease; sleep-disordered breathing; malignancies and the cardiovascular effects of cancer chemotherapy; hematologic disorders including thrombophilia; diabetes; kidney disease; acute and chronic dialysis; intracranial and extracranial cerebrovascular disease; and stroke.

3.2. Clinical Experience

Rotation on cardiology consultation services is an essential component of training in clinical cardiology. The training required to achieve this Level I competency requires firsthand experiences as a consultant in both the inpatient and outpatient settings. It is important that the cardiology consultation service expose the trainee to a broad array of patients at varied acuity and with a range of comorbidities. During the required rotations on the consultation service, trainees should conduct several initial patient evaluations daily in addition to providing follow-up care after initial consultation. Often, transition of care between inpatient and outpatient settings is an important component of care. In addition to the inpatient consultation experience, trainees should obtain robust clinical experiences in an outpatient setting that promotes continuity of patient care over the course of the fellowship. Current recommendations include that fellows should be responsible, on average, for 4 to 8 patients per half-day session. In each clinical setting, trainees should gain hands-on experience under the supervision of a faculty mentor or preceptor in a fashion that emphasizes patient-centered education in all aspects of cardiovascular management. It is important that in these experiences, the trainee assume the role of a consultant responsible for communication with the patient, family members, referring physicians, pharmacists, nurses, and other healthcare personnel.

3.3. Teaching Others

An important aspect of subspecialty training is the ability to educate trainees, such as medical students, residents, or fellows in other fields on such topics as the cardiovascular physical examination, pharmacology, electrocardiography, and cardiac imaging, at a level commensurate with their training and experience. This applies to peer-to-peer education through topic reviews, journal clubs, clinical case presentations, quality assurance programs, and preparation of case reports for publication. The objectives include enhancement of communication skills, consolidation of knowledge in core topic areas, development of enduring educational materials (e.g., syllabi, lecture slides, or web-based tools), and nurturing commitment to lifelong learning and maintenance of competency.

4. Summary of Training Requirements

4.1. Development and Evaluation of Core Competencies

Training and requirements in cardiovascular disease address the 6 general competencies promulgated by the ACGME/ABMS 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 core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 1 delineates each of the 6 competency domains as well as their associated curricular milestones for training in ambulatory, consultative, and longitudinal cardiovascular care. The milestones indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Given that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may vary as well. Level I competencies may be achieved at earlier or later time points. The table also describes examples of evaluation tools suitable for assessment of competence in each domain. It is also important to emphasize that while the table delineates key competency components for ambulatory, consultative, and longitudinal care, it is not comprehensive. Additional competency components required of a consultant cardiologist (Level I) are described in the other COCATS 4 task force reports.

Table 1. Core Competency Components and Curricular Milestones for Training in Ambulatory, Consultative, and Longitudinal Cardiovascular Care

Medical Knowledge	Milestones (Months)			
	12	24	36	Add
1. Know the major cardiovascular risk stratification tools and the principles of primary and secondary cardiovascular disease prevention.	I			
2. Know the roles of genetics and family history and the environmental and lifestyle factors in the development and clinical course of cardiovascular disease.		I		
3. Know the effects of age on cardiovascular function, response to medications, and in the risks of diagnostic and therapeutic procedures.		I		
4. Know the differential diagnosis of chest pain and the distinguishing features of the various etiologies.	I			
5. Know the cardinal findings and differential diagnosis of palpitations, lightheadedness, and syncope, and the distinguishing features of the various etiologies.	I			
6. Know the cardinal findings and differential diagnosis of dyspnea.	I			
7. Know the differential diagnosis of peripheral edema and the distinguishing clinical features of the various etiologies.	I			
8. Know the roles of kidney, hepatic, pulmonary, hematologic, rheumatologic, and endocrine disorders in the development, manifestations, and responses to treatment in patients with cardiovascular disease.		I		
9. Know the clinical pharmacology of cardiovascular medications, and drug-drug interactions of cardiac and noncardiac medications, including in special populations and in patients with relevant comorbidities.		I		
10. Know the roles of lifestyle, activity level, body mass, nutrition, alcohol and/or drug use in cardiovascular risk and disease.	I			
11. Know the potential cardiovascular toxicity and side effects of major classes of drugs used for the management of patients with common medical conditions, including antimicrobial agents, immune system modulators, chemotherapeutic agents, and antiParkinsonian drugs.			I	
12. Know the roles of stress, anxiety, and depression in patients with suspected cardiovascular disease.	I			
13. Know the guideline recommendations for blood pressure, blood glucose, and lipid management in diverse patient populations with and without cardiovascular disease.		I		
14. Know the appropriate use indications for cardiovascular screening studies, including carotid and abdominal ultrasound (or other imaging) modalities.		I		
15. Know the differential diagnosis and distinguishing characteristics of heart murmurs and bruits.		I		
16. Know the characteristic clinical manifestations, differential diagnosis, and appropriate testing for peripheral vascular disease.		I		
17. Know the mechanisms and cardinal symptoms and findings of stroke, transient cerebral ischemia, and dementia.		I		
18. Know the principles, modalities, and appropriate indications for palliative care.	I			
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, in-training exam				

Patient Care and Procedural Skills	12	24	36	Add
1. Skill to effectively and efficiently perform an initial outpatient cardiovascular consultation and establish a differential diagnosis.	I			
2. Skill to appropriately utilize diagnostic testing – both for initial diagnosis and for follow-up care.		I		
3. Skill to integrate clinical and testing results to establish diagnosis, assess cardiovascular risk, and formulate treatment and follow-up plans.		I		
4. Skill to appropriately obtain and integrate consultations from other healthcare professionals in a timely manner.		I		
5. Skill to recognize acute cardiovascular disorders or high-risk states that require immediate treatment and/or hospitalization, and prioritize management steps in patients with complex or multi-component illness.		I		
6. Skill to establish an effective medical regimen and monitor for side-effects, intolerance or noncompliance, and patient safety.		I		
7. Skill to assess the cardiovascular risks associated with recreational and/or competitive sports for individual patients and to counsel patients about levels of physical activity appropriate to their cardiovascular health in the context of disease prevention; rehabilitation; and promotion of longevity, functional capacity, and quality of life.		I		
8. Skill to effectively carry out chronic disease management in patients with chronic ischemic heart disease, hypertension, heart failure, and peripheral vascular disease.		I		
9. Skill to coordinate ambulatory and longitudinal follow-up care.			I	
10. Skill to effectively facilitate transition of care from hospital to ambulatory or intermediate care settings.		I		
11. Skill to perform preoperative assessments for noncardiac procedures in patients with cardiovascular disease.	I			
***Evaluation Tools*:** chart-stimulated recall, conference presentation, direct observation				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Effectively lead or participate in team-based care in patients with or at risk of developing cardiovascular disease.		I		
2. Effectively facilitate transitions of care.	I			
3. Effectively utilize electronic medical record systems, including clinical protocols and treatment/evaluation prompts.	I			
4. Effectively and appropriately use remote communication tools in the care of patients.	I			
5. Appropriately utilize and work with cardiac rehabilitation and intermediate care facilities.		I		
6. Recognize and address social, cultural, and financial barriers to patient compliance.	I			
Evaluation Tools: direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Utilize point-of-care electronic resources to provide up-to-date clinical information and guideline-driven evaluation and treatment.	I			
2. Identify gaps and carry out personalized education activities to address them.		I		
3. Integrate validated performance and patient satisfaction measures into clinical practice to foster continuous quality improvement.		I		

Evaluation Tools: chart-stimulated recall, direct observation, reflection and self-assessment				
Professionalism	**12**	**24**	**36**	**Add**
1. Practice patient-centered care with shared decision-making and appreciation of patients' values and preferences.	I			
2. Incorporate appropriate use criteria and risk-benefit considerations in treatment decisions.		I		
3. Practice in a manner that fosters patient benefit above self-interest and avoids conflict of interest.	I			
4. Interact respectfully with patients, families, and all members of the healthcare team, including ancillary and support staff.	I			
Evaluation Tools: chart-stimulated recall, direct observation, multisource evaluation				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate effectively with patients and families across a broad spectrum of ethnic, social, cultural, socioeconomic, and religious backgrounds.	I			
2. Exhibit sensitivity and empathy in dealing with life-threatening and end-of-life issues.	I			
3. Communicate effectively and in a timely manner with primary care and other referring or collaborating members of the healthcare team.		I		
Evaluation Tools: direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

4.2. Duration and Structure of Training

The specific competencies for training are delineated in Table 1. Continuity of longitudinal patient care is fundamental to training in ambulatory and consultative cardiolovascular care. Hence, while it is expected that all trainees will engage in this activity for no less than 1 half-day weekly for at least 40 weeks of each year of training during the general 3-year cardiovascular fellowship, attendance in weekly clinic sessions alone is not sufficient to satisfy this training requirement. Longitudinal care implies not only continuity in the ambulatory setting, but also a commitment to following patients in the event of hospitalization, telephone contacts, or other communication with and about the patient in the form of interactions with family members, collaborating physicians and other members of the healthcare team, as well as general availability to address whatever cardiovascular or related issues or conditions might arise in the course of long-term clinical management.

4.2.1. Acquisition of Key Skills

The ultimate goal of fellowship training is the integration of a sound foundation of knowledge and understanding of cardiac systems and the roles of testing and technology, on the one hand, with the ability to manage difficult and challenging situations, on the other hand. These goals require the effective integration of the ACGME 6 general competencies into the delivery of safe and effective patient care. The cardiologist must accept responsibility; identify, acknowledge, and overcome gaps in knowledge;

maintain flexibility and adjust direction; think creatively; keep an open mind; incorporate humanism; and employ discipline and organization to follow through with plans, motivate patients, and inspire others on the healthcare team. While the ambulatory care or outpatient setting represents an ideal environment for initial acquisition of these skills through teaching, mentoring, and example, mastery cannot be achieved without years of experience and a commitment to lifelong learning.

4.2.1.1. Medical Knowledge, Clinical Decision-Making, and Skills in Transitional Care

The ambulatory patient often presents less obvious evidence of disease than the hospitalized patient. Therefore, outpatient training is directed at acquiring knowledge, enhancing judgment, and sharpening skills in effectively transitioning patient care.

4.2.1.1.1. Medical Knowledge and Clinical Evaluation

The trainee should routinely question why the patient has developed a given condition or problem, and address the underlying etiology to guide diagnostic testing and treatment.

1. The cardiologist must be alert to life-threatening conditions that cannot be overlooked, while also recognizing both the most likely causes of symptoms or asymptomatic conditions and maintaining awareness of rare possible causes. He/she should learn to distinguish urgent situations from those that can be addressed more methodically.
2. It is valuable to understand the controversies and/or complexities that surround the evaluation or management of particular cardiovascular diseases or conditions, including comorbidities; the influences of genetics and aging; variations in drug metabolism and interactions; the impact of renal or hepatic dysfunction; fluid balance; the patient’s lifestyle and the influence of diet, exercise, alcohol, or recreational or illicit drugs. It is also essential to understand the roles of stress, anxiety, and depression in exacerbating hypertension, chest pain, cardiac arrhythmias, heart failure, and other conditions.
3. In formulating and executing an effective clinical management plan, the trainee should understand the cumulative burden of multiorgan dysfunction. Rarely does a physician encounter a purely cardiac patient. As the population ages, a panoply of conditions converge, and an appreciation of the interplay between individual patient characteristics and the natural history of disease enables the clinician to anticipate outcomes and complications, which is key to successful management. The cardiologist must balance emerging concepts and traditional strategies. Reliance on secondhand data should be avoided in favor of direct interaction with and examination of the patient, as well as direct review of

prior testing data from both within and outside one's own facility to enable comprehensive and insightful evaluation of a given problem in the context of the individual.

4.2.1.1.2. Clinical Decision-Making

Although clinical judgment is acquired through experience over time, strategies facilitating the development of clinical judgment can be taught and honed. Specific clinical examples (patient-specific teachable moments) help convey the art of medicine. Here the timing of tests, procedures, or interventions is vital, matching the intensity of action to the level of risk and severity of the condition. An example is to prefer initiation or adjustment of 1 drug at a time in non-urgent situations and proceed in logical sequence, rather than changing multiple aspects of a regimen concurrently. Clinical decision-making regarding testing and/or therapeutic decisions should also consider the balance of risk and benefit for the individual patient. In applying management recommendations from resources such as clinical practice guidelines, cardiovascular trainees must take into account the needs of special populations and appreciate the impact of comorbidities, particularly in older patients with cardiovascular disease who typically have multiple concurrent medical conditions that influence outcomes.

4.2.1.1.3. Effective Translation of Clinical Information

It is not sufficient to perform only an initial consultation and outline recommendations; specific instructions should be individualized and written down. Follow-up at timely intervals to assess and measure responses and outcomes on the basis of symptoms, functional status, weight, blood pressure, and heart rate, form the foundation for gauging clinical progress. The clinical problem, plan, rationale, potential risks or adverse effects, and specific directions given to the patient require careful documentation. Systematic quality assurance requires recording and quantifying both successful and unsuccessful outcomes.

4.2.1.2. Interpersonal and Communication Skills

4.2.1.2.1. Communication Skills

An important objective of office- or clinic-based clinical training is to develop a rapport and communicate effectively with the patient; convey understanding of the clinical condition and prognosis; and deliver this information in a respectful, empathetic, and caring manner. Outpatient encounters provide opportunities to heighten a physician's sensitivity to patient needs, values, and preferences, thus establishing the foundation for a relationship based on compassion and trust.

To develop the ability to communicate with patients across a range of cultural, ethnic, and socioeconomic backgrounds, the trainee must be sensitive to financial, cultural, and social barriers to diagnostic and treatment recommendations. Effective communication may require a qualified language translator. It also requires empathetic understanding of the emotional impact of and response to disease. Ultimately, the cardiologist must employ psychological insight to address the patient's hopes, fears, and desires and then leverage these to promote healthy behavior. Appreciation of differences between men and women, young and old, working, retired, indigent, middle-class, wealthy, educated, informed, urban versus rural dwelling, and other demographic variables is necessary to modulate and individualize medical decision-making and discussion.

4.2.1.2.1.1. Communication With Other Providers

As a consultant to other physicians, the trainee should develop the communication and practice management skills necessary to comanage patients with other providers, as noted below.

4.2.1.2.1.2. Communication With Referring Physicians

Timely communication with referring physicians, referral of patients with unusual or complex conditions when appropriate, and close interaction with surgical and interventional colleagues are essential to shared, informed decision-making and successful outcomes.

4.2.1.2.2. Interpersonal Skills

Successful clinicians share a common asset: interpersonal skills. This is among the most difficult to teach because it is highly dependent on personality, but attending physicians can often have a more substantial educational impact in the outpatient environment than in the acute care hospital setting. The requisite skills include the ability to interpret cues from body language, including recognition of fear, anxiety, depression, and denial of illness, to inspire, motivate, encourage, coach, and openly discuss goals of care and end-of-life issues. It is important to identify and overcome defensive or passive-aggressive attitudes and behavior. The cardiologist must enlist the support of spouses, children, and others with personal relationships to the patient, as well as aides, companions, and nurses, in the patient's interest. Interactions with ancillary staff may provide helpful insight into patient care issues, including identifying and overcoming barriers to effective care (e.g., home situation, insurance coverage) Interpersonal skills are essential for meaningful professional communication with physician colleagues; fellowship training in the ambulatory setting provides a prime opportunity to develop and master these skills.

4.2.1.3. Patient Care and Procedural Skills in Transitional Care

The trainee should recognize the challenges at the interfaces between hospital admission, inpatient management, and discharge. Such challenges include the need for early outpatient follow-up in select circumstances (e.g., following hospitalization for heart failure), the need for strategies to minimize adverse outcomes and avoid or delay readmission, deployment of ancillary resources to maintain surveillance of the patient's condition at home, and understanding indications for and components of cardiac rehabilitation and health maintenance. Similarly, in the longitudinal care of hospital inpatients, the cardiologist must ensure continuity during transitions of care to and from the intensive care unit and less acute settings and before and after invasive cardiovascular procedures or surgery.

Beyond standard communication skills, the cardiologist must be technologically proficient in the use of electronic health records and information systems, and incorporate automatic reminders, callbacks, test and procedure result tracking, laboratory flow sheets, and surveillance, to assure timely scheduling of interventions and surveillance. Trainees must also know and adhere to the requirements and precautions regarding the confidentiality of medical information.

4.2.1.4.1. Remote Communication Tools

The appropriate use of electronic communication and cost-effective use of technology, such as remote monitoring with ambulatory telemetry, point-of-care international normalized ratio systems for patient self-testing, and downloading readouts from implanted cardiac arrhythmia devices, are essential.

4.2.1.4.2. Remote Interaction Systems

Real-time interaction with emergency care facilities, clinics, other physicians, rehabilitation centers, and ancillary caregivers by telephone, fax, or electronic record messaging avoids redundancy of care, reduces the risk of error, and helps control cost. Examples are avoiding adverse drugs interactions through access to lists of concurrent medications and unnecessarily repeating tests or procedures through access to prior results.

4.2.1.4.3. Access to Internet Data

Within the context of the patient's condition, information widely accessible on the Internet may provide valuable insight, but caution is needed to avoid incorporating misinformation and inferences. Information must be validated through searches of primary sources, trustworthy textbooks, or recommendations from evidence-based practice guidelines. The trainee should become familiar with the array of electronic medical record systems and information technology resources that facilitate systems-based practice.

4.2.1.5. Practice-Based Learning

4.2.1.5.1. Adherence to Accepted Algorithms

Disease-specific algorithms for clinical decision-making and patient management provide foundations from which to individualize delivery of care for patients with cardiac conditions. Integration of personnel and electronic systems for organized follow-through based on target endpoints should emphasize the collaborative management of patients undergoing cardiac surgery or invasive procedures and an integrated approach to team-based patient care.

4.2.1.5.2. Appropriate Use Criteria

The trainee should incorporate relevant appropriateness criteria into decision making in the ambulatory setting. Outpatient training should offer a venue in which to practice evidence- and guideline-based care.

4.2.1.5.3. Performance Measures and Practice Improvement

The clinical trainee should gain exposure to his/her relevant, individual performance metrics through periodic reviews, including systematic updating and re-evaluation of patient charts as a means of performance assessment. Trainees should also identify opportunities for focused improvement; establish a pattern of enhancing competency; and ensure continuous quality improvement. These activities should be conducted at least twice annually throughout the fellowship as integral to the ambulatory care experience and be subject to both self-assessment and review by faculty mentors, with verbal feedback to the trainee and reporting to the Clinical Competency Committee and program director.

4.2.1.6. Professionalism

4.2.1.6.1. Advocacy and Mindset

The trainee should develop the mindset of being the patient’s advocate to engender confidence and mutual trust and optimize clinical outcomes. That being said, while maintaining empathy, the trainee should retain sufficient detachment to ensure objectivity, avoid bias, and sustain equanimity. Among the most important features of such a mindset approach are the following:

1. Training in patient-centered care, emphasizing shared decision-making and patient autonomy and eschewing conflicts of interest. Thus, when ordering a test or recommending a course of action, the cardiologist should clearly convey what is in the best interest of the patient. Furthermore, accepting part of the burden of worry and responsibility for the patient in difficult times—and a readiness to credit the patient, family, or caregivers when the outcome is successful—catalyzes trust.
2. Having the equanimity to avoid distress, frustration, or resentment when confronted with noncompliance while managing limited time and multiple obligations.
3. Developing the ability to challenge assumptions, open one’s thinking, and seek additional opinions. Acceptance of one’s limitations is important in the evolution of a fully developed physician and can both enhance overall patient care and help prevent physician burnout and cynicism.

4.2.1.6.2. Ability to Delegate

The ability to delegate appropriately to trusted ancillary staff, other physicians, nurses, dieticians, physical therapists, and other healthcare professionals is critical to ensuring that sufficient time is available to meet responsibilities to many patients. Micromanaging too many details can lead to exhaustion and increase rather than reduce the risk of error.

4.2.1.6.3. Management Plan

The trainee should be able to formulate a specific plan and present options to the patient, family, and referring physician. He/she should discuss risks and potential adverse outcomes of medications or other interventions or, conversely, the risks of foregoing actions, tests, or treatments in relation to outcome. Furthermore, the cardiology fellow must acquire skills in communicating unfortunate information when there are no remaining options, while conveying hope and open availability for discussion.

4.2.2. Cardiovascular Subspecialty Clinics

Opportunities should be provided to expose trainees to a range of ambulatory patients across a spectrum of cardiovascular diseases and conditions. This may involve a variety of mechanisms depending on the specialty, such as joining senior clinician tutors or attending clinics as a primary cardiovascular physician under the direction of faculty. Exposure to as many of the following specialty experiences as possible is recommended: 1) hospital-based general cardiology clinic, 2) general cardiology in the office of a senior clinician, 3) an obstetrical clinic visited by pregnant patients with heart disease, optimally in the context of an interdisciplinary approach to high-risk pregnancy, 4) a geriatric clinic visited by elderly patients with heart disease, optimally in an interdisciplinary geriatric practice, and 5) prevention and rehabilitation programs or clinics visited by patients with dyslipidemia, diabetes, hypertension, obesity, or other risk factors in both primary and secondary prevention situations. In addition, exposure to patients with pulmonary hypertension, sleep-disordered breathing, advanced heart failure, peripheral vascular diseases, complex arrhythmias, and implanted pacemakers and defibrillators, and to adult patients with congenital heart disease or genetic disorders should occur both in general clinical cardiology practice and, when possible, through participation in organized subspecialty practices or clinics under the direction of Level III-trained specialists in these fields. The overarching objective of these specialized ambulatory care experiences is to expose the trainee to the range of services available in these tertiary care settings and enhance his/her ability to generate timely referrals when indicated, interact appropriately with experts in the care of their own patients, and enhance the overall quality of cardiovascular care available to the population.

4.3. Competency in the Care of Patients with Specific Cardiovascular Conditions

Together, the COCATS Task Force reports form the core curriculum in cardiovascular medicine and describe a wide range of clinical experiences during which general cardiology trainees are expected to achieve competencies in evaluating and managing patients with, or at risk of developing, acute and chronic cardiovascular disorders, in both hospital and outpatient settings. There are several other key areas of cardiology that are not individually addressed in COCATS via specific task force reports. These include stable ischemic heart disease, acute coronary syndromes, valvular heart disease, and pericardial disease. The curricular competency components and milestones for these topics are summarized in Tables 2 to 4. Training in many of these areas is carried out in consultative, ambulatory, or longitudinal care experiences. For other topics, such as cardiac tumors, trauma, inflammatory and infectious diseases of the heart, and the evaluation and management of patients with known or suspected cardiovascular disease undergoing cardiac or noncardiac surgery, selected aspects are included in the competency tables of the relevant task force reports

Table 2. Core Competency Components and Curricular Milestones for Training in Stable Ischemic Heart Disease

Medical Knowledge	Milestones (Months)			
	12	24	36	Add
1. Know the epidemiology, pathophysiology, and natural history of atherosclerotic vascular disease and the characteristic features of stable and unstable coronary artery plaque.	I			
2. Know the determinants of coronary blood flow and myocardial oxygen consumption.	I			
3. Know the differential diagnosis of chest pain syndromes and the characteristic clinical features of typical angina, atypical angina, and noncardiac chest pain.	I			
4. Know the clinical features and natural history of angina pectoris in special populations: women, the elderly, and patients with diabetes.	I			
5. Know the causes of angina pectoris not related to atherosclerotic coronary disease (including valvular heart disease, hypertrophic cardiomyopathy, cocaine, congenital coronary anomalies, vasculitis, and coronary artery spasm).	I			
6. Know the medical conditions that can provoke or exacerbate angina pectoris.	I			
7. Know the differential diagnosis and prognosis of myocardial ischemia in patients with nonobstructive coronary disease.	I			
8. Know the characteristic electrocardiographic features of ischemia.	I			
9. Know the indications, contraindications, and limitations of noninvasive testing in the context of the pre-test likelihood and predictive value for diagnosis of coronary artery disease.	I			
10. Know the role of noninvasive testing in risk-assessment, including the clinical, functional capacity, ECG, and hemodynamic stress test findings indicative of advanced coronary disease or high-risk state.		I		
11. Know the lifestyle, activity, and exercise guidelines and risk factor treatment targets in patients with stable ischemic heart disease.	I			
12. Know the indications, contraindications, and the clinical pharmacology of medications used to improve symptoms and/or prognosis in patients with stable ischemic heart disease.	I			
13. Know the role of left ventricular systolic function in clinical decision-making and in	I			

estimation of prognosis in patients with ischemia.				
14. Know the indications, limitations, and risk of coronary angiography in patients with known or suspected ischemia.	I			
15. Know the anatomic and physiologic catheterization findings indicating significant coronary artery obstruction and the coronary angiographic features indicative of a high-risk state.	I			
16. Know the indications, risks, and benefits of percutaneous or surgical revascularization versus medical therapy in patients with stable ischemic heart disease.		I		
17. Know the treatment options for refractory symptomatic stable ischemic heart disease.		I		
18. Know the indications for noninvasive or invasive evaluation following revascularization procedures.	I			
Evaluation Tools: direct observation, in-training exam				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to obtain and utilize history, physical examination, and ECG findings in patients with chest pain syndromes to establish a clinical probability of the presence of symptomatic coronary artery disease.	I			
2. Skill to distinguish stable versus unstable coronary syndromes.	I			
3. Skill to select evidence-based and cost-effective noninvasive testing for diagnosis and/or risk assessment in patients with chest pain syndromes.	I			
4. Skill to interpret and apply results of noninvasive testing in the management of patients with stable ischemic heart disease.		I		
5. Skill to perform and interpret exercise electrocardiographic testing.		I		
6. Skill to establish an effective anti-ischemic medical regimen for patients with ischemia.	I			
7. Skill to identify appropriate candidates for coronary angiography and percutaneous or surgical revascularization.		I		
8. Skill to interpret and integrate diagnostic cardiac catheterization findings into patient management.		I		
9. Skill to implement lifestyle, physical activity guidelines, and pharmacologic interventions to safely control and achieve target levels of risk factors.	I			
10. Skill to perform preoperative risk assessment in cardiovascular patients undergoing noncardiac surgery.	I			
11. Skill to perform diagnostic cardiac catheterization.			II	
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, logbook				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Incorporate risk-benefit analysis and cost considerations in treatment decisions.		I		
2. Utilize a multidisciplinary coordinated approach for patient management, including transfer of care and employment-related issues.		I		
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Utilize decision and support tools for accessing guidelines and pharmacologic information at the point of care.	I			
2. Identify competency gaps and engage in opportunities to achieve focused education and performance improvement.		I		
Evaluation Tools: conference presentation, direct observation, in-training exam				
Professionalism	**12**	**24**	**36**	**Add**
1. Exhibit sensitivity to patient preference and end-of-life issues.		I		
2. Identify and manage conflicts of interest.		I		
3. Practice within the scope of personal expertise or technical skills.		I		
Evaluation Tools: chart-stimulated recall, direct observation, multisource evaluation, reflection and self-assessment				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate with and educate patients and families across a broad range of cultural, ethnic, and socioeconomic backgrounds.		I		

2. Engage in shared decision-making with patients about their condition and the options for diagnosis and treatment.		I		
Evaluation Tools: direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

Table 3. Core Competency Components and Curricular Milestones for Training in Acute Coronary Syndromes

Medical Knowledge	Milestones (Months)			
	12	**24**	**36**	**Add**
1. Know the epidemiology, causes, pathophysiology, and natural history of ACS, including the roles of plaque rupture or erosion and platelet activation and thrombosis.	I			
2. Know the disorders that can simulate or mask acute coronary syndromes.	I			
3. Know the risk-assessment tools in acute coronary syndromes.	I			
4. Know the indications and clinical pharmacology of antiplatelet, anticoagulant, and other pharmacologic therapies.	I			
5. Know the post-acute coronary syndromes risk assessment, rehabilitation, and secondary prevention measures.	I			
ST Elevation Myocardial Infarction:				
6. Know the characteristic symptoms, physical findings, electrocardiographic patterns, and biomarker findings.	I			
7. Know the effects and time course of ischemic injury on ventricular function and remodeling.	I			
8. Know the characteristic hemodynamic complications (including hypotension, low cardiac output, heart failure, and shock).		I		
9. Know the characteristic arrhythmia and conduction complications.		I		
10. Know the characteristic mechanical complications (including papillary muscle rupture and myocardial rupture).		I		
11. Know the characteristic findings and complications of right ventricular infarction.		I		
12. Know indications, contraindications, and risks of reperfusion therapies and the clinical, electrocardiographic, and angiographic signs of reperfusion.	I			
13. Know the relative benefits and risks of fibrinolysis and primary percutaneous coronary intervention as an initial reperfusion strategy.	I			
14. Know the indications for transfer, angiography, and revascularization in patients who did not receive primary percutaneous coronary intervention (including those who received fibrinolysis or did not receive initial reperfusion therapy).		I		
Non–ST-Elevation Acute Coronary Syndromes:				
15. Know the differential diagnosis and the characteristic clinical, electrocardiographic, and biomarker features for diagnosis and risk stratification.		I		
16. Know the relative risks and benefits of an initial invasive versus an ischemia-guided strategy for angiography and revascularization.		I		
***Evaluation Tools*:** chart-stimulated recall, conference presentation, direct observation, in-training exam				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to evaluate and diagnose patients with ST-elevation myocardial infarction and initiate appropriate reperfusion therapy within guideline time limits.	I			
2. Skill to employ appropriate antiplatelet, anticoagulant, and other pharmacologic therapies.	I			
3. Skill to recognize and treat hemodynamic disturbances (including hypotension, low cardiac output, heart failure, acute pulmonary edema, and shock) and diagnose the cause.		I		
4. Skill to recognize and treat arrhythmias and conduction disturbances.		I		

5. Skill to recognize and treat mechanical complications (including papillary muscle rupture and myocardial rupture).		I		
6. Skill to recognize and treat patients with right ventricular infarction.		I		
7. Skill to assess ventricular function and utilize in treatment strategy decisions.		I		
8. Skill to interpret invasive hemodynamic data and angiographic findings and apply to treatment strategies.		I		
9. Skill to perform and interpret coronary angiography.			II	
10. Skill to insert intra-arterial and pulmonary artery catheters and interpret the findings.		I		
11. Skill to assess overall risk, identify candidates for invasive evaluation and treatment, and establish optimal medical regimen in non–ST-elevation acute coronary syndromes.		I		
12. Skill to identify patients who would benefit from mechanical circulatory support.		I		
13. Skill to achieve risk-factor target levels for secondary prevention.	I			
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, simulation				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Work with emergency medical systems, emergency departments, and hospital teams to establish effective first medical contact strategies for cardiovascular emergencies.		I		
2. Identify and address financial, cultural, and social barriers to diagnostic and treatment recommendations.	I			
3. Utilize a multidisciplinary coordinated approach for patient management, including transfer of care and employment-related issues.		I		
4. Practice in a manner that fosters the balance of appropriate utilization of finite resources with the net clinical benefit for the individual patient.		I		
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, multisource evaluation, record review				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify gaps in performance and knowledge and perform appropriate personal learning activities.		I		
2. Utilize decision support tools for accessing guidelines and pharmacologic information at the point of care.	I			
Evaluation Tools: chart-stimulated recall, direct observation, reflection and self-assessment				
Professionalism	**12**	**24**	**36**	**Add**
1. Exhibit sensitivity to patient preference and end-of-life issues.	I			
2. Demonstrate sensitivity and responsiveness to diverse patient populations.	I			
3. Demonstrate a commitment to carry out professional responsibilities, appropriately refer patients, and respond to patient needs in a way that supersedes self-interest.	I			
4. Interact respectfully with patients, families, and all members of the healthcare team, including ancillary and support staff.	I			
Evaluation Tools: direct observation, multisource evaluation				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Effectively communicate with acutely ill patients across a broad range of cultural, ethnic, and socioeconomic backgrounds.	I			
2. Communicate with all healthcare providers involved in patient care.	I			
Evaluation Tools: chart-stimulated recall, direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

Table 4. Core Competency Components and Curricular Milestones for Training in Valvular Heart Disease

Medical Knowledge	Milestones (Months)			
	12	24	36	Add
1. Know the characteristic features and natural history of congenital bicuspid aortic valve disease.	I			
2. Know the etiology, natural history, pathophysiology, and differential diagnosis of acquired aortic, mitral, pulmonic, and tricuspid valve diseases.		I		
3. Know the characteristic features and natural history of rheumatic valvular heart disease.	I			
4. Know the cardinal symptoms and physical findings of aortic and of mitral stenosis and their role in management decisions.	I			
5. Know the cardinal symptoms and physical findings of chronic aortic and chronic mitral regurgitation and their roles in management decisions.		I		
6. Know the causes and distinguishing characteristics of acute versus chronic mitral and aortic regurgitation.		I		
7. Know the natural history, clinical features, and complications of mitral valve prolapse.	I			
8. Know the appropriate indications for, and characteristic findings of, echocardiographic testing for diagnosis and assessment of severity during initial evaluation and upon follow-up.		I		
9. Know the role of stress testing in assessment of valvular heart disease.			I	
10. Know the indications for MRI and CT in the assessment of valvular heart disease.		I		
11. Know the indications for, and characteristic findings with, cardiac catheterization in patients with valvular heart disease.		I		
12. Know the indications for, and clinical pharmacology of, drugs used for the treatment of native and prosthetic valvular heart disease, including anticoagulation and antibiotic prophylaxis.	I			
13. Know the effects of arrhythmias on the clinical manifestations, risks of complications, and management of valvular heart disease.		I		
14. Know the indications and expected outcomes for surgical therapy in valvular heart disease, including valve selection and repair versus replacement.		I		
15. Know the indications and expected outcomes for transcatheter therapy in valvular heart disease.		I		
16. Know the etiology, natural history, physical findings, differential diagnosis, complications, and treatment of native valve and prosthetic valve endocarditis.		I		
17. Know the effects of pregnancy on the clinical manifestations and management of patients with valvular heart disease (native and prosthetic).		I		
Evaluation Tools: chart-stimulated recall, direct observation, in-training exam				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to identify cardinal physical findings and ECG abnormalities in patients with valvular heart disease.		I		
2. Skill to distinguish innocent from pathologic heart murmurs.		I		
3. Skill to manage patients with valvular heart disease and coronary artery disease.		I		
4. Skill to select appropriate testing and integrate results with clinical findings in the evaluation and management of patients with valvular heart disease.		I		
5. Skill to distinguish aortic stenosis from hypertrophic obstructive cardiomyopathy and other causes of LVOT obstruction.	I			
6. Skill to recognize bicuspid aortic valve disease and its associated abnormalities.	I			
7. Skill to recognize impact of ventricular dysfunction on clinical decision-making in valvular heart disease.	I			
8. Skill to recognize the cause and impact of pulmonary hypertension in management of valvular heart disease.		I		
9. Skill to determine candidacy and optimal timing of cardiac surgical or transcatheter		I		

treatments in patients with valvular heart disease.				
10. Skill to perform and interpret transesophageal echocardiography in patients with valvular heart disease.			II	
11. Skill to perform and interpret diagnostic catheterization in patients with valvular heart disease.			II	
Evaluation Tools: chart-stimulated recall, direct observation, logbook, simulation				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Participate in interdisciplinary decision-making with regard to surgery and transcatheter therapy.		I		
2. Practice in a manner that fosters the balance of appropriate utilization of finite resources with the net clinical benefit for the individual patient.		I		
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify competency gaps and engage in opportunities to achieve focused education and performance improvement.		I		
2. Utilize decision support tools for accessing guidelines and pharmacologic information at the point of care.		I		
Evaluation Tools: in-training exam, reflection and self-assessment				
Professionalism	**12**	**24**	**36**	**Add**
1. Exhibit sensitivity to patient preference and end-of-life issues.		I		
2. Practice within the scope of personal expertise or technical skills.		I		
Evaluation Tools: in-training exam, reflection and self-assessment				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Engage in shared decision-making with patients about their condition and the options for diagnosis and treatment.		I		
Evaluation Tools: direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

Table 5. Core Competency Components and Curricular Milestones for Training in Pericardial Disease

Medical Knowledge	**Milestones (Months)**			
	12	**24**	**36**	**Add**
1. Know the pathophysiology, differential diagnosis, and natural history of acute and relapsing pericarditis.	I			
2. Know the pathophysiology, differential diagnosis, and natural history of pericardial effusion and pericardial tamponade.	I			
3. Know the pathophysiology, differential diagnosis, and natural history of constrictive pericarditis.		I		
4. Know the cardinal physical findings of acute pericarditis, pericardial tamponade, and constrictive pericarditis.		I		
5. Know the indications for pericardiocentesis.	I			
6. Know the indications for, and clinical pharmacology of, drugs used for the treatment of acute and relapsing pericarditis.	I			
7. Know the effects of pericardial disease on other organ systems.		I		
8. Know pericardial anatomy and structural abnormalities (pericardial cyst and congenital absence of the pericardium).		I		
9. Know the indications for, and characteristic findings in, imaging studies of pericardial diseases.		I		
10. Know the indications for surgical referral in pericardial diseases and the expected outcomes.		I		
Evaluation Tools: chart-stimulated recall, global evaluation, in-training exam				

Patient Care and Procedural Skills	12	24	36	Add
1. Skill to clinically evaluate, diagnose, and manage patients with acute pericarditis and with chronic relapsing pericarditis.		I		
2. Skill to identify cardinal physical findings and evaluate and manage patients with pericardial effusion, including tamponade.		I		
3. Skill to identify cardinal physical findings and evaluate and manage patients with constrictive pericarditis.		I		
4. Skill to appropriately select and incorporate data from laboratory testing and noninvasive imaging in the evaluation and management of patients with pericardial disease.		I		
5. Skill to perform pericardiocentesis.			II	
6. Skill to distinguish constrictive pericarditis from restrictive cardiac disease.		I		
7. Skill to identify patients who should be referred for cardiac catheterization in the evaluation of pericardial disease.		I		
8. Skill to identify patients with constrictive pericarditis who are candidates for referral for consideration of cardiac surgery.		I		
Evaluation Tools: direct observation, global evaluation, logbook, simulation				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Utilize a multidisciplinary coordinated approach for patient management, including transfer of care and employment-related issues.		I		
2. Incorporate risk-benefit analysis and cost considerations in diagnostic and treatment decisions.		I		
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify competency gaps and engage in opportunities to achieve focused education and performance improvement.		I		
Evaluation Tools: chart-stimulated recall, in-training exam, reflection and self-assessment				
Professionalism	**12**	**24**	**36**	**Add**
1. Exhibit sensitivity to patient preference and end-of-life issues.		I		
2. Practice within the scope of personal expertise or technical skills.		I		
***Evaluation Tools*:** direct observation, global evaluation, multisource evaluation				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate with and educate patients and families across a broad range of cultural, ethnic, and socioeconomic backgrounds.		I		
2. Engage in shared decision-making with patients about their condition and the options for diagnosis and treatment.		I		
Evaluation Tools: direct observation, global evaluation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

5. Evaluation of Competency

Evaluation tools in clinical cardiology include direct observation by instructors, in-training examinations, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, simulation, and reflection and self-assessment. Case management, judgment, interpretive and bedside skills must be evaluated in every trainee. Quality of care and follow-up;, reliability; judgment, 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 HIPAA-compliant electronic database or logbook that meets ACGME reporting standards and summarizes pertinent clinical information (e.g., number of cases, diversity of referral sources, diagnoses, disease severity, outcomes and disposition). The faculty under the aegis of the program director 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 assure achievement of selected training milestones and identify areas in which additional focused training may be required.

Key Words: ACC Training Statement ▪ COCATS ▪ fellowship training ▪ clinical competence ▪ ambulatory care ▪ consultative care ▪ longitudinal care.

1

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 1: TRAINING IN AMBULATORY, CONSULTATIVE, AND LONGITUDINAL CARDIOVASCULAR CARE

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
Jonathan L. Halperin *(Co-Chair)*	Icahn School of Medicine at Mount Sinai—Professor of Medicine	None	None	None	None	None	None
Eric S. Williams *(Co-Chair)*	Indiana University School of Medicine—Professor (Cardiology) and Associate Dean; Indiana University Health—Cardiology Service Line Leader	None	None	None	None	None	None
Valentin Fuster *(Co-Chair)*	Icahn School of Medicine at Mount Sinai, Zena and Michael A. Wiener Cardiovascular Institute—Director	None	None	None	None	None	None
Nancy R. Cho	Cardiology and Medicine Associates—Cardiologist	None	None	None	None	None	None
William Iobst	The Commonwealth Medical College—Vice President, Academic and Clinical Affairs, Vice Dean; *Former employment during writing effort:* American Board of Internal Medicine—Vice President, Academic Affairs	None	None	None	None	None	None
Debabrata Mukherjee	Texas Tech University Health Sciences Center—Chief, Cardiovascular Medicine	None	None	None	None	None	None

Prashant Vaishnava	The Icahn School of Medicine at Mount Sinai, Mount Sinai Heart —Director, Quality Assurance; Assistant Professor of Medicine	None	None	None	None	None	None

For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF1_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELEVANT RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES—COCATS 4 TASK FORCE 1: TRAINING IN AMBULATORY, CONSULTATIVE, AND LONGITUDINAL CARDIOVASCULAR CARE

Name	Employment	Representation	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
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Dhanunjaya Lakkireddy	Kansas University Cardiovascular Research Institute	Official Reviewer, ACC Board of Governors	None	None	None	None	None	None
Howard Weitz	Thomas Jefferson University Hospital—Director, Division of Cardiology; Sidney Kimmel Medical College at Thomas Jefferson University—Professor of Medicine	Official Reviewer, Competency Management Committee Lead Reviewer	None	None	None	None	None	None
Furman McDonald	American Board of Internal Medicine—Vice President Graduate Medical Education, Department of Academic Affairs and Professor, Medicine	Organizational Reviewer, ABIM	None	None	None	None	None	None
Kiran Musunuru	Brigham and Women's Hospital, Harvard University	Organizational Reviewer, AHA	None	None	None	None	None	None
Kenneth Ellenbogen	VCU Medical Center—Director,	Content Reviewer,	None	None	None	None	None	None

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Rosario Freeman	University of Washington—Director, Cardiology Fellowship Programs; Medical Director, Noninvasive Diagnostic Services; Associate Professor of Medicine	Content Reviewer, Competency Management Committee	None	None	None	None	None	None
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Larry Jacobs	Lehigh Valley Health Network, Division of Cardiology; University of South Florida—Professor, Cardiology	Content Reviewer, Cardiology Training and Workforce Committee	None	None	None	None	None	None

Andrew Kates	Washington University School of Medicine	Content Reviewer, Academic Research Council	None	None	None	None	None	None
Chittur A. Sivaram	University of Oklahoma—Vice Chief, Cardiovascular Section	Content Reviewer, Competency Management Committee	None	None	None	None	None	None
David Vorchheimer	Montefiore-Einstein Center for Heart & Vascular Care—Director, Clinical Cardiology; Professor, Clinical Medicine	Content Reviewer, Individual	None	None	None	None	None	None

For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ABIM = American Board of Internal Medicine; ACC = American College of Cardiology; and AHA = American Heart Association.

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

COCATS = Core Cardiovascular Training Statement

HIPAA = Health Insurance Portability and Accountability Act

References

1. Baughman KL, Duffy FD, Eagle KA, Faxon DP, Hillis LD, Lange RA. Task force 1: training in clinical cardiology. J Am Coll Cardiol 2008;51:339-48.

COCATS 4 Task Force 2: Training in Preventive Cardiovascular Medicine[3]

Sidney C. Smith, Jr., MD, FACC; *Chair*; Vera Bittner, MD, FACC; J. Michael Gaziano, MD, FACC; John C. Giacomini, MD, FACC; Quinn R. Pack, MD; Donna M. Polk, MD, MPH, FACC; Neil J. Stone, MD, FACC; Stanley Wang, MD, JD, MPH

1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The writing committee was selected to represent the American College of Cardiology (ACC) and included a cardiovascular training program director, a cardiology clinic director, early-career cardiovascular disease prevention experts, highly experienced specialists representing both the academic and community-based practice settings, a physician experienced in defining and applying training standards according to the core competencies structure that is promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialties (ABMS) and endorsed by the American Board of Internal Medicine (ABIM), and a fellow in training. The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiovascular training statement. Employment and affiliation details for the authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF2_Comprehensive_RWI_Supplement.pdf).

1.1.2. Document Development and Approval

The writing committee developed the document, approved it for peer review by individuals selected by the ACC, and then addressed peer reviewers' comments. The document was revised and posted for public

[3] The American College of Cardiology requests that this document be cited as follows: Smith SC Jr, Bittner V, Gaziano JM, Giacomini JC, Pack QR, Polk DM, Stone NJ, Wang S. COCATS 4 task force 2: training in preventive cardiovascular medicine. J Am Coll Cardiol. 2015;●●:●●●●–●●●●.

comment from December 20, 2015 to January 6, 2015. Authors addressed the additional from the public to complete the document. The final document was approved by the Task Force, COCATS Steering Committee, and ACC Competency Management Committee as well as ratified by the ACC Board of Trustees in March, 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

Atherosclerotic vascular disease with its clinical manifestations of myocardial infarction, stroke, and peripheral vascular disease is the world's leading cause of death, morbidity, and mortality and is therefore the major focus of training in prevention and in the strategies recommended in this document. Other disease prevention issues are dealt with in specific sections. The missions of the American College of Cardiology and the American Heart Association have been to ensure optimal care to those with or at risk for developing atherosclerotic cardiovascular disease (ASCVD). The cardiovascular specialist is expected to contribute significantly to treating and preventing CVD in the setting of a rapidly growing field of knowledge ranging from molecular and cellular mechanisms to clinical outcomes. Over the past 2 decades, there have been dramatic increases in knowledge concerning specific risk factors and guidelines developed to address these factors relating to atherosclerosis, hypertension, thrombosis, and other forms of vascular dysfunction.

Despite the fact that clinical outcomes can be improved by promoting favorable life habits and behaviors and by the proper use of drug treatment, the application of preventive interventions in the clinical practice of cardiovascular medicine is not optimal. Part of this problem may be the insufficient attention that prevention education currently receives during cardiovascular fellowship. A recent survey of cardiovascular fellowship programs revealed that most programs do not meet current ACC/COCATS training recommendations for cardiovascular disease prevention (1). In both the primary and secondary prevention settings, ASCVD prevention must no longer be peripheral to the practice of the cardiovascular specialist. The cardiovascular specialist must become proficient in primary and secondary prevention of ASCVD, having the ability to recommend specific primary and secondary preventive measures and to identify patients with subclinical ASCVD who may benefit from more aggressive risk factor modification. It is important for the cardiovascular fellow to understand which therapies promoted widely in practice and/or on the internet have a strong evidence base and which do not.

It is imperative that cardiovascular training programs provide the necessary education and training to promote best practices among their trainees, who bear the responsibility to provide optimal preventive services to their patients. This report outlines specific areas of knowledge and skills necessary to achieve this goal and also defines required and recommended standards to achieve this goal. The report updates previously published standards for training cardiology fellows enrolled in cardiac fellowship programs on the basis of changes in the field since 2008 (2) and as part of a broader effort to establish consistent training criteria across all aspects of cardiology. It also addresses the evolving framework of competency-based medical education described by the ACGME Outcomes Project and the 6 general competencies endorsed by the ACGME and ABMS. For the purpose of this document, all references to ASCVD prevention refer to both primary and secondary prevention.

The background and overarching principles governing fellowship training are provided in the Introduction to COCATS, and readers should become familiar with this foundation before considering the details of training in a subdiscipline like cardiovascular disease prevention. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally over time.

For most areas of adult cardiovascular medicine, 3 levels of training are delineated:

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 cardiology.

Level II training refers to additional training in 1 or more areas that enables some cardiologists to perform or interpret specific procedures or render more specialized care for specific patients and conditions. This level of training is recognized only for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. In the case of Prevention, the Task Force identified no specific competencies for Level II training. Given the central importance of prevention to managing patients with CVD, all competencies have been identified as Level I (required for all fellows) or relegated to advanced training post-fellowship.

Level III – Although there are programs for advanced training in prevention, such as may be required to qualify as director of a clinical service, research program, or both, there is, as yet, no formal Level III certification process for added qualification in prevention. Cardiologists who wish to focus their careers on CVD prevention may wish to consider advanced training outside the ACGME-accredited training program (see Section 4.2.3. Advanced Training).

2. General Standards

ASCVD or its antecedent risk factors acquired at a young age are often strongly related to poor lifestyle habits such as unhealthy diet, sedentary behavior, and tobacco use. If widely implemented, evidence-based population strategies have the promise to reduce the burden of CVD risk factors in the community and make preventive strategies more effective for high-risk patients (3). As noted earlier, training in cardiovascular disease prevention should be an essential part of all cardiovascular fellowship programs. Several important statements and guidelines provide the basis for training in the assessment and treatment of patients at risk of cardiovascular events. These statements have been developed by organizations such as the ACC; American Heart Association; and National Heart, Lung, and Blood Institute and should be included as core references in training as they become available and are updated (4-11). This evidence base will be especially useful when cardiologists begin practice after training and/or assume leadership positions.

2.1. Faculty

There should be adequate faculty, both in number and experience, to conduct training in preventive cardiovascular medicine. It is also highly desirable for at least some faculty to have expertise in vascular biology, atherosclerosis, hypertension, disorders of lipid metabolism, obesity and weight management, sleep medicine, diet and nutrition, smoking cessation, diabetes mellitus, thrombosis, clinical epidemiology, cardiac rehabilitation, exercise physiology, clinical pharmacology, genetics and pharmacogenomics, and the psychosocial aspects of CVD. Ideally, specific faculty in the cardiovascular medicine training program should be able to serve as topic area experts in 1 or more of these areas. This is important because the faculty should be able to function as role models in preventive cardiovascular medicine. Mentoring is important for cardiovascular trainees in their formative years, and prevention-oriented role models should function in this capacity.

2.2. Facilities

Facilities should be adequate to ensure experience in managing patients undergoing cardiac rehabilitation, as well as providing instruction on lifestyle measures such as diet, weight loss, physical activity, psychosocial evaluation, and smoking cessation. Programs without access to cardiac rehabilitation at the sponsoring institution may be able to access community resources or arrange for appropriate electives at other sites.

2.3. Equipment

Access to Web-based programs for assessing cardiovascular risk is important. The availability of equipment specified for noninvasive imaging (see COCATS Task Force 5, Echocardiography; Task Force 6, Nuclear Cardiology; Task Force 7, Cardiovascular Computed Tomography; and Task Force 8, Cardiovascular Magnetic Resonance) is essential.

2.4. Ancillary Support

Ancillary support to provide counseling on diet, exercise, weight loss, smoking cessation, and managing psychosocial risk factors should be available.

3. Training Components

3.1. Didactic Program

Didactic instruction may take place in a variety of formats, including but not limited to lectures, conferences, journal clubs, grand rounds, clinical case presentations, and patient safety or quality improvement conferences. The importance of clinical history should be taught on a regular basis and emphasized in patient-related conferences. Clinical history includes family history; assessment of diet, physical activity, fitness, and other lifestyle habits; physical examination; and electrocardiographic manifestations and findings from other noninvasive imaging tests used to identify subclinical atherosclerosis.

3.2. Clinical Experience

Rotation on general cardiovascular services is an essential component of training in cardiovascular disease prevention. Level I trainees should gain firsthand experience in treatment strategies for primary and secondary prevention, as well as in management of complex dyslipidemia and advanced hypertension.

Training in cardiovascular disease prevention should involve prevention across the risk continuum for patients of varying age, gender, and ethnicity. It should include patients who have undergone revascularization, cardiac transplantation, and other complex cardiovascular procedures. Given the importance of cardiovascular disease as a global threat, training obtained outside the primary institution, including international experiences, can provide valuable insight to trainees on the challenges involved in reducing cardiovascular risk in less technologically developed health systems.

3.3. Hands-On Experience

Hands-on experience is important for training in cardiovascular disease prevention. Trainees in cardiology should spend 6 to 12 months devoted to managing patients with advanced atherosclerosis, heart failure, valvular heart disease, arrhythmia, dyslipidemia, obesity, sedentary lifestyle, and hypertension. Additionally, trainees should participate in delivering cardiac rehabilitation in the appropriate inpatient and outpatient environments to acquire the core competencies. Opportunities to practice in disease prevention or wellness centers and in pediatric and adolescent prevention clinics may add valuable perspective and education on issues facing patients with less-advanced disease states.

4. Summary of Training Requirements

4.1. Development and Evaluation of Core Competencies

Training and requirements in cardiovascular disease prevention address the 6 general competencies promulgated by the ACGME/ABMS and endorsed by the ABIM. These competency domains include: 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 core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 1 delineates each of the 6 competency domains as well as their associated curricular milestones for training in cardiovascular disease prevention. The milestones indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Because programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may vary as well. Level I competencies may be achieved at earlier or later time points. The table also describes examples of evaluation tools suitable for assessing competence in each domain.

Table 1. Core Competency Components and Curricular Milestones for Training in Cardiovascular Disease Prevention

Medical Knowledge	Milestones (Months)			
	12	24	36	Add
1. Know the structure of the normal artery and the basic vascular biology of atherosclerotic vascular disease.	I			
2. Know the principles of genetics as applied to cardiovascular disease and pharmacogenomics as applied to cardiovascular therapy.		I		
3. Know the impact of family history on disease risk and utility of family screening in cardiovascular disease prevention.	I			
4. Know the clinical epidemiology of cardiovascular disease, including incidence/prevalence, sex and ethnic differences, and the influence of traditional risk factors and demographics on outcomes.	I			

5. Know the principles for implementation both of individual and population-based cardiovascular disease prevention.	I			
6. Know the major tools to assess both lifetime and 10-year risks of a first cardiovascular event and influence primary prevention measures.	I			
7. Know the evidence for incremental benefit over a traditional risk-based approach, as well as the advantages, disadvantages, and limitations of screening methods to assess subclinical atherosclerosis (including biomarkers, coronary calcification, carotid intima-media thickness, and ankle-brachial index).		I		
8. Know the effects of diabetes mellitus, obesity, hypertension, lipid disorders, physical inactivity, and tobacco use on the development and progression of atherosclerosis, and their treatment strategies.	I			
9. Know the physiology and assessment of diabetes mellitus and principles of its management and comanagement in patients with cardiovascular disease.	I			
10. Know the physiology, assessment, and management of lipid disorders, including in special populations.	I			
11. Know the physiology, presentation, evaluation and management of hypertensive disorders, including refractory hypertension.	I			
12. Know the principles of nutrition and obesity assessment and management, including the roles of pharmacotherapy and bariatric surgery.	I			
13. Know the roles and management principles for behavioral and psychosocial contributions to cardiovascular disease.	I			
14. Know the principles and roles of exercise physiology, physical activity counseling, and cardiac rehabilitation.	I			
15. Know the tools and principles for managing and counseling regarding tobacco cessation.	I			
16. Know the effects of systemic diseases and their treatments (including renal, hepatic, inflammatory, and autoimmune-related disorders) on cardiovascular risk factors and their management.	I			
17. Know adverse effects of obstructive and central sleep apnea on the incidence and control of hypertension, atrial fibrillation and other arrhythmias, congestive heart failure, and atherosclerosis.	I			
18. Know the indications for noninvasive screening for carotid artery disease, abdominal aortic aneurysm, and peripheral vascular disease.	I			
19. Know the impact of reproductive stages, pregnancy, and of hormonal treatment for reproductive disorders on cardiovascular risk.	I			
20. Know the principles of antithrombotic therapy in cardiovascular disease.	I			
21. Know the pharmacology, indications, contraindications, and interactions of medications commonly used in cardiovascular disease prevention and therapy (e.g., antithrombotic agents, antihypertensive agents, lipid-lowering agents, agents used in diabetes management, and agents used in cessation of tobacco).	I			
Evaluation Tools: chart-stimulated review, direct observation, in-training exam				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to perform global risk assessment and appropriately utilize diagnostic testing – both in patients at risk for and those with prior cardiovascular events or diagnoses.	I			
2. Skill to evaluate a patient's family history and appropriately recommend family screening.	I			
3. Skill to identify patients who may have common systemic disorders that affect cardiovascular disease diagnosis and treatment such as sleep apnea and thyroid disorders.	I			

4. Skill to implement and prescribe lifestyle approaches for the prevention and treatment of hypertension, dyslipidemia, tobacco use, obesity, and diabetes mellitus.	I			
5. Skill to assess physical activity patterns and exercise capacity and provide physical activity counseling and exercise prescription, as well as counseling on whether to return to sports.	I			
6. Skill to identify patients who will benefit from low-density lipoprotein apheresis.		I		
7. Skill to identify patients for whom antiplatelet therapy is indicated.	I			
8. Skill to identify and address factors that contribute to nonadherence to treatment regimen.	I			
9. Skill to utilize individualized risk-benefit assessment in the management of patients and adapt prevention strategies to patients with specific comorbidities (e.g., diabetes mellitus, chronic kidney disease, arthritis).	I			
10. Skill to appropriately integrate new medical information into patient care.	I			
Evaluation Tools: chart-stimulated recall, direct observation, registry and/or hospital program quality data				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Practice in a manner that best balances appropriate utilization of finite resources with the net clinical benefit for the individual patient.	I			
2. Utilize an interdisciplinary team approach for disease management.	I			
3. Coordinate patient care among healthcare providers, including transfer of care.	I			
4. Identify and address financial, cultural, and social barriers to treatment implementation and adherence.	I			
5. Appropriately utilize specialty care for patients with advanced or complex diabetes mellitus, complex lipid disorders, refractory hypertension, obesity, depression, or sleep apnea.	I			
6. Appropriately utilize disease management tools and protocols as an aid in the management of patients with high risk-factor burden and established chronic diseases.	I			
Evaluation Tools: direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.		I		
2. Utilize point-of-service resources to enhance adherence to guidelines and protocols and obtain new information from clinical trials and professional societies.		I		
Evaluation Tools: chart-stimulated recall, direct observation, registry and/or hospital program quality data, reflection and self-assessment				
Professionalism	**12**	**24**	**36**	**Add**
1. Know and promote adherence to guidelines and appropriate use criteria.		I		
2. Demonstrate respect for individuals with lifestyle disorders such as obesity and tobacco use.	I			
3. Practice prevention in your personal lifestyle and promote a culture of healthy lifestyle choices and physical activity in your work environment and community.	I			

Evaluation Tools: conference presentation, direct observation, multisource evaluation				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate with and educate patients and families across a broad range of cultural, ethnic, and socioeconomic backgrounds regarding appropriate risk factor modification.		I		
2. Communicate in ways that patients and families can understand the evidence on which recommendations are based.		I		
3. Evaluate a patient's health literacy and appropriately adapt counseling strategies and tools.	I			
4. Communicate effectively with patients, families, and referring physicians.	I			
Evaluation Tools: direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

4.2. Training Requirements

Training for CVD prevention should be incorporated into all aspects of a cardiovascular training program. Given the importance of prevention in managing patients with CVD, all competencies to be obtained during the 3-year fellowship program are denoted Level I, required for every trainee. Advanced training post fellowship, can be obtained to acquire a body of knowledge and career pathway to specialize in CVD prevention, leading to a leadership focus in this field. The specific training elements required are discussed in the following paragraphs.

4.2.1. Level I Training Requirements

Clinical trials have proven that strategies aimed appropriately detecting and modifying risk factors can slow progression of atherosclerosis and hypertension and reduce the occurrence of clinical events in both primary and secondary prevention settings. More recently, it has been shown that atherosclerosis can be stabilized or even modestly reversed with an associated reduction in undesirable clinical outcomes. Finally, the growing knowledge base of cardiovascular molecular genetics has potentially important implications for the future clinical practice of preventive cardiovascular medicine. Level I training is required of all cardiovascular specialists and includes the milestones outlined in Table 1. It is important to realize that this list of key measures should not be considered all-inclusive. The field of cardiovascular prevention is ever-changing, as epidemiologic and clinical trial data accumulate. Training programs should be oriented toward implementing the most up-to-date guidelines for all risk factors in CVD prevention.

To achieve this level of competency, the Task Force believes the typical fellow will require 1 month of dedicated training in ASCVD prevention. A potential mechanism to obtain this level of training could be participation in a 1-month (or longer) rotation dedicated to preventive cardiovascular medicine (Table 1). Acceptable alternatives include a 3-month (or longer) clinical cardiovascular rotation that allows concomitant exposure to a comprehensive cardiovascular rehabilitation program at least 1 day each week. This would allow incorporation of a broad range of preventive approaches in addition to the predominant rehabilitation focus of physical exercise. Ideally, the 1-month rotation should include weekly attendance at a cardiac rehabilitation program, diabetes mellitus or endocrinology clinic, hypertension clinic, and lipid disorders clinic. Another alternative includes obtaining training in these areas through consultative, inpatient, and outpatient rotations, with additional didactic sessions, such as monthly lectures focusing on cardiovascular prevention topics. If the latter approach is taken, the time allotted should be equivalent to at least 1 month of full-time training. Training program directors may also consider supplementing clinical experiences with short courses devoted exclusively to preventive cardiovascular medicine or risk factor evaluation and management.

4.2.2. Advanced Training Requirements

The most effective preventive cardiovascular medicine services incorporate the skills and knowledge of multiple providers, including cardiovascular physicians, nurses, nurse practitioners, physician assistants, dietitians, sleep and behavioral medicine specialists, and exercise physiologists. They operate on principles of interdisciplinary teamwork and use systemic approaches to patient care. Although such programs are more effective than routine cardiovascular practice, few training programs offer opportunities to learn these new skills. Programs interested in offering advanced training should incorporate these new concepts into the training program and trainees interested in advanced training should seek programs that offer these approaches to patient care (12). The type of skills developed in such advanced training programs might include competency in managing patients using low-density lipoprotein apheresis or leadership training to serve as director of a preventive cardiovascular medicine, hypertension, or lipid service, or of a cardiac rehabilitation program or vascular or sleep medicine laboratory; or a trainee who obtains a master's degree in public health, clinical epidemiology, or outcomes research. These competencies are beyond the Level I training in preventive cardiovascular medicine included in a cardiovascular fellowship program. Fellows interested in advanced training may wish to consider training and certification through participation in various subspecialty societies (e.g., the American Association of Cardiovascular and Pulmonary Rehabilitation, American Academy of Sleep Medicine, American Society of Hypertension, National Lipid Association, Association for the Treatment of Tobacco Use and Dependence, The Obesity Society/American Board of Obesity Medicine) or to participate in additional training in cardiovascular disease prevention during 3rd year electives or during a 4th year of training in non-ACGME training programs in cardiovascular disease prevention (12). Specific competencies for prevention specialists and medical directors of cardiac rehabilitation programs have been published previously (5,13).

5. Evaluation of Competency

Evaluation tools in cardiovascular disease prevention include direct observation by instructors, in-training examinations, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, simulation, and reflection and self-assessment. Case management, judgment, interpretation, and bedside skills must be evaluated in every trainee. Quality of care and follow-up; reliability; judgment, 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 (HIPAA)-compliant electronic database or logbook that meets ACGME reporting standards and summarizes pertinent clinical information (e.g., number of cases, dates, and patient identifiers such as medical record number and faculty supervisor).

The ACC, American Heart Association, and American College of Physicians published a curriculum on cardiovascular disease prevention (5). The ACC offers an Adult Clinical Cardiology Self-Assessment Program (ACCSAP) that includes information on preventive cardiovascular medicine, and other societies offer similar self-assessment programs (e.g., NLA-SAP from the National Lipid Association). Training directors and trainees are encouraged to incorporate resources such as these in the course of training, to utilize in-service examinations, and to ensure trainees (and faculty) have acquired appropriate knowledge of preventive cardiovascular medicine.

Under the aegis of the program director, the 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 assure achievement of selected training milestones and identify areas in which additional focused training may be required.

Key Words: ACC Training Statement ▪ COCATS ▪ fellowship training ▪ clinical competence ▪ cardiovascular disease prevention.

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)— COCATS 4 TASK FORCE 2: TRAINING IN PREVENTIVE CARDIOVASCULAR MEDICINE

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
Sidney C. Smith, Jr. *(Chair)*	University of North Carolina, Heart and Vascular Center—Professor of Medicine	None	None	None	None	None	None
Vera Bittner	University of Alabama at Birmingham—Medical Director, Coronary Care Unit; Professor of Medicine; Section Head, Preventive Cardiology; and Medical Director, Cardiac Rehabilitation	None	None	None	None	None	None
J. Michael Gaziano	Brigham and Women's Hospital, Cardiology Division—Chief, Division of Aging	None	None	None	None	None	None
John C. Giacomini	Stanford University Medical Center—Professor and Associate Chief, Division of Cardiovascular Medicine; Fellowship Director; VA Palo Alto Health Care System—Chief, Cardiology Section	None	None	None	None	None	None
Quinn R. Pack	Henry Ford Hospital—Cardiologist	None	None	None	None	None	None
Donna M. Polk	Brigham and Women's Hospital—Director, Cardiovascular Fellowship Program	None	None	None	None	None	None
Neil J. Stone	Northwestern Medicine; Bonow Professor of Medicine; Preventive Cardiology	None	None	None	None	None	None

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
Stanley Wang	Austin Heart—Cardiologist and Sleep Specialist; Heart Hospital of Austin Sleep Disorders Center— Medical Director	None	None	None	None	None	None

For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF2_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELEVANT RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES— COCATS 4 TASK FORCE 2: TRAINING IN PREVENTIVE CARDIOVASCULAR MEDICINE

Name	Employment	Representation	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
Richard Kovacs	Indiana University, Krannert Institute of Cardiology—Q.E. and Sally Russell Professor of Cardiology	Official Reviewer, ACC Board of Trustees	None	None	None	None	None	None
Dhanunjaya Lakkireddy	Kansas University Cardiovascular Research Institute	Official Reviewer, ACC Board of Governors	None	None	None	None	None	None
Howard Weitz	Thomas Jefferson University Hospital—Director, Division of Cardiology; Sidney Kimmel Medical College at Thomas Jefferson University—Professor of Medicine	Official Reviewer, Competency Management Committee Lead Reviewer	None	None	None	None	None	None
Kiran Musunuru	Brigham and Women's Hospital, Harvard University	Organizational Reviewer, AHA	None	None	None	None	None	None
Mouaz Al-Mallah	King Abdul-Aziz Cardiac Center—Associate Professor of Medicine	Content Reviewer, Prevention Council	None	None	None	None	None	None
Michael Emery	Greenville Health System	Content Reviewer, Sports and Exercise Cardiology Section Leadership	None	None	None	None	None	None

		Council						
Brian D. Hoit	University Hospitals Case Medical Center, Cleveland Ohio	Content Reviewer, Cardiology Training and Workforce Committee	None	None	None	None	None	None
Larry Jacobs	Lehigh Valley Health Network, Division of Cardiology; University of South Florida—Professor, Cardiology	Content Reviewer, Cardiology Training and Workforce Committee	None	None	None	None	None	None
Richard Josephson	University Hospitals Harrington Heart & Vascular Institute, Case Medical Center; Case Western Reserve School of Medicine—Division of Cardiology	Content Reviewer, Prevention Council	None	None	None	None	None	None
Andrew Kates	Washington University School of Medicine	Content Reviewer, Academic Cardiology Section Leadership Council	None	None	None	None	None	None
Deirdre Mattina	Henry Ford Hospital—Senior Staff Physician, Cardiology	Content Reviewer, Prevention Council	None	None	None	None	None	None

For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ACC = American College of Cardiology and AHA = American Heart Association.

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ACC = American College of Cardiology

ACCSAP = Adult Clinical Cardiology Self-Assessment Program

ACGME = Accreditation Council for Graduate Medical Education

COCATS = Core Cardiovascular Training Statement

HIPAA = Health Insurance Portability and Accountability Act

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COCATS 4 Task Force 3: Training in Electrocardiography, Ambulatory Electrocardiography, and Exercise Testing[4]

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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The writing committee was selected to represent the American College of Cardiology (ACC) and included a cardiovascular training program director, an early-career cardiologist, highly experienced members representing both academic and community-based practice settings, and physicians experienced in defining and applying training standards according to the core competencies structure promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialties (ABMS) and endorsed by the American Board of Internal Medicine (ABIM). The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiovascular training statement. Employment and affiliation details for the authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF3_Comprehensive_RWI_Supplement.pdf).

1.1.2. Document Development and Approval

The writing committee developed the document, approved it for review by individuals selected by the ACC, and then addressed the peer reviewers' comments. The document was revised and posted for public comment from December 20, 2015 to January 6, 2015. Authors addressed the additional comments from the public to complete the document. The final document was approved by the Task Force, COCATS

[4] The American College of Cardiology requests that this document be cited as follows: Balady GJ, Bufalino VJ, Gulati M, Kuvin JT, Mendes LA, Schuller JL. COCATS 4 task force 3: training in electrocardiography, ambulatory electrocardiography, and exercise testing. J Am Coll Cardiol. 2015;●●:●●●●–●●●●.

Steering Committee, and ACC Competency Management Committee as well as ratified by the ACC Board of Trustees in March, 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

The Task Force was charged with updating previously published standards for training fellows in clinical cardiology enrolled in ACGME-certified fellowship (1) on the basis of: 1) changes in the field since 2008,and 2) the evolving framework of competency-based medical education described by the ACGME Outcomes Project and the 6 general competencies endorsed by ACGME and ABMS. The updating effort was also convened as part of a broader effort to establish consistent training criteria across all aspects of cardiology. The background and overarching principles governing fellowship training are provided in the Introduction to COCATS 4, and readers should become familiar with this foundation before considering the details of training in a subdiscipline like electrocardiography (ECG), ambulatory ECG, and exercise ECG testing. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally.

1.3. Training Levels

For most areas of cardiovascular medicine, 3 levels of training are delineated:

Level I training, which is the basic training required to become a competent cardiovascular consultant, is required of all cardiovascular fellows and can be accomplished as part of a standard 3-year training program in cardiovascular medicine. All cardiologists should attain Level I training in ECG, ambulatory ECG, and exercise ECG testing, as these skills are fundamental to the practice of clinical cardiology. Although many of the skills and competencies for each of these procedures can be acquired within the first 12 months of training, it is expected that such skills will be further developed and refined over the 3-year training period.

Level II training refers to the additional training in 1 or more areas that enables some cardiovascular specialists to perform or interpret specific diagnostic tests and procedures or to render more specialized care for patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training in selected areas may be achieved by some trainees during the standard 3-year cardiovascular fellowship, depending on the trainees' career goals and use of elective rotations. There is no Level II training for ECG, ambulatory ECG, and exercise ECG testing.

Level III training requires additional training and experience beyond the cardiovascular fellowship to acquire specialized knowledge and competencies in performing, interpreting, and training others to perform specific procedures or render advanced, specialized care at a high level of skill. There is no Level III training in ECG, ambulatory ECG, and exercise ECG testing.

2. Electrocardiography

ECG is the most commonly used diagnostic test in cardiology. When properly interpreted, it contributes substantially to the diagnosis and management of patients with cardiac disorders, and it is essential to diagnosing cardiac arrhythmias and acute myocardial ischemic syndromes, which account for the majority of cardiac catastrophes. ECG is appropriately used as a screening test in many circumstances.

2.1. General Standards

Three organizations—the ACC, American Heart Association (AHA), and Heart Rhythm Society—have together provided recommendations for standardizing and interpreting the electrocardiogram (2-7), and have provided training requirements and guideline standards for ECG training as well as educational objectives for the ECG component of training in cardiovascular diseases (8). The recommendations from the different organizations are congruent and address faculty, facility requirements, emerging technologies, and practice applications. We recommend strongly that candidates for the ABIM examination for certification in cardiovascular diseases review the ABIM's requirements with specific attention to the ECG components, which include special question formats for ECG interpretation (9). The following recommendations are aimed at trainees in cardiovascular training programs.

Cardiovascular fellowship programs should satisfy the requirements regarding facilities and faculty for training in ECG. Eligibility for the ABIM cardiovascular diseases examination requires that training take place in a program accredited by the ACGME.

2.1.1. Faculty

Faculty should include specialists skilled in ECG interpretation. This should include specialists in both clinical cardiac electrophysiology and cardiology. Faculty should be board-certified in cardiovascular diseases or possess equivalent qualifications. A physician is considered to have equivalent qualifications if he or she trained in a similar environment for a similar duration of time and performed the required number of procedures.

2.1.2. Facilities

Facilities should provide adequate training in multiple clinical settings, including inpatient, outpatient, emergent, and invasive (catheterization and/or electrophysiology laboratory). Facilities should also be available for didactic teaching.

2.1.3. Equipment

Equipment should be sufficient to provide reliable and reproducible ECGs and should include computerized devices that record and store a graphic display, and automatically generate a preliminary interpretation.

2.1.4. Ancillary Support

Ancillary support staff should be well trained and available to administer high-quality ECG testing and collect the appropriate data, preferably in an electronic format.

2.2. Training Components

2.2.1. Didactic Program

Didactic instruction may take place in a variety of formats, including, but not limited to, lectures, conferences, journal clubs, grand rounds, clinical case presentations, and patient safety or quality improvement conferences. Fellows must be trained to interpret a large number of ECGs and review all interpretations with experienced faculty. Programs should encourage the trainee to interpret a majority of ECGs side-by-side with faculty for immediate review and feedback. Formal, correlative conferences in ECG are highly recommended as part of the fellowship curriculum and should be held regularly during training. In addition, the role of ECG in clinical practice should be thoroughly reviewed.

2.2.2. Clinical Experience

Training in ECG interpretation should include clinical correlation in patients from a wide range of clinical settings, such as intensive care units, emergency rooms, and pacemaker/defibrillator clinics, as well as exposure to all forms of clinically encountered arrhythmias, normal variants, and electrocardiographic patterns associated with acquired and congenital heart disease. Trainees should be trained to review, edit, and amend ECGs generated by computerized systems that provide a preliminary interpretation.

2.2.3. Hands-On Experience

Hands-on experience is essential for training in ECG interpretation. Additionally, trainees are expected to acquire the technical skills necessary to competently perform and record high-quality, standard 12-lead ECG tracings.

2.3. Summary of Training Requirements

2.3.1. Development and Evaluation of Core Competencies

Training and requirements for ECG and ambulatory ECG address the 6 general competencies promulgated by the ACGME/ABMS 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 core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 1 delineates each of the 6 competency domains, as well as their associated curricular milestones for training in ECG and ambulatory ECG. The milestones indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Given that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may also vary. Level I competencies may be achieved at earlier or later time points. The table also describes examples of evaluation tools suitable for assessing competence in each domain.

Table 1. Core Competency Components and Curricular Milestones for Training in ECG/Ambulatory ECG

Medical Knowledge	Milestones (Months)			
	12	24	36	Add
1. Know the basic principles of electrocardiography and the operation/use of the instruments to acquire, display, and store electrocardiograms. (See Appendix 3.)	I			
2. Know the underlying cellular and ionic mechanisms in the genesis of surface electrocardiograms and the effects of the autonomic nervous system. (See Appendix 3.)		I		
3. Know the normal values for electrical axis and electrocardiographic intervals, durations, and voltage.	I			
4. Know the anatomy of the specialized conducting tissue and the spread of excitation in conduction system and myocardium.	I			
5. Know reentry, automaticity, and triggered activity mechanisms for cardiac arrhythmias.		I		
6. Know the types and mechanisms of aberrancy.		I		
7. Know capture and fusion complexes and the electrocardiographic pattern criteria for distinguishing supraventricular arrhythmias with aberrancy, accessory pathway conduction, pacing, and artifact from ventricular arrhythmias.			I	
8. Know the concepts of concealed conduction and exit block and their manifestation on the electrocardiogram.			I	
9. Know the characteristic electrocardiographic patterns of key clinical diagnoses. (See Appendix 4.)			I	

10. Awareness of ECG changes that are commonly seen in highly trained athletes and the challenges in distinguishing normal from abnormal findings.		I		
11. Know the indications for, and limitations of, continuous (Holter) and intermittent (event) ambulatory electrocardiographic recording.	I			
Evaluation Tools: direct observation, ECG and rhythm interpretation during simulation training (e.g., mock codes), global evaluation, in-training exam				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Technical skills to perform and record high quality standard 12-lead electrocardiographic tracings.	I			
2. Skill to identify normal electrocardiographic patterns, normal variants, and artifacts (including incorrect lead placement).		I		
3. Skill to identify electrocardiographic signs of atrial abnormalities and right and left ventricular hypertrophy or enlargement.		I		
4. Skill to identify types and significance of intraventricular conduction delay or block (including functional or aberrant conduction abnormalities).			I	
5. Skill to identify types of atrioventricular dissociation.			I	
6. Skill to identify first-degree, second-degree (types I, II, 2:1, and high degree), and third-degree atrioventricular blocks.			I	
7. Skill to identify the electrocardiographic patterns and localization of cardiac ischemia and infarction.		I		
8. Skill to identify the electrocardiographic changes of electrolyte and metabolic abnormalities and drug effects.			I	
9. Skill to identify non-specific QRS and ST-T wave changes.		I		
10. Skill to identify atrial, atrioventricular, nodal, and ventricular arrhythmias.			I	
11. Skill to identify each of the specific patterns and rhythms in Appendix 4.			I	
12. Skill to integrate electrocardiographic findings into clinical and risk assessments and the management of patients.		I		
13. Skill to select and interpret ambulatory electrocardiographic recording studies.			I	
14. Skill to identify normal and abnormal pacemaker rhythms/functions, and when to seek consultation from an electrophysiologist for advanced interpretation.			I	
Evaluation Tools: direct observation, ECG exam, in-training exam				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Skill to retrieve and utilize ECG tracings in electronic data systems.	I			
Evaluation Tools: conference presentation, direct observation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.			I	
Evaluation Tools: conference presentation, ECG exam				
Professionalism	**12**	**24**	**36**	**Add**
1. Practice within the scope of expertise and technical skills.	I			
2. Know and adhere to evidence-based and appropriate use criteria for ECG testing.			I	
Evaluation Tools: conference presentation, direct observation, multisource evaluation, reflection and self-assessment				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate testing results to physicians and patients in an effective and timely manner.			I	

Evaluation Tool: multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

2.3.2. Training Requirements

All trainees should achieve Level I training in ECG interpretation. Attainment of skills and competencies during the training program is paramount and must be emphasized. There is no established threshold number of studies that can serve as a training landmark; however, interpreting approximately 3000 to 3500 ECGs within 36 months should provide ample experience to acquire such competencies. This represents the procedural volume typically required to obtain competency, but the trainee must also demonstrate that competence is achieved, as assessed by the outcomes evaluation measures. Acquisition of competence may be accomplished by 1 or more training periods assigned specifically for ECG interpretation or as a continuous experience through clinical rotations. The cardiovascular subspecialist should be familiar with nearly all clinically encountered arrhythmias (normal variants) and electrocardiographic patterns associated with acquired and congenital heart disease and those that may accompany high-level exercise and athletic conditioning (10). This knowledge should include an understanding of the physiologic mechanisms for arrhythmias and ECG waveforms, rather than simple recognition of patterns. The trainee should understand the clinical implications, sensitivity, and specificity of the ECG. Training in ECG interpretation requires additional experience with interpreting complex arrhythmias and those normal and abnormal rhythms associated with pacemaker and implantable defibrillator devices. As such rhythms can be quite complex, trainees should be able to recognize when to seek consultation and assistance from an experienced electrophysiologist. The ECG knowledge base is included in Appendixes 1 and 2, and contains minimum requirements for each trainee.

The trainee should also be familiar with the instrumentation necessary to acquire, process, and store ECGs in both analog and digital formats; understand the effect of acquisition rates and filter settings; and recognize electronic artifacts. In addition, they should be able to accurately measure basic ECG intervals in both analog and digital systems.

There is no Level II or Level III training in ECG. The interpretive skills for highly complex arrhythmia diagnosis, signal-averaged ECG interpretation, and those normal and abnormal rhythms associated with pacemaker and implantable defibrillator devices, would be acquired during specialized training in electrophysiology (see Task Force 11 report).

3. Ambulatory ECG Monitoring

Observation and documentation of cardiac rhythm during daily activities, and of the relation between the rhythm disturbances and patient symptoms, are important factors for clinical decision making and should be a focus for training in cardiovascular medicine. Major indications for ambulatory ECG monitoring include the following: detection of—or ruling out—rhythm disturbances as a cause of symptoms, detection and assessment of arrhythmias believed to be associated with an increased risk for cardiovascular events, identification and accurate interpretation of ambulatory ST-T wave changes, assessment of the efficacy of antiarrhythmic and anti-ischemic therapy, and investigation of the effects of therapeutic devices (e.g., pacemakers, implantable cardioverter-defibrillator).

Multiple methods of ambulatory ECG recording and analysis are available for clinical use, including continuous short-term recorders (e.g., Holter monitors) and intermittent longer-term recorders (e.g., patient-activated event and loop recorders, auto-triggered recorders, patch-type extended Holter monitoring, ambulatory telemetry monitoring) (11). The trainee should understand the similarities and differences between these devices; the indications, advantages, and disadvantages of each device; and the potential pitfalls inherent in the technology. In addition, the trainee should have current knowledge about what may represent a "normal" finding for various age groups during sleeping and waking hours and what should be considered "abnormal," realizing that the clinical significance of some findings on ambulatory monitoring remains unresolved.

3.1. General Standards

The ACC and the AHA have addressed competency, training requirements, and guidelines for ambulatory ECG (8). The following recommendations are aimed at trainees in cardiovascular training programs.

3.1.1. Faculty

The trainee should participate in interpretation sessions with a staff cardiologist knowledgeable in the indications for the test, the techniques of recording, and the clinical significance and correlations of findings. Faculty should be board-certified in cardiovascular diseases or possess equivalent qualifications. A physician is considered to have equivalent qualifications if he or she trained in a similar environment for a similar duration of time and performed the required number of procedures. If dedicated electrophysiology faculty are available, the trainee should take advantage of this knowledge for evaluating and managing complex arrhythmias. Faculty should be available to discuss individual cases and provide formal educational experiences.

3.1.2. Facilities

Cardiovascular departments (heart stations) should have staff and space available for collecting and organizing ambulatory ECG data, preferably using digital technology. These data should be readily accessible for faculty and fellows in a timely fashion. In addition, access to patients' medical information, preferably via an electronic health record, is important to correlate findings with clinical status. The reviewer of the ambulatory ECG should be able to locate and communicate with the treating physician to convey critical information.

3.1.3. Equipment

The trainee should be familiar with the various devices that are available for both continuous and intermittent recording of cardiac rhythms (11). Trainees should understand how to place the equipment to collect cardiac monitoring data accurately.

3.1.4. Ancillary Support

Ancillary support should be available to administer ambulatory ECG testing and collect the appropriate data, preferably in an electronic format.

3.2. Training Components

3.2.1. Didactic Program

A comprehensive educational program should be provided to trainees to complement hands-on interpretation of ambulatory ECG recordings. The training program shall include didactic lectures, interactive case presentations, and self-directed learning. The educational offerings for ambulatory ECG should be combined with teaching about ECG and other topics in electrophysiology. Over the course of cardiovascular fellowship training, trainees should understand how to interpret and report ambulatory ECG information and should be taught about advances in ECG technology and the importance of this type of testing in evaluating patients with cardiovascular disease.

3.2.2. Clinical Experience

Trainees should be exposed to a wide array of ambulatory ECG monitors from a mix of patient populations, including those with complex rhythm disturbances and congenital and acquired structural heart disease. Trainees should be responsible for analyzing and interpreting all aspects of the ambulatory ECG study. When appropriate, the trainee should have knowledge of the patient’s medical background and rationale for testing. An experienced attending cardiologist in ambulatory ECG should oversee the trainee and be responsible for evaluating and documenting the trainee’s progress and skill level. In addition, expert consultation should be sought for complex arrhythmias from faculty with advanced training in electrophysiology, if available.

3.2.3. Hands-On Experience

Trainees should be provided the opportunity to learn all aspects of ambulatory ECG monitoring, including understanding available technologies, advising the patient, ordering the test, placing the monitor on or in the patient, and downloading the information. Analysis and interpretation of the data are critical to developing competency in this area. Trainees should also understand how to relay critical findings to the patients and other healthcare team members. Each of these steps should be overseen by an attending cardiologist comfortable with this testing modality.

3.3. Summary of Training Requirements

Refer to Table 1 for a list of ambulatory ECG core competencies.

3.3.1. Training Requirements

Attainment of skills and competencies during the training program is paramount and must be emphasized. There is no established threshold number of studies that can serve as a training landmark. However, interpreting approximately 100 to 200 ambulatory ECGs within 36 months should provide ample experience to acquire such competencies. This volume of procedures is typically required to obtain competency, but there must also be demonstration of achievement of competence, as assessed by the outcomes evaluation measures. Acquisition of competence may be accomplished by 1 or more training periods assigned specifically for interpretation of ambulatory ECGs or as a continuous experience through clinical rotations. Trainees should be exposed to both full-disclosure (complete printout) and computer-assisted ambulatory ECG systems. In addition, trainees should be exposed to trans-telephonic and event-recorder devices for prolonged ambulatory ECG. Furthermore, trainees should be exposed to recordings such as artifact, pacemaker, and implantable cardioverter-defibrillator patterns; heart rate variability studies; and repolarization abnormalities. Trainees should demonstrate knowledge of the operation and limitations of a variety of types of ambulatory ECG instrumentation. In addition, all trainees should be skilled in interpreting in-hospital telemetry ECGs. Trainees should understand the indications and limitations of testing from structured training by experienced cardiologists with specific expertise in ambulatory ECG. Such training will provide knowledge to satisfy clinical competence in ambulatory ECG as indicated by the ACC/AHA/American College of Physicians-American Society of Internal Medicine Task Force on Clinical Competence (8).

There is no Level II or Level III training in ambulatory ECG. The interpretive skills for highly complex arrhythmia diagnosis, insertion and management of implantable loop recorders, and those normal and abnormal rhythms associated with pacemaker and implantable defibrillator devices, would be acquired during specialized training in electrophysiology (see Task Force 11 report).

4. Exercise ECG Testing

Exercise ECG testing is among the most fundamental and widely used tests in the evaluation of patients with cardiovascular disease. It is easy to administer, perform, and interpret and is readily available in hospital or practice settings. Initially developed to detect the presence of myocardial ischemia due to coronary artery disease, the exercise ECG is now widely recognized for its utility in predicting prognosis. Exercise test variables beyond the ST segment, especially when used in combination with clinical information, yield important information to predict outcomes and guide therapy in a broad range of individuals. Exercise ECG testing can be applied in the evaluation and management of patients with a wide variety of cardiovascular conditions, including coronary artery disease, valvular heart disease, congenital heart disease, genetic cardiovascular conditions, arrhythmias, and peripheral arterial disease. When appropriately used with adjunctive modalities to measure gas exchange and ventilation, or imaging techniques such as echocardiography or nuclear perfusion imaging, the power of the exercise ECG test is further enhanced. This section provides training and competency requirements specific to exercise ECG testing. Other COCATS Task Force sections will address training and competency requirements for exercise and pharmacological stress testing when combined with imaging techniques.

4.1. General Standards

The ACC and AHA have addressed competency, training requirements, and guidelines for exercise testing and testing laboratories (12-15). The recommendations are congruent and address faculty, facility requirements, emerging technologies, and practice. The trainee should become familiar with each of these standards and recommendations.

4.1.1. Faculty

Faculty should be effective teachers who are experts in the clinical use and interpretation of exercise ECG testing, and who perform these tests on a regular basis. Such faculty should be supervised by the physician medical director of the exercise testing laboratory, such that the specifics of exercise test performance, protocols, and interpretation are consistent with the laboratory’s policies and standards. The faculty should be board-certified in cardiovascular disease or possess equivalent qualifications. A physician is considered to have equivalent qualifications if he or she trained in a similar environment for a similar duration of time, and performed the required number of procedures.

4.1.2. Facilities

The laboratory should regularly perform exercise tests that involve a broad spectrum of both inpatients and outpatients with a variety of known and suspected cardiovascular disorders. Specifics standards regarding the exercise testing environment are outlined by the AHA (14).

4.1.3. Equipment

The laboratory should contain exercise testing equipment for testing and monitoring, as well as emergency medications and equipment as outlined by the AHA (14).

4.1.4. Ancillary Support

The exercise testing laboratory staff generally consists of a variety of personnel that may include exercise physiologists, nurses, nurse practitioners, physicians' assistants, and medical technicians. These individuals often perform several duties, including assessing and preparing patients for the test; conducting the technical aspects of the test, including protocol selection and patient monitoring; and assisting the physician staff with patient management and medical emergencies should the need arise. Appropriate training requirements and information about the cognitive and performance skills necessary to competently supervise exercise tests are available in published guidelines (8,14).

4.2. Training Components

4.2.1. Didactic Program

Didactic instruction may take place in a variety of formats, including, but not limited to, individual instruction during exercise test performance and interpretation sessions, lectures, conferences, journal clubs, grand rounds, and clinical case and correlative conferences. In addition, self-learning—through required reading material that includes relevant guidelines, textbooks, seminal papers, and emerging literature regarding exercise testing—is essential. Such learning material should be provided, updated, and monitored by the exercise laboratory director or other faculty.

4.2.2. Clinical Experience

The trainee must become proficient in the interpretation of commonly used measurements available from the exercise test that are performed in a wide variety of patients with various cardiovascular conditions and other comorbidities. The trainee must acquire a working knowledge of cardiovascular exercise physiology and a keen understanding of appropriate and inappropriate physiological responses to exercise. Understanding of all of the technical aspects of testing is essential to ensure proper test performance and interpretation of results. The trainee must be thoroughly familiar with methods used in determining exercise capacity and its importance in prognostic evaluation and activity prescription. The trainee should become proficient in integrating data such as hemodynamic measurements, exercise ECG analyses, and non–ST-segment variables in both the diagnostic and prognostic assessment of the patient. This training will provide knowledge to satisfy clinical competence in exercise testing, as indicated by the ACC/AHA/American College of Physicians- American Society of Internal Medicine Task Force on Clinical Competence (15).

4.2.3. Hands-On Experience

The training program should be structured so that the trainee is guided in the laboratory by a specially trained exercise professional until the trainee has become proficient at conducting and personally monitoring exercise tests under a variety of clinical circumstances. The trainee must be given the responsibility of initially interpreting all phases of the exercise study, as well as providing that detailed interpretation to, and reviewing it with, the attending cardiologist who is responsible and experienced in exercise testing.

4.3. Summary of Training Requirements

4.3.1. Development and Evaluation of Core Competencies

The training and requirements for exercise testing address the 6 general competencies promulgated by the ACGME/ABMS 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 core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 2 delineates each of the 6 competency domains, as well as their associated curricular milestones for training in exercise–ECG testing. The milestones indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Recognizing that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may vary as well. Level I competencies may be achieved at earlier or later time points. The table also describes examples of evaluation tools suitable for assessment of competence in each domain.

Table 2. Core Competency Components and Curricular Milestones for Training in Exercise ECG Testing

Medical Knowledge	Milestones (Months)			
	12	24	36	Add
1. Know the indications, risks, limitations, and contraindications for exercise stress testing both for diagnosis and risk stratification in patients with suspected or known coronary heart disease.		I		
2. Know the principles and details of exercise testing, including the standard requirements of a safe testing laboratory, and technical requirements of proper lead placement and skin preparation.		I		
3. Know the application of Bayes' theorem to interpret exercise test results.		I		
4. Know the common exercise test protocols and targets.		I		
5. Know the concept of metabolic equivalent (MET) and estimation of exercise intensity in different modes of exercise.		I		
6. Know the electrocardiographic criteria for a positive test.		I		
7. Know the normal and abnormal heart rhythm and blood pressure responses to graded		I		

exercise and in recovery.				
8. Know the electrocardiographic, exercise capacity, and/or hemodynamic findings indicating a strongly positive test or adverse prognosis.		I		
9. Know the changes in the electrocardiogram that may result from exercise, hyperventilation, ischemia, hypertrophy, conduction disorders, electrolytes, and drugs.			I	
10. Know the criteria and indications for stopping a test before reaching the target heart rate.		I		
11. Know the significance of exercise-associated arrhythmias.			I	
12. Know the use of exercise testing in special groups (women, asymptomatic subjects, post-myocardial infarction, or recent acute coronary syndrome patients).			I	
13. Know the use, precautions, and contraindications of exercise testing in patients with valvular and myocardial diseases.			I	
14. Know the effects of baseline electrocardiographic abnormalities and medications on exercise testing.		I		
15. Know clinical and baseline electrocardiographic findings that warrant the addition of imaging to the exercise electrocardiogram.		I		
16. Know the indications for the selection of pharmacologic rather than exercise testing.		I		
17. Know the indications for, and the sensitivity and specificity of, adding echocardiographic or nuclear perfusion imaging to stress ECG testing.			I	
18. Known the indications for myocardial perfusion imaging and the appropriate selection of exercise versus pharmacologic stress testing.		I		
19. Know the role of stress testing in assessment of valvular heart disease.			I	
20. Know the role of exercise ECG testing in the evaluation of arrhythmias.			I	
21. Know the role of exercise ECG testing in the evaluation of genetic cardiovascular conditions (e.g., long QT syndrome), including hypertrophic cardiomyopathy.			I	
22. Know the role of cardiopulmonary exercise testing in the evaluation of dyspnea.		I		
23. Know the role of exercise testing in physical activity and exercise prescription in patients with cardiovascular disease.		I		
24. Know the role of exercise testing with measurement of ankle-brachial indices in the evaluation of patients with known or suspected peripheral arterial disease.			I	
***Evaluation Tools**:* chart-stimulated recall, direct observation, in-training exam				

Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to select clinically-appropriate exercise test type and protocol for diverse patient types and clinical settings.			I	
2. Skill to safely perform appropriate heart-rate limited and maximal or near-maximal treadmill exercise tests.		I		
3. Skill to identify and effectively treat complications during and following stress testing.			I	
4. Skill to utilize exercise symptoms and capacity, ECG findings, and hemodynamic response in the risk assessment and management of patients.			I	
5. Skill to interpret limb segmental blood pressure measurements, pulse volume recordings, and treadmill vascular exercise tests.			I	

6. Skill to utilize data from the exercise test in deriving an exercise prescription for patients with cardiovascular disease.			I	
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, logbook				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Effectively lead and coordinate the exercise test inter-professional team (including nurses and technicians) to ensure safe and efficient care.			I	
2. Incorporate risk/benefit analysis and cost considerations in test selection.			I	
***Evaluation Tools**:* conference presentation, direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.			I	
2. Review practice alignment with guidelines.			I	
***Evaluation Tools**:* conference presentation, direct observation, reflection and self-assessment				
Professionalism	**12**	**24**	**36**	**Add**
1. Demonstrate sensitivity and responsiveness to diverse patient populations.			I	
2. Know and adhere to evidence-based and appropriate use criteria for utilizing stress testing.			I	
***Evaluation Tools**:* conference presentation, direct observation, multisource evaluation, reflection and self-assessment				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate with and educate patients and families across a broad range of cultural, ethnic, and socioeconomic backgrounds.			I	
2. Communicate testing results to physicians and patients in an effective and timely manner.			I	
***Evaluation Tool**:* multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

4.3.1. Training Requirements

The committee recommends that all trainees achieve Level I training in exercise ECG interpretation. The training of a cardiovascular fellow should include active participation in a fully equipped exercise testing laboratory. Attainment of skills and competencies during the training program is paramount and must be emphasized. Level I trainees will gain competency in supervision and interpretation of the standard exercise ECG test. There is no established threshold number of studies that can serve as a training landmark; however, personally supervising and interpreting approximately 200 to 300 exercise tests within 36 months should provide ample experience to acquire such competencies. This volume of procedures is typically required to develop competency, but the trainee must also demonstrate competence, as assessed by the outcomes evaluation measures. Acquisition of competence may be accomplished by 1 or more training periods assigned specifically for interpretation of exercise ECG testing; competence may be acquired concurrently with training in an exercise imaging laboratory as part of the training requirements in nuclear cardiology or echocardiography.

The trainee should become knowledgeable at performing both heart rate-limited and maximal or near-maximal treadmill testing and, when available, stationary cycle exercise tests. The training program should provide the opportunity for the trainee to know and understand cardiovascular exercise physiology and pathophysiology. The trainee should also be taught the technical aspects of exercise testing, such as skin preparation, electrode selection and application, choice of exercise testing protocols, blood pressure monitoring during exercise, and monitoring of the patient for adverse signs or symptoms. The trainee should be exposed to the technical aspects and interpretation of cardiopulmonary exercise testing, when available. The trainee should be thoroughly familiar with evidence-based indications and contraindications to exercise testing.

Level I trainees will become proficient in the supervision and interpretation of exercise tests in a wide variety of complex patients for a variety of indications, including the evaluation of coronary artery disease, valvular heart disease, congenital heart disease, genetic cardiovascular conditions, arrhythmias, and peripheral arterial disease. All trainees are expected to know the indications for ordering and the utility of the information provided by cardiopulmonary exercise testing, exercise testing for measurement of ankle-brachial indices in patients with peripheral arterial disease, and exercise testing performed to evaluate complex arrhythmia and genetic cardiovascular conditions; however, additional time would be needed to acquire the skills to perform and interpret these tests. Level I trainees should be proficient in proper test selection (exercise-ECG, exercise imaging, pharmacological imaging) for a given indication tailored to the physical and medical conditions of a given patient (see Task Force 5 and 6 reports). This includes the use of exercise testing in special populations such as athletes and patients with valvular heart disease or hypertrophic cardiomyopathy.

There is no Level II or Level III training in exercise ECG testing.

5. Evaluation of Competency

Evaluation tools in ECG, ambulatory ECG, and exercise ECG testing include direct observation by instructors, in-training exams, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, simulation, and reflection and self-assessment. Case management, judgment, interpretive, and bedside skills must be evaluated in every trainee. Quality of care and follow-up; reliability; judgment, 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 (HIPAA)-compliant electronic database or logbook that meets ACGME reporting standards and summarizes pertinent clinical information (e.g., number of cases, diversity of referral sources, diagnoses, disease severity, outcomes and disposition).

The ACC, AHA, and Heart Rhythm Society have formulated a clinical competence statement on ECG (8), and the ACC/AHA have jointly formulated a competence statement on stress testing (15). Self-assessment programs and competence examinations in ECG are available through the ACC and other organizations. Training directors and trainees are encouraged to incorporate these resources into their curriculum in order to document the trainee's competency. In addition, on a regular basis, faculty should assess and document the trainee's progress, including technical performance and ability to interpret results. The program director is responsible for confirming experience and competence and for reviewing the overall progress of individual trainees with the Clinical Competency Committee to assure achievement of selected training milestones and identify areas in which additional focused training may be required.

Key Words: ACC Training Statement ▪ COCATS ▪ electrocardiography ▪ ambulatory electrocardiography ▪ exercise electrocardiography ▪ exercise treadmill test ▪ stress test.

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 3: TRAINING IN ELECTROCARDIOGRAPHY, AMBULATORY ELECTROCARDIOGRAPHY, AND EXERCISE TESTING

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF3_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELEVANT RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES—COCATS 4 TASK FORCE 3: TRAINING IN ELECTROCARDIOGRAPHY, AMBULATORY ELECTROCARDIOGRAPHY, AND EXERCISE TESTING

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ACC = American College of Cardiology and AHA = American Heart Association.

APPENDIX 3. ELECTROCARDIOGRAPHIC CORE COMPETENCIES: TECHNICAL ASPECTS AND ELECTROPHYSIOLOGY

Anatomy and Electrophysiology

- Anatomy of the specialized conducting system (sinoatrial node, atrioventricular node, His bundle, bundle branches), concept of the trifascicular conduction system
- Spread of excitation in the ventricles
- Difference between unipolar and bipolar leads
- Einthoven triangle; frontal and horizontal lead reference system
- Vectorial concepts
- Significance of a positive and negative deflection in relation to lead axis
- Relation between electrical and mechanical activity

Technique and the Normal ECG

- Effect of improper electrode placement (limb and precordial)
- Effect of muscle tremor
- Effect of poor frequency response of the equipment
- Effect of uneven paper transport
- Measurement of PR, QRS, QT, normal values/rate correction of QT interval
- Normal ranges of axis in the frontal plane
- Effect of age, weight, and body build on the axis in the frontal plane, as well as specific ECG diagnoses (i.e., left ventricular hypertrophy, left ventricular hypertrophy, and strain)
- Normal QRS/T angle
- Differential diagnosis of normal ST-T, T-wave variants (e.g., “juvenile” pattern and early repolarization syndrome)

Arrhythmias: General Concepts

- Reentry, automaticity, triggered activity
- Aberration (various mechanisms)
- Capture and fusion complexes
- Escape (passive, accelerated) complexes or rhythms: atrial, junctional, and ventricular
- Interpolated premature beat
- Parasystole (atrial, junctional, ventricular), modulated parasystole
- Vulnerability
- Exit block
- Reciprocation
- Concealed conduction
- Supernormality

ECG = electrocardiogram.

1 **APPENDIX 4. ECG CORE COMPETENCIES: PATTERN AND ARRHYTHMIA RECOGNITION**

General Features
- Normal ECG
- Normal variant
- Incorrect electrode placement
- Artifact

Atrial Abnormalities
- Left atrial abnormality
- Right atrial abnormality
- Biatrial abnormality

Sinoatrial Rhythm
- Normal sinus rhythm
- Sinus tachycardia
- Sinus bradycardia
- Sinus arrhythmia
- Sinoatrial pause or arrest
- Sinoatrial exit block

Atrial Rhythms
- Atrial premature complexes (conducted; nonconducted)
- Atrial tachycardia (ectopic)
- Atrial tachycardia with atrioventricular block
- Atrial fibrillation
- Atrial flutter (typical and atypical forms)
- Atrial tachycardia, multifocal

AV Junctional Rhythms
- Premature junctional complexes
- Atrioventricular node re-entrant tachycardia (AVNRT-common and uncommon types)
- Nonparoxysmal junctional tachycardia/accelerated junctional rhythm
- Atrioventricular re-entrant tachycardia (AVRT) with an accessory pathway
- AV junctional escape complex or escape rhythm

Ventricular Rhythms
- Ventricular ectopic complexes
- Accelerated idioventricular rhythm
- Ventricular tachycardia: uniform (monomorphic), multiform (pleomorphic or polymorphic), sustained, nonsustained, bidirectional, and torsades de pointes
- Ventricular flutter, ventricular fibrillation
- Ventricular escape complexes or rhythm

AV Relationship and Conduction

Atrioventricular dissociation due to:
- Slowing of dominant pacemaker
- Acceleration of subsidiary pacemaker
- Third-degree atrioventricular block
- Isorhythmic atrioventricular dissociation

Atrioventricular Block
- First degree
- Second degree: 2:1, Mobitz type I (Wenckebach), Mobitz type II, high-degree atrioventricular block
- Third-degree atrioventricular block (complete)

QRS Voltage and Axis
- Low voltage
- Left axis deviation
- Right axis deviation
- Left ventricular hypertrophy
- Right ventricular hypertrophy
- Biventricular hypertrophy
- Electrical alternans

Intraventricular Conduction Disturbances
- Incomplete and complete left bundle-branch block
- Incomplete and complete right bundle-branch block
- Left anterior and left posterior fascicular blocks
- Indeterminate (nonspecific) intraventricular conduction defects
- Aberrant intraventricular conduction (rate related; Ashman)
- Ventricular pre-excitation syndromes (Wolff-Parkinson-White pattern)

Myocardial Ischemia and Infarction
- ST-T wave changes due to ischemia
- Acute current of injury
- ST elevation myocardial infarction
- Q-wave myocardial infarction
- Abnormal Q waves not associated with infarction
- Time course of ECG changes in MI (acute/recent; age-undetermined/old)
- ECG localization of myocardial infarction

Miscellaneous ST-T, U-wave Abnormalities
- Non-specific ST-T wave abnormalities
- Prolonged Q-T interval
- Prominent U waves
- ST-T wave abnormalities secondary to hypertrophy

Pacemaker
- Fixed-rate pacemaker
- Atrial pacing
- Ventricular demand pacing
- Atrial triggered ventricular pacing
- Atrioventricular dual pacing
- Biventricular pacing
- Malfunctioning: demand acting as fixed rate, failure to sense, slowing of rate, acceleration of rate, failure to capture, failure to pace (inappropriate inhibition)

Clinical Diagnoses (Selected)
- Hyperkalemia
- Hypokalemia
- Hypercalcemia
- Hypocalcemia
- Long-QT syndromes (congenital and acquired)
- Atrial septal defect, secundum
- Atrial septal defect, primum
- Dextrocardia
- Mitral stenosis
- Acute cor pulmonale, including pulmonary embolus
- Pericardial effusion
- Acute pericarditis
- Hypertrophic cardiomyopathy
- Brugada Disease
- Arrhythmogenic Right Ventricular Dysplasia
- Central nervous system disorder
- Myxedema
- Hypothermia
- Sick sinus syndrome
- Digitalis effect
- Digitalis toxicity
- Effects of other drugs (e.g., tricyclic or antiarrhythmic agents)

APPENDIX 5. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

AHA = American Heart Association

COCATS = Core Cardiovascular Training Statement

ECG = electrocardiography

HIPAA = Health Insurance Portability and Accountability Act

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COCATS 4 Task Force 4: Training in Multimodality Imaging[5]

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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The Writing Committee was selected to represent the American College of Cardiology (ACC) and included the chairs of the COCATS Imaging Task Forces on Cardiovascular Computed Tomography (CCT), Cardiovascular Magnetic Resonance (CMR), Nuclear Cardiology, and Echocardiography, a cardiovascular training program director, early-career experts, highly experienced specialists practicing in both academic and community-based settings, and members experienced in defining and applying training standards according to the core competencies structure promulgated by the Accreditation Council for Graduate Medical Education (ACGME), American Board of Internal Medicine, and American Board of Medical Specialties. The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiovascular training statement. Employment and affiliation details for the authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for the authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF4_Comprehensive_RWI_Supplement.pdf).

1.1.2. Document Development and Approval

The Writing Committee developed the document, approved it for review by individuals selected by the ACC, and addressed the reviewers' comments. The document was revised and posted for public comment

[5]The American College of Cardiology requests that this document be cited as follows: Narula J, Chandrashekhar YS, Dilsizian V, Garcia MJ, Kramer CM, Malik S, Ryan T, Sen S, Wu JC. COCATS 4 task force 4: training in multimodality imaging. J Am Coll Cardiol. 2015;••:••••–••••.

from December 20, 2015 to January 6, 2015. Authors addressed the additional comments from the public to complete the document. The final document was approved by the Task Force, COCATS Steering Committee, and ACC Competency Management Committee, and ratified by the ACC Board of Trustees in February, 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

The Task Force was charged with updating previously published standards for training fellows in clinical cardiology who are enrolled in ACGME-certified fellowships (1, 2) on the basis of changes in the field since 2008 and as part of a broader effort to establish consistent training criteria across all aspects of cardiology. This document does not provide specific guidelines for training in advanced cardiovascular subspecialty areas because these are already defined by individual modality-specific task forces, but it does identify opportunities to obtain advanced training where appropriate. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally over time.

For most areas of adult cardiovascular medicine, 3 levels of training are delineated:

Level I training, the basic training required of all fellows to become competent consultants, is considered a foundation for further multimodality imaging (MMI) training and can be accomplished during a standard 3-year training program in cardiology but does not qualify the trainee for independent practice as an imager.

Level II training refers to the additional training in 1 or more areas that enables cardiologists to perform or interpret specific diagnostic tests and procedures or to render more-specialized care for specific patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training in selected areas may be achieved by some trainees during the standard 3-year cardiovascular fellowship, depending on the trainees' career goals and use of elective rotations. This level of training generates the MMI specialists needed to provide the majority of imaging services in routine patient care, particularly in the ambulatory arena, for diagnosis and surveillance of common cardiovascular conditions.

Level III training requires additional experience beyond the standard 3-year cardiovascular fellowship to acquire specialized knowledge and competencies in performing, interpreting, and training others to perform specific procedures or render advanced, specialized care at a high level of skill. Level III training in MMI leads to the ability to direct a MMI center, train others, and conduct advanced research in cardiovascular imaging. Level III training is described here only in broad terms to provide context for trainees and clarify that these advanced competencies are not covered during the cardiovascular fellowship. The additional exposure and requirements for Level III training will be addressed in a subsequent, separately published Advanced Training Statement.

2. General Standards

2.1. Basic Clinical Training in Noninvasive Imaging (Level I Training)

The curriculum assumes that the typical fellow can acquire the requisite knowledge and skills for Level I training in all noninvasive imaging modalities within approximately 7 months. Development of Level II competency requires additional training as described in the Task Force reports pertaining to the individual modalities. Level II competency in more than 2 imaging modalities typically requires additional training beyond the standard 3-year cardiovascular fellowship.

Noninvasive imaging techniques are key components of the evaluation of patients with cardiovascular disease, and every cardiovascular trainee should gain a basic understanding of how to utilize them properly in patient care. In line with this, every cardiovascular trainee should learn the principles underlying echocardiographic, nuclear, CCT, and CMR imaging modalities, including their respective advantages, limitations, and potential risks. Trainees should develop competence in evidence-based application of each of these imaging methods and in selecting the most appropriate imaging modality for common clinical conditions. Furthermore, required competence extends to integrating the results of noninvasive imaging with other components of the patient evaluation in order to manage patients with known or suspected cardiovascular disease. On the other hand, since noninvasive cardiovascular imaging modalities are increasingly complex and expensive, appropriate use of the technologies is essential for the competent practice of clinical cardiology. This requires that the cardiologist learn to identify complex settings in which consultation with an advanced imaging specialist can help in selection of the optimal imaging approach for addressing questions relevant to an individual patient most accurately and efficiently. These principles are equally pertinent when noninvasive imaging is employed in conjunction with surgical and catheter-based interventional or electrophysiological procedures and as newer applications are introduced, making the dynamic integration of MMI intrinsic to the continuing commitment of cardiologists to lifelong learning.

The core curriculum embraces these principles while acknowledging that each of the 4 major noninvasive imaging modalities (echocardiography, nuclear cardiology, CCT, and CMR) have evolved independently. Moreover, as each modality has become more complex, few cardiologists now have the training or experience to function at the current state of the art across the full multimodality spectrum.

Although specialization in 1 modality enhances and focuses specific knowledge and skills, it may sometimes limit one's capacity to judiciously apply alternative modalities, each with its own unique set of strengths and weaknesses for particular clinical situations. The future of cardiac imaging will include enhanced integration across modalities of critical information regarding cardiac structure, function, physiology, and pathology. This deeper integration will facilitate patient-centric imaging by which cardiologists select the best test to achieve optimal outcomes using an advanced toolbox to provide high-quality, efficient, cost-effective care. In short, application of a given modality should be dictated by the specific needs of a particular patient rather than the expertise of the cardiologist (3). Modalities should be viewed as hierarchically complementary depending on the clinical problem. For any single patient or clinical scenario, there is almost always a best test (or best test combination) most likely to answer the question safely and accurately. Good patient outcomes require understanding of the nuances of multiple modalities and avoiding duplication to reduce cost, minimize risk and discomfort, and enhance value. Training programs are encouraged to embrace these concepts and offer opportunities for fellows at all levels of training to concurrently assess the findings generated by more than 1 imaging modality, allowing them to experience firsthand how these can yield complementary information.

2.2. Advanced Imaging Training for Selected Fellows (Levels II and III)

Training should be flexible and aligned with future career goals. Most trainees should develop independent competency (Level II) in echocardiography during the standard 3-year fellowship. Selected fellows, depending on their career objectives and educational experiences (including elective rotations), may develop independent competency (Level II) in an additional imaging modality (nuclear, CCT, or CMR) during the standard 3-year fellowship. Level II competency in more than 2 modalities typically requires additional training beyond the standard 3-year cardiovascular fellowship. An especially adept and committed fellow in a program well equipped with the faculty, facilities, case volume, and educational infrastructure may accomplish competency in 3 modalities during the standard fellowship through flexible rotations. *Competency-based learning—which emphasizes successful graduation on the basis of articulated and rigorously evaluated competency rather than on the amount of time devoted to a particular skill or the number of procedures performed or interpreted during training—will help ensure quality*.

Satisfactory acquisition of the knowledge and skills corresponding to Level II competency should be measured and documented by recognized methods, such as by meeting the criteria for the examinations offered by the National Board of Echocardiography or the Certification Board of Nuclear Cardiology. More advanced competency (Level III) in 1 or more imaging modalities requires additional training beyond the standard 3-year cardiovascular fellowship. Advanced training in multimodality cardiovascular imaging results in a higher level of competency and the ability to direct a multimodality imaging center and train others in cardiovascular imaging. Except in selected areas, this advanced Level III training in cardiovascular imaging will generally entail training in more than 1 modality.

3. Summary of Training Requirements

3.1. Development and Evaluation of Core Competencies

Training requirements in noninvasive cardiovascular imaging address the 6 general competency domains promulgated by the ACGME/ABMS and endorsed by the ABIM. These domains are: Medical Knowledge, Patient Care and Procedural Skills, Practice-Based Learning and Improvement, Systems-Based Practice, Interpersonal and Communication Skills, and Professionalism. In parallel with the evolution of the ACGME's Next Accreditation System, the ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. It is also developing tools to assist physicians in assessing, enhancing, and documenting these competencies and delineated milestones in noninvasive cardiac imaging that identify particular behaviors and attributes within each competency domain to provide a developmental roadmap for fellows as they progress through various levels of training.

3.2 Structure of Training

The reports of the Task Forces addressing the individual imaging modalities provide a general framework for training in patient-centered noninvasive cardiovascular imaging organized around defining a central clinical question. The recommendations address: 1) the structure of the training program; 2) the need for emphasis on a cross-modality curriculum; 3) real-time evaluation of trainee progress; and 4) integration of modality-specific training guidelines defined by specialty societies as standards for training and demonstrating competency. In general, training in MMI should not be provided in a separate rotation but should instead be offered as part of an integrated, correlative experience during rotations in the various component imaging modalities.

The individual Task Force reports emphasize concurrent training and consolidation of common curricula across modalities. Quality and appropriateness measures are emphasized as they apply to each test encountered during the training, and the effectiveness of training is evaluated in competency-based terms. Unifying imaging around image information rather than mode of acquisition can generate creative ways of structuring training time and competency-based evaluation. Length of training is not the primary determinant of quality. Hands-on, supervised participation in direct image acquisition, interpretation, and integration with other clinical data are essential elements of training in advanced imaging.

Table 1. Key Principles for Training in Multimodality Noninvasive Cardiovascular Imaging

1. Cardiovascular imaging techniques are key components in the evaluation of patients with known or suspected heart and vascular disease, and every cardiology trainee should have a basic understanding of their proper use in patient care.

2. Noninvasive cardiovascular imaging modalities are increasingly complex and expensive, making appropriate use of the technologies essential for the high-quality, efficient, and cost-effective practice of clinical cardiology.

3. All cardiovascular trainees should understand the basic principles underlying echocardiographic, nuclear cardiology, CCT, and CMR, along with their limitations and potential risks.

4. All cardiovascular trainees should achieve competence in evidence-based application of noninvasive cardiovascular imaging and selection of the most appropriate imaging modality for common clinical conditions. A guiding educational principle is that utilization of noninvasive imaging for a given clinical situation should not be aligned with or committed to a specific or single modality but should instead involve selection of the optimum test to address the clinical situation at hand, within the setting of available technical resources and professional expertise.

5. Every standard 3-year cardiovascular fellow should understand the distinguishing concepts of echocardiography, nuclear cardiology, CCT, and CMR as the basis for Level I competency in all 4 modalities. Programs can provide this training through on-site facilities, off-site collaboration with other programs, and access to audiovisual resources and courses organized by subspecialty organizations.

6. Concurrent training across multiple imaging modalities is encouraged when possible. Topics common to multiple modalities (e.g., radiation physics, image processing) can be grouped to avoid duplication or repetition.

7. Trainee competency is the primary determinant of sufficient training, rather than the time, exposure, or volume of imaging studies performed or interpreted. All cardiovascular trainees should become competent in integrating the results of noninvasive imaging with other components of clinical evaluation to manage patients with cardiovascular disease. Correlation of findings across multiple imaging modalities should be emphasized to enhance the understanding of the strengths and weaknesses of each modality. Common workstations that display images generated by multiple imaging modalities are useful for this purpose.

8. All cardiovascular trainees should be able to identify complex settings in which consultation with a specialist in advanced cardiovascular imaging can help in selecting the imaging approach that addresses the clinical questions most accurately and efficiently.

9. All standard 3-year cardiovascular fellows should gain a deep understanding of appropriate use criteria (AUC) and be encouraged to link all logged procedures to the corresponding AUC.

10. Programs should offer opportunities to facilitate Level II training in 1 or more modalities, which are to be selected on the basis of each fellow's aptitude, interests, and career goals. More advanced competency beyond Level II typically requires additional training beyond the standard 3-year cardiovascular fellowship.

11. Satisfactory acquisition of the knowledge and skills corresponding to Level II competency should be measured and documented by recognized methods, such as by meeting the criteria for the examinations offered by the National Board of Echocardiography and the Certification Board of Nuclear Cardiology and

Cardiac Computed Tomography.

12. Cardiology programs should strongly consider providing standard 3-year cardiovascular fellows with independent competency (Level II) in echocardiography during the standard 3-year fellowship.

13. Advanced training in multimodality cardiovascular imaging (beyond that obtained during the general fellowship) results in a higher level of competency and the ability to both direct a MMI center and train others in noninvasive cardiovascular imaging.

14. As medical school and residency training provides more advanced imaging training and a wider array of modalities is introduced in the future, fellows in cardiology should be progressively better prepared to understand, utilize, and perform cardiac imaging.

AUC = appropriate use criteria; CMR = cardiovascular magnetic resonance; and CCT = cardiovascular computed tomography.

4. Advanced Imaging Training

Some cardiologists may seek advanced skills in more than 1 imaging modality, although few will attain advanced skill levels in all imaging modalities. Program directors should consider the dynamic nature of this field when advising fellows. During a standard 3-year fellowship, selected fellows, depending on their career focus, could obtain Level II competency in up to 2 imaging modalities. Fellows interested in greater expertise in MMI may seek Level III competency, which requires additional training after the standard 3-year fellowship. Fellows interested in procedural careers (interventional cardiology or electrophysiology) may modify training to align with their choice. For instance, a higher level of understanding regarding CCT angiography might be useful for those undertaking careers in coronary intervention. An arrhythmia specialist might find it important to obtain a deeper understanding of CMR or CCT for prognostication, localization of foci, and targeting catheter-based ablation procedures. Similarly, fellows interested in heart failure might choose to concentrate on echocardiography and CMR imaging.

5. Evaluation of Competency

Evaluation tools in noninvasive cardiovascular imaging include direct observation by instructors, in-training exams, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, and simulation. Selection of the optimum modality on a case-by-case basis, judgment, acquisition, and interpretive skills should be evaluated in every trainee. Interaction with other physicians, patients, and laboratory support staff; initiative; reliability; decisions or actions that result in complications; and the ability to make appropriate decisions independently and follow-up appropriately should be considered in these assessments. Trainees should maintain records of participation and advancement in the form of a Health Insurance Portability and Accountability Act (HIPAA)-compliant electronic database or logbook that meets ACGME reporting standards. These records should summarize pertinent clinical information (e.g., number of cases, diversity of referral sources, testing modalities, diagnoses and findings). The use of all tests should be aligned with both clinical need and appropriateness criteria. Trainees should be prepared to explain why a given procedure is better suited to the clinical question than another imaging option. Fellows should document clinical correlation with the other imaging, hemodynamic, invasive laboratory, surgical pathology, and outcomes data to enhance their understanding of the diagnostic utility and value of various imaging procedures. Finally, imaging experiences should be assessed against measures of quality with regard to test selection, performance, interpretation, and reporting (4, 5), to ensure an appreciation of the potential adverse consequences of suboptimal, redundant, or unnecessary testing.

Under the aegis of the program director and director of each imaging laboratory, facility, or program, the faculty should record and verify each trainee's experiences, assess his or her performance, and document satisfactory achievement. The program director is responsible for confirming trainees' experience and competence and reviewing the overall progress of individual trainees with the Clinical Competency Committee to assure achievement of selected training milestones and to identify areas in which additional focused training may be required.

Key Words: ACC Training Statement ▪ COCATS ▪ fellowship training ▪ clinical competence ▪ echocardiography ▪ nuclear cardiology ▪ cardiovascular computed tomography ▪ cardiovascular magnetic resonance ▪ multimodality imaging.

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 4: TRAINING IN MULTIMODALITY IMAGING

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF4_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELEVANT RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES—COCATS 4 TASK FORCE 4: TRAINING IN MULTIMODALITY IMAGING

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ACC = American College of Cardiology; ASE = American Society of Echocardiography; ASNC = American Society of Nuclear Cardiology; SAIP = Society of Atherosclerosis Imaging and Prevention; SCAI = Society for Cardiovascular Angiography and Interventions; and SCMR = Society for Cardiovascular Magnetic Resonance.

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

CCT = cardiovascular computed tomography

CMR = cardiovascular magnetic resonance

COCATS = Core Cardiovascular Training Statement

HIPAA = Health Insurance Portability and Accountability Act

MMI = multimodality imaging

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COCATS 4 Task Force 5: Training in Echocardiography[6]

Endorsed by the American Society of Echocardiography

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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The Writing Committee was selected to represent the American College of Cardiology (ACC) and American Society of Echocardiography (ASE) and included a cardiovascular training program director, an echocardiography training program director, early-career echocardiography experts, highly experienced specialists practicing in both the academic and community-based practice settings, and physicians experienced in defining and applying training standards according to the 6 general competency domains promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Subspecialties (ABMS), and endorsed by the American Board of Internal Medicine (ABIM). The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiovascular training statement. Employment and affiliation details for authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF5_Comprehensive_RWI_Supplement.pdf).

1.1.2. Document Development and Approval

The Writing Committee developed the document, approved it for review by individuals selected by the ACC and ASE, and addressed the reviewers' comments. The document was revised and posted for public comment from December 20, 2015 to January 6, 2015. Authors addressed the additional comments from the public to complete the document. The final document was approved by the Task Force, COCATS

[6] The American College of Cardiology requests that this document be cited as follows: Ryan T, Berlacher K, Lindner JR, Mankad SV, Rose GA, Wang A. COCATS 4 task force 5: training in echocardiography. J Am Coll Cardiol. 2015;●●:●●●●–●●●●.

Steering Committee, and ACC Competency Management Committee, and ratified by the ACC Board of Trustees and endorsed by ASE in March, 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

Echocardiography is the most widely used and readily available imaging technique for assessing cardiovascular anatomy and function. Clinical application of ultrasound encompasses M-mode, 2-dimensional (2D), 3-dimensional (3D), pulsed, tissue, and continuous-wave Doppler and color-flow imaging. Echocardiography noninvasively provides diagnostic and prognostic information concerning cardiovascular anatomy, function (i.e., ejection fraction), hemodynamic variables (i.e., gradient or pressure), and flow disturbances by means of pulsed, continuous-wave, and color-flow Doppler imaging. Moreover, these cardiovascular parameters can be assessed at rest, as well as during conditions of increased hemodynamic demand such as exercise.

The Task Force was charged with updating previously published standards for training clinical adult cardiovascular fellows on the basis of changes in the field since 2008 and as part of a broader effort to establish consistent training criteria across all aspects of cardiology. The changes herein address the necessary balance between the development of increasingly specialized and sophisticated echo techniques and the need to provide a broad and complete training experience within a 3-year fellowship period. The Task Force also updated previously published standards to address the evolving framework of competency-based medical education described by the ACGME Outcomes Project and the 6 general competencies endorsed by ACGME andABMS. The background and overarching principles governing fellowship training are provided in the Introduction to COCATS, and readers should become familiar with this foundation before considering the details of training in a subdiscipline like echocardiography. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally over time.

For most areas of adult cardiovascular medicine, 3 levels of training are delineated:

Level I training, the basic training required of trainees to become competent consultants, is required by all fellows in cardiology and can be accomplished as part of a standard 3-year training program in cardiology. For echocardiography, Level I training is defined as an introductory or early level of competency in performing and interpreting transthoracic echocardiography (TTE) that is achieved during fellowship training but not sufficient to provide independent interpretation of results.

Level II refers to the additional training in 1 or more areas that enables some cardiovascular specialists to perform or interpret specific diagnostic tests and procedures or to render more specialized care for patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training in selected areas may be achieved by trainees during the standard 3-year cardiovascular fellowship, depending on his or her career goals and use of elective rotations. Level II training in echocardiography is required to provide independent interpretation of echocardiograms.

Level III training usually requires additional experience beyond the standard 3-year cardiology fellowship to acquire specialized knowledge and competencies in performing, interpreting, and training others to perform specific procedures or render advanced, specialized care at a high level of skill and are defined by competency components and outcome metrics. The skills and experience achieved during Level III training prepare the trainee to perform and interpret complex studies in special populations, engage in research, direct an academic echocardiography laboratory, and train others in advanced aspects of echocardiography. These advanced competencies are usually not covered during the general cardiology fellowship, but require additional training during which they are integrated with training in other imaging modalities. For selected fellows wishing to attain advanced competencies in echocardiography, training beyond Level II can be achieved either during the standard 3-year fellowship (for those individuals seeking dedicated Level III training focused on echocardiography) or during an additional period of training beyond the standard 3-year fellowship for those desiring advanced echocardiography competency as part of multimodality imaging training. Fellows pursuing this advanced training during the 3-year fellowship will devote all available elective time to echocardiography, precluding acquisition of Level II competency in any other imaging modality. In both pathways, Level III training in echocardiography should take place in laboratories with Level III trained faculty and with the necessary infrastructure to provide the advanced training experience. Level III training is described here in relatively broad terms to provide context for trainees. The additional exposure and requirements for Level III training will be addressed in a subsequent, separately published Advanced Training Statement.

The numbers of cases, procedures, and experiences recommended are based on published guidelines, competency statements, and the opinions of the members of the writing group. It is assumed that training is directed by appropriately trained mentors in an ACGME-accredited program and that satisfactory completion of training is documented by the program director. The number and types of encounters and the duration of training required for each level of training are summarized in Section 4.

2. General Standards

Optimal training in echocardiography relies on the interplay between the learner and the educational environment. Success depends on the background, abilities, and commitment of the trainee; the volume and variety of cases; the effectiveness of faculty; and the educational culture of the laboratory. The current trend to introduce the fundamental principles, indications, applications, and limitations of echocardiography into the education of medical students and residents is encouraged and will facilitate subsequent mastery of this discipline. In particular, experience at an early stage with hand-carried ultrasound (HCU) enhances the learning process and facilitates an understanding of cardiovascular anatomy and hemodynamics.

2.1. Faculty

The echocardiographic laboratory in which training of cardiovascular fellows is undertaken should be under the direct supervision of a full-time qualified director (or directors) who has achieved Level III training (1, 2). Participation of additional full- or part-time faculty provides a diversity of experience and is highly desirable. Exposure by the trainee to faculty and sonographers with different strengths and interests ensures a range of experience and a broader base of knowledge.

2.2. Facilities and Equipment

To provide acceptable fellowship training in echocardiography, a laboratory must have equipment capable of providing comprehensive transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE), including M-mode and 2D and 3D imaging, pulsed and continuous-wave Doppler echocardiography, tissue Doppler, stress echo, and color-flow imaging. The laboratory environment should offer a broad range of clinical material. The laboratory should conform to continuing quality improvement guidelines (3) and ideally perform at least 2000 echocardiographic studies per year to give the fellow an appropriate variety of experience. Accreditation of the laboratory through an organization such as ICAEL is strongly encouraged. Intraprocedural (including intraoperative) echocardiography and an exposure to adults with structural and congenital heart disease (CHD) should be available.

A rich and diverse clinical milieu will provide an environment in which the echocardiographic findings can be correlated with other diagnostic data and patient outcomes. Access during echo training to other imaging modalities provides an opportunity to understand the strengths and limitations of echocardiography relative to other techniques. At an early stage, the trainee should be exposed to quality improvement initiatives, structured reporting, process improvement, and appropriate use. For those fellows who plan to be involved in clinical research, formal training in modern research methodology, including biostatistics, clinical trial design, ethics, and grant writing, should be available.

3. Training Components

Specific requirements for echocardiographic examination of pediatric patients have been published elsewhere (2, 4, 5). Training guidelines in the present document are primarily directed to trainees performing echocardiographic examinations in adult patients with acquired and CHDs.

3.1. Didactic Program

Didactic instruction may occur in a variety of formats, including lectures, conferences, journal clubs, and clinical case conferences. A program of didactic instruction is intended to provide the trainee with an understanding of the basic principles and appropriate clinical application of echocardiography. It should incorporate relevant knowledge of cardiac embryology, anatomy, pathology, and physiology, and integrate clinical information gained from other imaging disciplines, such as cardiovascular computed tomography (CCT), cardiovascular magnetic resonance (CMR), angiography, and nuclear medicine. The program should also expose trainees to appropriate use criteria (AUC) for ordering echocardiographic tests. With the increased role of echocardiography in guiding interventional procedures, a specific program of instruction in the intraoperative use of echocardiography and its role in guiding management of structural/arrhythmic heart disease should be available for the advanced trainee.

The precise format for best achieving these educational goals will vary from institution to institution; however, given the increasing clinical application of other imaging modalities within cardiology, it is recommended that a common element of any didactic program include specific multimodality imaging conferences that address the appropriate use of echocardiography in clinical decision making.

3.2. Clinical Experience

Echocardiography plays an important role in the diagnosis and treatment of a wide variety of acquired and congenital cardiac disorders. Accordingly, exposure to the entire spectrum of heart disease in a diverse patient population should be available to the trainee. Although a recommended number of clinical cases to encounter during training is provided (see Section 4.2), these criteria merely serve as proxies for clinical exposure. In terms of the overall quality of the educational experience and depth of understanding, the number of echocardiographic studies in which the trainee participates is less important than the range of pathologies encountered and adequacy of supervision and instruction. The criteria described herein are similar to those in other publications on this topic (1, 2, 6-9). If the case mix available for the trainee is skewed, additional cases beyond the numbers quoted may be required to ensure appropriate experience (10).

3.3. Hands-On Experience

The echocardiographic examination is an exceedingly operator-dependent procedure in which it is possible to introduce confounding artifacts or to omit data of diagnostic importance. The echocardiographic examination is interactive, requiring the real-time recognition of specific diagnostic findings to obtain a study that is of clinical benefit. Therefore, fellowship training in echocardiography must emphasize the ability of the trainee to perform a hands-on examination independently with understanding of the results at the time of image acquisition. The trainee should develop sufficient technical skills in using an echocardiographic instrument to answer common clinical questions.

Such training is important not so much to develop true technical expertise as to better understand the diagnostic capabilities and potential pitfalls of the echocardiographic examination. It also helps trainees to learn tomographic cardiac anatomy and integrate planar views into a 3D framework. Highly skilled cardiac sonographers with broad experience in the performing echocardiographic examinations are necessary to facilitate this training.

In contrast to transthoracic and stress echocardiography, which are most often performed by sonographers, advanced echocardiographic modalities, such as TEE and 3D echo, require the trainee to acquire technical competency in image acquisition and image presentation. Clinical exposure to a broad range of cardiac pathologies and sufficient hands-on experience with the technology are essential for the advanced trainee to gain the requisite technical competency (See Section 4.2).

As part of the hands-on aspect of the echocardiographic training program, experience with HCU devices is desirable. These devices extend the clinical utility of echocardiography by allowing the operator to offer a "visual physical examination" in a manner that can be applied practically in the clinical setting (11). HCU devices offer capabilities similar to but less robust than their standard echocardiographic counterparts. Their appropriate application nevertheless requires that the operator have a fundamental understanding of echocardiographic principles, cardiac anatomy/physiology, and resultant echocardiographic correlates. Therefore, participation in a didactic echocardiographic educational program and hands-on training with conventional echocardiographic equipment best prepares the cardiovascular fellow to utilize HCU in the clinical setting as an adjunct to physical examination.

4. Summary of Training Requirements

4.1. Development and Evaluation of Core Competencies

Training and requirements for echocardiography address the 6 general competencies promulgated by the ACGME/ABMS 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 core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 1 delineates each of the 6 competency domains, as well as their associated curricular milestones for training in echocardiography. The milestones are categorized into Level I, Level II, and Level III training (as previously defined in this document) and indicate the stage of fellowship training (12, 24 or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Given that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may also vary. Level I competencies may be achieved at earlier or later time points. Acquisition of Level II skills requires additional training during the standard 3-year cardiovascular fellowship. Level III skills may be attained during the standard 3-year fellowship in a dedicated program focused on advanced cardiac ultrasound imaging or may be acquired during a period of additional training, typically for those fellows seeking multimodality imaging training. The table also describes examples of evaluation tools suitable for assessing competence in each domain.

Table 1. Core Competency Components and Curricular Milestones for Training in Echocardiography

Medical Knowledge	**Milestones (Months)**			
	12	**24**	**36**	**Add**
1. Know the physical principles of ultrasound, and the instrumentation used to obtain images.	I			
2. Know the appropriate indications, including the AUC, for: M-mode, 2-dimensional, and 3-dimensional transthoracic echocardiography; Doppler echocardiography and color flow imaging; transesophageal echocardiography; tissue Doppler and strain imaging; and contrast echocardiography.		I		
3. Know the limitations and potential artifacts of the echocardiographic examination.	I			
4. Know the standard views included in a comprehensive transthoracic echocardiography.	I			
5. Know the standard views included in a comprehensive transesophageal echocardiography.		I		
6. Know the techniques to quantify cardiac chamber sizes and evaluate left and right ventricular systolic and diastolic function and hemodynamics.			II	
7. Know the characteristic findings of cardiomyopathies.		I		
8. Know the use of echocardiographic and Doppler data to evaluate native and prosthetic valve function and diseases.			II	
9. Know the echocardiographic and Doppler findings of cardiac ischemia and infarction, and the complications of myocardial infarction.		I		
10. Know the echocardiographic findings of pericardial disease, pericardial effusion, and pericardial constriction.		II		

11. Know the characteristic findings of basic adult congenital heart disease.			II	
12. Know the findings of complex/postoperative adult congenital heart disease.			III*†	III*
13. Know the techniques to evaluate cardiac masses and suspected endocarditis.		II		
14. Know the techniques to evaluate diseases of the aorta.		II		
15. Know the techniques to assess pulmonary artery pressure and diseases of the right heart.		II		
16. Know the use and characteristic findings in the evaluation of patients with systemic diseases involving the heart.		II		
17. Know the indications for, and the echocardiographic findings in, patients with known or suspected cardioembolic events.		II		
18. Know key aspects of contrast echocardiography including interpretation, administration techniques, and safety information.			II	
19. Understand the principles and applications of 3-dimensional echocardiography.		II		
20. Recognize and treat the potential complications of stress, contrast, and transesophageal echocardiography.		II		
Evaluation Tools: conference presentation, direct observation, in-training exam				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to perform and interpret a basic transthoracic echocardiography exam.		I		
2. Skill to perform and interpret comprehensive transthoracic echocardiography exam.			II	
3. Skill to perform and interpret comprehensive transesophageal echocardiography exam.			II	
4. Skill to recognize pathophysiology, quantify severity of disease, identify associated findings, and recognize artifacts in echocardiography.			II	
5. Skill to integrate echocardiographic findings with clinical and other testing results in the evaluation and management of patients.		I		
6. Skill to interpret stress echocardiography.			II	
7. Skill to incorporate stress hemodynamic information in the management of complex valve disease or hypertrophic cardiomyopathy.			II	
8. Skill to utilize echocardiographic techniques during cardiac interventions, including intraoperative transesophageal echocardiography.			III†	III
9. Skill to perform and interpret basic 3-dimensional echocardiography.			II	
10. Skill to utilize advanced 3-dimensional echocardiography during guidance of procedures and/or surgery.			III†	III
11. Skill to perform and interpret contrast echocardiography studies.			II	
Evaluation Tools: direct observation, logbook, simulation				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Work effectively and efficiently with the echocardiography laboratory staff.	I			
2. Incorporate risk/benefit, safety, and cost considerations in the use of ultrasound techniques.			I	
3. Participate in echocardiographic quality monitoring and initiatives.			II	
Evaluation Tools: direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.		I		
Evaluation Tools: conference presentation, direct observation				
Professionalism	**12**	**24**	**36**	**Add**
1. Know and promote adherence to guidelines and appropriate use criteria.		I		
2. Interact respectfully with patients, families, and all members of the healthcare team, including ancillary and support staff.	I			
Evaluation Tools: conference presentation, direct observation, multisource evaluation, reflection and self-assessment				
Interpersonal and Communication Skills				
1. Communicate with and educate patients and families across a broad range of cultural, ethnic,		II		

and socioeconomic backgrounds.				
2. Communicate testing results to physicians and patients in an effective and timely manner.		II		
3. Communicate detailed information on cardiac anatomy for surgical planning or guidance of interventional procedures.			II	
Evaluation Tools: direct observation, multisource evaluation				

*Because of its unique and specialized nature, competency in interpreting complex and post-operative congenital heart disease echocardiography studies will usually require training beyond Level II.
†See definition of Level III training in Section 1.2.
Add = additional months beyond the 3-year cardiovascular fellowship.

4.2. Training Requirements

Echocardiography is integral to the practice of cardiology. Because of the fundamental and essential nature of the technique, all fellows should have the opportunity to achieve Level II competency, which would prepare them to perform and interpret echocardiograms independently. This varies from prior versions of COCATS in which Level II training was considered optional and provided only to those fellows who desired such training.

Fellowship training in echocardiography should include instruction in the basic aspects of ultrasound such as the principles, technology, indications, and limitations of the techniques. Every trainee should be educated in the physical principles and instrumentation of ultrasound and in cardiovascular anatomy, physiology and pathophysiology, both with regard to the cardiovascular system in general and in relation to the echocardiogram, in particular. Trainees at all levels should perform the echocardiographic and Doppler examination to integrate their understanding of tomographic and 3D cardiac anatomy. Trainees should correlate the findings from the echocardiographic and Doppler examination with the results of other imaging modalities and physical examination. The trainee should master the relationships between the echocardiographic findings and results of other cardiovascular tests, such as catheterization, angiography, MRI, and electrophysiology. The trainee should also understand the impact of the results of the echocardiographic examination on the medical and surgical management of the patient.

Ultrasound imaging is an evolving technology experiencing continued improvement with an expanding list of clinical indications. Every cardiovascular fellow should become familiar with the technical performance, interpretation, strengths, multiple clinical applications and limitations of 2D echocardiographic/Doppler technology. Level I fellows should also be familiar with the risks associated with intravenous administration of echocardiographic contrast agents and have a general understanding of their intended advantages to enhance image quality, particularly myocardial border definition.

Within the scope of fellowship training, this document defines 3 levels of training (Table 2). Level I training provides the basic or introductory exposure that should be achieved by most trainees over the first 2 years of fellowship. This entails understanding the basic principles, indications, appropriate use, applications, and technical limitations of echocardiography and the interrelation of this technique with other diagnostic methods. All fellows should achieve Level I competency to perform and interpret basic echocardiographic studies in the context of managing their patients. This level of training does not qualify a trainee to perform echocardiography or to independently interpret complex echocardiograms or a full range of echocardiograms typically acquired in an echocardiography laboratory. The competencies developed as part of this level of exposure are described in Table 1.

Beyond the basic exposure provided by Level I training, most cardiovascular fellows should attain Level II competency. Level II training prepares the fellow to independently perform and interpret basic and comprehensive echocardiographic studies, including resting transthoracic M-mode, 2D, and Doppler examinations, stress and TEE in adults. Familiarity with published AUC (12) should begin during Level I training and continue throughout fellowship.

Advanced (Level III) expertise requires additional experience during, and in some cases, beyond the general 3-year cardiology fellowship to acquire specialized knowledge and competencies, including additional and more specialized training in various ultrasound procedures (i.e., transesophageal, stress, and intraoperative procedures). This level of training also prepares an individual to direct an academic echocardiography laboratory and pursue a research career in echocardiography. Fellows who wish to incorporate advanced clinical investigation in echocardiography or multimodality imaging should attain Level III competency in a program that meets requirements addressed in a subsequent, separately published Advanced Training Statement (formerly Clinical Competence Statement).

The requirements for each level of training are summarized in Table 2. In defining these levels, it is recognized that specifying the duration of training and number of procedures is both necessary and desirable. It should be emphasized, however, that the quality of experience, intensity of the educational environment, variety and complexity of cases, and commitment of both faculty and fellow are the primary determinants of the value of fellowship training. As such, training duration and procedure volume for each level are provided as a guide, and flexibility and the individual needs of the trainee must be considered as well.

Table 2. Summary of Training Requirements for Echocardiography

Level	Duration of Training* (Months)	Cumulative Duration** of Training (Months)	Minimal No. of TTE Exams Performed	Minimal No. of TTE Exams Interpreted	TEE and Special Procedures
I	3	3	75	150	Yes†
II	3	6	150 (75 Add)	300 (150 Add)	Yes‡
III	3	9	300 (150 Add)	750 (450 Add)	Yes

* Typical duration assuming acceptable progress toward milestones and demonstrated competency.
†Exposure to TEE and other special procedures.
‡Completion of Level II and additional special training are needed to achieve full competence in TEE and other special procedures.
Add = additional; TEE = transesophageal echocardiography; TTE = transthoracic echocardiography.

4.2.1. Level I Training Requirements

Level I training typically requires 3 months of full-time training or its equivalent devoted to understanding functional anatomy and physiology in relation to the echocardiographic examination. The trainee should participate in the interpretation of a minimum of 150 complete (M-mode, 2D, and Doppler) examinations and personally perform 75 of these studies under the supervision of the laboratory director, designated faculty, and cardiac sonographers. The Level I trainee should be able to recognize common cardiovascular pathologic entities. During Level I training, initial exposure to TEE and other special procedures may be appropriate, but full competence in these areas requires additional training. No other clinical or service responsibility, other than required outpatient clinic and routine night call duties, should be expected of the trainee during the dedicated period of Level I training in echocardiography.

4.2.2. Level II Training Requirements

Level II training is intended to prepare trainees to perform and interpret both basic and complex echocardiograms independently. During Level II training, emphasis should be placed on the variety, quality, and completeness of studies; quantification in diagnostic studies; and correlation with other diagnostic and clinical results in a broad range of clinical problems. To accomplish this, the typical fellow will need an additional 3 months, or the equivalent, of full-time training, interpreting an additional 150 (300 total) complete ultrasound imaging and Doppler hemodynamic examinations. Of these, at least 75 (150 total) should be performed by the trainee under appropriate supervision. The fellow with Level II training should be able to perform an echocardiographic and Doppler study that is diagnostic, complete, and quantitatively accurate. Competence at this level implies sufficient experience to interpret echocardiographic examinations accurately and independently. Continued experience in special echocardiographic procedures such as TEE, 3D, and stress echocardiography is appropriate during Level

II training, but full competence to perform these techniques independently requires completion of Level II training and supervised performance of the requisite number of special studies. Additional guidelines for training in these areas are described later in this document. Gaining experience in the appropriate use of contrast and the role of echocardiography in congenital heart disease should also be part of Level II training. Additionally, Level II training should include recognition of the echocardiographic changes that can develop in highly conditioned athletes. This level of training is recognized by successful completion of a qualifying examination such as the National Board of Echocardiography examination.

4.2.3. Level III Training Requirements

Advanced expertise in echocardiography requires Level III training during, and in some cases, beyond the 36-month cardiovascular fellowship. To achieve Level III competency during a 3-year fellowship period, all available elective time must be devoted to echocardiography. Level III training is intended for those fellows who plan careers in echocardiography and should include exposure to echocardiographic laboratory administration, including quality improvement and the understanding and ability to incorporate new and evolving ultrasound technologies and applications. To obtain Level III competence, the trainee should fulfill all of the previously described requirements (including those delineated in Table 2) and develop additional experience in performing and interpreting special procedures, such as intraprocedural, 3D, strain, and contrast echocardiography in a program that meets requirements that will be addressed in a subsequent, separately published Advanced Training Statement (formerly a Clinical Competence Statement).

4.3. Training in Multiple Imaging Modalities

The recent emergence of other noninvasive imaging modalities, especially cardiovascular magnetic resonance and computed tomography angiography, is having a profound impact on the practice of cardiology and the fellowship training experience. The cardiovascular medicine specialist is increasingly expected to provide expertise in 2 or more imaging techniques. Trainees should therefore gain exposure to multiple imaging modalities during the cardiovascular fellowship. To the degree possible, the training program should strive to meet these needs by offering multimodality imaging experiences (see COCATS Task Force 4: Multimodality Imaging) that address each technique's uses and clinical indications, strengths and limitations, safety issues, and relevant guidelines and appropriateness criteria, when available.

4.4. Special Ultrasound Procedures

Special procedures are those that require specialized training. Exposure to these procedures may begin during Level I training, but competence requires at least completion of Level II and additional specialized training as described in the following text. Some are covered under Level II training, such as stress echocardiography, TEE, tissue Doppler, contrast echocardiography and in some cases intraoperative TEE. Others generally require Level III training, such as evaluation of advanced myocardial mechanics (strain echocardiography, dyssynchrony assessment), 3D echocardiography, epicardial and epivascular echocardiography, and echocardiography during catheter-based interventional procedures. Adequate training in special ultrasound procedures depends on a full understanding of the principles, indications, risks, and technical limitations of the techniques. In addition to special expertise, mastery of these procedures involves the ability to integrate the information from the procedures into clinical practice. Each special procedure can only be learned at a high-volume reference laboratory with an adequate volume of cases under the supervision of fully qualified physician experts who perform and interpret a large number of the procedures annually according to specific guidelines applicable to the procedure. Specific recommendations for the various procedures follow.

4.4.1. Transesophageal Echocardiography

Transesophageal echocardiography is best learned in a laboratory that performs at least 500 TEE studies annually. Although the technical expertise needed to perform TEE may be acquired in a lower volume setting, a smaller volume limits exposure to the critical and unusual abnormalities uniquely identified by TEE. Training should include exposure to TEE examinations performed for a broad array of indications, including but not limited to assessment of native and prosthetic valve disease, aortic disease, acquired or congenital structural heart disease, and evaluation of masses (e.g., thrombus or vegetation). Minimum training for independent performance and interpretation of TEE requires performance of 25 esophageal intubations and 50 supervised complete multiplanar diagnostic studies (2); however, in many instances, this level of expertise will be inadequate to expose the trainee to the full range of pathologies encountered in the clinical practice of TEE. Therefore, continued instruction under the supervision of an experienced operator for an additional 50 studies is recommended. The growing availability of TEE simulation to supplement clinical experience will likely make this an increasingly important and practical way to enhance TEE skills.

Competence requires full knowledge of the indications, contraindications, and complications of TEE which can be achieved through both experiential and didactic education. Independent performance of TEE also requires knowledge of and experience in the administration of conscious sedation. For most cardiovascular training programs, initial exposure to TEE can begin during Level I training, with competence in nonintraoperative TEE being a component of Level II training.

4.4.2. Intraoperative Transesophageal Echocardiography

Intraoperative TEE requires training in routine TEE followed by additional experience evaluating patients undergoing a variety of cardiac procedures in the operating room (13, 14). Experience in the operating room should involve the evaluation and monitoring of patients undergoing routine coronary bypass surgery, as well as the examination of patients during valve replacement and repair procedures. Published guidelines for training in intraoperative TEE (15) have been developed primarily for the cardiovascular anesthesiologist who has not had prior training in routine TEE. For cardiovascular fellows who have achieved Level II training in echocardiography (having performed at least 50 TEE studies), competency in intraoperative TEE requires a minimum of 100 additional intraoperative TEE studies supervised by a qualified expert. Competency in intraoperative TEE also requires an understanding of the cardiac surgical procedures, cardiopulmonary bypass, and intraoperative changes in hemodynamics as assessed by echocardiography. Intraoperative monitoring of procedures for patients with congenital heart disease requires specific training that is often best acquired in a pediatric training laboratory (16).

4.4.3. Echocardiography During Interventional Procedures

Echocardiography plays an essential role in the selection of patients with structural heart disease for catheter-based interventions, planning for these procedures and intraprocedural monitoring (17, 18). Interventional procedures that are typically guided by echocardiography (transthoracic, transesophageal, or intracardiac) include but are not limited to transcatheter valve replacement or repair and closure of atrial or ventricular septal defects, perivalvular sources of regurgitation, and the left atrial appendage. Training should occur in a center that performs a high volume of interventional procedures for structural heart disease. There are currently no guidelines for training in echocardiographic guidance of interventional procedures, although there are courses of instruction on the echocardiographic guidance of transcatheter valve devices. A high level of expertise in probe manipulation and advanced understanding of cardiac anatomy related to echocardiographic imaging are vital for these procedures. Accordingly, guidance of interventional procedures requires Level III training and special competency in 3D echocardiography. Competency for independent performance is demonstrated by the ability to completely characterize the cardiovascular anatomy and hemodynamics relevant to each specific interventional procedure, and to provide both immediate guidance to operators during device-related procedures and feedback regarding the satisfactory completion of the intervention.

4.4.4. Stress Echocardiography

Training in stress echocardiography entails exposure to a mix of exercise and pharmacologic stress testing, including patient selection, stress modality selection, stress test supervision, and integration of all diagnostic information (19, 20). Exposure to stress echocardiography may begin during Level I training; however, because of the difficulty in interpreting segmental wall-motion abnormalities developing during stress echocardiography, achieving basic competence in this area is an objective of Level II training and generally requires supervised interpretation of more than 100 stress echocardiography studies. For competence and independence in stress echocardiography, additional training beyond Level II is recommended. In addition to supervised interpretation, the training experience should include both didactic and experiential training in the indications for stress echocardiography; the advantages, limitations, and risks of different stress imaging approaches; monitoring of the stress test; and integration of stress echocardiography results in clinical cardiovascular medicine. For independent supervision and interpretation of stress echocardiography, training must include participation in and interpretation of a minimum of 100 stress echocardiograms under the supervision of a Level III trained physician. Level III experience includes advanced training in and understanding of: 1) the application of stress echocardiography for evaluation of abnormal hemodynamic responses in patients with valvular heart disease such as aortic stenosis, mitral regurgitation or mitral stenosis; 2) the role of stress echocardiography in evaluation of patients with hypertrophic cardiomyopathy and pulmonary hypertension; and 3) the use of stress echocardiography for assessment of myocardial viability (20).

4.4.5. Intracardiac and Intravascular Ultrasound

Intravascular ultrasound is a specialized procedure most often performed in conjunction with cardiac catheterization (21). It is increasingly used to guide interventional and electrophysiology procedures (22). This procedure requires close collaboration with the interventional cardiologist to ensure proper interpretation of all available imaging data. Because interpretation of these studies has the potential for immediate and significant impact on patient management, communication among involved parties is critical. Performance and interpretation of intravascular ultrasound requires specific, dedicated training in both image acquisition and interpretation in a high-volume laboratory. Training in intracardiac echocardiography should be part of Level III training and the requisite skills can be obtained only in a reference laboratory where this examination is performed routinely.

4.4.6. Contrast Echocardiography

Contrast echocardiography is a broad discipline. Encapsulated microbubble contrast agents that are stable in the blood produce left-sided cavity opacification and can be helpful for identification of endocardial borders and detection of intracardiac thrombi and masses (23, 24). The ability to supervise and interpret these studies is part of Level II training in a laboratory that routinely incorporates agitated saline contrast in the evaluation of patients with suspected right-to-left shunts or unexplained hypoxemia. Training in contrast echocardiography should include instruction on the composition and safety of microbubble contrast agents, contrast-specific imaging methods, indications and contraindications, and specific scenarios in which contrast is likely to add value. The individual completing Level II training should have the requisite skills to perform and interpret contrast-enhanced echocardiograms under the supervision of a Level III echocardiographer trained in contrast imaging. Level III competency in echocardiography includes more extensive exposure to rest and stress contrast echocardiography as well as acquisition of advanced knowledge of microbubble administration protocols, physical principles of contrast signal generation, and specific machine settings to optimize image quality.

4.4.7. Three-Dimensional Echocardiography

Three-dimensional echocardiography is a technically complex modality that has an increasing role in characterizing structural heart disease and is also used in planning and guiding certain interventional and surgical procedures (25). Level II training in echocardiography should provide a basic understanding of the principles of 3D echocardiography and recognition of the clinical situations in which 3D representation can add incremental value over 2D imaging. Level II training should prepare fellows to apply 3D echocardiography appropriately and expose them to basic image acquisition and interpretation. Because of the evolving nature and complexity of 3D echocardiography, independent performance, processing, and interpretation of 3D echocardiography is part of Level III training under the supervision of a Level III expert.

Training should be obtained in a laboratory in which 3D echocardiography is used in a variety of applications including but not limited to assessment of ventricular volumes, valvular heart disease, and atrial septal defects. Competence to perform 3D echocardiography independently requires demonstration of skills in image acquisition, image processing (3D image set manipulation and display), interpretation of 3D transthoracic and transesophageal echocardiograms, and accurate communication of findings.

4.4.8. Strain Echocardiography and Myocardial Mechanics

Advanced methods have been developed for echocardiographic assessment of global or regional myocardial function, regional timing of myocardial contraction, myocardial strain, strain rate, and deformation (26). Although these techniques are not part of routine diagnostic echocardiography, they enhance diagnostic capabilities and will likely play an increasing role in the future. Level II training in echocardiography should include knowledge of the principles and potential applications of strain echocardiography. Independent interpretation and proper use of strain or strain rate echocardiography requires Level III training under the supervision of an expert in a laboratory in which these procedures are routinely performed. Training includes instruction in the physical principles of imaging cardiac mechanics, image processing, and scenarios in which strain imaging may contribute to clinical care.

Echocardiographic assessment of ventricular dyssynchrony can contribute to understanding cardiovascular pathophysiology and causes of symptoms (26, 27) and may have a role in selecting patients for resynchronization therapy. Training in echocardiographic assessment of ventricular dyssynchrony should be obtained in a reference laboratory in which this examination is routinely performed and should include instruction in echocardiography-based optimization of resynchronization of pacemakers.

5. Evaluation of Competency

Evaluation tools in echocardiography include direct observation by instructors, in-training examinations, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, simulation, and reflection and self-assessment. Acquisition and interpretive skills should be evaluated in every trainee. Interaction with other physicians, patients, and laboratory support staff; initiative; reliability; decisions or actions that result in clinical error; and the ability to make appropriate decisions independently and follow-up appropriately should be considered in these assessments. Trainees should maintain records of participation and advancement in the form of a HIPAA-compliant electronic database or logbook that meets ACGME reporting standards and summarizes pertinent clinical information (e.g., number of cases, diversity of referral sources, testing modalities, diagnoses and findings). Every echocardiographic study should be justified, and during training fellows should be required to link each procedure to the corresponding AUC indication/code in their log book. Trainees should be prepared to explain why a given echocardiographic test is better suited to the clinical question than another imaging option. Fellows should document clinical correlation with the other imaging, hemodynamic, invasive laboratory, surgical pathology, and outcomes data to enhance understanding of the diagnostic utility and value of various studies. Finally, experiences in echocardiography should be assessed against measures of quality with regard to test selection, performance, interpretation, and reporting (28, 29) in the interest of appreciating the potential adverse consequences of suboptimal testing.

The ACC, AHA, and ASE have formulated a clinical competence statement on the performance, interpretation, and reporting of ultrasound studies (2). Self-assessment programs in echocardiography are available through the ACCF and other organizations. Program directors and trainees are encouraged to incorporate these resources in the course of training. In addition, objective examinations have been created by the National Board of Echocardiography for physicians with Level II training who want to test and demonstrate their competency. To confirm competency, trainees should strongly consider preparing for and taking the appropriate National Board of Echocardiography examination.

Under the aegis of the program director and director of each imaging laboratory, facility, or program, the 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 assure achievement of selected training milestones and to identify areas in which additional focused training may be required.

Key Words: ACC Training Statement ▪ COCATS ▪ fellowship training ▪ clinical competence ▪ echocardiography ▪ transthoracic echocardiography ▪ transesophageal echocardiography ▪ stress echocardiography

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 5: TRAINING IN ECHOCARDIOGRAPHY

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF5_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 5: TRAINING IN ECHOCARDIOGRAPHY

Name	Employment	Representation	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
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		Cardiology Section Leadership Council						

For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ACC = American College of Cardiology, ASE = American Society of Echocardiography.

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

ASE = American Society of Echocardiography

COCATS = Core Cardiovascular Training Statement

HCU = hand-carried ultrasound

HIPAA = Health Insurance Portability and Accountability Act

TEE = transesophageal echocardiography

TTE = transthoracic echocardiography

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COCATS 4 Task Force 6: Training in Nuclear Cardiology[7]

Endorsed by the American Society of Nuclear Cardiology
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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The Writing Committee was selected to represent the American College of Cardiology (ACC) and the American Society of Nuclear Cardiology (ASNC) and included a cardiovascular training program director; a nuclear cardiology training program director; early-career experts; highly experienced specialists in both academic and community-based practice settings; and physicians experienced in defining and applying training standards according to the 6 general competency domains promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialities (ABMS), and endorsed by the American Board of Internal Medicine (ABIM). The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiovascular training statement. Employment and affiliation details for authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF6_Comprehensive_RWI_Supplement.pdf).

1.1.2. Document Development and Approval

The Writing Committee developed the document, approved it for review by individuals selected by the ACC and ASNC, and addressed their comments. The document was revised and posted for public comment from December 20, 2015 to January 6, 2015. Authors addressed additional comments from the public to complete the document. The final document was approved by the Task Force, COCATS Steering Committee, and ACC Competency Management Committee as well as ratified by the ACC

[7] The American College of Cardiology requests that this document be cited as follows: Dilsizian V, Arrighi JA, Cohen RS, Miller TD, Solomon AJ, Udelson JE. COCATS 4 task force 6: training in nuclear cardiology. J Am Coll Cardiol. 2015;••:••••–••••.

Board of Trustees and endorsed by ASNC in March, 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

Nuclear cardiology provides important diagnostic and prognostic information that is an essential part of the knowledge base required of the well-trained cardiologist for optimal management of the cardiovascular patient (Table 1).

Table 1. Classification of Nuclear Cardiology Procedures and Skills

Procedures in which competency should be achieved during Level II training:

1. Myocardial perfusion imaging
    a. SPECT, with or without attenuation correction
    b. ECG-gated perfusion images
    c. Stress protocols (exercise and pharmacologic)
    d. Viability assessment using SPECT and/or PET
2. Radionuclide angiography
3. Use of methods for acquisition, reconstruction, and quantitative analysis of images
4. Appropriate radiation safety and quality improvement programs
5. Use of radiation monitoring instruments

Procedures in which medical knowledge should be demonstrated and achievement of competency may be accomplished during or after fellowship:

1. PET myocardial perfusion imaging
2. Myocardial blood flow quantification
3. Cardiac planar imaging
4. Hybrid PET/CT and SPECT/CT
5. Myocardial innervation
6. Myocardial metabolism

CT = computed tomography; ECG = electrocardiogram; PET = positron emission tomography; SPECT = single-photon computed tomography.

The Task Force was charged with updating previously published standards for training fellows in adult nuclear cardiology on the basis of changes in the field since 2008 and as part of a broader effort to establish consistent training criteria across all aspects of cardiology. This document does not provide specific guidelines for training in advanced cardiovascular subspecialty areas but identifies opportunities to obtain advanced training where appropriate. The Task Force also updated previously published standards to address the evolving framework of competency-based medical education described by the ACGME Outcomes Project and the 6 general competencies endorsed by the ACGME and ABMS. The background and overarching principles governing fellowship training are provided in the Introduction to COCATS, and readers should become familiar with this foundation before considering the details of training in a subdiscipline like nuclear cardiology. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally over time.

For most areas of adult cardiovascular medicine, 3 levels of training are delineated:

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 cardiology. For nuclear cardiology, Level I training enables trainees to become conversant with the field of nuclear cardiology for application in general clinical management of cardiovascular patients.

Level II training refers to the additional training in 1 or more areas that enables some cardiologists to perform or interpret specific procedures or render more specialized care for patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training in selected areas may be achieved by some trainees during the standard 3-year cardiovascular fellowship, depending on the trainees' career goals and use of elective rotations. In the case of nuclear cardiology, Level II training provides trainees with expertise to practice clinical nuclear cardiology as a subspecialty by providing supervision and interpretation of the following: myocardial perfusion single-photon emission computed tomography (SPECT) and/or positron emission tomography (PET); cardiac function assessment with gated SPECT and/or PET; and gated equilibrium radionuclide angiography. Additionally, Level II training will provide the requisite training for clinicians to learn emerging nuclear cardiology procedures with appropriate additional clinical training and experience.

Level III – This advanced level of training requires additional experience beyond the 3-year cardiovascular fellowship dedicated to acquiring specialized knowledge and competencies in performing, interpreting, and training others to perform specific procedures or to render advanced, specialized care at a high level of skill. Level III training is described here only in broad terms to provide context for trainees and clarify that these advanced competencies are not covered during the cardiovascular fellowship and require additional training and designation by an independent accrediting board, often coupled with a certifying examination. Level III training cannot be obtained during the standard 3-year cardiovascular fellowship and requires additional exposure in a program that meets requirements that will be addressed in a subsequent, separately published in Advanced Training Statement (formerly in Clinical Competence Statement).

It is assumed that training at all levels is directed by appropriately trained mentors in an ACGME-accredited program and that satisfactory completion of training is documented by the program director. The number and types of encounters and duration of training required for trainees are summarized in Section 4.

2. General Standards

Three organizations—the ACC, American Heart Association, and ASNC—have addressed training requirements and guidelines for patient selection, imaging protocols, interpretation, correlation with coronary anatomy, follow-up, and prognosis. The recommendations are congruent and address faculty, facility requirements, emerging technologies, and clinical practice. We recommend strongly that candidates for the ABIM examination for certification in cardiovascular diseases who seek competency in nuclear cardiology, as well as those seeking certification and Authorized User status for nuclear cardiology procedures, review the specific requirements of the Certification Board of Nuclear Cardiology (CBNC) and Nuclear Regulatory Commission (NRC) (1, 2).

Cardiovascular fellowship programs should satisfy the requirements regarding facilities and faculty for training in Nuclear Cardiology as defined below. Eligibility for the CBNC examination requires that training take place in a cardiology, radiology, or nuclear medicine training program that is accredited by the ACGME. The intensity of training and required resources vary according to the level of training

To have an adequate understanding of the clinical applications of nuclear cardiology and to perform tests safely, the cardiovascular trainee must acquire knowledge and competency in the following areas of general cardiology:

1. Coronary angiography and physiology
2. Cardiac physiology and pathophysiology
3. Rest and exercise electrocardiography
4. Exercise physiology
5. Pharmacology of standard cardiovascular drugs
6. Cardiopulmonary resuscitation and treatment of other cardiac emergencies
7. Pharmacology and actions of commonly used stress agents, such as dipyridamole, adenosine, regadenoson, and dobutamine
8. Clinical outcomes assessment

2.1. Faculty

Faculty should include specialists skilled in administering and interpreting stress testing (exercise and pharmacological), performing and interpreting radionuclide cardiac imaging, and assessing the potential risks of radiation exposure to patients and medical personnel. There must be a minimum of 1 faculty member who is the Authorized User at the training institution. Clinical faculty should be certified in CBNC or possess equivalent board qualifications in American Board of Nuclear Medicine or American

Board of Radiology. A physician is considered to have equivalent qualifications if he or she trained in a similar environment for a similar duration of time and performed the required number of procedures.

2.2. Facilities

Facilities should be adequate to ensure a safe, secure, and effective environment for noninvasive radionuclide SPECT and/or PET studies. The facilities should maintain all Radiation Safety, NRC, and **Joint Commission on Accreditation of Healthcare Organizations** requirements. Accreditation of the facility through the **Intersocietal Commission for the Accreditation of Nuclear Medicine Laboratories** or American College of Radiology is strongly encouraged.

2.3. Equipment

Nuclear laboratories should be equipped with at least 1 SPECT camera. Additional attenuation correction capability, hybrid SPECT/computed tomography (CT), PET, and hybrid PET/CT cameras are optional.

2.4. Ancillary Support

Ancillary support should be available to perform nuclear cardiology procedures, including nuclear technologists, nurses to perform stress testing, a physicist, and a radiation safety officer.

3. Training Components

3.1. Didactic Program

3.1.1. Lectures, Radiation Safety, Radiopharmacy and Self-Study

This component consists of lectures on the basic aspects of nuclear cardiology and parallel self-study material consisting of reading and viewing case files. The material presented should integrate the role of nuclear cardiology into total patient management. Such information can be included within the didactic curriculum of the training program and should include presentation and discussion of nuclear cardiology image data as it relates to diagnostic and therapeutic management. In addition, there should be a didactic program on radiation safety and radiopharmacy, which should provide the fellow with an understanding of radiation safety as it relates to patient selection and risk/benefit assessment of diagnostic tests that utilize ionizing radiation.

3.2. Clinical Experience

At least 2 months of the cardiovascular fellowship training should be dedicated to nuclear cardiology. Fellows should actively participate in daily nuclear cardiology study interpretation (at least 100 cases). Experience in as many areas as possible from those listed in Table 1 is recommended. If some procedures are not available or are performed in low volume, an adequate background for fellowship training can be satisfied by appropriate reading or review of case files. The teaching file should consist of perfusion and ventricular function studies with angiographic/cardiac catheterization documentation of disease.

3.3. Hands-On Experience

3.3.1. Clinical Cases

All fellows should perform complete nuclear cardiology studies alongside a qualified technologist or other qualified laboratory personnel. They should, under supervision, observe and participate in a large number of the standard procedures and as many of the less commonly performed procedures as possible. Fellows should have experience in the practical aspects of radiation safety associated with performing clinical patient studies.

3.3.2. Radiation Safety

All Level I fellows need to be familiar with radiation biology and the regulations governing the use of radioactive materials and ionizing radiation for performing diagnostic nuclear cardiology and hybrid CT studies. This knowledge includes details for protecting patients, the public, and the user from the effects of radiation.

3.3.3. Additional Training

The requirements for Level II training in nuclear cardiology are delineated in Section 4, below.

4. Summary of Training Requirements

4.1. Development and Evaluation of Core Competencies

Training and requirements in the nuclear cardiology address the 6 general competencies promulgated by the ACGME/ABMS 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 core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 2 delineates each of the 6 competency domains, as well as their associated curricular milestones for training in nuclear cardiology. The milestones are categorized into Level I, Level II, and Level III training (as previously defined in this document) and indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Given that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may also vary. Level I competencies may be achieved at earlier or later time points. Acquisition of Level II skills requires additional training. The table also describes examples of evaluation tools suitable for assessing competence in each domain.

Table 2. Core Competency Components and Curricular Milestones for Training in Nuclear Cardiology

Medical Knowledge	**Milestones (Months)**			
	12	**24**	**36**	**Add**
1. Know the principles of single-photon emission computed tomography and radionuclide ventriculography image acquisition and display, including the standard tomographic planes and views.		I		
2. Know the properties and use of standard perfusion tracers.			I	
3. Know the principles of radiation safety and how to minimize radiation exposure.			II	
4. Know the indications for myocardial perfusion imaging and the appropriate selection of exercise versus pharmacologic stress testing.	I			
5. Know the principles and use of pretest probability and sequential probability analysis to assess posttest probability.	I			
6. Know the mechanism of pharmacologic stress agents, methods of their administration, and safety issues in using the agents.		I		
7. Know the protocols for administration of standard perfusion agents and the influence of the clinical situation on choice of imaging protocol.		I		
8. Know the quality control issues, how to review raw data, and recognize artifacts.			II	
9. Know the use of nuclear cardiology in the assessment of ventricular function.		I		
10. Know the protocols for the use of perfusion imaging to assess myocardial viability.		I		
11. Know the indications for positron emission testing imaging and use of positron emission testing tracers.			II	
Evaluation Tools: direct observation, in-training exam				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to select the appropriate imaging study.		I		
2. Skill to integrate perfusion imaging findings with clinical and other test results in the evaluation and management of patients.		I		
3. Skill to identify results that indicate a high-risk state.		I		
4. Skill to perform and interpret gated stress-rest perfusion study.			II	
5. Skill to perform and interpret a radionuclide ventriculography study.			II	
6. Skill to perform and interpret hybrid SPECT/CT and PET/CT imaging.				III
7. Skill to perform and quantify PET absolute myocardial blood flow and metabolism.				III
8. Skill to perform and interpret cardiac innervation, first pass,				III

and planar studies.				
Evaluation Tools: conference presentation, direct observation, logbook				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Work effectively and efficiently with the nuclear laboratory staff.			II	
2. Incorporate risk/benefit and cost considerations in the use of radionuclide imaging techniques.			I	
3. Participate in laboratory quality monitoring and initiatives.			II	
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.			I	
Evaluation Tools: conference presentation, direct observation				
Professionalism	**12**	**24**	**36**	**Add**
1. Know and promote adherence to guidelines and appropriate use criteria.		I		
2. Interact respectfully with patients, families, and all members of the health care team- including ancillary and support staff.	I			
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate effectively and timely with patients, families, and referring physicians.		I	II	
2. Communicate test results in a comprehensive and user-friendly manner.			II	
Evaluation Tools: direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

4.2. Number of Procedures and Duration of Training

The specific competencies for Levels I and II are delineated in Table 2. The minimum duration of training and volume of procedures required for each level of training in nuclear cardiology are summarized in Table 3. A brief discussion of the competencies and training requirements follows.

Table 3. Summary of Training Requirements for Nuclear Cardiology

Level	Minimum Duration of Training (Months)†	Minimum No. of Examinations
I	2	100*
II	4†	300*

*These are approximate cumulative numbers of examinations. At least 30 cases with hands-on experience must be performed and interpreted under supervision, with a greater emphasis on demonstrating competency in both clinical interpretation and technical aspects as assessed by the outcomes evaluation measures.
† Refer to t"COCATS 4 Task Force 4: training in multimodality imaging" for guidelines regarding the number of months that may be shared with training in other imaging modalities.

4.2.1. Level I Training Requirements

The trainee is exposed to the fundamentals of nuclear cardiology for at least 2 months during training. This 2-month experience provides familiarity with nuclear cardiology technology and its clinical applications in the general clinical practice of adult cardiology, but it is not sufficient for the specific practice of nuclear cardiology. The 3 components of training include a didactic program that involves lectures, self-study, instruction in radiation safety and regulations, interpretation of nuclear cardiology studies, and hands-on experience.

4.2.2. Level II Training Requirements

Fellows who wish to practice the specialty of nuclear cardiology are required to have at least 4 months of training. Level II training includes a minimum of 700 hours work experience in nuclear cardiology, inclusive of radiation safety. This requirement is based in part on NRC regulations. Didactic instruction, clinical study interpretation, and hands-on involvement in clinical cases are all required. In training programs with a high volume of procedures, clinical experience may be acquired in as little as 4 months during fellowship. In programs with a lower volume of procedures, at least 6 months of clinical experience will be necessary to achieve Level II competency. The additional training required of Level II trainees is intended to enhance their clinical skills, knowledge, and hands-on experience in radiation safety and to qualify them to become authorized users of radioactive materials in accordance with the regulations of the NRC and/or the Agreement States.

The various nuclear cardiology procedures are listed in Table 1. It is recommended that all fellows receive training aligned with achieving competency in the procedures listed in section A of this table. For procedures listed in section B, which may not be widely available, fellows should receive at minimum didactic instruction, and, when available, clinical experience to achieve competency. For Level II training in cardiac PET, direct patient experience with at least 40 patient studies of myocardial perfusion, metabolism, or both, is required. Level II training must also provide experience in computer methods for analysis. This should include perfusion and functional data derived from thallium or technetium agents and ejection fraction and regional wall motion measurements from radionuclide angiographic studies.

The didactic training required to develop Level II competence should include in-depth details of all aspects of the procedures listed in Table 1. This program may be scheduled over a 12- to 24-month period concurrent and integrated with other fellowship assignments. Alternatively, a fellow may choose to fulfill the advanced procedures of Table 1 by pursuing an additional year of fellowship dedicated to nuclear cardiology.

Classroom and laboratory training needs to include extensive review of radiation physics and instrumentation, radiation protection, mathematics pertaining to the use and measurement of radioactivity, chemistry of byproduct material for medical use, radiation biology, effects of ionizing radiation, and radiopharmaceuticals in order to meet the NRC requirements and qualifications for becoming an authorized user. There should be a thorough review of regulations dealing with radiation safety for the use of radiopharmaceuticals and ionizing radiation. This experience should total at least 80 hours and be documented separately. This experience may include web-based didactics.

It is expected that the foundation of Level II nuclear cardiology training, including didactic instruction, radiation safety training, and clinical experience during fellowship, is required to achieve competency after formal fellowship training for those emerging procedures listed in Table 1. Didactic instruction in those procedures listed in Table 1 should include the topics listed in Table 4.

Fellows seeking Level II training should participate in the interpretation of nuclear cardiology imaging data for a minimum of 4 months. It is imperative that the fellows have experience in correlating catheterization or CT angiographic data with radionuclide-derived data for a minimum of 30 patients. A teaching conference in which the fellow presents the clinical material and nuclear cardiology results is an appropriate forum for such experience. A minimum of 300 cases should be interpreted under preceptor supervision from direct patient studies. Upon satisfactory completion of Level II training, which includes demonstration of competency in both clinical interpretation and technical aspects as assessed by the outcomes evaluation measures, fellows will be eligible for the CBNC examination.

The CBNC was established jointly by the ACC and ASNC and assesses knowledge and mastery in the areas of radiation safety and the technical and clinical performance of nuclear cardiology procedures. The CBNC is recognized by the NRC as a certification pathway for obtaining authorized user status for administering radiotracers that are specific to the field of cardiology. Information concerning the eligibility requirements for the examination can be obtained from the CBNC. Privileges to interpret nuclear cardiology studies should be based mainly on satisfactory completion of the training outlined in this document, including demonstration of competence and technical expertise. The issues of ongoing clinical competence and training or retraining of practicing cardiologists are beyond the scope of this document.[8]

Fellows acquiring Level II training should have hands-on, supervised imaging experience with a minimum of 30 patients: 25 patients with myocardial perfusion imaging and 5 patients with radionuclide angiography. Such experience should include pre-test patient evaluation; radiopharmaceutical preparation (including experience with relevant radionuclide generators and CT systems); performance of studies with and without attenuation correction; administration of the dosage, calibration, and setup of the gamma

[8] For additional information, contact CBNC at 101 Lakeforest Boulevard, Suite 401, Gaithersburg, MD 20877; http://www.cccvi.org/cbnc/.

camera and CT system; setup of the imaging computer; processing the data for display; interpretation of the studies; and generating clinical reports.

Level II trainees must acquire 620 hours work experience inclusive of radiation safety (in addition to the 80 hours of classroom and laboratory experience) during training in the clinical environment where radioactive materials are being used. This training should take place under the supervision of an authorized user who meets the NRC requirements of Part 35.290 or Part 35.290(c)(ii)(G) and Part 35.390 or the equivalent Agreement State requirements and must include the following:

a. Ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys
b. Performing quality control procedures on instruments used to determine the activity of dosages as well as performing checks for proper operation of survey meters
c. Calculating, measuring, and safely preparing patient or human research subject dosages
d. Using administrative controls to prevent a medical event that involves the use of unsealed byproduct material
e. Using procedures to safely contain spilled radioactive material and using proper decontamination procedures
f. Administering dosages of radioactive material to patients or human research subjects
g. Eluting generator systems appropriate for preparation of radioactive drugs for imaging and localization studies; measuring and testing the eluate for radionuclide purity; and processing the eluate with reagent kits to prepare labeled radioactive drugs

Table 4. Didactic Instruction in Procedures in Which Medical Knowledge Should be Demonstrated and Achievement of Level II Competency May Be Accomplished During or After Fellowship

Cardiac PET

a) Production and use of positron-emitted radiotracers
b) Instrumentation and physics of PET
c) Radiation safety and regulatory requirements unique to PET
d) Range of PET cardiac studies (e.g., myocardial perfusion, metabolism, innervation)

Hybrid SPECT/CT and PET/CT

a) Use for attenuation correction
b) Coronary calcium scoring
c) Combined anatomic/physiologic imaging

Myocardial Innervation

a) I-123 MIBG imaging

CT = computed tomography; PET = positron emission testing; SPECT = single-photon emission computed tomography.

4.2.3. Level III Training Requirements

For fellows planning an academic career in nuclear cardiology or a career directing a clinical nuclear cardiology laboratory, an extended program is required. More advanced competency (Level III) in nuclear cardiology is generally obtained within the context of multimodality imaging training and requires additional training beyond the standard 3-year cardiovascular fellowship. In addition to the recommended program for Level II, the Level III program should include advanced quality control of nuclear cardiology studies and active participation and responsibility in ongoing laboratory or clinical research. In parallel with participation in a research program, the trainee should participate in clinical imaging activities; some of these experiences may involve concurrent training in other imaging modalities as defined in the guidelines for “COCATS 4 Task Force 4: training in multimodality imaging.” Fellows pursuing Level III training should already be eligible for the CBNC on the basis of their prior Level II training. Level III training should include both hands-on experience and supervised interpretative experience greater than that required for Level II training. Additional training in nuclear cardiology may include quantification of absolute myocardial blood flow, assessment of coronary artery disease and myocardial perfusion using hybrid PET/CT and/or SPECT/CT protocols, patient preparation and imaging protocols for planar imaging, first-pass radionuclide angiography, myocardial metabolism, and innervation.

4.2.4. Training in Multiple Imaging Modalities

The recent emergence of other noninvasive imaging modalities, especially cardiovascular magnetic resonance and computed tomography angiography, is having a profound impact on the practice of cardiology and the fellowship training experience. The cardiovascular medicine specialist is increasingly expected to provide expertise in 2 or more of the imaging techniques. It is understandable that trainees will desire the opportunity to gain exposure to multiple imaging modalities during their fellowship experience. To the degree possible, the training program should strive to meet these needs by offering a “multimodality” imaging experience (see “COCATS 4 Task Force 4: training inmultimodality imaging”). This might include an appreciation for each technique’s uses and clinical indications, strengths and limitations, safety issues, and relevant guidelines and appropriateness criteria, when available.

5. Evaluation of Competency

Evaluation tools in nuclear cardiology include direct observation by instructors, in-training examinations, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, and simulation. Acquisition and interpretive skills should be evaluated in every trainee. Interaction with other physicians, patients, and laboratory support staff; initiative; reliability; decisions or actions that result in clinical error; and the ability to make appropriate decisions independently and follow-up appropriately should be considered in these assessments. Trainees should maintain records of participation and advancement in the form of a Health Insurance Portability and Accountability Act (HIPAA)-compliant electronic database or logbook that meets ACGME reporting standards and summarizes pertinent clinical information (e.g., number of cases, diversity of referral sources, testing modalities, diagnoses and findings). The use of nuclear cardiology should be aligned with clinical need and appropriateness criteria. Trainees should be prepared to explain why a given nuclear cardiology test is better suited to the clinical question than another imaging option. Fellows should document clinical correlation with the other imaging, hemodynamic, invasive laboratory, surgical pathology, and outcomes data to enhance understanding of the diagnostic utility and value of various studies. Finally, experiences in nuclear cardiology should be assessed against measures of quality with regard to test selection, performance, interpretation, and reporting in the interest of appreciating the potential adverse consequences of suboptimal testing (3-5).

Under the aegis of the program director and director of each imaging laboratory, facility, or program, the 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 assure achievement of selected training milestones and identify areas in which additional focused training may be required.

Key Words: ACC Training Statement ▪ COCATS ▪ fellowship training ▪ clinical competence ▪ cardiovascular imaging ▪ nuclear cardiology.

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 6: TRAINING IN NUCLEAR CARDIOLOGY

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF6_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELEVANT RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES—COCATS 4 TASK FORCE 6: TRAINING IN NUCLEAR CARDIOLOGY

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ACC = American College of Cardiology.

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

ASNC = American Society of Nuclear Cardiology

CBNC = Certification Board of Nuclear Cardiology

COCATS = Core Cardiovascular Training Statement

CT = computed tomography

HIPAA = Health Insurance Portability and Accountability Act

NRC = Nuclear Regulatory Commission

PET = positron emission tomography

SPECT = single-photon emission computed tomography

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COCATS 4 Task Force 7: Training in Cardiovascular Computed Tomographic Imaging[9]

Endorsed by the American Society of Nuclear Cardiology, Society for Cardiovascular Angiography and Interventions, Society of Atherosclerosis Imaging and Prevention, and Society of Cardiovascular Computed Tomography

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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The Writing Committee was selected to represent the American College of Cardiology (ACC), American Society of Nuclear Cardiology (ASNC), Society for Cardiovascular Angiography and Interventions (SCAI), Society of Atherosclerosis Imaging and Prevention (SAIP), and Society of Cardiovascular Computed Tomography (SCCT), and included a cardiovascular training program director, a cardiovascular computed tomography (CCT) training program director, an advanced-multimodality cardiovascular imaging training program director, an early-career cardiologist, as highly experienced specialists practicing in both academic and community-based settings, and physicians experienced in defining and applying training standards according to the 6 general competency domains promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialties (ABMS), and endorsed by the American Board of Internal Medicine (ABIM). The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiovascular training statement. Employment and affiliation details for authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories.

[9] The American College of Cardiology requests that this document be cited as follows: Garcia MJ, Blankstein R, Budoff MJ, Dent JM, Drachman DE, Lesser JR, Grover-McKay M, Schussler JM, Voros S, Wann LS. COCATS 4 task force 7: training in cardiovascular computed tomographic imaging. J Am Coll Cardiol. 2015;••:••••–••••.

Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF7_Comprehensive_RWI_Supplement.pdf).

1.1.2. Document Development and Approval

The writing committee developed the document; approved it for review by individuals selected by the ACC, ASNC, SAIP, SCAI, and SCCT; and addressed the reviewers' comments. The document was revised and posted for public comment from December 20, 2015 to January 6, 2015. Authors addressed additional comments from the public to complete the document. The final document was approved by the Task Force, COCATS Steering Committee, and ACC Competency Management Committee, and ratified by the ACC Board of Trustees and endorsed by the ASNC, SAIP, SCAI, and SCCT in March, 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

CCT is a rapidly evolving technique for assessing cardiovascular anatomy. The anatomical detail, complex imaging devices, protocols, and evolving clinical applications of this modality require that all cardiovascular trainees receive training in CCT imaging during fellowship. Clinical application of CCT encompasses noncontrast (coronary calcium evaluation), contrast (CCT angiography and function), and hybrid studies (combining nuclear cardiology techniques with CCT). Computed tomography, like catheterization, provides anatomical and functional information (e.g., coronary anatomy and left ventricular ejection fraction, respectively). Hybrid devices incorporate high-speed multidetector computed tomography (MDCT) technology, positron emission tomography (PET), and single-photon emission computed tomography (SPECT) detector systems. Current hybrid systems (MDCT plus nuclear) provide attenuation correction for SPECT and PET, further improving the diagnostic accuracy of traditional radionuclide techniques.

This training statement has been designed for fellows-in-training and is not intended for physicians already in practice (1). Fellows-in-training are expected to gain exposure to CCT during their fellowship years and combine this experience with knowledge of echocardiography, nuclear cardiology, cardiovascular magnetic resonance, and cardiac catheterization, as appropriate. All fellows should be exposed to the fundamental aspects of CCT, but only those who achieve levels of experience beyond Level I will be sufficiently qualified to interpret CCT scans independently. At the conclusion of training, all fellows should be familiar with CCT assessment of cardiovascular anatomy, physiology, and pathophysiology and know the clinical application of CCT and the principles of CCT physics and radiation generation and exposure. Since many CCT studies require the administration of intravenous iodinated contrast, fellows should be familiar with the protocols for contrast administration and subsequent contrast kinetics, as well as the potential adverse events resulting from contrast exposure and appropriate treatment. In particular, fellows should be able to define the methods for contrast-enhanced CCT imaging of the pericardium, right and left heart chambers, and the great vessels. Given the potential hazards of exposure to medical radiation, trainees should become familiar with appropriate patient selection, dose reduction techniques, and the principle of maintaining radiation exposure at the lowest level reasonably achievable.

Every cardiovascular fellow should develop familiarity with the technical performance, interpretation, strengths, and limitations of CCT and its multiple clinical applications. In addition, every cardiovascular fellow should gain an understanding of how to effectively use the information provided by CCT, together with other clinical and imaging tests (when available), in making patient management decisions. It is recognized that CCT is an evolving technology in a rapid phase of development and improvement, with an expanding list of clinical indications.

The Task Force was charged with updating previously published standards for training fellows in clinical cardiology enrolled in ACGME-certified fellowship programs (2) on the basis of : 1) changes in the field since 2008; and 2) the evolving framework of competency-based medical education described by the ACGME Outcomes Project and the 6 general competencies endorsed by ACGME and ABMS. The updating effort was also convened as part of a broader effort to establish consistent training criteria across all aspects of cardiology. The background and overarching principles governing fellowship training are provided in the Introduction to COCATS, and readers should become familiar with this foundation before considering the details of training in a subdiscipline like CCT. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally over time.

For most areas of cardiovascular imaging, 3 levels of training are delineated:

Level I training defines the fundamental level of experience required of all fellows-in-training in order to be considered competent to practice cardiology independently. Level I training should be accomplished during every standard 3-year training program in cardiology. This entails understanding the basic principles, indications, applications, and technical limitations of CCT, as well as the interrelationship between CCT and other diagnostic methods. Level I certification does not qualify a trainee to perform or interpret CCT studies independently.

Level II training refers to the additional training in 1 or more areas that enables a cardiologist to perform or interpret specific procedures or render more specialized care for patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training in selected areas may be achieved by some trainees during the standard 3-year cardiovascular fellowship, depending on the trainees' career goals and use of elective rotations. It is anticipated that during a standard 3-year cardiovascular fellowship training program, sufficient time will be available for the trainee to receive Level II training in a specific subspecialty. In the case of CCT, Level II is defined as the minimum level of experience required to perform and interpret CCT independently.

Level III training in CCT, as in other noninvasive imaging modalities, should include the principles of multimodality imaging (see "COCATS 4 Task Force 4: training in multimodality imaging"). This requires additional training and experience beyond the cardiovascular fellowship to allow the trainee to acquire specialized knowledge and experience in performing, interpreting, and training others to perform specific procedures or render advanced specialized care at a high level of skill. In the case of CCT, Level III expertise would enable the trainee to direct a CCT laboratory, train others in CCT, and conduct advanced imaging research. Level III training is described here only in broad terms to provide context for trainees. The additional exposure and requirements for Level III training will be addressed in a subsequent, separately published Advanced Training Statement.

The number of cases, procedures, and experiences recommended is based on published guidelines, competency statements, and the opinions of the members of the writing group. It is assumed that training is directed by appropriately trained mentors in an ACGME-accredited program and that satisfactory completion of training is documented by the program director. The number and types of encounters and the duration of training typically required are summarized in Section 4.

2. General Standards

Three organizations—the ACC, American Heart Association, and SCCT—have addressed training requirements and guidelines for patient selection (1, 3); clinical indications (4, 5); study performance, interpretation, and reporting (6, 7); and educational objectives (2) for fellowship training in CCT. The recommendations are congruent and address faculty, facility requirements, emerging technologies, and practice. Cardiovascular fellowship programs should satisfy the requirements regarding facilities and faculty for training in CCT. Candidates for the ABIM examination for certification in cardiovascular diseases should review the specific ABIM requirements, and those seeking advanced certification in CCT should review the specific requirements of the Certification Board of Cardiovascular Computed Tomography (8).

To be eligible to sit for the CBCCT examination, U.S.-trained cardiovascular fellows must have undergone training in a program accredited by the ACGME (8). The intensity and depth of training and required resources may vary according to the level of training provided.

2.1. Faculty

Faculty should include cardiovascular imaging specialists knowledgeable about the risks to the patient as well as medical personnel associated with radiation exposure and skilled in performing and interpreting CCT studies. The program must have at least 2 key clinical CCT faculty members, including the program director, who are board-certified in CCT or possess equivalent qualifications. A physician is considered to have equivalent qualifications if he or she trained in a similar environment for a similar duration of time, supervised the required number of studies, and performed both supervised and independent interpretations. Faculty must participate with trainees in imaging acquisition, processing, and interpretation.

2.2. Facilities

Facilities must be adequate to ensure a safe and effective environment for conducting diagnostic CCT studies and providing didactic instruction to fellows-in-training. Appropriate infrastructure, personnel, and equipment should be available to enable image processing, interpretation, and didactic interactions between faculty and trainees.

The CCT laboratory in which training is undertaken should be under the direct supervision of a full-time qualified director (or directors) with Level III training or equivalent. The training guidelines set forth in this document pertain primarily to trainees performing CCT examinations in adult patients with acquired or congenital heart disease.

2.3. Equipment

CCT laboratories require specialized equipment for the safe performance and interpretation of diagnostic studies. This equipment includes a multislice CCT scanner with a minimum of 64-slice and electrocardiographic-gating capabilities; specialized equipment for contrast administration and patient monitoring; and computer network infrastructure for data storage, transmission, processing, study interpretation, and reporting (8).

2.4. Ancillary Support

Ancillary support should be available to obtain intravenous access, administer intravenous medications, monitor patients after procedures, and treat potential complications, including performance of emergency cardiopulmonary resuscitation.

3. Training Components

3.1. Didactic Program

The educational curriculum in CCT should include didactic lectures, reference reading material, case discussions, and formal case presentations. The curriculum should supplement the hands-on and clinical case interpretation experiences to ensure that the medical knowledge milestones detailed in Section 4.1 are met. Consequently, knowledge pertaining to CCT should be acquired in the following areas: epidemiology, CCT physics, image processing, pathophysiology, and management of coronary artery disease. In addition, didactic sessions should include discussions of the diagnostic accuracy of CCT, including sensitivity and specificity, when compared with the reference standard of invasive angiography or myocardial perfusion imaging, as well as knowledge of the advantages and disadvantages of CCT compared with other cardiovascular imaging modalities. Didactic teaching should address appropriate utilization of CCT and integration of the CCT results with other data to enhance patient management.

Each fellow should receive documented training from a CCT mentor and/or physicist in the basic physics of CT in general and CCT in particular. Lectures should include training in principles of radiation protection, hazards of radiation exposure to both patients and personnel, and techniques for reporting and measuring radiation doses. The CCT mentor should also discuss cardiac and great-vessel anatomy, contrast administration and kinetics, principles of 3-dimensional imaging and post-processing, and appropriate post-procedural patient monitoring.

3.2. Clinical Experience

Interpretation of a designated minimum number of CCT studies will typically be required to approach Level I competency (See Section 4.2). In addition, for a certain number of cases, the trainee should be present and participate in image acquisition. For these cases, the following 3 conditions must be met:

1. The trainee must be present in the scanning control room.
2. For Level I or II training, the fellow must participate interactively in manipulation of the processed images for evaluation of the study. Interpretation of each case should include all components of cardiac structure and function (when available), as well as noncardiac structures.
3. During this image evaluation process, there must be an opportunity for interaction between the trainee and the trainer.

The CCT program should expose trainees to a wide array of CCT indications and imaging protocols and to a varied patient population, including patients with complex congenital heart disease. It is important to emphasize that merely completing a certain number of studies does not equate to competency, which instead must be assessed individually by supervising faculty.

3.3. Hands-On Experience

Hands-on training is important, not only to develop technical expertise regarding image acquisition and interpretation, but also as a valuable aid to learning tomographic and 3-dimensional cardiac anatomy. Through acquisition and interpretation of data, trainees should learn to recognize appropriate image quality and understand the source of—and recognize techniques for avoiding—artifacts (e.g., breath-holding, gating, arrhythmias).

4. Summary of Training Requirements

4.1. Development and Evaluation of Core Competencies

Training and requirements for CCT address the 6 general competencies promulgated by the ACGME/ABMS 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 core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 1 delineates each of the 6 competency domains, as well as their associated curricular milestones for training in CCT. The milestones are categorized into Level I and Level II (as previously defined in this document) and indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Given that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may also vary. Level I competencies may be achieved at earlier or later time points. Acquisition of Level II skills requires additional training and acquisition of Level III skills requires training in a dedicated CCT program. The table also describes examples of evaluation tools suitable for assessing competence in each domain.

Table 1. Core Competency Components and Curricular Milestones for Training in Cardiovascular Computed Tomography

Medical Knowledge	**Milestones (Months)**			
	12	**24**	**36**	**Add**

1. Know the principles of cardiovascular computed tomographic scanning and the scanning modes.		I		
2. Know the risks and safety measures for cardiovascular computed tomographic scanning, including radiation reduction strategies.			I	
3. Know the appropriate indications for cardiovascular computed tomography for screening or evaluating symptoms in patients with suspected cardiac disease.		I		
4. Know the indications, potential adverse effects, prevention, and treatment of complications of iodinated contrast agent use in cardiovascular computed tomographic studies.		I		
5. Know the indications and protocols for beta-adrenergic blocking drugs and nitroglycerin during cardiovascular computed tomographic studies.			II	
6. Know the principles of cardiovascular computed tomographic scan collimation, temporal resolution, table speed, field of view, and window and level view settings.			II	
7. Know the principles of post-processing methods for cardiovascular computed tomographic scanning.			II	
8. Know the algorithms used for reconstruction, and recognize and isolate causes of artifacts.			II	
9. Know the principles of quantitative coronary artery calcium scoring.			II	
10. Know normal chest anatomy and common incidental extra cardiac findings.			II	
11. Know the characteristic cardiovascular computed tomographic images of normal cardiac chambers and great vessels, normal coronary arteries and veins, and normal variants.			I	
12. Know the characteristic cardiovascular computed tomographic findings of coronary atherosclerosis including plaque morphology and assessment of stenosis severity.			II	
13. Know the characteristic cardiovascular computed tomographic findings of anomalous coronary arteries and other common congenital anomalies.			II	
14. Know the characteristic cardiovascular computed tomographic findings in postoperative cardiac surgical patients including internal mammary artery and saphenous vein bypass grafts.			II	
15. Know the characteristic cardiovascular computed tomographic findings of acquired and congenital valvular disease.			II	
16. Know the characteristic cardiovascular computed tomographic findings of left atrial and pulmonary and coronary venous abnormalities.			II	
17. Know the characteristic cardiovascular computed tomographic findings of pericardial disease.			II	
18. Know the characteristic cardiovascular computed tomographic findings of cardiomyopathies and infiltrative myocardial diseases.			II	
19. Know the differential diagnosis of cardiac masses identified by cardiovascular computed tomography.			II	
20. Know the characteristic cardiovascular computed tomographic findings of common diseases of the aorta and great vessels.			II	
21. Know the characteristic cardiovascular computed tomographic findings of pulmonary embolism and primary and acquired pulmonary vascular diseases.			II	
22. Know when to request help with interpretation of difficult studies, such as patients with complex congenital heart disease.			I	
***Evaluation Tools*:** conference presentation, direct observation, in-training exam				

Patient Care and Procedural Skills	12	24	36	Add
1. Skill to appropriately utilize cardiovascular computed tomography in the evaluation and management of patients with known or suspected cardiovascular disease.			I	
2. Skill to integrate cardiovascular computed tomographic findings with other clinical information in patient evaluation and management.			I	
3. Skill to recognize and treat contrast-related adverse reactions.	I			
4. Skill to independently perform and interpret cardiovascular computed tomography.			II	
5. Skill to perform and interpret hybrid CT/SPECT and CT/PET imaging.				III
***Evaluation Tools*: conference presentation, direct observation, logbook**				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Incorporate appropriate use criteria, risk/benefit, and cost considerations in the use of cardiovascular computed tomography and alternative imaging modalities.		I		
***Evaluation Tools*:** conference presentation, direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.			I	
2. Utilize point-of-care educational resources (e.g., guidelines, appropriate use criteria, and clinical trial results).			I	
***Evaluation Tools*:** conference presentation, direct observation, reflection and self-assessment				
Professionalism	**12**	**24**	**36**	**Add**
1. Work effectively in an interdisciplinary CCT environment.		I		
2. Reliably obtain patient informed consent, ensuring that patients understand the risks and benefits of, and alternatives to, cardiovascular computed tomographic testing.		I		
3. Know and promote adherence to clinical practice guidelines.		I		
Evaluation Tools: conference presentation, direct observation, multisource evaluation				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate testing results to physicians and patients in an effective and timely manner.		I		
***Evaluation Tools*:** direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

4.2. Number of Procedures and Duration of Training

The specific competencies for Levels I and II are delineated in Table 1. The minimum volume of procedures typically required to achieve competence at each level of training in CCT is summarized in Table 2.

Table 2. Requirements for CCT Study Performance and Interpretation to Achieve Level I and Level II Clinical Competence

	Minimum Number of Mentored Examinations Present During Performance	Minimum Number of Mentored Examinations Interpreted
Level I	15	50
Level II	65	250 CCT cases*

*Cumulative numbers; caseload recommendations may include studies from an established teaching file, previous CCT cases, journals and/or textbooks, and electronic/on-line courses/continuing medical education.

Although approximate numbers of procedures are listed, it is more important to assess achievement by evaluation of outcome measures. Requirements for Level II training may be satisfied, for example, by supervised time, courses, case studies, CD/DVD training, participation in major medical meetings devoted to CCT, or other relevant educational training activities. The caseload recommendations may include studies from an established teaching file, previous CCT cases, and electronic/online learning tools or courses.

4.2.1. Level I Training Requirements

Level I training is the minimal introductory experience necessary to gain familiarity with CCT but does not provide sufficient competence for independent interpretation of CCT images. The trainee should obtain intensive exposure to the methodology and multiple applications of CCT for approximately 1 month. This exposure may occur in conjunction with other training activities. During this cumulative experience, individuals should be actively involved in CCT interpretation under the direction of a qualified (at minimum Level II, but preferably Level III–trained) physician-mentor (1). There should be a mentored interpretative experience of at least 50 studies for which other correlative cardiovascular imaging data are also available. Mentored interpretive experience may include studies from an established teaching file of CCT cases, CD/DVD, and on-line training.

For all levels of competence, the trainee should attend lectures on the basic concepts of CCT and, in parallel, utilize self-study reading material. A basic understanding of CCT includes the physics of CCT imaging; basics of CCT scan acquisition; safety issues; recognition and management of side effects of medications administered in the course of CCT, including beta-blockers and nitrates in addition to iodinated contrast; post-processing methods; and basics of CCT interpretation compared with other cardiovascular imaging modalities, including echocardiography, nuclear cardiology, cardiovascular magnetic resonance, and invasive cardiovascular x-ray angiography. Ancillary cardiac diagnostic studies should evaluate ventricular hypertrophy; dilation; valvular pathology such as mitral stenosis/annular and leaflet calcification; cardiac masses; aortic valve pathology (number of cusps, calcification and stenosis); pericardial and infiltrative myocardial diseases; internal mammary arteries; left atrial, pulmonary, and coronary venous abnormalities; thoracic aortic pathology; and saphenous vein grafts.

4.2.2. Level II Training Requirements

Level II training is defined as the minimum experience necessary for a physician to independently perform and interpret CCT. To accomplish this, the fellow should devote an additional 1 month or equivalent and interpret a minimum of 200 additional contrast studies. Non-contrast and contrast-enhanced studies may be evaluated in the same patients. Of these, at least 65 should be performed with the fellow present under appropriate supervision. Competence at this level implies that the fellow is sufficiently experienced to help acquire, if necessary, and interpret the CCT examination accurately and independently. Continued exposure to special CCT procedures, such as hybrid studies with nuclear imaging and integration of images into electrophysiologic procedures, is appropriate during Level II training.

To qualify for Level II certification, the trainee should be exposed to an additional 200 cases, demonstrate competency for independent performance and interpretation, and meet the following components:

1. The trainee must be present in the scanning suite control room and actively participate in the acquisition of 50 cases.
2. A trainee may view a maximum of 50 cases from an educational CD or presentation granting continuing medical education credit that contains CCT data review, clinical information, and appropriate clinical correlative information (e.g., invasive coronary angiographic images).
3. At least 150 cases must involve interactive manipulation of reconstructed data sets using a 3-dimensional imaging workstation.
4. At least 20 cases must include evaluation of cardiac function.
5. At least 20 cases should involve evaluation of structural and/or congenital heart disease.
6. At least 15 cases must involve evaluation of bypass graft vessels.
7. At least 40 cases should be correlated with invasive angiography and/or myocardial perfusion imaging.
8. In at least 50 cases, the trainee should be actively involved and demonstrate competency in acquisition, interpretation, and reporting of CCT images.

A fellow with Level II training should demonstrate a clear understanding of the various types of CCT scanners available for cardiovascular imaging and understand, at a minimum, common issues related to imaging, post-processing, and scan interpretation.

4.2.2.1. Incidental Noncardiac Findings

During a CCT examination, the standard use of a small field of view (e.g., limited lung fields) precludes complete evaluation of the entire thorax. To address the possibility that significant noncardiac imaging findings, (e.g., aortic disease, hilar adenopathy, large pulmonary nodules, pulmonary emboli) might be present on a CCT scan, specific interpretation of the extracardiac fields should be performed as discussed below. The patient, referring physician, and trainee should understand that the focus of the CCT examination is the detection of cardiac disease, and that the scan does not encompass the entire lung field. Fellows should be trained to recognize incidental findings in the interest of providing high-quality care. Cases in which these extracardiac findings are identified require referral to a specialist with expertise in chest imaging. To this end, Level II and Level III training should encompass review of all cardiovascular cases for noncardiac findings. The review of 150 CCT cases for incidental findings should include studying a dedicated teaching file of CCT cases featuring significant extracardiac pathology, and the core curricula for Level II and Level III should include specific didactic training in the extracardiac pathology often encountered during diagnostic CCT.

4.2.3. Level III Training Requirements

Level III training enables a physician to direct an academic CCT section, independent CCT facility, or clinic. This individual would be responsible for quality control and training technologists and mentoring other physicians in training. In addition to the requirements for Level I and Level II training, Level III training requires training devoted to CCT, beyond the standard 3-year cardiovascular fellowship, and training in at least 1 other imaging modality, since Level III training in any noninvasive modality requires training in more than 1 noninvasive imaging modality. Level III trainees in CCT should be involved in the acquisition and interpretation of imaging examinations and demonstrate the ability to over-read CCT studies independently. Level III training should include participation in research, teaching, and the administrative aspects of laboratory operations, including data management, report generation and distribution, quality improvement, and accreditation as well as development of an understanding of evolving multimodality imaging technologies.

4.2.4. Training in Multiple Imaging Modalities

The recent emergence of noninvasive imaging modalities, especially cardiovascular magnetic resonance and computed tomography angiography, is having a profound impact on the practice of cardiology and the fellowship training experience. The cardiovascular medicine specialist is increasingly expected to provide expertise in 2 or more of the imaging techniques. It is understandable, then, that trainees will desire the opportunity to gain exposure to multiple imaging modalities during their fellowship experience. To the degree possible, the training program should strive to meet these needs by offering a "multimodality" imaging experience (see "COCATS 4 Task Force 4: training in multimodality imaging"). This might include an appreciation for each technique's uses and clinical indications, strengths and limitations, safety issues, and the relevant guidelines and appropriateness criteria, when available.

4.2.5. Vascular CT Imaging

Vascular computed tomography represents an optional portion of training. As a cardiovascular specialist, the cardiovascular fellow should acquire skills beyond those pertaining to cardiac structure and the coronary vasculature. Among the advantages of newer MDCT equipment is its capacity for very rapid imaging of the carotid, renal, or peripheral vessels with small contrast requirements and high spatial resolution. The physics, acquisition parameters, and reconstruction techniques are similar, but vascular imaging requires additional knowledge of the anatomy and pathophysiology specific to each vascular territory. Level I, II, or III CCT training does not imply that trainees have acquired the vascular imaging expertise associated with the corresponding levels of CCT training.

5. Evaluation of Competency

Evaluation tools in CCT include direct observation by instructors, in-training exams, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, simulation, and reflection and self-assessment. Acquisition and interpretive skills should be evaluated in every trainee. Interaction with other physicians, patients, and laboratory support staff; initiative; reliability; decisions or actions that result in clinical error; and the ability to make appropriate decisions independently and follow-up appropriately should be considered in these assessments. Trainees should maintain records of participation and advancement in the form of a Health Insurance Portability and Accountability Act (HIPAA)-compliant electronic database or logbook that meets ACGME reporting standards and summarizes pertinent clinical information (e.g., number of cases, diversity of referral sources, testing modalities, diagnoses and findings). The use of cardiovascular magnetic resonance should be aligned with both clinical need and appropriateness criteria. Trainees should be prepared to explain why a given CCT test is better suited to the clinical question than is another imaging option. Fellows should document clinical correlation with the other imaging; and with hemodynamic, invasive laboratory, surgical pathology, and outcomes data to enhance understanding of the diagnostic utility and value of various studies. Finally, experiences in CCT should be assessed against measures of quality with regard to test selection, performance, interpretation, and reporting in the interest of appreciating the potential adverse consequences of suboptimal testing (2).

The ACC, American Heart Association, and SCCT have formulated a clinical competence statement on the performance, interpretation, and reporting of CCT studies (5). Self-assessment programs and competence examinations in CCT are available through the ACC and other organizations. Program directors and trainees are encouraged to incorporate these resources in the course of training. We strongly encourage the use of examinations (e.g., the Cardiac Computed Tomography Self-Assessment Program[CCTSAP]) at the end of CCT training.

Under the aegis of the program director and director of each imaging laboratory, facility, or program, the 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.

Key Words: ACC Training Statement ■ COCATS ■ cardiovascular computed tomography ■ cardiovascular imaging ■ cardiovascular magnetic resonance ■ positron emission tomography ■ single-photon emission computed tomography.

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHERS ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 7: TRAINING IN CARDIOVASCULAR COMPUTED TOMOGRAPHY

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF7_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELEVANT RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES—COCATS 4 TASK FORCE 7: TRAINING IN CARDIOVASCULAR COMPUTED TOMOGRAPHY

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ACC = American College of Cardiology, AHA = American Heart Association, ASNC = American Society of Nuclear Cardiology, SAIP = Society of Atherosclerosis Imaging and Prevention, SCAI = Society for Cardiovascular Angiography and Interventions, and SCCT = Society of Cardiovascular Computed Tomography.

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

CCT = cardiovascular computed tomography

COCATS = Core Cardiovascular Training Statement

HIPAA = Health Insurance Portability and Accountability Act

PET = positron emission tomography

SAIP = Society of Atherosclerosis Imaging and Prevention

SCCT = Society of Cardiovascular Computed Tomography

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COCATS 4 Task Force 8: Training in Cardiovascular Magnetic Resonance Imaging[10]

Endorsed by the Society for Cardiovascular Magnetic Resonance

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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The Writing Committee was selected to represent the American College of Cardiology (ACC) and the Society for Cardiovascular Magnetic Resonance (SCMR) and included a cardiovascular training program director, a cardiovascular magnetic resonance (CMR) training program director, early-career experts, highly experienced specialists representing both the academic and community-based practice settings, and physicians experienced in defining and applying training standards according to the 6 general competency domains promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialties (ABMS) and endorsed by the American Board of Internal Medicine (ABIM). The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiovascular training statement. Employment and affiliation details for authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF8_Comprehensive_RWI_Supplement.pdf).

1.1.2. Document Development and Approval

The Writing Committee developed the document, approved it for review by individuals selected by the ACC and SCMR, and then addressed the reviewers' comments. The document was revised and posted for

[10] The American College of Cardiology requests that this document be cited as follows: Kramer CM, Hundley WG, Kwong RY, Martinez MW, Raman SV, Ward RP. COCATS 4 task force 8: training in cardiovascular magnetic resonance imaging. J Am Coll Cardiol. 2015;●●:●●●●–●●●●.

public comment from December 20, 2015 to January 6, 2015. Authors addressed these additional comments from the public to complete the document. The final document was approved by the Task Force, COCATS Steering Committee, and ACC Competency Management Committee and was ratified by the ACC Board of Trustees and endorsed by the SCMR in March 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

The Task Force was charged with updating previously published standards for training fellows in clinical cardiology enrolled in ACGME-certified fellowship (1) on the basis of: 1) changes in the field since 2008;; and 2) the evolving framework of competency-based medical education described by the ACGME Outcomes Project and the 6 general competencies endorsed by ACGME and American Board of Medical Specialties. The updating effort was also convened as part of a broader effort to establish consistent training criteria across all aspects of cardiology. The background and overarching principles governing fellowship training are provided in the Introduction to COCATS, and readers should become familiar with this foundation before considering the details of training in a subdiscipline like CMR. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally.

CMR, one of the newest cardiovascular imaging modalities, often provides useful and unique information with which all cardiologists should be conversant. Accordingly, all standard 3-year cardiovascular trainees should receive training that would provide at least a basic understanding of the methods and utility of CMR in the practice of cardiology. To provide fellows with different levels of interest in CMR with such an understanding, training in CMR should be provided at 3 levels—basic, specialized, and advanced, as described below.

For most areas of adult cardiovascular medicine, 3 levels of training are delineated:

Level I training is the basic training required of all trainees to become competent consultant cardiologists and must be accomplished during a standard 3-year training program in cardiology.

Level II training refers to the additional training in 1 or more areas that enables some cardiologists to perform or interpret specific procedures or render more specialized care for specific patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training in selected areas may be achieved by some trainees during the standard 3-year cardiovascular fellowship, depending on the trainees' career goals and use of elective rotations. It is anticipated that during a standard 3-year cardiovascular fellowship training program, sufficient time will be available to receive Level II training in a specific subspecialty. In the case of CMR, Level II training is required for individuals who wish to perform and interpret CMR examinations as part of their practice of cardiovascular medicine.

Level III training requires additional training and experience beyond the standard 3-year cardiovascular fellowship to acquire specialized knowledge and competencies in performing, interpreting, and training others to perform specific procedures or render advanced specialized care at a high level of skill. In the case of CMR, Level III training would enable the trainee to direct a CMR laboratory or train others in CMR. As for other noninvasive imaging modalities, Level III training in CMR requires training in multimodality imaging (see “COCATS Task Force 4: training in multimodality imaging”). Level III training is described here only in broad terms to provide context for trainees. The additional exposure and requirements for Level III training will be addressed in a subsequent, separately published in Advanced Training Statement.

The number of cases, procedures, and experiences recommended is based on published guidelines, competency statements (2), and the opinions of the members of the writing group. It is assumed that training is directed by appropriately trained mentors in an ACGME-accredited program and that satisfactory completion of training is documented by the program director. The number and types of encounters and the duration of training required for trainees are summarized in Section 4.

2. General Standards

Three organizations—the ACC, the American College of Radiology, and the SCMR—have addressed training requirements for CMR (2-4). The recommendations address faculty, facility requirements, emerging technologies, and practice. We strongly recommend that candidates for certification in cardiovascular diseases, as well as those seeking certification of subspecialty qualification in CMR, review the specific requirements of other organizations.

Cardiovascular fellowship programs should satisfy the requirements regarding facilities and faculty for training in CMR. Eligibility for supplemental subspecialty CMR examination training requires that training take place in a cardiovascular disease program accredited by the ACGME. The intensity of training and required resources vary according to the levels of certification desired.

An examination of core competency in CMR is currently under development by the CMR Exam Board in collaboration with SCMR. This group is under agreement to develop the exam with the Council for Certification in Cardiovascular Imaging which comprises the former certification boards for nuclear cardiology and computed tomography. Thus, examinations for 3 of the 4 imaging modalities will be housed within the same organization.

2.1. Faculty

CMR training faculty should include specialists who are skilled in CMR image acquisition, interpretation, and reporting and are knowledgeable about the risks to the patient and medical personnel associated with magnetic resonance procedures. There should be at least 1 key clinical CMR faculty member with Level II or (preferably) Level III certification in CMR. Occasionally, a Level II- or III-trained CMR mentor will not be available in the institution housing the standard 3-year fellowship program but will be available at a nearby nonacademic medical center accredited for CMR by an organization such as the Intersocietal Accreditation Commission for Magnetic Resonance Imaging (IAC MRI). Under these circumstances, it is acceptable to provide all levels of CMR training at such a medical center.

2.2. Facilities

This training should generally be acquired through the ACGME—an approved cardiovascular or radiology program with expertise in CMR and under the aegis of a Level II- or (preferably) a Level III-qualified mentor in a laboratory accredited by an organization such as the IAC MRI. Facilities should be adequate to ensure a safe and effective environment for the performance of diagnostic CMR procedures.

2.3. Equipment

CMR laboratories require not only the magnet, but also specialized equipment for the safe monitoring and performance of diagnostic procedures, particularly stress testing. This MR safe equipment may include monitoring and recording systems, power injectors for administering contrast, and systems to provide inhalational as well as intravenous medications.

2.4. Ancillary Support

Ancillary support should be available to perform the CMR procedures, including those trained in general anesthesia for those centers performing procedures under high levels of sedation.

3. Training Components

3.1. Didactic Program

Lectures and self-study in CMR: Didactic training consists of lectures on the basic aspects of CMR and parallel reading material comprising selected articles, digital training programs, or CMR text. The lectures and reading should provide the fellow with a basic understanding of CMR imaging techniques (Table 1) and applications (Table 2). Specificity, sensitivity, diagnostic accuracy, utility in assessing prognosis, costs, appropriate use criteria, artifacts, indications, contraindications, and pitfalls must be included for each cardiovascular diagnostic subset. Such information could be effectively transmitted within a weekly noninvasive or clinical teaching conference during which CMR data are presented. Mentored interpretation of CMR studies should be coupled with comparison and integration of CMR results with other relevant clinical, imaging, and laboratory test results.

Table 1. Classification of Basic Cardiovascular Magnetic Resonance Techniques

Morphologic Imaging
Still-frame imaging (black or bright blood)
Systolic and Diastolic Function Imaging
Cine imaging
Cine myocardial tagging or equivalent for quantitative regional strain
Blood Flow Imaging
Velocity-encoded phase contrast imaging
Stress Testing
First-pass myocardial perfusion imaging during pharmacologic stress and at rest
Cine imaging of left ventricular structure/function with exercise or dobutamine
Myocardial Tissue Characterization
Late gadolinium enhancement (LGE) imaging for myocardial infarction, fibrosis, or infiltration
T2-weighted imaging for myocardial edema/inflammation/injury
Myocardial T2* myocardial iron content imaging
Quantitative tissue mapping (T1 and/or T2)
Angiography
Magnetic resonance coronary angiography
Left atrial and pulmonary vein magnetic resonance angiography
Magnetic resonance angiography of the aorta, peripheral arteries, and venous system

LGE = late gadolinium enhancement.

Table 2. Classification of Common Cardiovascular Magnetic Resonance Applications

CMR Study Indications	Cardiac Features of Interests	Key CMR techniques
Myocardial Viability	• Left ventricular function • Infarct transmurality for recovery of	• Cine imaging • LGE imaging

	systolic function • Contractile reserve of heart function	• Cine imaging with low-dose dobutamine
Myocardial ischemia	• Left ventricular function • Presence and extent of ischemia • Presence and extent of infarction	• Cine imaging • Either cine imaging during dobutamine or exercise, or myocardial perfusion imaging during vasodilator stress and at rest • LGE imaging
Acute myocardial infarction	• Left and right ventricular function • Myocardial edema • Infarct size and microvascular obstruction • Imaging of complications (e.g., ventricular septal defect, pericardial disease, acute mitral regurgitation)	• Cine imaging • T2-weighted imaging • LGE imaging • Cine imaging, still-frame imaging (black or bright blood), velocity-encoded imaging
Detecting acute coronary syndrome or determining other causes of myocardial injury	• Left and right ventricular function • Myocardial edema/inflammation • Presence and extent of ischemia • Myocardial infarction and myocarditis	• Cine imaging • T2-weighted imaging • Myocardial perfusion imaging at rest and during vasodilator stress • LGE imaging
Assessing cardiomyopathy or new-onset heart failure of unknown cause	• Left and right ventricular function • Myocardial edema • Myocardial iron content • Myocardial fibrosis • Myocardial blood flow • Myocardial infarction or infiltration	• Cine imaging • T2-weighted imaging • T2*imaging • Quantitative tissue mapping (T1 and/or T2) • Myocardial perfusion imaging at rest • LGE imaging
Pericardial disease	• Left and right ventricular function • Ventricular interdependence • Pericardial thickening • Pericardial inflammation • Pericardial adhesions	• Cine imaging • Real-time cine imaging • Still-frame imaging (black or bright blood) • LGE imaging • Cine myocardial tagging
Valvular heart disease	• Left and right ventricular function • Flow volume and velocity across valves • Great vessel anatomy (e.g. aorta for bicuspid aortic valve)	• Cine imaging (including real-time imaging) • Velocity-encoded imaging • Still-frame imaging (black or bright blood) and/or MR angiography
Cardiac Mass/Thrombus	• Location, size, attachment, and motion • Tissue characteristics • Vascularity and fibrotic contents • Tumor necrosis and suspected thrombus	• Cine imaging • T1, T2W black blood imaging without and with fat saturation • First-pass perfusion imaging at rest and T1-W imaging pre- and post-contrast • LGE imaging
Left atrial mapping and pulmonary vein ablation	• Left and right ventricular function • Left atrial volume and pulmonary venous anatomy	• Cine imaging • MR angiography of the left atrium
Congenital heart disease	• Left and right ventricular function • Great vessel anatomy • Anomalous coronary artery anatomy • Flow volume and velocity across heart valves and shunt ratio • Myocardial fibrosis	• Cine imaging • MR angiography of the great vessels • MR coronary angiography • Velocity-encoded imaging • LGE imaging

Aorta and peripheral artery disease	• Aortic anatomy (intramural hematoma, dissection, coarctation, aneurysm) • Anatomy of peripheral arterial stenosis • Severity of peripheral artery stenosis • Anatomy of venous system	• T1, T2W black blood imaging • MR angiography • Velocity-encoded imaging

CMR = cardiovascular magnetic resonance; LGE = late gadolinium enhancement; MR = magnetic resonance.

Additional training should include an understanding of 1) sources of artifacts, including motion, arrhythmias, and metal objects; 2) the safety of implanted devices (e.g., pacemakers, automatic implantable cardioverter-defibrillators), external ferromagnetic devices, and gadolinium-based contrast agents (for a summary of safety issues in CMR, see www.mrisafety.com); 3) basic post-processing approaches and analyses; 4) noncardiac incidental findings and an approach to their recognition; and 5) Appropriate Use Criteria as they relate to CMR.

Trainees should receive didactic lectures from CMR faculty and/or physicists on the basic physics of MR in general and physics that relates to CMR and patients with cardiovascular disease in particular. The content should include the materials noted in Table 3. These lectures may be web-based, if available.

Table 3. Classification of Basic Cardiovascular Magnetic Resonance Physics Principles

Image Contrast T1, T2, Proton-density, T2*
Image Formation k-space, gradient echo, spin echo, fast spin echo, spiral, steady-state free precession, and parallel imaging
Pulse Sequence Parameters Slice selection, frequency and phase encoding, flip angle, repetition time, echo time, field of view, matrix
Hardware Field strength, gradient coil design, receiver coils, and digital sampling
Specialized Sequences T1 and T2-mapping, velocity encoded imaging, non-contrast and contrast angiography, strain imaging, dark blood preparation, T2 preparation, saturation recovery perfusion, inversion recovery gradient echo, phase sensitive inversion recovery, fat-water separation
Contrast Agents Gadolinium-based agents, iron-based agents
Image Acquisition Parameters Electrocardiography gating, peripheral pulse gating, breath-holding, navigator sequences

3.2. Clinical Experience

Level I training should include exposure to the methods and applications of CMR for a period of not less than 1 month or its equivalent when integrated with other training activities. During the 1 month of training, the trainee should actively participate in daily CMR study interpretation under the direction of

CMR faculty. Studies should incorporate the range of techniques and procedures listed in Tables 1 and 2, including exposure to a minimum of 25 cases, some of which may come from an established CMR teaching file.

3.3. Hands-On Experience

Hands-on experience is not necessary for Level I training but is an integral part of Level II training, as discussed above. The trainee should take an active role in planning and implementing protocol decision making.

4. Summary of Training Requirements

4.1. Development and Evaluation of Core Competencies

Training and requirements for CMR address the 6 general competencies promulgated by the ACGME/ABMS 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 core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 4 delineates each of the 6 competency domains as well as their associated curricular milestones for training in CMR. The milestones are categorized as Level I, Level II, or Level III training (as previously defined in this document) and indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular disease trainee should achieve the designated level. Given that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may also vary. Level I competencies may be achieved at earlier or later time points. Acquisition of Level II skills requires additional training that can usually be obtained during elective time in the standard 3-year cardiovascular fellowship, whereas Level III skills require an additional period of training in a dedicated CMR program beyond the cardiovascular fellowship. The table also describes examples of evaluation tools suitable for assessing competence in each domain.

Table 4. Core Competency Components and Curricular Milestones for Training in Cardiovascular Magnetic Resonance

Medical Knowledge	Milestones (Months)			
	12	24	36	Add
1. Know the principles of cardiovascular magnetic resonance image acquisition.		I		
2. Know the principles of safety and contraindications for cardiovascular magnetic resonance imaging.	I			
3. Know the uses, potential side effects, and contraindications of using gadolinium-based contrast agents in cardiovascular magnetic resonance imaging.	I			
4. Know the indications for cardiovascular magnetic resonance to assess left and right heart chamber sizes and function.		I		
5. Know the cardiovascular magnetic resonance indications for assessment of myocardial viability.		I		
6. Know the cardiovascular magnetic resonance indications and characteristic findings of myocardial ischemia.		I		
7. Know the cardiovascular magnetic resonance indications and characteristic findings of acute myocardial infarction.		I		
8. Know the cardiovascular magnetic resonance indications and characteristic findings of acute coronary syndromes and other causes of myocardial injury.		I		
9. Know the cardiovascular magnetic resonance indications and differential findings in cardiomyopathies of uncertain cause.		I		
10. Know the cardiovascular magnetic resonance indications to assess diseases of the pericardium.		I		
11. Know the cardiovascular magnetic resonance indications to evaluate valvular heart disease.		I		
12. Know the cardiovascular magnetic resonance indications and characteristic findings of myocardial masses and thrombi.			I	
13. Know the cardiovascular magnetic resonance indications for left atrial and pulmonary vein mapping prior to ablation of atrial fibrillation.		I		
14. Know the cardiovascular magnetic resonance indications for evaluation of adult congenital heart disease including identification of coronary artery anomalies.			I	
15. Know the cardiovascular magnetic resonance indications to detect and evaluate diseases of the aorta and peripheral arteries.			I	
Evaluation Tools: conference presentation, direct observation, in-training exam				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to appropriately order and integrate the results of cardiovascular magnetic resonance testing with other clinical findings in the evaluation and management of patients.			I	
2. Skill to interpret cardiovascular magnetic resonance tissue characterization (late gadolinium enhancement) to distinguish the etiology of cardiomyopathy and acute myocardial injury.			I	
3. Skill to interpret regional and global left and right ventricular wall motion and ejection fraction.			II	
4. Skill to interpret vascular diseases of the aorta (e.g., intramural hematoma, dissection, coarctation, and aneurysm).			II	
5. Skill to identify and characterize myocardial masses.			II	
6. Skill to identify and characterize pericardial disease.			II	
7. Skill to identify and diagnose basic congenital heart disease in adults.			II	
8. Skill to identify and diagnose complex adult congenital heart disease, including quantification of intracardiac shunting, and anomalous coronary arteries.			II	
9. Skill to perform and interpret cardiovascular magnetic resonance stress testing.			II	
10. Skill to interpret vascular diseases of the peripheral arteries.				III
Evaluation Tools**:** conference presentation, direct observation, logbook				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Incorporate risk/benefit and cost considerations in the use of cardiovascular		I		

magnetic resonance testing.				
2. Participate in cardiovascular magnetic resonance quality monitoring and initiatives.			II	
***Evaluation Tools*:** chart-stimulated recall, conference presentations, direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.			I	
Evaluation Tools: chart-stimulated recall, conference presentations, direct observation, reflection and self-assessment				
Professionalism	**12**	**24**	**36**	**Add**
1. Practice within the scope of expertise and technical skills.			I	
2. Know and promote adherence to guidelines and appropriate use criteria.		I		
***Evaluation Tools*:** chart-stimulated recall, conference presentations, direct observation, multisource evaluation				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate testing results to physicians and patients in an effective and timely manner.		II		
Evaluation Tools: direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

4.2. Number of Cases and Duration of Training

Although the training duration and numbers of procedures stated above are typically required to obtain competency, there must also be demonstration of achievement of the competencies as assessed by the outcomes evaluation measures.

4.2.1. Level I Training Requirements

Level I training should be required of all 3-year cardiovascular fellows and includes exposure to the methods and the applications of CMR (Tables 1 and 2) for a period of not less than 1 month or its equivalent when integrated with other training activities. This experience should provide basic background knowledge in CMR sufficient for the practice of adult cardiology and appropriate referral for CMR evaluation, and for report interpretation, but not for the practice or independent clinical interpretation of CMR. It is expected that trainees will be exposed to at least 25 mentored cases. As a practical matter, many fellowship programs in cardiovascular medicine may not be able to fulfill CMR training requirements. In these instances, fellows should be encouraged to obtain experience in an alternate program with appropriate training and accreditation in the performance of CMR studies.

4.2.2. Level II Training Requirements

Level II is for trainees who wish to practice the clinical subspecialty of CMR, including independent interpretation of CMR studies. Level II trainees must have at least 3 months of dedicated CMR training (where 1 month is defined as 4 weeks and 1 week is defined as 35 hours), including familiarity with the CMR techniques and applications listed in Tables 1 and 2, respectively. In addition to Level I requirements, the Level II trainee should have a clear understanding of CMR physics and how it relates to image acquisition, sequence building, and troubleshooting through formal CMR physics lectures when possible. These lectures should include the topics listed in Table 3 and may be web-based, if this is available.

During the 3 or more months of experience necessary to develop Level II competence, trainees should actively participate in daily CMR study interpretation under the direction of Level II or (preferably) Level III CMR faculty. In addition to Level I requirements, the trainee should interpret at least 150 CMR examinations during this training period, including 50 for which the trainee is present during the scanning procedure, directs the imaging acquisition, and serves as the primary interpreter. Up to 50 of the 100 examinations for which the trainee is not the primary interpreter can be derived from established teaching files, journals and/or textbooks, or electronic/online courses. Careful documentation of all case material and the details of the way in which the case was derived are essential. For all studies in which other cardiac imaging data are available, such information should be correlated with CMR data. Rather than seeking a certain number of case experiences, trainees should seek competency in performing and managing CMR.

4.2.3. Training in Multiple Imaging Modalities

The cardiovascular medicine specialist is increasingly expected to provide expertise in 2 or more of the noninvasive cardiovascular imaging techniques. It is understandable, then, that trainees will desire the opportunity to gain exposure to multiple imaging modalities during their fellowship experience. To the degree possible, the training program should strive to meet these needs by offering a “multimodality” imaging experience (see “COCATS 4 Task Force 4: training in multimodality imaging”). This might include an appreciation for each technique’s uses and indications, strengths and limitations, safety issues, and relevant guidelines and appropriateness criteria, when available.

4.2.4. Level III Training Requirements

Level III training enables a physician to direct an academic CMR section, independent CMR facility, or CMR clinic. This individual would be responsible for quality control, and training technologists, and mentoring other physicians in training. In addition to the requirements for Level I and Level II training, Level III training requires training devoted to CMR beyond the standard 3-year cardiovascular fellowship, and training in at least 1 other imaging modality, since Level III training in any noninvasive modality requires training in more than 1 noninvasive imaging modality. Level III trainees in CMR should be involved in the acquisition and interpretation of imaging examinations and demonstrate the ability to over-read CMR studies independently. Level III training should include participation in research, teaching, and the administrative aspects of laboratory operations, including data management, report generation and distribution, quality improvement, accreditation, and understanding of evolving multimodality imaging technologies.

5. Evaluation of Competency

Evaluation tools in CMR include direct observation by instructors, in-training exams, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, simulation, and reflection and self-assessment. Acquisition and interpretive skills should be evaluated in every trainee. Interaction with other physicians, patients, and laboratory support staff; initiative; reliability; decisions or actions that result in clinical error; and the ability to make appropriate decisions independently and follow-up appropriately should be considered in these assessments. Trainees should maintain records of participation and advancement in the form of a Health Insurance Portability and Accountability Act (HIPAA)-compliant electronic database or logbook that meets ACGME reporting standards and summarizes pertinent clinical information (e.g., number of cases, diversity of referral sources, testing modalities, diagnoses and findings). The use of CMR should be aligned with both clinical need and appropriateness criteria. Trainees should be prepared to explain why a given CMR test is better suited to the clinical question than is another imaging option. Fellows should document clinical correlation with the other imaging, hemodynamic, invasive laboratory, surgical pathology, and outcomes data to enhance their understanding of the diagnostic utility and value of various studies. Finally, experiences in CMR should be assessed against measures of quality with regard to test selection, performance, interpretation, and reporting in the interest of appreciating the potential adverse consequences of suboptimal testing (5-7).

The ACC, American Heart Association, and SCMR have formulated a clinical competence statement on the performance, interpretation, and reporting of CMR studies, as well as an expert consensus document (2,8). Program directors and trainees are encouraged to incorporate these resources in the course of training.

Under the aegis of the program director and director of each imaging laboratory, facility, or program, the 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.

Key Words: ACC Training Statement ▪ COCATS ▪ cardiovascular imaging ▪ cardiovascular magnetic resonance ▪ steady-state free precession.

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 8: TRAINING IN CARDIOVASCULAR MAGNETIC RESONANCE IMAGING

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF8_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 8: TRAINING IN CARDIOVASCULAR MAGNETIC RESONANCE IMAGING

Name	Employment	Representation	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
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Dhanunjaya Lakkireddy	Kansas University Cardiovascular Research Institute	Official Reviewer, ACC Board of Governors	None	None	None	None	None	None
Howard Weitz	Thomas Jefferson University Hospital—Director, Division of Cardiology; Sidney Kimmel Medical College at Thomas Jefferson University—Vice Chair, Department of Medicine	Official Reviewer, Competency Management Committee Lead Reviewer	None	None	None	None	None	None
Warren Manning	Beth Israel Deaconess Medical Center, Division of Cardiology—Professor, Medicine and Radiology	Organizational Reviewer, SCMR	None	None	None	None	None	None
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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ACC = American College of Cardiology, SCMR = Society for Cardiovascular Magnetic Resonance.

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

CMR = cardiovascular magnetic resonance

COCATS = Core Cardiovascular Training Statement

HIPAA = Health Insurance Portability and Accountability Act

SCMR = Society for Cardiovascular Magnetic Resonance

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COCATS 4 Task Force 9: Training in Vascular Medicine[11]

Endorsed by the Society for Vascular Medicine

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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The writing committee was selected to represent the American College of Cardiology (ACC), Society for Vascular Medicine (SVM), American Board of Internal Medicine (ABIM), and American Board of Vascular Medicine (ABVM), and included a cardiovascular training program director, a vascular medicine program training director, early-career vascular medicine experts, and highly experienced specialists representing both the academic and community-based practice settings. The committee also included physicians experienced in defining and applying training standards according to the 6 general competency domains promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialties (ABMS) and endorsed by the ABIM. The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiovascular training statement. Employment and affiliation details for authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF9_Comprehensive_RWI_Supplement.pdf).

[11] The American College of Cardiology requests that this document be cited as follows: Creager MA, Gornik HL, Gray BH, Hamburg NM, Iobst WF, Mohler ER, White CJ. COCATS 4 task force 9: training in vascular medicine. J Am Coll Cardiol. 2015;••:••••–••••.

1.1.2. Document Development and Approval

The writing committee developed the document, approved it for review by individuals selected by the ACC and SVM, and then addressed the peer reviewers' comments. The document was revised and posted for public comment from December 20, 2015 to January 6, 2015. Authors addressed the additional comments from the public to complete the document. The final document was approved by the Task Force, COCATS Steering Committee, and ACC Competency Management Committee, and ratified by the ACC Board of Trustees and endorsed by the SVM in March 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

Cardiovascular physicians frequently encounter patients with peripheral vascular diseases. Atherothrombosis, in particular, is a systemic disorder with clinical manifestations in the peripheral circulation. These and other vascular diseases account for substantial cardiovascular morbidity and mortality. Moreover, technological advances in imaging techniques and endovascular therapies have brought the management of vascular diseases firmly into the sphere of the cardiovascular medicine specialist. As part of a broader effort to standardize training criteria for all aspects of cardiovascular medicine, this Task Force was charged with updating previously published adult vascular medicine training guidelines (1, 2) on the basis of changes in the field since 2008. One modification presented by this update is the transferal of the training recommendations on catheter-based peripheral vascular interventions to Task Force 10: Training in Cardiac Catheterization, thus integrating the recommendations with other cardiovascular interventional training components. The Task Force also updated previously published standards to address the evolving framework of competency-based medical education described by the ACGME Outcomes Project and by the 6 general competencies endorsed by ACGME and ABMS. The background and overarching principles governing fellowship training are provided in the Introduction to COCATS, and readers should become familiar with this foundation before considering the details of training in a subdiscipline like vascular medicine. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally.

For most areas of cardiovascular medicine, 3 levels of training are delineated:

Level I training, the basic training required to become a competent cardiovascular consultant, is required of all cardiovascular fellows and can be accomplished as part of a standard 3-year training program in cardiovascular medicine. All cardiovascular fellows should receive basic training in vascular medicine and acquire sufficient knowledge to care for most patients with vascular disease.

Level II training refers to the additional training in 1 or more areas that enables some cardiovascular specialists to perform or interpret specific diagnostic tests and procedures or render more specialized care for patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. 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. It is anticipated that during a standard 3-year cardiovascular fellowship training program, sufficient time will be available for the trainee to receive Level II training in a specific subspecialty. In the case of vascular medicine, Level II training can be elected by fellows seeking additional expertise in interpreting noninvasive diagnostic tests and evaluating and managing patients with peripheral vascular diseases. Level II training is also recommended prior to or in conjunction with training in catheter-based peripheral vascular intervention (see “COCATS 4 Task Force 10: training in cardiac catheterization”).

Level III training requires additional training and experience beyond the cardiovascular fellowship to acquire specialized knowledge and competencies in performing, interpreting, and training others to perform specific procedures or render advanced specialized care at a high level of skill. In the case of vascular medicine, Level III training pertains to advanced knowledge in diagnostic and therapeutic modalities for evaluating and managing vascular disease, and leads to the ability to direct a vascular laboratory, train others, and conduct advanced research in vascular medicine. Level III training is described here only in broad terms to provide context for trainees and clarify that these advanced competencies are not covered during the cardiovascular fellowship. The additional exposure and requirements for Level III training will be addressed in a subsequent, separately published Advanced Training Statement.

The knowledge and competencies recommended at each level of training are based on published guidelines, competency statements, and the experience and opinions of the writing group. It is assumed that training is directed by appropriately trained mentors and that satisfactory completion of training is documented by the program director. The milestones required for each level of training are summarized in Section 4.

2. General Standards

The ACC and the SVM have addressed training requirements and guidelines for vascular medicine training (1, 2). The recommendations are congruent and address faculty, facility requirements, emerging technologies, and clinical practice. We strongly recommend that candidates for the ABIM examination for certification in cardiovascular diseases, as well as those seeking certification from the ABVM, review the specific examination requirements (3). Cardiovascular fellowship programs should satisfy the requirements regarding faculty and facilities for training in vascular medicine (1, 2). The intensity of training and required resources vary according to the level of training provided.

2.1. Faculty and Facilities

2.1.1. Faculty

Trainees should be exposed to individuals with special training in vascular medicine. In some institutions, leadership of the vascular medicine component of training will come from vascular medicine specialists. In other programs, training in vascular medicine will be guided by faculty in other disciplines such as general cardiology, hematology, neurology, vascular surgery, and vascular or interventional radiology. All faculty members responsible for training fellows in vascular medicine should be board certified or board eligible in their subspecialties.

Ideally, faculty will include individuals certified in vascular medicine by the ABVM. Recognizing that this may not be possible at all institutions, cardiovascular fellows may spend time in other departments or divisions to gain the expertise necessary to interpret noninvasive vascular studies and to evaluate and manage patients with vascular disease. Faculty with expertise in disciplines relevant to vascular medicine, such as vascular surgery, vascular radiology, hematology, neurology, dermatology, and rheumatology, play important roles in training cardiovascular fellows. Faculty should provide didactic and practical education to fellows and deliver appropriate feedback about the performance of trainees.

2.2. Facilities

The training institution should provide comprehensive facilities for the care of patients with vascular disease and include offices for outpatient evaluation and treatment, inpatient vascular consultative services, a noninvasive vascular laboratory accredited by the Intersocietal Accreditation Commission (IAC Vascular Testing Division, formerly ICAVL), facilities for computed tomographic angiography and magnetic resonance angiography, a peripheral vascular catheterization laboratory, and comprehensive vascular surgery and wound care programs (4).

2.3. Equipment

Noninvasive vascular laboratories require dedicated equipment to perform diagnostic studies, including duplex ultrasound units capable of high-resolution B-mode (grayscale) imaging as well as color and spectral Doppler analysis, equipment for physiological testing with appropriately sized cuffs to measure blood pressure at multiple sites in the limbs, Doppler and plethysmographic devices (e.g., pulse volume recordings, photoplethysmographic sensors), and equipment for digital image recording and archiving. Equipment required for cardiovascular computed tomography, cardiovascular magnetic resonance, and catheter-based angiography is discussed in the reports from Task Forces 7, 8, and 10, respectively.

2.4. Ancillary Support

Ancillary support should be available to facilitate appointment scheduling and follow-up; manage clinical and financial records; retrieve laboratory and other clinical reports; enable telephone communications between patients and providers (e-mailing optional); provide clean, prepared examination and consultation rooms; and properly contain, control, and remove medical waste.

3. Training Components

3.1. Didactic Program

3.1.1. Lectures and Conferences

Conferences for Level I training in vascular medicine for cardiovascular fellows should include case presentations and formal lectures that review diagnostic and therapeutic approaches to vascular diseases. Case presentations should illustrate the use of clinical tools, including noninvasive laboratory testing, magnetic resonance, computed tomographic, and catheter-based angiography, and therapeutic approaches for patients with vascular diseases. Lectures should provide information regarding vascular anatomy, pathobiology and pathophysiology; epidemiology and the natural history of peripheral vascular disorders; diagnostic evaluation; perioperative evaluation and management; and therapeutic options, including the risks and benefits of medical, endovascular, and surgical approaches to vascular disease, to complement teaching in the clinic and at the bedside.

In addition to the lectures and case presentations described above for Level I trainees, didactic activities for Level II and III trainees should include a comprehensive longitudinal conference series on vascular topics, including peripheral artery disease; renal artery stenosis; mesenteric vascular disease and extracranial cerebrovascular disease; aneurysmal disease of the aorta and peripheral arteries; vasculitis; vasospastic and temperature-related diseases; venous thromboembolism; chronic venous insufficiency and varicose veins; lymphedema; less-common disorders such as fibromuscular dysplasia and arteriopathies associated with inherited diseases of connective tissue; congenital vascular malformations and arterial entrapment syndromes; leg ulcers; and the preoperative evaluation and perioperative management of patients undergoing vascular surgery. Conferences should also cover the noninvasive vascular laboratory, including principles of vascular physiology, vascular ultrasound imaging and

Doppler flow velocity measurements, ultrasound physics, blood pressure measurement and pulse volume recordings, transducer technology, imaging artifacts, and reviews of the noninvasive evaluation of specific vascular diseases. Lectures and case presentations should cover other vascular imaging modalities such as magnetic resonance and computed tomographic and catheter-based angiography. The lecture series should include regularly scheduled patient safety or quality improvement conferences, journal clubs, or other fora for interactive discussion of the established literature and emerging scientific advances. Interaction with vascular specialists from other disciplines at these conferences is recommended.

3.2. Clinical Experience

Level I trainees should gain experience in vascular disease management in both the inpatient and outpatient settings, assisting in patient care in a manner that provides patient-centered education. It is important that Level I trainees evaluate and manage patients with arterial, venous, and lymphatic disorders. Training in vascular medicine may occur either in dedicated rotations or throughout the cardiovascular clinical training period. During the course of patient-based rotations, Level I trainees should encounter and receive instruction in the bedside evaluation of patients with peripheral (limb) artery disease, renal and mesenteric artery disease, extracranial carotid artery disease, thoracic and abdominal aortic aneurysms, acute aortic syndromes, deep vein thrombosis, pulmonary embolism, and chronic venous insufficiency. Program activity should include appropriate use of vascular diagnostic modalities (physiologic testing, duplex ultrasound imaging, magnetic resonance, and computed tomographic and catheter-based angiography); indications for and use of pharmacotherapy to prevent and treat atherosclerosis, venous thromboembolism, and their risk factors; the role of endovascular and surgical revascularization; assessment of cardiovascular risk; and periprocedural/perioperative management of patients undergoing endovascular procedures and vascular surgery.

Level II training for a cardiovascular specialist concentrating in vascular medicine should include the evaluation and management of patients with vascular disease in both the outpatient clinic and the hospital, extending the skills acquired during Level I training. Level II training must include performance and interpretation of noninvasive vascular tests. Trainees should understand physiological and ultrasound vascular testing and should perform and interpret segmental pressure measurements, pulse volume recordings, and duplex ultrasonography for venous thrombosis, venous insufficiency, peripheral artery disease, abdominal aortic aneurysm, renal and mesenteric artery disease, and carotid artery disease.

Level III training in vascular medicine should provide the knowledge and skills to function as a vascular specialist, including the ability to interpret patients' clinical presentation, plan diagnostic testing, apply clinical and laboratory information, and develop appropriate management plans for patients across the entire range of vascular diseases, including but not limited to peripheral artery disease, renal artery disease, mesenteric vascular disease, extracranial cerebrovascular disease, aneurysmal disease of the aorta and peripheral arteries, vasculitis, venous thromboembolism, chronic venous insufficiency, varicose veins, lymphedema, leg ulcers, and Raynaud's phenomenon and other vasospastic and temperature-related disorders. Trainees should also acquire skills to evaluate patients before and after interventional peripheral vascular procedures.

3.3. Hands-On Experience

Trainees should perform physical examinations and noninvasive vascular testing appropriate to their level of training. Level I trainees should be able perform a complete vascular examination and measure the ankle-brachial index using a hand-held Doppler device, and should become familiar with the interpretation of vascular laboratory reports as they apply to the noninvasive assessment of obstructive arterial and venous thromboembolic diseases affecting the vessels of the lower extremities.

Level II and III trainees should independently perform and interpret arterial physiological studies of the limbs and vascular ultrasound examinations of the veins and arteries of the limbs, abdominal vessels, and extracranial carotid arteries. Additional experience in the vascular laboratory during Level III training may include transcranial Doppler examinations, treatment of femoral artery pseudoaneurysms with ultrasound-guided compression or thrombin injection, and ultrasound-guided treatment of varicose veins. Level III training may include training in wound care techniques, including debridement and application of appropriate dressings.

4. Summary of Training Requirements

4.1. Development and Evaluation of Core Competencies

Training and requirements in vascular medicine address the 6 general competencies promulgated by the ACGME/ABMS 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 core clinical competencies for cardiovascular medicine. 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 1 delineates each of the 6 competency domains as well as their associated curricular milestones for training in vascular medicine. The milestones are categorized into Level I, Level II, and Level III training (as previously defined in this document) and indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Given that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may also vary. Level I competencies may be achieved at earlier or later time points. Acquisition of Level II skills requires additional training that may be completed during the standard 3-year cardiovascular fellowship. Level III skills require additional training in a dedicated advanced vascular medicine program after completion of the general cardiovascular fellowship. The table also describes examples of evaluation tools suitable for assessing competence in each domain.

Table 1. Core Competency Components and Curricular Milestones for Training in Vascular Medicine

Medical Knowledge	Milestones (Months)			
	12	24	36	Add
1. Know the anatomy of the peripheral arterial and venous systems.	I			
2. Know the causes and clinical epidemiology of atherosclerotic peripheral vascular disease, including the incidence and prevalence, sex and ethnic differences, role of genetics, and the influence of traditional risk factors and demographics on outcomes.	I			
3. Know the pathophysiology of peripheral artery disease, including atherosclerosis, thrombosis, embolism, entrapment, vasculitis, and vasospasm.		I		
4. Know the pathophysiology, causes and clinical epidemiology of aortic aneurysms.	I			
5. Know the pathophysiology, causes, and clinical epidemiology of acute aortic syndromes such as dissection and intramural hematoma.		I		
6. Know the pathophysiology, causes, and clinical epidemiology of deep vein thrombosis and pulmonary embolism.	I			
7. Know the pathophysiology, causes, and clinical epidemiology of cerebrovascular disease.		I		
8. Know the pathophysiology, causes, and clinical epidemiology of chronic venous insufficiency and varicose veins.		I		
9. Know the pathophysiology, causes, and clinical epidemiology of lymphedema.			II	
10. Know the cardinal symptoms and physical findings of peripheral atherosclerotic vascular diseases, including peripheral artery disease, renal and mesenteric artery disease, extracranial cerebrovascular disease, and abdominal aortic aneurysm.	I			
11. Know the cardinal symptoms and physical findings of venous diseases including venous thromboembolism, chronic venous insufficiency, and varicose veins.	I			
12. Know the differentiating characteristics between arterial, venous, and neurotrophic lower extremity ulcers.			II	

13. Know the natural history and prognosis of deep vein thrombosis and pulmonary embolism.	I			
14. Know the natural history and prognosis of peripheral atherosclerotic vascular diseases including peripheral artery disease, renal and mesenteric artery disease, extracranial carotid artery disease, and abdominal aortic aneurysm.		I		
15. Know the indications for noninvasive screening for abdominal aortic aneurysm.		I		
16. Know the indications for duplex ultrasound of the peripheral veins and carotid arteries and for duplex and physiological testing of the peripheral arteries.		I		
17. Know the indications for duplex ultrasonography of the renal and mesenteric arteries, arterial bypass grafts and stents, aortic endografts, and intracranial vessels (i.e., transcranial Doppler).			II	
18. Know the indications and contraindications for computed tomographic angiography and magnetic resonance angiography in patients with suspected vascular disease.		I		
19. Know the appropriate indications and laboratory tests to assess for inherited and acquired thrombophilia.		I		
20. Know the appropriate indications and laboratory tests to assess for vasculitis.		I		
21. Know the indications, contraindications, risks, clinical pharmacology, and interactions of drugs used to treat atherosclerotic vascular diseases.		I		
22. Know the indications, contraindications, risks, clinical pharmacology, and interactions of drugs used to treat thrombotic disorders.	I			
23. Know the indications, contraindications, risks, and expected outcomes for thrombolytic therapy for venous thromboembolism (pulmonary embolism and deep vein thrombosis).	I			
24. Know the indications and risks for surgical and endovascular treatments for acute aortic syndromes; and, the expected outcomes.		I		
25. Know the indications and risks for surgical and endovascular treatments for aortic aneurysm; and, the expected outcomes.		I		
26. Know the indications and risks for surgical and endovascular treatments for peripheral atherosclerotic vascular diseases, including peripheral artery disease, renal and mesenteric artery disease, and extracranial cerebrovascular disease; and the expected outcomes.		I		
Evaluation Tools: chart-stimulated recall, global evaluation, in-training exam				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to perform the comprehensive physical examination of the peripheral arteries, including palpation of the abdominal aorta and peripheral pulses and auscultation for bruits.	I			
2. Skill to perform physical examination for suspected peripheral venous disorders, including deep vein thrombosis, varicose veins, and chronic venous insufficiency.		I		
3. Skill to perform and interpret an ankle-brachial index measurement.		I		
4. Skill to perform physical examination maneuvers for arterial compression syndromes (e.g., thoracic outlet, median arcuate ligament, and popliteal artery entrapment syndromes).				III
5. Skill to interpret limb segmental blood pressure measurements, pulse volume recordings and Doppler waveforms, and treadmill vascular exercise tests.			II	

6. Skill to interpret duplex ultrasound examinations of the extracranial carotid arteries, peripheral arteries, abdominal aorta, renal and mesenteric arteries, and peripheral veins.			II	
7. Skill to evaluate and manage aortic aneurysms including identification of patients for whom surgical or endovascular repair is indicated.		I		
8. Skill to evaluate and manage acute aortic syndromes including identification of patients for whom surgical or endovascular therapy is indicated.		I		
9. Skill to evaluate and manage patients with deep venous thrombosis and pulmonary embolism, including identification of patients for whom thrombolytic therapy is indicated.		I		
10. Skill to perform preoperative risk assessment and manage patients undergoing vascular surgery.		I		
11. Skill to evaluate and manage lower extremity peripheral artery disease.		I		
12. Skill to evaluate and manage extracranial carotid artery disease.		I		
13. Skill to evaluate and manage patients with chronic venous insufficiency and varicose veins, including use of compression therapy and identification of patients for whom additional venous procedures are indicated (i.e., sclerotherapy, ablation, or surgery).				III
14. Skill to evaluate lymphedema.			II	
15. Skill to manage lymphedema.				III
16. Skill to diagnose and manage arterial access complications, including arteriovenous fistula and arterial pseudoaneurysms.				III
17. Skill to evaluate and manage lower extremity wounds, including indications for adjunctive imaging and biopsy, indications and techniques for debridement, and selection of appropriate dressings.				III
18. Skill to evaluate and manage Raynaud's phenomenon.				III
19. Skill to evaluate and manage other temperature related disorders, including acrocyanosis, pernio, and erythromelalgia.				III
20. Skill to evaluate and manage uncommon vascular disorders, including vascular compression syndromes (e.g., thoracic outlet, popliteal entrapment), fibromuscular dysplasia, arteriopathies associated with inherited disorders of connective tissue, and congenital vascular malformations.				III
21. Skill to evaluate and manage peripheral and visceral artery aneurysms including identification of patients for whom surgical or endovascular repair is indicated.				III
Evaluation Tools: chart-stimulated recall, direct observation, global evaluation				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Practice in a manner that balances appropriate utilization of finite resources with the net clinical benefit for the individual patient.		I		
2. Utilize an interdisciplinary, coordinated approach for patient management.			II	
3. Utilize a coordinated approach for patient management, including coordination with rehabilitation services, physical and occupational therapy, and consideration of employment-related issues.				III
4. Know the components of quality assurance in the noninvasive vascular laboratory, including certification of technical and medical personnel,			II	

laboratory accreditation, and internal quality improvement initiatives.				
Evaluation Tools: chart-stimulated recall, direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.		I		
2. Utilize decision support tools for accessing guidelines and pharmacologic information at the point of care.		I		
Evaluation Tools: chart-stimulated recall, conference presentation, global evaluation				
Professionalism	**12**	**24**	**36**	**Add**
1. Forego recommending unvalidated diagnostic testing or treatments.		I		
2. Demonstrate a commitment to carry out professional responsibilities, appropriately refer patients, and respond to patient needs in a way that supersedes self-interest.			II	
3. Know and promote adherence to guidelines and appropriate use criteria.			I	
4. Interact respectfully with patients, families, and all members of the healthcare team, including ancillary and support staff.	I			
Evaluation Tools: chart-stimulated recall, direct observation, multisource evaluation				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate with and educate patients and families across a broad range of cultural, ethnic, and socioeconomic backgrounds.	I			
2. Communicate with other specialists for optimal interdisciplinary management of patients.			II	
Evaluation Tools: direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

4.2. Duration and Structure of Training

Level I competencies must be obtained by all fellows during the 3-year cardiovascular disease fellowship training program. Level II competencies may be obtained by selected fellows during the cardiovascular disease fellowship depending on their career focus and elective experiences. Level III competencies are noted as additional requirements for advanced training beyond the standard 3-year fellowship. The duration and structure of training required for the typical fellow to gain competencies in Levels I, II, and III training in vascular medicine are summarized below. In all cases, achievement of the competencies must be assessed.

4.2.1. Level I Training Requirements

Level I training typically requires 2 months of exposure on vascular medicine services, either as dedicated rotations or in aggregate, to provide the knowledge, skills, and attitudes required for diagnosis and management of patients with vascular diseases (Table 1). Training should focus on the value of the clinical history and examination for diagnosis, and exposure to bedside testing, vascular physiologic testing, duplex ultrasound imaging, and other noninvasive angiographic imaging modalities (computed tomographic angiography and magnetic resonance angiography). The curriculum should include testing methods, indications, diagnostic criteria, and technical limitations. Level I trainees should understand the advantages and disadvantages of the various vascular testing modalities for specific clinical conditions. Sufficient exposure to catheter-based angiography and endovascular procedures should be provided to allow understanding of the roles of these modalities in diagnosis and management. The Level I trainee should understand basic concepts of surgical and endovascular treatments, including indications, contraindications, and potential complications. Level I trainees should also be instructed in the comprehensive evaluation of patients undergoing vascular surgery, including indications and risks of preoperative testing and management of perioperative cardiovascular problems and complications. They should learn to recognize and manage disorders associated with vascular diseases, including hypertension, hypercholesterolemia, and diabetes, throughout the cardiovascular fellowship, and should know when it is appropriate to refer patients to a vascular specialist for further evaluation and intervention.

4.2.2. Level II Training Requirements

Level I training in vascular medicine is a prerequisite for Level II training. In addition to the 24 months of clinical training required for board eligibility in cardiovascular medicine, further training, typically during the third year, should enable the fellow to become more knowledgeable and skilled in vascular medicine and noninvasive vascular laboratory procedures (1, 2). At completion of Level II training, the trainee should be able to perform and interpret noninvasive vascular diagnostic examinations. In addition to interpretion, hands-on experience and familiarity with scanning protocols are required. Completion of the vascular laboratory curriculum during Level II or Level III training should make the trainee eligible for the Physicians' Vascular Interpretation (PVI) Examination and meet the requirements to serve as medical staff or medical director of an accredited vascular laboratory. Trainees seeking additional competency in vascular medicine during cardiovascular fellowship should participate in additional inpatient and outpatient vascular medicine consultations and noninvasive vascular laboratory activities, and should observe magnetic resonance and computed tomographic and catheter-based angiography and interventions.

4.2.3. Level II and III Noninvasive Vascular Laboratory Training

Expertise in the noninvasive vascular laboratory is important for vascular medicine specialists and required for Level II and III trainees. The curriculum should include diagnostic testing procedures and equipment, indications, diagnostic criteria, and technical limitations. In addition to the curricular components, Level II and III trainees should have extensive mentored experience in interpreting vascular studies. The PVI Examination should be successfully completed after either Level II or III training. Interpretation under faculty supervision of at least 500 studies distributed across the vascular testing areas is a prerequisite for the PVI Examination. These areas include duplex ultrasonography of limb veins, limb arteries (including bypass grafts and stents), carotid arteries, renal and mesenteric arteries, and the abdominal aorta, physiological testing for peripheral artery disease, and transcranial Doppler examination. The vascular laboratory curriculum for the Level III trainee should include laboratory quality and accreditation processes, a review of correlation studies, and participation in quality improvement activities, such as peer review and cross-modality correlation studies.

4.2.4. Level III Training Requirements

Level III training should provide trainees with the knowledge and skills to interpret the clinical presentation, plan diagnostic testing, apply clinical and laboratory information, and develop appropriate management plans for patients with a variety of vascular disorders as a vascular medicine specialist. This extends the knowledge and skills acquired during Level I training to the entire range of vascular diseases, as described in Sections 3.2 and 3.3 and outlined in Table 1, and includes performance and interpretation of noninvasive vascular diagnostic examinations, as described in Section 4.2.3.

Fellows planning careers as vascular medicine specialists require advanced training beyond the 24 months of clinical training required for board eligibility in cardiovascular medicine, typically during a fourth year dedicated to this field (1, 2). Level I training in vascular medicine is a prerequisite for Level III training, and Level II training can be applied to Level III training, decreasing the time required to gain Level III competence. Level III training cannot be obtained during the standard 3-year cardiovascular fellowship and requires additional exposure in a program meeting requirements that will be addressed in a subsequent, separately published Advanced Training Statement (formerly Clinical Competence Statements) (1, 2). The Level III trainee is expected to pass the certification examination offered by the ABVM. Fellows seeking training in peripheral vascular interventions should consult “COCATS 4Task Force 10: training in cardiac catheterization”) which integrates peripheral endovascular intervention with other cardiovascular interventional training components.

5. Evaluation of Competency

A key characteristic of the competency- and curricular milestone-based system is integration with outcomes-based evaluations. For training programs, evaluation tools include a variety of modalities, such as direct observation by instructors, in-training examinations, procedure logbooks, conference and case presentations, multisource evaluations, trainee portfolios, and simulation. Case management, judgment, and interpretive and technical skills must be evaluated in every trainee. An optimum training environment includes bidirectional evaluations in which faculty evaluate and provide positive or negative feedback to trainees, and trainees evaluate faculty after each rotation. The program director should review these evaluations with the trainee and faculty individually. Mechanisms should be incorporated so that the fellow who performs suboptimally can be counseled and further action taken if necessary.

Within a given clinical area, achievement of competence is expected for each of the specific Level I curricular milestones. It is not expected, however, that the training program formally evaluate each component (curricular milestone) individually. Rather, evaluation tools may focus on representative components in a given area. The program director should record each trainee's experiences and performance of various patient care skills to document satisfactory achievement at each level of training. Trainees should maintain records of participation and advancement in the form of a Health Insurance Portability and Accountability Act (HIPAA)-compliant electronic database or logbook that meets ACGME reporting standards and summarizes pertinent clinical information (e.g., number of cases, diagnoses, disease severity, outcomes and disposition). The program director is responsible for confirming the experience and competence of trainees. Under the aegis of the program director, the faculty should record each trainee's experiences and assess performance to document satisfactory achievement. The fund of knowledge regarding vascular disease must be evaluated in every trainee. Quality of clinical skills; reliability; judgment; and actions that result in complications and interactions with other physicians, patients, and laboratory support staff, are key components of the evaluation. Initiative and the ability to make independent and appropriate decisions should also be assessed. The program director and Clinical Competency Committee should specifically review the overall progress of individual trainees and achievement of selected training milestones, and identify areas in which additional focused training is required.

Along with other professional organizations, including the SVM, the ACC has formulated a clinical competence statement on Vascular Medicine and Catheter-Based Vascular Interventions (2). The SVM has defined the essential components of a specialized program for training in vascular medicine (1). Self-assessment programs are available through the ACC. Training directors and trainees are encouraged to incorporate these resources in the course of training.

Evidence of competence can be ascertained by several certification examinations. The American Registry for Diagnostic Medical Sonography (ARDMS) offers a certifying examination for physicians performing and interpreting noninvasive vascular examinations (the PVI Examination) for individuals completing the noninvasive vascular laboratory prerequisites during Level II or Level III training. Information concerning the eligibility and prerequisites for this examination can be obtained from ARDMS (5). The ABVM offers an examination for certification in vascular medicine for individuals completing Level III training. Information concerning eligibility requirements can be obtained from the

ABVM (3). Certifying examinations for peripheral endovascular intervention are discussed in the report of Task Force 10.

Key Words: ACC Training Statement ▪ COCATS ▪ vascular medicine ▪ peripheral vascular catheter-based intervention ▪ computed tomography angiography ▪ peripheral vascular intervention.

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 9: TRAINING IN VASCULAR MEDICINE

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
Mark A. Creager *(Chair)*	Brigham & Women's Hospital, Cardiovascular Division—Professor of Medicine, Cardiology	None	None	None	None	None	None
Heather L. Gornik	Cleveland Clinic Foundation Cardiovascular Medicine—Medical Director, Noninvasive Vascular Laboratory; Staff Physician, Vascular Medicine	None	None	None	None	None	None
Bruce H. Gray	University of South Carolina School of Medicine/Greenville—Professor of Surgery/Vascular Medicine; Upstate Vascular Specialists—Vascular Medicine Specialist	None	None	None	None	None	None
Naomi M. Hamburg	Boston Medical Center Cardiovascular Medicine—Associate Professor of Medicine	None	None	None	None	None	None
Emile R. Mohler, III	University of Pennsylvania Health System—Associate Professor of Medicine	None	None	None	None	None	None
Christopher J. White	The Ochsner Clinical School, University of Queensland—Professor and Chairman of Medicine	None	None	None	None	None	None
William Iobst	The Commonwealth Medical College, Vice Dean and Vice President for Academic and Clinical Affairs; *Former employment during writing effort:* American Board of Internal Medicine—Vice President, Academic Affairs	None	None	None	None	None	None

For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF9_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELEVANT RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES—COCATS 4 TASK FORCE 9: TRAINING IN VACULAR MEDICINE

Name	Employment	Representation	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
Richard Kovacs	Indiana University, Krannert Institute of Cardiology—Q.E. and Sally Russell Professor of Cardiology	Official Reviewer, ACC Board of Trustees	None	None	None	None	None	None
Dhanunjaya Lakkireddy	Kansas University Cardiovascular Research Institute	Official Reviewer, ACC Board of Governors	None	None	None	None	None	None
Howard Weitz	Thomas Jefferson University Hospital—Director, Division of Cardiology; Sidney Kimmel Medical College at Thomas Jefferson University—Professor of Medicine	Official Reviewer, Competency Management Committee Lead Reviewer	None	None	None	None	None	None
Furman McDonald	American Board of Internal Medicine—Vice President, Graduate Medical Education, Department of Academic Affairs and Professor, Medicine	Organizational Reviewer, ABIM	None	None	None	None	None	None
Kiran Musunuru	Brigham and Women's Hospital, Harvard University	Organizational Reviewer, AHA	None	None	None	None	None	None
Aditya M. Sharma	University of Virginia Health System, Cardiovascular Division —Assistant Professor,	Organizational Reviewer, SCAI	None	None	None	None	None	None

	Medicine							
Kanwar Singh	University of Virginia Health System—Cardiovascular Division	Organizational Reviewer, SCAI	None	None	None	None	None	None
Geoffrey Barnes	University of Michigan Frankel Cardiovascular Center—Cardiovascular Medicine and Vascular Medicine	Organizational Reviewer, SVM	None	None	None	None	None	None
Esther S.H. Kim	Cleveland Clinic—Staff Physician, Department of Cardiovascular Medicine	Organizational Reviewer, SVM	None	None	None	None	None	None
Brian D. Hoit	University Hospitals Case Medical Center, Cleveland Ohio	Content Reviewer, Cardiology Training and Workforce Committee	None	None	None	None	None	None
Larry Jacobs	Lehigh Valley Health Network, Division of Cardiology; University of South Florida—Professor, Cardiology	Content Reviewer, Cardiology Training and Workforce Committee	None	None	None	None	None	None
Andrew Kates	Washington University School of Medicine	Content Reviewer, Academic Cardiology Section Leaderhip Council	None	None	None	None	None	None
Gregory Piazza	Brigham and Women's Hospital/Harvard Medical School—Cardiovascular Division	Content Reviewer, PVD Council	None	None	None	None	None	None

For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ABIM = American Board of Internal Medicine; ACC = American College of Cardiology; AHA = American Heart Association; PVD = Peripheral Vascular Disease; SCAI = Society for Cardiovascular Angiography and Interventions; and SVM = Society for Vascular Medicine.

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ABVM = American Board of Vascular Medicine

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

ARDMS = American Registry for Diagnostic Medical Sonography

COCATS = Core Cardiovascular Training Statement

HIPAA = Health Insurance Portability and Accountability Act

PVI = Physicians' Vascular Interpretation

SVM = Society for Vascular Medicine

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COCATS 4 Task Force 10: Training in Cardiac Catheterization[12]

Endorsed by the Society for Cardiovascular Angiography and Interventions

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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The writing committee was selected to represent the American College of Cardiology (ACC) and the Society for Cardiovascular Angiography and Interventions (SCAI) and included a cardiovascular training program director, an interventional cardiology training program director, an early-career cardiologist, highly experienced specialists representing both the academic and community-based practice settings, and physicians experienced in defining and applying training standards according to the 6 general competency domains promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialties (ABMS) and endorsed by the American Board of Internal Medicine (ABIM). The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiovascular training statement. Employment and affiliation details for authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document. (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF10_Comprehensive_RWI_Supplement.pdf).

[12] The American College of Cardiology requests that this document be cited as follows: King SB, Babb JD, Bates ER, Crawford MH, Dangas GD, Voeltz MD, White CJ. COCATS 4 task force 10: training in cardiac catheterization. J Am Coll Cardiol. 2015;••:••••–••••.

1.1.2. Document Development and Approval

The writing committee developed the document, approved it for review by individuals selected by the ACC and SCAI, and addressed the peer reviewers' comments. The document was revised and posted for public comment from December 20, 2015 to January 6, 2015. Authors addressed the additional comments from the public to complete the document. The final document was approved by the Task Force, COCATS Steering Committee, and ACC Competency Management Committee; and ratified by the ACC Board of Trustees and endorsed by SCAI in March, 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

The role of the cardiac catheterization laboratory in trainee education and clinical care continues to evolve. The cardiac catheterization laboratory serves as both a diagnostic and therapeutic facility. This document addresses training in diagnostic cardiac catheterization (invasive cardiology) as distinct from therapeutic catheterization (interventional cardiology). The catheterization laboratory has an important diagnostic role in the evaluation and management of all types of cardiovascular disease (i.e., coronary, structural heart, primary myocardial, peripheral, and cerebrovascular diseases). This role includes invasive hemodynamic measurements and angiographic delineation of cardiovascular anatomy and pathology. The information derived from these studies overlaps with and complements that derived from non-invasive diagnostic modalities such as echocardiography, nuclear imaging, computed tomography, and magnetic resonance imaging. This relationship has value in both enhancing diagnostic accuracy and fostering the understanding of cardiovascular anatomy, pathology, physiology, and pathophysiology. The widespread use of echocardiography in addition to the growing use of cardiovascular magnetic resonance and computed tomography angiography has also changed the practice of invasive and interventional cardiology. Patients with diagnostic, echocardiographic, hemodynamic assessment of valvular or myocardial/pericardial disease may be referred for diagnostic coronary angiography only; however, patients in whom echocardiographic findings are inconclusive are still referred to the catheterization laboratory for hemodynamic assessment. These patients are often exceedingly complex. Thus, even in this era of enhanced noninvasive imaging, the understanding and proper performance of detailed hemodynamic evaluation in such patients remains critical.

The therapeutic role of the cardiac catheterization laboratory continues to grow as interventional cardiovascular procedures are applied to increasingly complex and critically ill patients. Urgent catheterization and percutaneous revascularization are now considered the standard of care for patients with acute coronary syndromes, ST-elevation myocardial infarction, and cardiogenic shock. Furthermore, new adjunctive pharmacologic regimens and interventional diagnostic and therapeutic devices have emerged. In addition, many noncoronary therapeutic procedures—including percutaneous closure of atrial septal defects, valve repair or replacement, alcohol septal ablation, and peripheral vascular procedures—are performed frequently. These procedures, together with the use of left ventricular assist and support devices, have significantly expanded the scope of interventional cardiology. This evolution has increased the cognitive and technical knowledge base required of invasive and interventional cardiologists. It is essential that all cardiologists understand the appropriate applications of invasive and interventional cardiology and that those planning to practice these disciplines achieve the knowledge and skills needed for advanced training. Consequently, this document revises and updates the standards for training in cardiac catheterization during the 3-year cardiovascular disease training program (1).

In addition to the cardiovascular disease examination, the ABIM provides a certifying examination in interventional cardiology (2), and the Residency Review Committee of the ACGME has a formal accreditation mechanism for interventional cardiovascular training programs (3). In 1999, the ACC published a training statement on recommendations for the structure of an optimal adult interventional cardiovascular training program (4), and the recommendations to prepare for advanced training in interventional cardiology are updated in this document. The recommendations in this document are consistent with the requirements of the ABIM, the ACGME, and the ABMS. This document covers training in cardiac catheterization, and the ACC/American Heart Association (AHA)/American College of Physicians clinical competence statement on coronary artery interventional procedures covers training in interventional cardiology (5).

Training in diagnostic cardiac catheterization must occur and be able to be completed within a cardiovascular training program that is fully accredited by the ACGME. If the program does not include an accredited training program in interventional cardiology, exposure to an active interventional cardiovascular program should be provided. All invasive cardiovascular training programs in the United States must satisfy the basic standards developed by the ACGME in order for the candidates to be eligible for the ABIM's clinical cardiovascular certificate. The ACGME standards represent the qualifying requirements. COCATS 4 endorses the ACGME standards for program accreditation and makes additional recommendations over and above those standards.

The ultimate goal of a cardiac catheterization training program is to teach the requisite cognitive and technical knowledge of invasive cardiology. This includes indications and contraindications for the procedures, procedural skills, pre- and post-procedure care, management of complications, and analysis and interpretation of hemodynamic and angiographic data. The cardiac catheterization laboratory provides a platform for teaching the core knowledge base of cardiac anatomy, pathology, physiology, and pathophysiology that should be possessed by all cardiologists regardless of whether they perform invasive cardiovascular procedures. In addition, it is this experience that provides the basic intravascular catheter insertion and manipulation skills needed to care for cardiac patients in critical care environments.

The Task Force was charged with updating previously published standards for training fellows in cardiology enrolled in cardiac fellowship programs on the basis of changes in the field since 2008 (1) and as part of a broader effort to establish consistent training criteria across all aspects of cardiology. The Task Force also updated previously published standards to address the evolving framework of competency-based medical education described by the ACGME Outcomes Project and the 6 general competencies endorsed by ACGME and ABMS. The background and overarching principles governing fellowship training are provided in the Introduction to COCATS, and readers should become familiar with this foundation before considering the details of training in a subdiscipline like cardiac catheterization. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally.

For most areas of adult cardiovascular medicine, 3 levels of training are delineated:

Level I training, the basic training required of trainees to become competent consultant cardiologists, is required of all cardiovascular fellows and can be accomplished as part of a standard 3-year training program in cardiology. In the case of cardiac catheterization, Level I represents training for those who will practice noninvasive cardiology and whose invasive activities will be confined to critical care unit procedures. This level will also provide training in the indications for the procedure and in the accurate interpretation of data obtained in the catheterization laboratory.

Level II training refers to the additional training in 1 or more areas that enables some cardiologists to perform or interpret specific procedures or render more specialized care for patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training in selected areas may be achieved by some trainees during the standard 3-year cardiovascular fellowship, depending on the trainees' career goals and use of elective rotations. It is anticipated that during a standard 3-year cardiovascular fellowship training program, sufficient time will be available for the trainee to receive Level II training in a specific subspecialty. In the case of cardiac catheterization and peripheral angiography, Level II is defined as training for those who will either practice diagnostic cardiovascular catheterization or pursue further training in interventional cardiology. Level II training may also be sought by those who aspire to advanced training in heart failure or electrophysiology. Notably, no certification examination currently exists to assess Level II competency in this field.

Level III training requires additional training and experience beyond the cardiovascular fellowship in order for the trainee to acquire specialized knowledge and competencies in performing, interpreting, and training others to perform specific procedures or render advanced specialized care at a high level of skill. Level III training is described here only in broad terms to provide context for trainees and clarify that these advanced competencies are not covered during the cardiovascular fellowship and require additional training and designation by an independent accrediting board, often coupled with a certifying examination. Level III training cannot be obtained during the standard 3-year cardiovascular fellowship and requires additional exposure in a program that meets requirements that will be addressed in a subsequent, separately published Advanced Training Statement (formerly in Clinical Competence Statement).

In the case of interventional cardiology, Level III training is for those who will practice diagnostic, interventional cardiac, and peripheral vascular catheterization and is undertaken during a dedicated interventional cardiovascular training program. Level II training in vascular medicine (see “COCATS 4 Task Force 9: training in vascular medicine”) is also suggested prior to or in conjunction with Level III training in catheter-based peripheral vascular intervention.

The number of procedures recommended at each level of training is based on published guidelines (6), competency statements (5,7), and the experience and opinions of the writing group. It is assumed that training is directed by appropriately qualified mentors in an ACGME-accredited program and that satisfactory completion of training is documented by the program director. The number of procedures and duration of training required for each level of training are summarized in Section 4.

2. General Standards

Several organizations, such as ACC, AHA, American College of Physicians, and SCAI, have addressed training requirements and guidelines for interventional cardiology. The recommendations are congruent and address faculty, facility requirements, emerging technologies, and practice. We recommend strongly that candidates for the ABIM examination for certification in cardiovascular diseases, as well as those seeking certification in interventional cardiology, review the specific requirements of ABIM (2).

2.1. Faculty

Faculty must be experienced and committed to the teaching program. All requirements for faculty are outlined in ABMS and ACGME documents (3). Exposure to multiple faculty mentors substantially enhances the quality of a training experience. The faculty should consist of a full-time training director, key faculty, and other associated faculty. An optimal program should have at least 3 key faculty members, 1 of whom is the training director, who devotes at least 20 hours per week to the program. Associated faculty may have varying levels of commitment and involvement in the program

2.1.1. Training Director

The training director for the diagnostic catheterization curriculum must be certified in cardiovascular medicine by the ABIM and should be recognized as an expert in cardiac catheterization. Preferably, the director should be a full-time faculty member of the overall cardiovascular training program, committed to medical education and teaching. If the director also serves as training director of interventional cardiology, certification in interventional cardiology is required. The director should be responsible for the invasive teaching curriculum and overall teaching program in addition to trainee evaluation. If the program director is also the director of the catheterization laboratory, this individual should also be responsible for the administration of the laboratory, quality assurance, and radiation safety.

2.1.2. Other Key Faculty

Key faculty members should be certified in cardiovascular medicine by the ABIM and have expertise in all aspects of diagnostic procedures, including the evaluation of coronary, valvular, congenital, cardiomyopathic and peripheral vascular disease, and should be familiar with complex hemodynamics in patients with all types of heart disease. The program faculty should include individuals with expertise in the performance of trans-septal catheterization, the interpretation and performance of intravascular imaging, and physiologic assessment. If the program also provides training in interventional cardiology, its faculty must satisfy the requirements for programs in interventional cardiology by the ACGME (3) and the requirements outlined in the previously-published ACC training statement (1). Ideally, the program should include faculty who possess skills in advanced interventional cardiovascular techniques, including interventional therapy of structural heart, peripheral arterial, and carotid artery disease.

2.2. Facilities

All training facilities must be equipped and staffed to function in accordance with the ACC/AHA/SCAI clinical expert consensus document on cardiac catheterization laboratory standards (7).

2.3. Equipment

2.3.1. X-Ray Imaging Equipment

The cardiac catheterization laboratory must generate high-quality x-ray digital images during diagnostic and interventional catheterization procedures. Laboratories performing peripheral and carotid angiography must have digital subtraction angiography and appropriately sized image intensifiers (i.e., 12-in to 16-in). The laboratory must have access to the support personnel needed to ensure that image quality is optimal and that radiation exposure to patients and staff is both monitored and minimized. Radiation exposure to trainees must be carefully monitored on a monthly basis.

2.3.2. Hemodynamic Monitoring and Recording Equipment

The facility must have high-quality physiologic monitoring and recording equipment to permit accurate assessment of complex hemodynamic conditions. The presence of equipment for assessing both coronary physiology, such as fractional flow reserve and coronary and structural heart anatomy, such as intravascular and intracardiac ultrasound, is strongly recommended.

2.4. Ancillary Support

The program must have on-site access to all core cardiovascular services, including a cardiac critical care facility, and echocardiography and stress testing with nuclear imaging. Complete electrophysiologic testing onsite is desirable, but alternatively, it may be arranged by referral to an affiliated institution. On-site support services for interventional cardiovascular training include cardiac surgery, anesthesia, vascular and interventional radiology, vascular surgery, vascular medicine, neurology, nephrology, and hematology.

3. Training Components

3.1. Didactic Program

For Level I and Level II training, all trainees must attend a weekly cardiac catheterization conference. This may be a combined medical/surgical conference. The conference must present hemodynamic and angiographic data that are discussed in context with history, physical examination, and noninvasive findings. Indications, complications, and management strategies should also be discussed. It is particularly important that the Level I and Level II curricula should focus on teaching hemodynamics, cardiovascular physiology, and the pathophysiology of the major cardiovascular disorders in addition to coronary and peripheral vascular pathoanatomy. In this role, it is important that the cardiac catheterization program establish a close liaison with other noninvasive diagnostic laboratories. The educational program should emphasize relationships between the findings provided by the different diagnostic modalities in order to create a clear picture of the physiology and pathophysiology of the various cardiovascular disorders. A regular patient safety or quality improvement conference, either as part of the cardiac catheterization conference or as a separate conference, is also required. Additionally, exposure to and participation in regular catheterization laboratory peer review conferences is strongly recommended to educate trainees in focused and functional practices in peer review using random case selection, anonymization, and concordance with guidelines.

3.2. Clinical Experience

Level I and Level II training require exposure to the wide variety of cardiovascular disorders and clinical procedures. This experience is important to provide not only direct hands-on training, but also the requisite material for clinical conferences. In addition to becoming familiar with the many manifestations of coronary artery disease, all trainees should also acquire experience in the hemodynamic assessment, evaluation, and management of patients with valvular, myocardial, peripheral vascular, and congenital heart disease.

3.3. Hands-On Experience

The nature of a trainee’s participation in a given procedure will vary depending on the procedure’s complexity and the trainee’s experience level. Requisite participation in a procedure includes the following elements:

1. *Pre-procedural evaluation to assess appropriateness and plan procedure strategy.* Before the procedure, it is expected that the trainee will review the patient's medical record and obtain a confirmatory history and physical examination, giving specific attention to factors known to increase the risk of the procedure, such as vascular disease, renal failure, history of contrast reaction, congestive heart failure, anemia, active infection, and conditions known to increase the risk of bleeding. The trainee should also obtain informed consent and document a pre-procedural note that includes indications for the procedure, opportunities for the findings to influence the care of the patient, risks of the procedure, alternatives to the procedure, and understanding by the patient. This should be done and documented in conjunction with the supervising faculty member.
2. *Performance of the procedure by the trainee at a level appropriate to experience, always (at all levels) under the direct supervision of a program faculty member.* Level I trainees will begin in a mostly observational role and assume greater participation as experience is gained. Level II trainees will assume progressive responsibility for conducting diagnostic procedures and coordinating the various functions of ancillary staff in the room (e.g., directing nurses, hemodynamic technicians, junior fellows) as they acquire skills. Highly experienced Level II (or Level III) trainees may collaborate in a procedure with Level I trainees under the direct supervision of a program faculty member. In this circumstance, both Level I and Level II (or Level III) trainees may claim credit for participation in the procedure.
3. *Participation in analyzing the hemodynamic and angiographic data obtained during the procedure and preparation of the procedure report as well as formulation of treatment plans and relevant communication back to the referring doctors.* Trainees should participate in the creation of the procedure report, including drawing appropriate conclusions and making recommendations to ordering physicians and care teams. Procedure results should be communicated to care teams clearly and concisely by the fellow and/or supervising physician.
4. *Active involvement in pre- and post-procedural management inside and outside of the catheterization laboratory.* After the procedure, a note should be placed in the medical record. The trainee should monitor the patient and be available to respond to adverse reactions or complications that may arise, such as hypotension, vascular complications, bleeding, heart failure, renal failure, or myocardial ischemia. A final report should be completed within the time frame stipulated by local institutional policy and regulatory standards. If a complication occurs, the trainee should participate in the follow-up and management of the complication.

4. Summary of Training Requirements

4.1. Development and Evaluation of Core Competencies

Training and requirements in invasive cardiology address the 6 general competencies promulgated by the ACGME/ABMS and endorsed by the ABIM. These competency domains are: Medical Knowledge, Patient Care and Procedural Skills, Systems-Based Practice, Practice-Based Learning and Improvement, Professionalism, and Interpersonal and Communication Skills. The ACC has used this structure to define and depict the components of the core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 1 delineates each of the 6 general competency domains, as well as their associated curricular milestones for training in invasive cardiology. The milestones are categorized into Level I, Level II, and Level III training (as previously defined in this document), and indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Given that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may also vary. Level I competencies may be achieved at earlier or later time points. Acquisition of Level II skills requires additional training and Level III skills requires training in a dedicated interventional cardiovascular program. The table also describes examples of evaluation tools suitable for assessment of competence in each domain.

Table 1. Core Competency Components and Curricular Milestones for Training in Invasive Cardiology

Medical Knowledge	**Milestones (Months)**			
	12	**24**	**36**	**Add**
1. Know the indications/contraindications and potential complications of cardiac catheterization for assessment of coronary, valvular, myocardial, and basic adult congenital heart diseases.		I		
2. Know the principles of radiation safety.		I		
3. Know the use and complications of contrast media and the role of renal protection measures.		I		
4. Know the indications for, and clinical pharmacology of, antiplatelet and anticoagulant drugs, and vasopressor and vasodilator agents, used in the cardiac		I		

catheterization laboratory.				
5. Know normal cardiovascular hemodynamics and the principles and interpretation of waveforms, pressure, flow, resistance, and cardiac output measurements.		I		
6. Know the characteristic hemodynamic findings with myocardial, valvular, pericardial, and pulmonary vascular diseases.		I		
7. Know the methods to detect and estimate the magnitude of intracardiac and extracardiac shunts.		I		
8. Know coronary anatomy, its variations and congenital abnormalities, and its coronary blood flow physiology.		I		
9. Know the angiographic features of coronary artery disease and how to assess the anatomic and physiologic severity.		I		
10. Know the vascular anatomy and the indications and contraindications for, and complications of, peripheral vascular angiography.		I		
11. Know the indications and potential complications of percutaneous coronary, peripheral, valvular, and structural heart interventions.		I		
12. Know the indications and contraindications for, and the complications of, endomyocardial biopsy and pericardiocentesis.		I		
13. Know the indications for, and the mechanisms of action of, mechanical circulatory support devices.		I		
14. Know the indications for, and complications of, vascular access and closure strategies and devices.		I		
Evaluation Tools*:* conference presentation, direct observation, in-training exam, logbook, simulation				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to perform pre-procedural evaluation, assess appropriateness, obtain informed consent, and plan procedure strategy.		I		
2. Skill to perform venous and arterial access and obtain hemostasis.		I		
3. Skill to perform right heart catheterization.		I		
4. Skill to analyze hemodynamic, ventriculographic, and angiographic data, and to integrate with clinical findings for patient management.		I		
5. Skill to manage post-procedural patients, including complications and coordination of care.		I		
6. Skill to perform endomyocardial biopsy.			II	
7. Skill to perform pericardiocentesis.			II	
8. Skill to perform diagnostic left heart catheterization, ventriculography, and coronary angiography.			II	
9. Skill to place an intra-aortic balloon pump emergently.			II	
10. Skill to perform diagnostic peripheral (excluding carotid) angiography.			II	
11. Skill to perform percutaneous coronary interventions.				III
12. Skill to perform peripheral, carotid, valvular, and structural heart interventions.				III

13. Skill to insert and manage percutaneous left ventricular support devices.				III
***Evaluation Tools**:* chart-stimulated recall, conference presentation, direct observation, logbook, simulation				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Coordinate care in an interdisciplinary approach for patient management, including transition of care.		I		
2. Utilize cost-awareness and risk/benefit analysis in patient care.		I		
***Evaluation Tools**:* chart-stimulated recall, conference presentation, direct observation, logbook				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Locate, appraise, and assimilate information from scientific studies, guidelines, and registries in order to identify knowledge and performance gaps.		I		
2. Document number and outcomes of diagnostic and therapeutic procedures.		I		
***Evaluation Tools**:* conference presentation, direct observation, logbook, reflection and self-assessment				
Professionalism	**12**	**24**	**36**	**Add**
1. Practice within the scope of expertise and technical skills.		I		
2. Know and promote adherence to guidelines and appropriate use criteria.		I		
3. Interact respectfully with patients, families, and all members of the healthcare team, including ancillary and support staff.	I			
***Evaluation Tools**:* conference presentation, direct observation, multisource evaluation, reflection and self-assessment				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate with and educate patients and families across a broad range of socioeconomic, ethnic, and cultural backgrounds, including obtaining informed consent.		I		
2. Communicate and work effectively with physicians and other professionals on the healthcare team regarding procedure findings, treatment plans, and follow-up care coordination.		I		
3. Complete procedure records and communicate testing results to physicians and patients in an effective and timely manner.		I		
***Evaluation Tools**:* direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

4.2. Structure and Duration of Training

The specific competencies for Levels I, II, and III are delineated in Table 1. Level I competencies must be obtained by all fellows during the cardiovascular disease fellowship training program. Level II competencies may be obtained during the cardiovascular disease fellowship by selected fellows depending on their career focus and elective experiences. Level III competencies are noted so that fellows are aware of the competencies for which additional, advanced training beyond the standard 3-year fellowship is required. A brief discussion of the competencies and training requirements for Levels I, II, and III follow. Although the training duration and numbers of procedures are typically required to obtain competency, trainees must also demonstrate oachievement of the competencies as assessed by the outcomes evaluation measures.

4.2.1. Level I Training Requirements

Level I training requires approximately 4 months of experience in the cardiac catheterization laboratory. During this period, a trainee should generally participate in a minimum of 100 diagnostic cardiac catheterization procedures. At least 50 of these procedures should involve coronary angiography and 25 should involve hemodynamic assessment of valvular, myocardial, pericardial, or congenital disease. Only 1 Level I trainee may claim credit for participation in a given procedure; however, a Level I and a Level II (or III) trainee may claim credit for the same procedure if he/she performs different functions, applicable to his/her training level and expertise. An essential part of Level I training is t instruction in evaluating hemodynamic data and reading cardiac and coronary angiographic studies.

4.2.2. Level II Training Requirements

Level II training generally requires a total of approximately 6 months in the cardiac catheterization laboratory and participation in the performance (under direct supervision) of approximately 300 diagnostic cardiac catheterization procedures. For competency in peripheral vascular angiography, the typical candidate should participate in the performance (under direct supervision) of approximately 100 invasive diagnostic peripheral vascular (not carotid) angiographic procedures. This competency may not be acquired by all Level II trainees and is further addressed in the "COCATS 4 Task Force 9: training in vascular medicine." Only 1 Level II trainee may claim credit for participation in a given diagnostic procedure. A Level II trainee may claim 1 cardiac procedure and 1 peripheral vascular diagnostic procedure for the same patient when appropriate.

4.2.3. Level III Training Requirements

Level III training must be performed during additional year(s) of fellowship dedicated to cardiovascular interventional training (2). Level II training in vascular medicine (Task Force 11) is suggested prior to or in conjunction with training in catheter-based peripheral vascular intervention. Level III training leads to the ability to direct a cardiac catheterization laboratory, train others, and conduct advanced research in interventional cardiology.

5. Evaluation of Competency

Evaluation tools in cardiac catheterization include direct observation by instructors, in-training exams, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, simulation, and reflection and self-assessment. Case management, judgment, interpretive, and bedside skills must be evaluated in every trainee. Quality of care and follow-up; reliability; judgment, 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 (HIPAA)-compliant electronic database or logbook that meets ACGME/ABIM reporting standards and summarizes pertinent clinical information (e.g., number of cases, diversity of referral sources, diagnoses, disease severity, outcomes and disposition).

The ACC, AHA, and SCAI have formulated a clinical competence statement on invasive and interventional cardiovascular procedures (5). Self-assessment programs and competence examinations are available through the ACC and other organizations. Training directors and trainees are encouraged to incorporate these resources in the course of training.

The faculty under the aegis of the program director 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 for reviewing the overall progress of individual trainees with the Clinical Competency Committee to assure achievement of selected training milestones and to identify areas in which additional focused training may be required.

Key Words: ACC Training Statement ▪ COCATS ▪ fellowship training ▪ clinical competence ▪ cardiac catheterization.

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 10: TRAINING IN CARDIAC CATHETERIZATION

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF10_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELEVANT RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES—COCATS 4 TASK FORCE 10: TRAINING IN CARDIAC CATHETERIZATION

Name	Employment	Representation	Consultant	Speaker's Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
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J. Dawn Abbott	Warren Alpert Medical School of Brown University—Director, Interventional Cardiology Fellowship; Associate Professor of Medicine	Organizational Reviewer, SCAI	None	None	None	None	None	None
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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ACC = American College of Cardiology, SCAI = Society for Cardiovascular Angiography and Interventions.

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

AHA = American Heart Association

COCATS = Core Cardiovascular Training Statement

HIPAA = Health Insurance Portability and Accountability Act

SCAI = Society for Cardiovascular Angiography and Interventions

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COCATS 4 Task Force 11: Training in Arrhythmia Diagnosis and Management, Cardiac Pacing, and Electrophysiology[13]

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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The writing committee was selected to represent the American College of Cardiology (ACC) and the Heart Rhythm Society (HRS) and included a cardiovascular training program director; an electrophysiology (EP) program training director; early-career experts; highly experienced specialists representing both the academic and community-based practice settings; and physicians experienced in defining and applying training standards according to the 6 general competency domains promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and the American Board of Medical Specialties (ABMS) and endorsed by the American Board of Internal Medicine (ABIM). The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiovascular training statement. Employment and affiliation details for authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF11_Comprehensive_RWI_Supplement.pdf).

1.1.2. Document Development and Approval

The writing committee developed the document, approved it for review by individuals selected by the ACC and HRS, and addressed the reviewers' comments. The document was revised and posted for public comment from December 20, 2015 to January 6, 2015. Authors addressed additional comments to

[13] The American College of Cardiology requests that this document be cited as follows: Calkins H, Awtry EH, Bunch TJ, Kaul S, Miller JM, Tedrow UB. COCATS 4 task force 11: training in arrhythmia diagnosis and management, cardiac pacing, and clectrophysiology. J Am Coll Cardiol. 2015;●●:●●●●–●●●●.

complete the document. The final document was approved by the Task Force, COCATS Steering Committee, and ACC Competency Management Committee; and ratified by the ACC Board of Trustees in March, 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

The diagnosis and management of cardiac arrhythmias and conduction disorders are common and important components of the practice of clinical cardiology and are thus part of the core competency training of a clinical cardiologist. Clinical cardiac electrophysiologists are responsible for the comprehensive care of patients with more complex arrhythmias, along with advanced testing and invasive therapiesClinical cardiac electrophysiologists are trained to implant cardiac electrical devices, perform diagnostic EP procedures and therapeutic catheter ablation procedures, and employ pharmacological agents to treat patients with complex arrhythmias and conduction disturbances. Cardiac implantable electrical devices (CIEDs) include pacemakers, implantable cardioverter-defibrillators (ICDs), resynchronization (CRT) devices, implantable hemodynamic monitors, and implantable loop recorders (ILRs). For this document, implantable hemodynamic monitors and ILRs are excluded from the minimum training requirements. All cardiovascular trainees are expected to understand their indications for clinical use and to learn how to interpret the generated results in providing clinical care as part of their basic training.

The Task Force was charged with updating previously published standards for training fellows in cardiology enrolled in cardiac fellowship programs (1-4) on the basis of changes in the field since 2008 (2) and as part of a broader effort to establish consistent training criteria across all aspects of cardiology. This document does not provide specific guidelines for advanced cardiac electrophysiology training. Recommendations for advanced training in clinical cardiac electrophysiology (CCEP) are provided in the 2006 Clinical Competence Statement (5). The 2006 Clinical Competence Document is currently being revised and retitled as the Electrophysiology Advanced Training Statement. In its revised form, it will provide detailed recommendations for the electrophysiology training required to obtain ABIM certification. The Task Force also updated previously published standards to address the evolving framework of competency-based medical education described by the ACGME Outcomes Project and the 6 general competencies endorsed by ACGME and ABMS. The background and overarching principles governing fellowship training are provided in the Introduction to COCATS, and readers should become familiar with this foundation before considering the details of training in a subdiscipline like electrophysiology. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally.

For most areas of adult cardiovascular medicine, 3 levels of training are delineated:

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 cardiology.

Level II training refers to additional training in 1 or more areas that enables some cardiologists to perform or interpret specific procedures or render more specialized care for patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training in selected areas may be achieved by some trainees during the standard 3-year cardiovascular fellowship, depending on the trainees' career goals and use of elective rotations. It is anticipated that during a standard 3-year cardiovascular fellowship training program, sufficient time will be available to receive Level II training in a specific subspecialty. In the case of EP, Level II training is required for individuals to provide specialized arrhythmia and CIED management, including implantation, interrogation, and programming of pacemakers and ILRs, and interrogation and programming of implanted defibrillators. Those cardiovascular fellows seeking to implant ICDs and cardiac resynchronization devices without subspecialty board certification in CCEP are required to take an additional year of dedicated training beyond the 3 years required for cardiovascular training.

Level III training requires additional training and experience beyond the cardiovascular fellowship for the trainee to acquire 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. In the case of EP, Level III training is required of individuals seeking subspecialty board certification (CCEP). As noted above, those cardiovascular fellows seeking to implant ICDs and cardiac resynchronization devices without subspecialty board certification in CCEP are required to take an additional year of dedicated training beyond the 3 years required for cardiovascular training.

The recommended number of cases, procedures, and experiences is based on published guidelines, competency statements, and the experience and opinions of the members of the writing group. It is assumed that training is directed by appropriately trained mentors in an ACGME-accredited program and that satisfactory completion of training is documented by the program director. The number and types of encounters and the duration of training required for fellows are summarized in Section 4. Level III training is described here only in broad terms to provide context for trainees and clarify that these advanced competencies are not covered during the cardiovascular fellowship. The additional exposure and requirements for Level III training will be addressed in a subsequent, separately published, Advanced Training Statement, previously described in the 2006 Clinical Competency Statement (5).

2. General Standards

Three organizations—the ACC, American Heart Association, and HRS—have addressed training requirements and guidelines for the following topic areas: permanent pacemaker selection, implantation, and follow-up (6, 7); implantation and follow-up of ICDs (8, 9); training in catheter ablation procedures (10, 11); and educational objectives for fellowship training in CCEP (2, 12, 13). The recommendations are congruent and address faculty, facility requirements, emerging technologies, and practice. We strongly recommend that candidates for the ABIM examination for certification in cardiovascular diseases, as well as those seeking certification of added qualifications in CCEP, review the specific requirements of the ABIM (14, 15).

The intensity of training and required resources vary according to the level of training provided. Cardiovascular fellowship programs do not have to satisfy the requirements regarding facilities and faculty for training in EP (10, 11), unless they also have an ABIM-certified EP training program designed to provide Level III training. Eligibility for the ABIM CCEP examination requires that training take place in a program accredited by the ACGME (14).

2.1. Faculty

Faculty involved in training in arrhythmia diagnosis and management, cardiac pacing, and electrophysiology should include specialists who are skilled in the pharmacological, catheter-based, and surgical aspects of pacing and EP and are knowledgeable about the risks to the patient and medical personnel associated with radiation exposure. This faculty should include at least 1 board-certified electrophysiologist (CCEP) or 1 who possesses equivalent qualifications. A physician is considered to have equivalent qualifications if he or she trained in a similar environment for a similar period of time and performed the required number of procedures.

2.2. Facilities

Facilities should include a cardiac electrophysiology laboratory that provides a safe, sterile, and effective environment for invasive diagnostic EP studies, catheter ablation procedures, and CIED implantation. In addition, outpatient clinical facilities should be available for implantation of CIEDs, training in the consultative aspects of arrhythmia management, and device therapy.

2.3. Equipment

EP laboratories require fluoroscopy and specialized equipment for the safe performance of diagnostic procedures, catheter ablation procedures, and CIED implantation. This equipment includes EP pacing and recording systems, radiofrequency generators, and defibrillators. Additional equipment is needed in programs performing lead extraction (16).

2.4. Ancillary Support

Ancillary support should be available to perform EP and ablation procedures and to implant CIEDs, including general anesthesia and surgical backup in the event of complications requiring surgical intervention.

3. Training Components

3.1. Didactic Program

Didactic instruction may take place in a variety of formats, including but not limited to lectures, conferences, journal clubs, grand rounds, clinical case presentations, and patient safety or quality improvement conferences. The electrocardiographic (ECG) manifestations of arrhythmias should be taught on a regular basis during formal ECG conferences.

3.2. Clinical Experience

Rotation on an arrhythmia service is an essential component of all levels of EP training. A Level I trainee should gain first-hand experience as a consultant in arrhythmia management. It is important that the arrhythmia consultation service have a robust patient mix and acuity level. During the required 2 months on the consultation arrhythmia service, Level I trainees should evaluate 1 or more inpatient arrhythmia consultations daily in addition to providing follow-up care after initial consultation. In addition to participating in arrhythmia consultations, it is also important for Level I trainees to observe electrophysiology procedures including diagnostic EP studies, placement of implantable loop recorders (ILRs), catheter ablation procedures including atrial fibrillation ablation procedures, and device implantation procedures (permanent pacemakers, ICDs, and CRTs). Level I trainees should also observe a number of interrogations of implanted devices (permanent pacemakers, ICDs, and CRTs) and gain a basic understanding of concepts involved in programming and interrogating implantable devices.

Level II and Level III training require robust clinical experiences in the outpatient setting, inpatient and inpatient consultation setting, and EP laboratory. In each of these clinical settings, trainees assist in patient care in a supervised setting that provides for patient-centered education in all aspects of arrhythmia management.

3.3. Hands-On Experience

Hands-on experience is important for training in arrhythmia and CIED management. Trainees in cardiology should spend a minimum of 2 months on an arrhythmia service to acquire the core competencies (Level I). During this period or during rotations in the coronary care unit and cardiac catheterization laboratory, trainees should perform cardioversion procedures; implant, evaluate and adjust temporary pacemakers; and interpret the results of tilt-table testing.

Level II knowledge and skills can typically be obtained within 6 months dedicated training by the arrhythmia service. During this additional training, trainees should perform cardioversion procedures; implant, evaluate, and adjust temporary pacemakers; learn how to interrogate and troubleshoot implantable devices (permanent pacemakers, ICDs, and CRTs); perform and interpret the results of tilt-table testing; implant ILRs; and spend time in the device and arrhythmia clinic. Level II trainees may use part of this dedicated training period to learn to implant permanent pacemakers safely and appropriately. The minimum number of such procedures is provided later in this document.

Level III training in cardiac EP requires additional training beyond the standard 3-year cardiovascular fellowship and typically requires 24 months of exposure to advanced cardiac electrophysiology, including a considerable amount of time in the EP laboratory performing specific procedures. Level III training is required of individuals seeking subspecialty board certification in CCEP.

4. Summary of Training Requirements

4.1. Development and Evaluation of Core Competencies

Training and requirements in cardiac arrhythmia diagnosis, pacing, and electrophysiology address the 6 general competency domains promulgated by the ACGME/ABMS 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 the components of the core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs.

Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 1 delineates each of the 6 competency domains as well as their associated curricular milestones for training in cardiac arrhythmias and electrophysiology. The milestones are categorized into Level I, Level II, and Level III training (as previously defined in this document) and indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Given that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may also vary. Level I competencies may be achieved at earlier or later time points. Acquisition of Level II skills requires additional training and acquisition of Level III skills requires training in a dedicated CCEP program. The table also describes examples of evaluation tools suitable for assessment of competence in each domain.

Table 1. Core Competency Components and Curricular Milestones for Training in Cardiac Arrhythmias and Electrophysiology

Medical Knowledge	**Milestones (Months)**			
	12	**24**	**36**	**Add**
1. Know the mechanism and characteristics of normal sinus rhythm and of sinus node dysfunction.	I			
2. Know the pathophysiology, differential diagnosis, clinical significance, and approach to management of reentrant tachycardia (atrioventricular nodal re-entrant tachycardia; atrioventricular reciprocating tachycardia), ectopic atrial tachycardias, and accelerated atrioventricular junctional rhythm.		I		
3. Know the pathophysiology, differential diagnosis, clinical significance, and approach to management of atrial fibrillation and flutter, including the assessment of stroke and bleeding risk, indications of anticoagulation, and selection of anticoagulant medications.	I			
4. Know the risk factors for stroke and for bleeding in patients with atrial fibrillation or atrial flutter, as well as the indications for, and use of, anticoagulant medications.	I			
5. Know the pathophysiology, differential diagnosis, clinical significance, and approach to management of sustained and nonsustained ventricular tachyarrhythmias.		I		
6. Know the pathophysiology, differential diagnosis, and approaches to risk stratification and management of sudden cardiac death and cardiac arrest, including sudden cardiac death in athletes.		I		
7. Know the types, mechanisms, differential diagnosis, clinical significance, and approach to management of atrioventricular dissociation and atrioventricular heart blocks (first, second, and third degree).	I			
8. Know the physical examination characteristics of arrhythmias (e.g., findings of atrioventricular dissociation).		I		
9. Know the significance of underlying structural or congenital heart disease in the likelihood and significance of cardiac arrhythmias, including sudden death risk, and their impact in clinical		I		

management decisions.				
10. Know the indications, contraindications, and clinical pharmacology of antiarrhythmic medications, including drug-drug and drug-device interactions and proarrhythmia potential (including acquired long QT syndrome).		I		
11. Know the indications and limitations of noninvasive testing in the diagnosis and management of patients with arrhythmias: electrocardiogram, ambulatory, event, implantable loop recorder, and tilt-table testing.		I		
12. Know the indications for, and limitations and complications of, invasive electrophysiologic testing, as well as catheter ablation for cardiac arrhythmias.		I		
13. Know the indications and contraindications for permanent pacemaker placement, cardiac resynchronization therapy, and implantable cardioverter-defibrillator placement.		I		
14. Know the pathophysiology, differential diagnosis, natural history, and approach to management of syncope, including neurocardiogenic causes and syncope in athletes.	I			
15. Know the mechanisms, findings, clinical significance, and approach to management of ventricular pre-excitation.		I		
16. Know the pathology, clinical significance, and approach to evaluation (including the role of genetic testing) and management of inherited diseases that may cause cardiac arrhythmias due to ion channel abnormalities or structural changes in the heart (including the long QT syndrome, Brugada syndrome, arrhythmogenic right ventricular dysplasia, hypertrophic dilated cardiomyopathy, and myotonic dystrophy).		I		
17. Know the principles and practice of radiation safety as applied to the evaluation and management of cardiac electrical disorders.	I			
18. Know the basic principles of programming and interrogating implanted devices (permanent pacemakers, implantable cardioverter-defibrillators, cardiac resynchronization therapies, and implantable monitors)		I		
Evaluation Tools: chart-stimulated recall, global evaluation, in-training exam				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to evaluate and manage patients with palpitations.		I		
2. Skill to evaluate and manage patients with syncope.		I		
3. Skill to evaluate and manage patients with supraventricular tachyarrhythmias.		I		
4. Skill to evaluate and manage patients with atrial fibrillation and flutter (including rate and rhythm control and anticoagulation strategies).		I		
5. Skill to evaluate and manage patients with wide-QRS tachycardia.		I		
6. Skill to manage patients with nonsustained and sustained ventricular arrhythmias.		I		
7. Skill to evaluate and manage patients with bradycardia and/or heart block.		I		
8. Skill to perform electrical cardioversion.	I			
9. Skill to perform defibrillation.	I			

10. Skill to perform tilt-table testing.		II		
11. Skill to perform temporary pacemaker placement.		I		
12. Skill to select and manage patients requiring a permanent pacemaker, implantable cardioverter-defibrillator, or biventricular pacing.			I	
13. Skill to integrate the information provided in cardiac electrophysiology consultation, and reports of procedures and device interrogation, into the overall clinical assessment of the patient and plan of management.		I		
14. Skill to perform pacemaker and implantable cardioverter-defibrillator interrogation, programming, and surveillance.			II	
15. Skill to perform single- and dual-chamber permanent pacemaker implantation and manage complications, including device infections and chronic lead failure.			II	
16. Skill to perform implantation of implantable loop recorders, interpret results to guide patient management, and manage complications.			II	
17. Skill to perform implantable cardioverter-defibrillator and biventricular device implantation and manage complications.				III
18. Skill to perform and interpret invasive electrophysiologic testing and carry out ablation therapy.				III
19. Skill to utilize magnetic resonance imaging, computed tomography, and intracardiac echocardiography in facilitating invasive electrophysiology and ablation therapies.				III
20. Skill to follow-up, interrogate, and troubleshoot patients with implanted devices (permanent pacemakers, implantable cardioverter-defibrillators, cardiac resynchronization therapies), including remote interrogation.			II	
21. Skill to evaluate and manage patients with cardiac arrest.		I		
22. Skill to prescribe and interpret the results of electrocardiographic recording devices.		I		
Evaluation Tools: chart-stimulated recall, patient safety or quality improvement conference presentation, direct observation, global evaluation, logbook, simulation				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Utilize an interdisciplinary coordinated approach for patient management, including transfer of care and employment-related issues.		I		
2. Use technology and available registries to assess appropriateness, performance, and safety of implanted devices.		I		
3. Incorporate risk/benefit analysis and cost considerations in diagnostic and treatment decisions.		I		
Evaluation Tools: chart-stimulated recall, direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.		I		
2. Utilize decision support tools for accessing guidelines and pharmacologic information at the point of care.		I		

Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, logbook				
Professionalism	**12**	**24**	**36**	**Add**
1. Demonstrate sensitivity to patient preferences and end-of-life issues.		I		
2. Practice within the scope of expertise and technical skills.		I		
3. Interact respectfully with patients, families, and all members of the healthcare team, including ancillary and support staff.	I			
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate with and educate patients and families across a broad range of cultural, ethnic, and socioeconomic backgrounds.		I		
2. Engage in shared decision-making with patients, including decisions regarding options for diagnosis and treatment.		I		
Evaluation Tools: direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

4.2. Number of Procedures and Duration of Training

The specific competencies for Levels I, II, and III are delineated in Table 1. Level I competencies must be obtained by all fellows during the 3-year cardiovascular disease fellowship training program. Level II competencies may be obtained during the cardiovascular disease fellowship by selected fellows depending on their career focus and elective experiences. Level III competencies are noted so that fellows are aware of the competencies for which additional, advanced training beyond the standard 3-year fellowship is required. Details for advanced training will be included in an updated version of the 2006 Clinical Competence Statement on Invasive Electrophysiology Studies, Catheter Ablation, and Cardioversion (5), which is currently under revision. The minimum duration of training and volume of procedures required for Level I and Level II training in CCEP are summarized in Tables 2 and 3. Although these minimum training durations and numbers of procedures are typically required to obtain the competency levels, trainees must also demonstrate achievement of the competencies as assessed by the outcomes evaluation measures. A brief discussion of the competencies and training requirements follows.

Table 2. Cardiac Arrhythmia and Electrophysiology Curriculum Training Summary for 3-Year Cardiovascular Fellowship Training Program

Level	Curriculum/Skills	Time Requirement	Optional Training in Device Implantation
I	Cardiac arrhythmia and electrophysiology core	2 months (in addition to Task Force 2 training requirements)	No
II	Advanced noninvasive arrhythmia management	6 months	Level II trainees who wish to implant permanent pacemakers and ILRs may receive this training during this 6-month period of time.

Table 3. Core Cardiac Arrhythmia and Electrophysiology Curriculum Training for 3-Year Cardiovascular Fellowship Training Program

Level	Minimum Number of Procedures	Cumulative Duration of Training
I	5 temporary pacemakers 20 cardioversions	2 months
II	***For Level II training alone (without training in pacemaker implantation):*** - 100 CIED interrogations/programming - 25 remote device interrogations ***For Level II training, including pacemaker implantation:*** - 40 permanent pacemaker implantations with at least 20 single-chamber and 20 dual-chamber pacemakers	6 months

CIED = cardiac implantable electrical device.

4.2.1. Level I Training Requirements

Level I training should occupy at least 2 months on a CCEP rotation designed to acquire knowledge, skills, and experience in the diagnosis and management of arrhythmias (Table 1). Level I training should focus on the value of the clinical history in the diagnosis of cardiac arrhythmias and the ECG interpretation of arrhythmias, including differentiation of supraventricular from ventricular tachycardia. Also important for Level I training is exposure to the noninvasive diagnosis of cardiac arrhythmias, including ambulatory ECG monitoring (see COCATS Task Force 2 recommendations), event recorders, ILRs, exercise testing for arrhythmia assessment, and tilt-table testing. Exposure to invasive EP studies (including measurements of AH and HV intervals, and basic activation sequences) should be provided in Level I training to allow understanding of the role of invasive EP testing in diagnosis of cardiac arrhythmias. The Level I trainee should understand the basic concepts of catheter ablation, including indications, contraindications, techniques and potential complications. Similarly, the Level I trainee should understand the basic concepts of CIEDs, including the indications, techniques, and potential complications of ICDs and biventricular pacemakers. Knowledge of the fundamentals of cardiac pacing should encompass recognition of normal and abnormal pacemaker function (2); pacing modes; and techniques of interrogation, programming, and surveillance of pacemakers and ICDs. Instruction in cardiac pacing should emphasize the indications, cost-effective use, and limitations of these devices. Level I trainees should understand the proper use of anticoagulant and antiarrhythmic agents, including their toxicity, and drug-drug and drug –device interactions.

The cardiovascular trainee should be instructed in and gain experience with the indications for insertion, management, and follow-up of temporary pacemakers (2), including measurement of pacing and sensing thresholds, recording of intracardiac electrograms, and recognition of procedure-related complications. The cardiovascular trainee should also be instructed in and gain experience with cardioversion and cardiac defibrillation (17). Temporary pacemaker and cardioversion procedures may be performed in the cardiac catheterization laboratory, electrophysiology laboratory, cardiac care unit, or other critical care settings. Instruction leading to acquisition of the core competencies required of Level I trainees should meet the minimum procedural volume criteria detailed in Table 3. These experiences and skills should be obtained throughout the cardiovascular clinical training period and be integrated with formal didactic ECG conferences, core curriculum sessions, and rotation on the arrhythmia consultation service.

4.2.2. Level II Training Requirements

Trainees who wish to have more training in cardiac EP should be enrolled in programs that include specific inpatient services and outpatient clinics designed for patients requiring therapy for cardiac arrhythmias and conduction disorders, as described for Level I; however, in addition to ensuring a curriculum that satisfies the specifics of Level I training, such programs must offer greater intensity and exposure to a broader spectrum of therapeutic modalities. Level II training can be accomplished within the scope of the 3 years of initial cardiovascular training. Trainees in a Level II curriculum should actively participate in didactic activities relating more specifically to EP, including research conferences, seminars, and journal clubs with cardiac electrophysiological disorders as a primary focus.

Level II training involves more advanced knowledge and skills than Level I training but less than the comprehensive training in cardiac EP required for Level III training. Level II training typically involves 6 months of training in mechanisms of arrhythmia; pharmacology of antiarrhythmic and anticoagulant drugs; and noninvasive and invasive techniques of diagnosis, treatment, and longitudinal care of patients with complex arrhythmias.

The Level II trainee should acquire the skills and experience to manage patients with CIEDs, including permanent pacemakers, ICDs, biventricular pacemakers, and ILRs. Level II trainees who wish to implant permanent pacemakers may spend time during their 6 months of dedicated Level II training implanting permanent pacemakers. Level II training obtained during a standard 3-year clinical cardiovascular fellowship does not qualify the trainee to implant defibrillators or biventricular devices. Rather, defibrillator and biventricular device implantation requires Level III training in invasive CCEP or an additional 12 months of dedicated training in ICD and biventricular device implantation and management. During this additional 12-month period, the volume requirements for device programming and ICD and biventricular device implants must be met. The core competencies appropriate for Level II training, including minimum procedural volume criteria, are outlined in Table 3.

4.2.2.1. Optional Training in Pacemaker Implantation (Level II)

Those who have obtained Level II training and wish to implant permanent single- and dual-chamber pacemakers should spend time implanting permanent pacemakers during the 3-year cardiovascular fellowship program if 6 months is dedicated to acquiring the knowledge and skills pertaining to permanent pacemaker implantation and related patient management and follow-up. Competence in the indications for, implantation techniques, and follow-up of ILRs is desirable. This training does not satisfy the ABIM requirements for admission to the CCEP examination and is not considered adequate training to implant implantable defibrillators.

4.2.3.1. Training in Defibrillator Implantation

Individuals who spend an additional 12 months (beyond a standard 3-year cardiovascular fellowship) obtaining additional training in ICD, biventricular device, and pacemaker implantation without satisfying the full requirements for Level III training in Advanced Cardiac Electrophysiology (Level III training) can be granted privileges to implant CIEDs, including ICDs and biventricular devices. It is recommended that this type of training for CIED implantation follow the aforementioned COCATS requirements. Although these individuals are not eligible for the ABIM EP Board Examination, they may be candidates for the International Board of Heart Rhythm Examiners (IBHRE) physician examination (18).

4.2.3. Level III Training Requirements

The ACGME has defined the essential components of a specialized program for training in CCEP; the ABIM offers an examination for this additional certification. Information concerning the eligibility requirements for the examination can be obtained from the ABIM. Privileges to perform invasive procedures should be based mainly on satisfactory completion of the training outlined in this document, including demonstration of competence and technical expertise.

Level III training prepares the physician to specialize in invasive CCEP (5, 19, 20). Level III trainees should meet all Level II training requirements and obtain additional, advanced training in performing diagnostic EP procedures, catheter-based ablation procedures, and implantation of ICDs and biventricular pacemakers. The minimal procedure volume requirements are provided in the Clinical Competency Statement (5, 19, 20). The Clinical Competency Statement for training in electrophysiology will be replaced by an ACC/American Heart Association/HRS Electrophysiology Advanced Training Statement currently under development. The appropriate use, safe performance, and judicious interpretation of these complex procedures require highly specialized training for competence to be achieved. Advanced understanding of CCEP and cardiac pharmacology is required along with the technical and cognitive skills to manage patients with complex arrhythmias.

Level III training should include performing diagnostic EP procedures for a variety of indications, including evaluation of syncope, determination of the precise mechanism of supraventricular arrhythmias, and risk-stratification in patients with malignant arrhythmias. In many patients, these diagnostic EP procedures may be performed in conjunction with planned catheter ablation procedures for treatment of supraventricular arrhythmias. Level III training in EP requires experience in left ventricular lead implantation procedures, ICD implantation, and performance of pacing and defibrillation threshold testing at the time of implantation and during follow-up.

Level III training in preparation for the CCEP Board examination includes training in implantable defibrillator implantation, during which the physician should develop expertise in the placement of permanent atrial, right and left ventricular, and ICD leads. Trainees should also develop expertise in the implantation and testing of subcutaneous ICDs. This entails adhering to principles of surgical asepsis, mastering surgical implantation techniques, and managing implant-related complications. Trainees in implantable defibrillator implantation should acquire extensive knowledge of the indications for and contraindications to ICDs; thorough understanding of advanced ICD electrocardiography; knowledge of drug-device interactions; competency in interrogation and programming of complex pacemaker and ICD systems; expertise in threshold testing, ventricular fibrillation induction, and defibrillator testing; experience in managing device-related complications; and competence in managing high pacing, defibrillation thresholds, and device malfunction. Level III trainees gain extensive knowledge of the indications for placement of left ventricular leads, contraindications, and management of biventricular device malfunctions and interactions. Because competency in these procedures is related to caseload, minimal procedural volumes must be satisfied during Level III training.

5. Evaluation of Competency

Evaluation tools in cardiac arrhythmia diagnosis, pacing, and electrophysiology include direct observation by instructors, in-training examinations, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, and simulation. Case management, judgment, interpretive, and bedside skills must be evaluated in every trainee. Quality of care and follow-up; reliability; judgment, 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 (HIPAA)-compliant electronic database or logbook that meets ACGME reporting standards and summarizes pertinent clinical information (e.g., number of cases, diversity of referral sources, diagnoses, disease severity, outcomes and disposition).

The ACC, American Heart Association, and HRS have formulated a clinical competence statement on invasive EP studies, catheter ablation, and cardioversion (5). Self-assessment programs and competence examinations in ECG are available through the ACC and other organizations. Training directors and trainees are encouraged to incorporate these resources in the course of training.

Under the aegis of the program director, the 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 ensuring achievement of selected training milestones and identifying areas in which additional focused training may be required.

Key Words: ACC Training Statement ▪ COCATS ▪ fellowship training ▪ clinical competence ▪ electrophysiology ▪ pacemakers ▪ implantable defibrillators ▪ cardiac arrhythmias.

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 11: TRAINING IN SPECIALIZED ELECTROPHYSIOLOGY, CARDIAC PACING, AND ARRHYTHMIA MANAGEMENT

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF11_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 11: TRAINING IN SPECIALIZED ELECTROPHYSIOLOGY, CARDIAC PACING, AND ARRHYTHMIA MANAGEMENT

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ACC = American College of Cardiology.

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

CIED = cardiac implantable electrical devices

COCATS = Core Cardiovascular Training Statement

CRT = resynchronization devices

ECG = electrocardiographic

EP = electrophysiology

HIPAA = Health Insurance Portability and Accountability Act

HRS = Heart Rhythm Society

ICD = implantable cardioverter-defibrillator

ILR = implantable loop recorder

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COCATS 4 Task Force 12: Training in Heart Failure[14]

Endorsed by the Heart Failure Society of America

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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The Writing Committee was selected to represent the American College of Cardiology (ACC) and the Heart Failure Society of America (HFSA) and included a cardiovascular training program director, a heart failure training program director, an HFSA representative, an early-career cardiologist, highly experienced specialists representing both the academic and community-based practice settings, and physicians experienced in defining and applying training standards according to the 6 general competency domains promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialties (ABMS) and endorsed by the American Board of Internal Medicine (ABIM). The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiovascular training statement. Employment and affiliation details for authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF12_Comprehensive_RWI_Supplement.pdf).

1.1.2. Document Development and Approval

The writing committee developed the document, approved it for review by individuals selected by the ACC and HFSA, and then addressed the reviewers' comments. The document was revised and posted for public comment from December 20, 2015 to January 6, 2015. Authors addressed additional comments to complete the document. The final document was approved by the Task Force, COCATS Steering

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Committee, and ACC Competency Management Committee; ratified by the ACC Board of Trustees in February, 2015; and endorsed by the HFSA. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

The Task Force was charged with updating published standards for training fellows in clinical cardiology enrolled in fellowship programs (1-4) on the basis of changes in the field since 2008 (3) and as part of a broader effort to establish consistent training criteria across all aspects of cardiology. This document does not provide specific guidelines for training advanced cardiovascular subspecialty areas but identifies opportunities to obtain advanced training where appropriate. The Task Force also updated previously published standards to address the evolving framework of competency-based medical education described by the ACGME Outcomes Project and the 6 general competencies endorsed by ACGME and ABMS. The background and overarching principles governing fellowship training are provided in the Introduction to COCATS, and readers should become familiar with this foundation before considering the details of training in a subdiscipline like heart failure. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally over time.

For most areas of adult cardiovascular medicine, 3 levels of training are delineated:

Level I training is the basic training required for trainees to become competent consultant cardiologists. It is required of all fellows in cardiology and can be accomplished as part of a standard 3-year training program in cardiology. In the case of heart failure, Level I training will provide an understanding of the depth and breadth of the heart failure syndrome, as well as nuances of diagnosis and management, including the important topic of heart failure prevention. Trainees should understand which heart failure patients should be considered for implantable cardioverter-defibrillators, cardiac resynchronization therapies, or more advanced therapies such as cardiac transplant or mechanical circulatory support (MCS). (In this document, MCS represents both durable ventricular assist devices and temporary mechanical support, such as intra-aortic balloon pumps, or the Impella device).The trainee should be able to delineate the potential risks and benefits of these therapies for heart failure patients and provide appropriate referral.

Level II training refers to additional training in 1 or more areas that enables some cardiologists to perform or interpret specific procedures or render more specialized care for patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training in selected areas may be achieved by some trainees during the standard 3-year cardiovascular fellowship, depending on the trainee's career goals and use of elective rotations. It is anticipated that during a standard 3-year cardiovascular fellowship training program, sufficient time will be available to receive Level II training in a specific subspecialty. In the case of heart failure, Level II training will be for those individuals who wish to develop expertise in caring for heart failure patients, particularly those with more advanced and challenging syndromes. This curriculum can, in particular, provide the opportunity to learn to manage devices (other than durable MCS) implanted for heart failure therapy, arrhythmia, or hemodynamic monitoring. Level II will also emphasize more detailed hemodynamic assessment of these patients and will focus on transitions of care for heart failure patients as well as the systems of care that are necessary to avoid hospital admission and/or readmission. Level II training also prepares individuals with a focused interest in heart failure to develop expertise sufficient to perform an initial screen for advanced therapies of individuals cared for at non-transplant /non-durable MCS facilities, in collaboration with Level III-trained individuals at advanced therapy sites.

Level III training requires additional training and experience beyond the cardiovascular fellowship for the trainee to acquire 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. In the case of heart failure, Level III training is directed at those who anticipate focusing the majority of their clinical or research activities on the syndromes of heart failure, with a curriculum requiring additional fellowship training beyond that required for cardiovascular specialization board examination. It is recognized that not all cardiovascular fellowship training programs are capable of providing the most intense Level III training curriculum. Level III training is covered in a range of programs that might include heart transplantation, mechanical circulatory support devices, advanced heart failure electrophysiology, and end-of-life management skills,although not necessarily all of these. See further resources for ABIM policies and ACGME training requirements (5). Level III training is described here only in broad terms to provide context for trainees and clarify that these advanced competencies are not covered during the cardiovascular fellowship. The additional exposure and requirements for Level III training will be addressed in a subsequent, separately published Advanced Training Statement.

2. General Standards

Three organizations—the ACC, American Heart Association, and HFSA—have addressed training requirements and guidelines for the management of patients with heart failure in both inpatient and outpatient settings (2,4,6). The recommendations are congruent and address faculty, system requirements, management, emerging technologies, and practice. We recommend strongly that candidates for the ABIM examination for certification in cardiovascular diseases, as well as those seeking certification of added qualifications in Advanced Heart Failure and Transplantation (AHFT), review the specific requirements of the ABIM documents (5,7).

Cardiovascular fellowship programs should satisfy the requirements regarding facilities and faculty for training in heart failure. Eligibility for the ABIM AHFT examination requires that training take place in a program accredited by the ACGME. The intensity of training and required resources vary according to the level of training provided. The recommended number of cases, procedures, and experiences is based on published guidelines (2,4), competency statements (6), and the experience and opinions of the writing group. It is assumed that training is directed by appropriately trained mentors in an ACGME-accredited program (7) and that satisfactory completion of training is documented by the program director. The number and types of encounters and the duration of training required for trainees are summarized in Section 4.

2.1. Faculty

Faculty should include specialists skilled in evaluating heart failure patients and in the pharmacologic, catheter-based, and surgical aspects of heart failure care. For a program to be certified to train candidates for AHFT, there must be a minimum of 2 key clinical, board-certified, AHFT faculty members, including the program director. To provide Level I training in heart failure, however, faculty need not be board-certified in AHFT.

2.2. Facilities

Facilities should be adequate to ensure a safe, sterile, and effective environment for the optimal management of patients with heart failure of all etiologies and severity. In addition, outpatient clinical facilities should be available for training in the consultative aspects of heart failure management, including appropriate referral for advanced therapies such as transplant or MCS devices.

3. Training Components

3.1. Didactic Program

During training, fellows should actively participate in didactic activities relating specifically to heart failure. The core curriculum of the fellowship program should include didactics focused on providing the trainee with appropriate medical knowledge in heart failure. At a minimum, such a program should provide the trainee with knowledge of current heart failure guidelines as well as an understanding of the medical knowledge milestones expected for Level I training. Additionally, didactic opportunities to acquire Level II medical knowledge should be available to interested trainees. In addition to the core curriculum, the didactic portion of training should include research conferences and journal clubs with the heart failure syndrome as their primary focus and include topics related to enhancement of patient safety and resource management.

3.1.1. Heart Failure Disease Management

Education and counseling strategies include: a) the importance of nonpharmacologic, as well as pharmacologic, management; b) end-of-life care, including care options and participation in a interdisciplinary palliative care team; c) assessment for quality of life, psychological problems (e.g., anxiety and depression), cognitive impairment, literacy problems, social isolation, financial problems, and other barriers to adherence and risk factors for rehospitalization; d) management of heart failure with multiple comorbidities; e) collaboration and skill as a team leader with nurses, dietitians, social workers, pharmacists, and other health professionals in the management of patients to stabilize or improve health status and prevent hospitalization; and f) transitional care principles, that is, facilitating communication between caregivers and physician extenders.

3.2. Clinical Experience

Trainees must have formal instruction and clinical experience in the following specific areas to attain Level I curricular milestones:

1. Basic disease mechanisms leading to syndromes of acute and chronic systolic and diastolic heart failure
2. Clinical trial evidence relevant to heart failure management
3. Indication, prescription, pharmacology, adverse effects, and appropriate monitoring of all classes of drugs relevant to the heart failure patient, including those known to benefit patients with heart failure, those suspected of benefiting patients with heart failure, and those known or suspected of adversely affecting patients with heart failure, in both the acute and chronic settings
4. Indication and prescription of nonpharmacologic/nondevice treatment modalities in heart failure, including diet, exercise,and patient's involvement in daily clinical assessment such as weight, fluid intake, and exercise capacity
5. Indications for cardiac transplantation and both durable and non-durable mechanical circulatory support devices
6. Recognition of differences in appropriate management and response to therapy based on differences in etiology, cardiac structure and function, age, gender, ethnic background, and genetics
7. Impact of psychosocial factors on the manifestations, expression, and management of heart failure
8. Existence, importance, and management of common comorbidities encountered in patients with heart failure, including but not limited to obesity, metabolic syndrome, diabetes, sleep breathing disorders, depression, anxiety, and sexual dysfunction

These scenarios represent a broad and basic spectrum of clinical heart failure. It is accepted that for some specific situations (i.e., heart failure patients with congenital heart disease or pregnancy-related heart failure states), clinical material may not be readily available. In those specific situations, didactic and interactive, case-based training would be an acceptable substitute for formal inpatient or outpatient clinical exposure.

3.2.1. Prevention of Heart Failure

With respect to heart failure prevention, trainees must have formal instruction regarding conditions and factors known to predispose patients to, or exacerbate, heart failure syndromes. Specifically, a curriculum that emphasizes comprehensive cardiovascular risk factor modification more generally (e.g., primary and secondary prevention of coronary artery disease, treatment of hypertension), and with respect to the heart failure syndrome specifically, will be required. Trainees are expected to know the risk factors associated with the development of heart failure and the pathophysiology of myocardial cellular dysfunction, ventricular remodeling, and ventricular dysfunction.

3.3. Hands-On Experience

Hands-on experience is required for effective training in heart failure management. During rotations in the cardiac care unit, trainees should assess and manage the variety of heart failure patients referred to above, including appropriately referring heart failure patients for surgery, devices, and advanced therapies. In addition to inpatient experience, Level I and II trainees are expected to gain experience managing outpatients with mild-to-moderate chronic heart failure and to determine the appropriate medical and device therapies for these patients.

4. Summary of Training Requirements

4.1. Development and Evaluation of Core Competencies

Training and requirements in heart failure address the 6 general competencies promulgated by the ACGME/ABMS 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 the components of the core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 1 delineates each of the 6 competency domains as well as their associated curricular milestones for training in heart failure. The milestones are categorized into Level I, Level II, and Level III training (as previously defined in this document) and indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Given that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may also vary. Level I competencies may be achieved at earlier or later time points. Acquisition of Level II skills requires additional training that may be completed during the standard 3-year cardiovascular fellowship. Level III skills require additional training in a dedicated advanced heart failure program after completion of the general cardiovascular fellowship. The table also describes examples of evaluation tools suitable for assessment of competence in each domain.

Table 1. Core Competency Components and Curricular Milestones for Training in Heart Failure

Medical Knowledge	Milestones (Months)			
	12	24	36	Add
1. Know the pathophysiology, differential diagnosis, stages, and natural history of heart failure.		I		
2. Know the characteristic history and physical exam findings, and their limitations, in evaluation of heart failure syndromes.	I			
3. Know the pathophysiology of heart failure at the molecular, cellular, organ, and organismal levels, with emphasis on the roles of neurohormonal activation and left ventricular remodeling in disease progression.		I		
4. Know the indications, contraindications, and clinical pharmacologyfor drugs used for treatment of heart failure, including adverse effects.	I			
5. Know the indications, contraindications, and clinical pharmacology for the drugs used for the treatment of heart failure of all etiologies and degrees of severity and in special populations.			II	
6. Know the indications and clinical rationale for the pharmacologic management of patients implanted with mechanical circulatory support.				III
7. Know the indications, contraindications, and clinical pharmacology for intravenous, vasoactive, and inotropic drugs used for cardiovascular support in advanced/refractory heart failure.		I		
8. Know the appropriate pharmacologic or nonpharmacologic treatment for the prevention of heart failure in patients with either "pre" or "established" heart failure.	I			
9. Know the clinical pharmacology and use of immunosuppressive medications and other interventions in heart transplant patients in the treatment of acute rejection.			II	
10. Know the types of and indications for mechanical circulatory support.			II	
11. Know the effects and interactions of heart failure with other organ systems (kidney, nutritional, metabolic) and in the setting of other systemic disease.		I		
12. Know the management of cardiac arrhythmias in heart failure patients, as well as the indications and risks of use of implantable cardioverter-defibrillator and cardiac resynchronization therapies.		I		
13. Know the indications for referral for cardiac transplantation.		I		
14. Know the late stage complications of heart failure in patients with congenital heart disease.				III
15. Know the management and diagnostic strategies for populations with heart failure not due to ischemic heart disease, including infiltrative and restrictive			II	

cardiomyopathies, inherited cardiomyopathies, and those associated with pregnancy and chemotherapy.				
16. Know the management strategies for highly specialized populations with heart failure, including those associated with congenital heart disease and chronic pulmonary disease.				III
Evaluation Tools: chart-stimulated recall, direct observation, in-training exam				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to evaluate and manage patients with new-onset, chronic, and acute decompensated heart failure.	I			
2. Skill to evaluate and manage patients with severe heart failure despite treatment.			II	
3. Skill to evaluate and manage patients with mechanical circulatory support or after heart transplant.				III
4. Skill to appropriately obtain and incorporate data from the history, laboratory studies, and imaging modalities in evaluation and management of heart failure patients.	I			
5. Skill to interpret imaging results in the evaluation of heart failure patients.		I		
6. Skill to interpret imaging results found in advanced, rare, or uncommon forms of heart failure.				III
7. Skill to use history and physical examination findings to accurately assess volume status and perfusion in patients with heart failure.			II	
8. Skill to perform invasive hemodynamic monitoring.		I		
9. Skill to incorporate the results of hemodynamic measurements and monitoring to make appropriate management decisions in heart failure patients of all etiologies and severity.			II	
10. Skill to incorporate results of hemodynamic measurements and monitoring to make appropriate management decisions in complex or advanced heart failure patients of all etiologies and severity or in patients with mechanical circulatory support.				III
11. Skill to identify appropriate candidates for palliative care and hospice.		I		
12. Skill to recognize and manage cardiac arrhythmias, including the identification of appropriate candidates for implantable cardioverter-defibrillators, cardiac resynchronization therapy, or arrhythmia ablation.		I		
13. Skill to select and implement appropriate arrhythmia management, including utilization of implantable cardioverter-defibrillators, cardiac resynchronization therapy, and ablation of arrhythmias in patients with heart failure of all etiologies and severity.			II	
14. Skill to manage patients with advanced heart failure and complex arrhythmias, including patients with mechanical circulatory support, in conjunction with clinical cardiac electrophysiologists.				III
15. Skill to recognize and manage comorbidities in heart failure patients.		I		
16. Skill to manage heart failure patients with complex contributing comorbidities.			II	
17. Skill to identify and manage patients who require transition from hospital to home or to a care facility while on infusion of inotropic or vasoactive agents.			II	
18. Skill to identify and manage patients who require transition from hospital to home or to a care facility after heart transplant or permanent mechanical circulatory support.				III
19. Skill to appropriately utilize initial screening studies to determine patient eligibility for advanced therapies of individuals cared for at non-transplant / non-ventricular assist device facilities, in collaboration with Level III-trained individuals, who work at advanced therapy sites.			II	
20. Skill to evaluate, order all appropriate testing, and determine the appropriateness of a patient for cardiac transplant or mechanical circulatory support.				III
21. Skill to interpret and incorporate results of cardiopulmonary exercise testing into management of heart failure patients, including physical activity and exercise recommendations.			II	
22. Skill to recognize, manage, and seek appropriate consultation for depression or		I		

undue anxiety in heart failure patients as part of their overall care.				
Evaluation Tools: chart-stimulated review, direct observation, multisource evaluation				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Utilize appropriate care settings and teams for various levels and stages of heart failure.		I		
2. Incorporate risk/benefit analysis and cost considerations in diagnostic and treatment decisions.		I		
3. Identify and address financial, cultural, and social barriers to diagnostic and treatment recommendations.	I			
4. Utilize an interdisciplinary, coordinated, team approach for patient management, including care transitions, palliative care, and employment-related issues.		I		
5. Effectively utilize an interdisciplinary approach to monitor the progress of ambulatory patients with heart failure to maintain stability and avoid preventable hospitalization.			II	
6. Identify the financial, social, and emotional barriers to successful outcomes after surgery.				III
Evaluation Tools: chart-stimulated recall, direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.		I		
2. Utilize decision support tools for accessing guidelines and pharmacologic information at the point of care.			II	
Evaluation Tools: conference presentation, direct observation, global evaluation, reflection and self-assessment				
Professionalism	**12**	**24**	**36**	**Add**
1. Show compassion and effective management of end-of-life issues, including family meetings across the spectrum of patients with heart failure.	I			
2. Clearly and objectively discuss the therapies available for advanced heart failure, including palliative care, transplant, or mechanical circulatory support.				III
3. Interact respectfully with patients, families, and all members of the healthcare team, including ancillary and support staff.	I			
Evaluation Tools: conference presentation, direct observation, multisource evaluation, reflection and self-assessment				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate with and educate patients and families across a broad range of cultural, ethnic, and socioeconomic backgrounds.	I			
2. Engage in shared decision-making with patients, including options for diagnosis and treatment.		I		
3. Effectively lead and communicate with the interdisciplinary team involved in heart transplant and mechanical circulatory support.				III
Evaluation Tools: direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

4.2. Number of Procedures, Cases, and Duration of Training

The goals of the Heart Failure Milestones and Competencies are to ensure that cardiovascular medicine trainees acquire an appropriate degree of skill and knowledge in the care of patients with heart failure at basic (Level I) or more refined levels (Levels II and III). Training directors and trainees are encouraged to incorporate this resource in the course of training. The specific competencies for Levels I, II, and III are delineated in Table 1. Trainees in cardiology should spend a minimum of 2 months on a heart failure consultation service to acquire the core competencies identified in Table 1. Level I competencies must be obtained by all fellows during the 3-year cardiovascular disease fellowship training program. Level II competencies may be obtained during the cardiovascular disease fellowship by selected fellows depending on their career focus and elective experiences. Level III competencies are noted so that fellows are aware of the competencies for which additional, advanced training beyond the standard 3-year fellowship is required. A brief discussion of the competencies and training requirements for Levels I, II, and III follow. There are no volume or procedural requirements for heart failure training at Levels I and II. Please refer to the ACGME program requirements for an outline of procedures and volume requirements for Level III training. Although the training duration and numbers of procedures are typically required to obtain competency, trainees must also demonstrate achievement of the competencies as assessed by the outcomes evaluation measures.

This training scheme recognizes that there is an ever-increasing number of treatments and interventions that improve outcomes and significantly alter the course of the heart failure syndrome. These treatments have generally increased the complexity of care. Thus, additional and special expertise are needed to best effect and improve utilization of many heart failure evaluation and treatment strategies. It is also recognized that a significant portion of initial and follow-up care for heart failure patients will continue to be under the purview of cardiologists and primary care clinicians; however, the more advanced Level II and III programs will provide increased sophistication and more skills necessary to manage advanced heart failure syndromes.

It is important to point out that Level III training and subsequent competency do not necessarily equate with the level of experience in cardiac transplantation required for qualification as a heart transplant physician under United Network of Organ Sharing (UNOS) criteria (8). It is anticipated that a much broader group of individuals will be interested in establishing competency in advanced heart failure cardiology than will be directly managing patients undergoing cardiac transplantation. Nonetheless, many programs will offer an experience within the Level III curriculum that can establish heart transplant physician competency according to UNOS criteria.

4.2.1. Level I Training Requirements

The heart failure training Level I curriculum must ensure that trainees have formal instruction and clinical experience in the evaluation and management of a full spectrum of heart failure patients within the first 2 years of training. The fellow must have access to a patient population with a variety of clinical problems and stages of diseases. The patient population must include patients of each gender and a broad age range, including geriatric patients.

The fundamental concepts of heart failure's pathophysiology and its treatment should be understood by all trainees in cardiovascular medicine as part of the Level I training curriculum. Training in the clinical management of heart failure should include supervised experience in both inpatient and outpatient settings and expose the trainee to a broad spectrum of underlying causes of heart failure. Trainees should be well acquainted with the nuances of therapy for heart failure that are specific to different etiologies and should be well informed about the pharmacology of standard cardiovascular drugs used to treat heart failure. Trainees should also be aware of the treatment strategies for patients with both chronic disease and acute exacerbations. An important element of the curriculum will be to train clinicians to appropriately refer heart failure patients for pacemaker, defibrillator, and percutaneous cardiovascular interventions; surgical procedures (including insertion of mechanical circulatory support devices); and cardiac transplantation. Through interaction with this variety of patients, the trainee will acquire necessary competence and subsequent expertise as outlined in the milestones table (Table 1).

4.2.2. Level II Training Requirements

Trainees who wish to have more training in advanced heart failure should be enrolled in programs that include specific outpatient clinics and inpatient services designed for patients requiring therapy for heart failure, as described for Level I; however, in addition to ensuring a curriculum that satisfies the specifics of Level I training, such programs must offer a greater intensity and exposure to a broader spectrum of heart failure therapy modalities. Level II training can be accomplished within the scope of the 3 years of initial cardiovascular training, generally during the third year of the cardiovascular training program. Trainees in a Level II curriculum should actively participate in didactic activities relating more specifically to heart failure, including research conferences, seminars, and journal clubs, with the heart failure syndrome as the primary focus.

In addition to satisfying all Level I competencies outlined in Table 1, trainees should have experiences in interpreting the hemodynamic data of advanced heart failure patients during acute and chronic interventions and during prognosis assessment. Alternatively, they might spend more time in the outpatient heart failure clinics, where exposure to a broader range of patients with heart failure will occur. Level II trainees should develop a fundamental understanding of emerging genetic risk factors and biomarkers for the development of heart failure and the use of genetic markers and biomarkers as strategies for heart failure prevention (9).

4.2.3. Level III Training Requirements

In addition to the curriculum specified in Levels I and II training, fellows should have formal instruction and attain understanding of the following for Level III competency:

1. Advanced training in cellular, cardiomyocyte, and extracellular matrix biology, including calcium dysregulation; mechanisms of arrhythmia generation; beta-receptor abnormalities; mechanisms of apoptosis, stem cells and regeneration; metabolic abnormalities of the failing myocyte; and the roles of matrix remodeling in the progression of heart failure

2. Genetics, including common mutations leading to hypertrophic and dilated cardiomyopathies and an understanding of genetic polymorphisms related to both myocardial disease and targeted heart failure treatment.

To qualify for heart failure Level III training, fellows must have a more in-depth and formal instruction in heart failure disease management, have clinical experience, and demonstrate proficiency as part of an interdisciplinary care team in a clinical setting dedicated to heart failure. Managing interdisciplinary heart failure clinics and home-based care services is envisioned as a primary role of the advanced heart failure cardiologist, who should achieve proficiency in: a) specific behavioral strategies to enhance adherence to a heart failure therapeutic regimen; b) supervision of home-based titration and monitoring of diuretics and evidence-based medications, with surveillance for renal dysfunction and electrolyte disturbances; and c) the comprehensive education and counseling needs of heart failure patients and family members.

Level III training requires further demonstration of proficiency in additional arenas that include exposure to patients with more advanced or challenging heart failure conditions. Level III trainees should spend a considerable amount of time acquiring expertise in the evaluation and management of patients with advanced heart failure, including the hemodynamic evaluation of such inpatients and outpatients, referral for devices such as implantable cardioverter-defibrillators or cardiac resynchronization therapies, and the appropriate selection of patients for transplant or MCS devices.

Level III training requires an additional 12 months of training beyond that required for basic cardiovascular fellowship. A variety of curricula can be created to satisfy Level III training requirements. The competencies identified in Table 1 represent the core expectations or milestones. Other components are noted in Sections 3.1.3.1. and 3.1.3.2.

5. Evaluation of Proficiency

Evaluation tools in heart failure include direct observation by instructors, in-training exams, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, simulation, and reflection and self-assessment. Case management, judgment, interpretive, and bedside skills must be evaluated in every trainee. Quality of care and follow-up; reliability; judgment, 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 (HIPAA)-compliant electronic database or logbook that meets ACGME reporting standards and summarizes pertinent clinical information (number of cases, diversity of referral sources, diagnoses, disease severity, outcomes and disposition) for each encounter.

The ACC, American Heart Association, American College of Physicians, HFSA, and International Society for Heart and Lung Transplantation have formulated a clinical competence statement on the management of patients with advanced heart failure (10).

Under the aegis of the program director, the 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 at least twice annually to ensure achievement of selected training milestones and identify areas in which additional focused training may be required.

Key Words: ACC Training Statement ▪ COCATS ▪ fellowship training ▪ clinical competence ▪ heart failure.

AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 12: TRAINING IN HEART FAILURE

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF12_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELEVANT RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES—COCATS 4 TASK FORCE 12: TRAINING IN HEART FAILURE

Name	Employment	Representation	Consultant	Speaker's Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
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Dhanunjaya Lakkireddy	Kansas University Cardiovascular Research Institute	Official Reviewer, ACC Board of Governors	None	None	None	None	None	None
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Andrew Kates	Washington University School of Medicine	Content Reviewer, Academic Cardiology Section Leadership Council	None	None	None	None	None	None
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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ACC = American College of Cardiology, AHA = American Heart Association, HF&T = Heart Failure and Transplant, and HFSA = Heart Failure Society of America.

Appendix 3. Abbreviation List

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

AHFT = Advanced Heart Failure and Transplantation

COCATS = Core Cardiovascular Training Statement

HFSA = Heart Failure Society of America

HIPAA = Health Insurance Portability and Accountability Act

MCS = mechanical circulatory support

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COCATS 4 Task Force 13: Training in Critical Care Cardiology[15]

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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The writing committee was selected to represent the American College of Cardiology and included a cardiovascular training program director; a director of a coronary care unit; experts in advanced interventional procedures, cardiothoracic surgery, electrophysiology, and heart failure; early-career experts; highly experienced specialists representing both the academic and community-based practice settings; and physicians experienced in defining and applying training standards according to the 6 general competency domains promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialties (ABMS) and endorsed by the American Board of Internal Medicine (ABIM). The ACC determined that relationships with industry or other entities were not relevant to the creation of this cardiology training statement. Employment and affiliation details for authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF13_Comprehensive_RWI_Supplement.pdf).

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1.1.2. Document Development and Approval

The writing committee developed the document, approved it for review by individuals selected by the ACC, and then addressed the reviewers' comments. The document was revised and posted for public comment from December 20, 2014 to January 6, 2015. Authors addressed these additional comments from the public to complete the document. The final document was approved by the Task Force, COCATS Steering Committee, and ACC Competency Management Committee, and ratified by the ACC Board of Trustees in February 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

The field of critical care cardiology has evolved considerably over the past 2 decades. The coronary care unit of the 1970s and 1980s was populated most frequently by patients with acute—and often uncomplicated—myocardial infarction or unstable angina. Detection and rapid treatment of arrhythmias were the primary goals of therapy. Today, patients with acute coronary syndromes, including those with ST-segment elevation myocardial infarction who have undergone primary percutaneous coronary intervention, may be managed at some institutions in step-down units with continuous telemetry monitoring. At all institutions, contemporary critical care cardiology is increasingly focused on the management of patients with advanced hemodynamic compromise, complex ventricular arrhythmias, and established or incipient multi-organ failure, thus demanding a broader and more in-depth knowledge base and refined skill set than that expected of care providers in years past. In addition, at many institutions, increasing numbers of patients undergoing transcatheter valve therapies or ventricular assist devices are cared for in cardiac intensive care units. A premium is placed not only on the ability to participate in or lead interdisciplinary care teams in this environment, but also on the skills needed to ensure orderly transitions of care once patients are ready for transfer to less intensive hospital units or directly to a rehabilitation facility. The competencies important for the cardiovascular medicine fellow to achieve during critical care cardiology training have not been included in previous iterations of COCATS and are provided here in recognition of the need to define them within the context of this evolving and complex field. Many of the competencies pertinent to critical care cardiology will be acquired during other rotations; these include cardiac catheterization, electrophysiology, and advanced heart failure.

In addition, this report addresses the evolving framework of competency-based medical education described by the ACGME Outcomes Project and the 6 general competencies endorsed by ACGME and ABMS. The background and overarching principles governing fellowship training are provided in the Introduction to COCATS, and readers should become familiar with this foundation before considering the details of training in a subdiscipline like critical care cardiology. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally.

For most areas of cardiovascular medicine, 3 levels of training are delineated:

Level I training is the basic training required to become a competent cardiovascular consultant. This level of training is required of all cardiovascular fellows and can be accomplished as part of a standard 3-year training program in cardiovascular medicine. Cardiovascular fellows should be well equipped to manage the majority of patients in a critical care cardiology environment.

Level II training refers to additional training in 1 or more areas that enables some cardiovascular specialists to perform or interpret specific diagnostic tests and procedures or render more specialized care for patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training in selected areas may be achieved by some trainees during the standard 3-year cardiology fellowship, depending on the trainee's career goals and use of elective rotations. It is anticipated that during a standard 3-year cardiovascular fellowship training program, sufficient time will be available for trainees to receive Level II training in a specific subspecialty. Additional training of this type would signify a strong career interest in critical care cardiology. There are currently challenges to measurement and verification of these additional competencies that require further adjudication. Although some fellows may obtain enhanced procedural skills in the context of a 3-year cardiovascular medicine fellowship by spending additional time (3 to 6 months) dedicated to critical care cardiology experiences, there is currently no Level II designation in this field of cardiology.

Level III training requires advanced training and experience beyond the cardiovascular fellowship to acquire specialized knowledge and competencies in performing, interpreting, and training others to perform specific procedures or render advanced specialized care at a high level of skill. For critical care cardiology, Level III training involves completion of a 1-year clinical fellowship in critical care medicine within the Department of Medicine in addition to the 3-year cardiovascular medicine fellowship (1).

2. General Standards

The essentials of critical care cardiology should be taught to all fellows. Critical care training should be integrated into the fellowship program and include the evaluation and management of patients with acute, life-threatening cardiovascular illnesses; exposure to noninvasive and invasive diagnostic modalities commonly used in the evaluation of such patients; familiarity with both temporary and long-term mechanical circulatory support devices; and an understanding of the management of critically ill patients. The majority of critical care cardiology training will occur during dedicated rotations in the cardiac intensive care unit, as well as in the cardiac surgical intensive care unit; however, knowledge and skills relevant to critical care cardiology will also be integral components of other rotations, such as electrophysiology (See "COCATS 4 Task Force 11: arrhythmia diagnosis and management, cardiac pacing, and electrophysiology.), advanced heart failure and transplantation (2) ("COCATS 4 Task Force 12: heart failure"), cardiac catheterization ("COCATS 4 Task Force 10: cardiac catheterization"), and imaging (COCATS Task Forces 4 to 8: multimodality imaging, nuclear cardiology, cardiovascular computed tomography, cardiovascular magnetic resonance, respectively). Acquiring this fundamental knowledge will permit the fellow to diagnose a broad array of cardiovascular disorders, initiate appropriate medical management, and consult when necessary with other specialists to enable further evaluation and treatment. Importantly, the fellow will acquire the skills necessary to work with other care team members in the interdisciplinary management of critically ill patients and demonstrate competency in ensuring safe and orderly transitions of care. These recommendations are congruent with other training documents and address faculty and facility requirements, emerging technologies, and practice (1, 3, 4). We recommend that candidates for the ABIM examination for certification in cardiovascular diseases, as well as those seeking certification of added qualifications in critical care, review the specific requirements of the ABIM.

Cardiovascular fellowship programs should satisfy the requirements regarding faculty and facilities for training in critical care cardiology. Eligibility for the ABIM examination requires that training take place in a program accredited by the ACGME. The intensity of training and required resources vary with the level of training provided.

2.1. Faculty

Faculty should include dedicated cardiovascular specialists with extensive critical care experience as well as representatives from several cardiovascular specialty disciplines necessary for an interdisciplinary approach to critical care. Cardiovascular critical care specialists should possess adequate knowledge of pharmacological, device-based, and surgical therapies relevant to the field of critical care cardiology. Relevant faculty from various cardiovascular specialties participating in critical care training should include general cardiologists, electrophysiologists, coronary and structural interventionists, heart failure specialists, and surgeons (including those with knowledge of or specialization in the application of advanced hemodynamic support of critically ill patients). Other faculty expected to contribute to the care of critically ill cardiovascular patients include those with expertise in nephrology, neurology, pulmonary medicine, infectious diseases, gastroenterology, hematology, and anesthesiology. The cardiovascular critical care team also includes representation from nursing, pharmacy, respiratory care, nutrition, dialysis, physical/occupational therapy, social work, and hospital ethics committees, among others. All team members contribute to training the cardiovascular fellow in this environment.

There must be at least 1 key clinical faculty member dedicated to training fellows in critical care cardiology. This faculty member should be board-certified in cardiology and demonstrate that s/he is meeting requirements for maintenance of certification. In most instances, this individual will serve as the medical director of the critical care cardiology unit and assume responsibility for curriculum development and oversight, working in collaboration with the training program director. Sufficient numbers of qualified faculty experts in critical care cardiology must exist to provide direct supervision of all fellows as fellows rotate through the cardiac critical care unit. Critical care faculty should have sufficient experience with the indications for and contraindications to bedside diagnostic and treatment procedures to allow them to independently supervise fellows in their performance (see "COCATS 4 Task Force 10: cardiac catheterization" and COCATS 4 Task Force11: arrhythmia diagnosis and management, cardiac pacing, and electrophysiology").

2.2. Facilities

Facilities should be adequate to ensure a safe, supportive, efficient, and effective environment for the provision of critical care services to an increasingly complex patient population. The cardiac care unit must be of sufficient size to serve the patient load, with adequate space in each room as determined by staff and equipment needs. Providing separate rooms for each patient is optimal and isolation rooms either within or immediately available to the unit should be utilized as necessary. Sufficient workspace to accommodate staff functions, preferably in a centralized location allowing direct or indirect visualization of all patients at all times, is necessary. To augment routine monitoring of each patient, facilities should include appropriate equipment in each room and at the nursing station. Additional space and resources required for the safe performance of invasive procedures in the cardiac critical care unit (e.g., pulmonary artery catheter or temporary pacemaker placement) should be available.

2.3. Equipment

The critical care unit should be equipped to provide comprehensive bedside monitoring and support. Requirements include continuous electrocardiographic monitoring; invasive arterial, venous, and pulmonary arterial pressure monitoring; oxygen saturation monitoring; bedside imaging; mechanical circulatory support devices; and mechanical ventilator support devices. Equipment should be available for systemic cooling as part of hypothermia protocols and for renal replacement therapy when required. Electronic health record resources should be available to organize patient-related data efficiently and enhance communication among members of the critical care team.

2.4. Ancillary Support Capabilities

Ancillary support should be available to care for critically ill cardiovascular patients, including on-site access to all core cardiovascular and imaging services. These services include cardiac catheterization, echocardiography, and electrophysiology facilities, as well as comprehensive radiology services for brain, vascular, thoracic, abdominal, and pelvic imaging. Required support services also include cardiac surgery, anesthesia, endovascular and interventional radiology, vascular surgery, neurology, nephrology, pulmonary, social work, ethics, palliative care, and pharmacy services with 24/7/365 availability.

3. Training Components

3.1. Didactic Program

An important aspect of training in critical care cardiology is didactic instruction. Didactic sessions can occur in a variety of formats, including but not limited to lectures, conferences, journal clubs, grand rounds, and clinical case presentations. The majority of case-based teaching for critical care cardiology will occur during scheduled rotations in the critical care unit, but such teaching need not be limited to this care site. Rather, teaching that is relevant to the care of critically ill patients will occur throughout the fellowship training program.

3.2. Clinical Cases

Trainees should gain firsthand experience in the evaluation and management of critically ill cardiac patients during unit rotations that include a minimum exposure of 8 (not necessarily consecutive) weeks during the first 24 months of training. Exposure should allow the trainee to obtain the knowledge and skills required to manage the broad spectrum of acute coronary syndromes, mechanical complications of myocardial infarction, acutely decompensated severe heart failure, severe pulmonary hypertension with/without right ventricular failure, circulatory collapse/shock, acute severe heart valve disorders, pericardial tamponade, aortic dissection, hypertensive emergencies, massive or submassive pulmonary embolism, and life-threatening arrhythmias and cardiac conduction disorders. During this exposure, the trainee is expected to demonstrate understanding of and apply the findings from invasive hemodynamic monitoring to patient care and to recognize the indications for advanced interventional or surgical treatments, including mechanical circulatory support, coronary artery bypass grafting, percutaneous coronary intervention, heart valve repair/replacement (including transcatheter techniques), pericardiocentesis, open or endovascular aortic repair, and pulmonary embolectomy or fragmentation. The cardiac critical care unit experience should include opportunities to participate in and, when appropriate, lead interdisciplinary care teams, as noted in Section 2.1.

3.3. Hands-On Experience

Level 1 trainees should demonstrate knowledge and make appropriate use of medications necessary for the treatment of critically ill cardiac patients, including but not limited to inotropic, vasopressor, vasodilator, fibrinolytic, anticoagulant, antiplatelet, antiarrhythmic, sedative, analgesic, and paralytic agents. In addition, over the 24 months of clinical training—and in sequence with cardiac catheterization laboratory rotations—all trainees should develop the skills necessary to insert central venous lines, temporary transvenous pacemakers, radial arterial lines, and balloon-flotation pulmonary artery catheters. All of these procedures may be performed at the bedside. Trainees should recognize the indications for endotracheal intubation, mechanical ventilation, and renal replacement therapy and demonstrate the skills needed to evaluate and treat spontaneous or treatment-related acute bleeding complications. Level I trainees should know the indications for mechanical circulatory support, including intra-aortic balloon counterpulsation and ventricular assist devices (5, 6). These trainees should have the skill to utilize therapeutic hypothermia for victims of out-of-hospital cardiac arrest, should demonstrate an understanding of how to integrate palliative and hospice care, and identify when further care is futile. Trainees should also develop the knowledge and skills needed to ensure appropriate transitions of care.

4. Summary of Training Requirements

4.1. Development and Evaluation of Core Competencies

Training and requirements in critical care cardiology address the 6 general competencies promulgated by the ACGME/ABMS 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 core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 1 delineates each of the 6 competency domains as well as their associated curricular milestones for training in critical care cardiology. The milestones are categorized into Level I and Level III training (as previously defined in this document) and indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Given that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may also vary. Level I competencies may be achieved at earlier or later time points. Acquisition of Level III skills requires training in a dedicated critical care cardiology program. The table also describes examples of evaluation tools suitable for assessment of competence in each domain.

Table 1. Core Competency Components and Curricular Milestones for Training in Critical Care Cardiology

Medical Knowledge	Milestones (Months)			
	12	24	36	Add
1. Know the pathophysiology, differential diagnosis, and characteristic clinical, hemodynamic, radiographic, and laboratory findings of cardiogenic, hypovolemic, septic, and mixed circulatory shock, and of the systemic inflammatory response syndrome.		I		
2. Know the indications for, and characteristic findings with, bedside invasive and noninvasive hemodynamic monitoring.		I		
3. Know the indications, contraindications, and clinical pharmacology for vasoactive and inotropic medications used in the treatment of patients with advanced heart failure, hypotension, or shock.		I		
4. Know the indications, contraindications, and clinical pharmacology for anticoagulant, antiplatelet and fibrinolytic agents.		I		
5. Know the indications for, contraindications to, and clinical pharmacology of agents used to treat hypertensive urgencies and emergencies.		I		
6. Know the indications, contraindications, and clinical pharmacology for agents used to treat pulmonary hypertension, including intravenous, inhalational and oral agents.		I		
7. Know the indications, contraindications, and clinical pharmacology for agents used to treat supraventricular and ventricular arrhythmias.		I		
8. Know the indications for, contraindications to, and risks of catheter-based techniques to treat supraventricular and ventricular arrhythmias.		I		
9. Know the characteristic clinical, electrocardiographic, echocardiographic, and radiographic findings with pulmonary embolism, aortic dissection, pericardial tamponade, acute decompensated severe heart failure, severe valvular heart disease, and myocardial infarction.		I		
10. Know the indications for oxygen supplementation, endotracheal intubation, and mechanical ventilator support for patients with hypoxia and/or respiratory failure.		I		
11. Know the differential diagnosis and characteristic laboratory findings of oliguria and acute kidney injury.		I		
12. Know the characteristic physical examination, echocardiographic, angiographic, and hemodynamic findings of mechanical complications of myocardial infarction (e.g., ventricular septal defect, mitral regurgitation, and right ventricular infarction).		I		
13. Know the types of, and indications for, mechanical circulatory support, including intra-aortic balloon counterpulsation, ventricular assist (both percutaneous and		I		

surgical) devices, and extracorporeal membrane oxygenation.				
14. Know the principles of treatment of hypotension in special populations, including patients with cardiogenic shock, hypertrophic obstructive cardiomyopathy, right ventricular infarction, massive pulmonary embolism, pericardial tamponade, and distributive shock.		I		
15. Know the indications for emergency surgery in patients with aortic dissection.		I		
16. Know the indications for emergent/urgent surgery and transcatheter valve replacement/repair in patients with severe valvular heart disease.		I		
17. Know the differential diagnosis of heart failure or shock in cardiac transplant patients.		I		
18. Know the elements of risk scoring systems for the assessment of prognosis in acute coronary syndrome, advanced heart failure, and pulmonary hypertension, including demographics and findings from the clinical examination, electrocardiogram, biomarker testing, angiography, echocardiography, and invasive hemodynamic assessment.		I		
19. Know the indications for use of hypothermia protocols and the principles of post-resuscitation bundled care.		I		
20. Know the elements of scoring systems for assessment of the risk of major bleeding in patients treated with antithrombotic medications.		I		
Evaluation Tools: conference presentation, direct observation, in-training exam, simulation				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to manage patients with acute myocardial infarction and any associated rhythm, conduction, or mechanical complications.		I		
2. Skill to evaluate and manage acutely unstable cardiac patients by integrating the findings from clinical, electrocardiographic, telemetry, imaging, and hemodynamic assessment – and to develop a plan for bedside intervention.		I		
3. Skill to place arterial, central venous, and pulmonary artery catheters and temporary transvenous pacemakers in sequence with cardiac catheterization laboratory rotations.		I		
4. Skill to recognize when renal replacement therapy is indicated, and to manage in conjunction with nephrology consultants.		I		
5. Skill to utilize appropriately therapeutic hypothermia protocols in survivors of cardiac arrest in conjunction with neurologic consultants.		I		
6. Skill to evaluate and manage patients with hemodynamic instability following cardiac surgery.		I		
7. Skill to evaluate and manage patients with hemodynamic instability following transcatheter valve therapy.		I		
8. Skill to evaluate and manage supraventricular and ventricular arrhythmias and conduction disturbances in unstable patients in collaboration with electrophysiology specialists.		I		
9. Skill to use vasopressor and inotropic therapy appropriately in various types of shock.		I		
10. Skill to incorporate mechanical circulatory support in the management of critically ill patients.		I		
11. Skill to place intra-aortic balloon pump emergently.				III*

12. Skill to identify and manage pericardial tamponade, including emergency pericardiocentesis.		I		
13. Skill to participate in the perioperative care of heart transplant and ventricular assist device patients, in collaboration with heart failure experts, interventional cardiologists, and surgical consultants.		I		
14. Skill to monitor blood pressure and hemodynamic state in patients with continuous flow left ventricular assist devices, in collaboration with heart failure specialists, interventional cardiologists, and/or surgeons.		I		
15. Skill to manage hypertensive urgencies and emergencies.		I		
16. Skill to manage special populations of critically ill cardiovascular patients including those with aortic dissection, massive or submassive pulmonary embolism, acute severe valvular regurgitation, and advanced pulmonary hypertension with right ventricular dysfunction.		I		
17. Skill to manage patients with acute bleeding, including bleeding from vascular access or spontaneous bleeding.		I		
18. Skill to perform noninvasive ventilation and CO_2 monitoring.		I		
19. Skill to incorporate oxygen supplementation and mechanical ventilation in patient management.		I		
20. Skill to perform endotracheal intubation.				III
21. Skill to utilize risk assessment scoring systems when appropriate in patient management and counseling.		I		
22. Skill to identify when further medical care is futile and to counsel families on end-of-life care.		I		
23. Skill to coordinate safe and effective transitions of care in collaboration with other members of the care team.		I		
Evaluation Tools: conference presentation, direct observation, logbook, simulation				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Work effectively with all members of the critical care unit team including heart failure/transplant specialists, electrophysiologists, interventionalists, surgeons, pulmonary critical care physicians, nephrologists, neurologists, nurses, physician's assistants, pharmacists, social workers, and other team members as required.		I		
2. Function effectively as team leader for the critical care unit team.				III
3. Participate in hospital quality and safety initiatives in the critical care units.		I		
4. Design quality and safety initiatives.				III
5. Utilize interdisciplinary input and expertise in comanagement of critically ill patients, including transitions of care.		I		
Evaluation Tools: conference presentation, direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.		I		

	12	24	36	Add
2. Utilize point-of-service resources to enhance adherence to guidelines and protocols and obtain new information from trials and professional societies.		I		
3. Incorporate appropriate use criteria, risk/benefit analysis, and cost considerations in the use of testing and treatment.		I		
Evaluation Tools: conference presentation, direct observation				
Professionalism	**12**	**24**	**36**	**Add**
1. Work effectively in an interdisciplinary critical coronary care unit environment.		I		
2. Demonstrate sensitivity to patient preferences and values and end-of-life issues.		I		
3. Practice within the scope of expertise and technical skills.		I		
4. Interact respectfully with patients, families, and all members of the healthcare team, including ancillary and support staff.		I		
Evaluation Tools: conference presentation, direct observation, multisource evaluation				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Communicate with and educate patients and families across a broad range of cultural, ethnic, and socioeconomic backgrounds.		I		
2. Communicate and work effectively with physicians and other professionals on the healthcare team in the management of critically ill patients and their transition to other care environments.		I		
3. Communicate with families with regard to end-of-life decisions with respect to programming of pacemakers and implantable cardioverter-defibrillators.		I		
Evaluation Tools: direct observation, multisource evaluation				

*Fellows seeking to gain the skill to insert intra-aortic balloon pumps emergently may do so as part of Level II training in cardiac catheterization (see COCATS Task Force 10 report).Add = additional months beyond the 3-year cardiovascular fellowship.

4.2. Number of Procedures and Duration of Training

The specific competencies for Levels I and III are delineated in Table 1. Level I competencies must be obtained by all fellows during the 3-year cardiovascular disease fellowship training program. The minimum duration of training for Level I competencies is 8 weeks over the course of the first 24 months of training. Specific procedural volume targets are not provided. Many of these will be obtained during other rotations, such as cardiac catheterization and electrophysiology. Nevertheless, outcomes-based evaluation measures must demonstrate that such competencies have been achieved. Designation of Level II competencies will require further clarification once additional experience is gained with the critical care cardiology pathway. Level III competencies are noted so that fellows are aware of the competencies for which additional, advanced training beyond the standard 3-year fellowship is required. Level III training could be accomplished with a dedicated year of critical care medicine training, in conjunction with the Department of Medicine at the sponsoring institution. A brief discussion of the competencies and training requirements for Levels I, II, and III follows. Although the minimum training duration and numbers of procedures are typically required to obtain competency, trainees must also demonstrate achievement of the competencies as assessed by the outcomes evaluation measures.

4.2.1. Level I Training Requirements

Level I training will typically require at least 8 weeks of cardiology critical care exposure designed to allow the trainee to acquire the knowledge, skills and experience necessary to achieve the competencies listed in Table 1. Because both dedicated critical cardiology time and complementary experiences necessary to gain knowledge and skills through other cardiovascular rotations may be assigned at various times to trainees over the first 24 months of training, the milestones for the relevant competencies should be reached by 24 months.

4.2.2. Future Level II Training Requirements

Level II training will involve more advanced knowledge and skills than Level I training, likely with greater experience with bedside procedures and the skills needed for leading interdisciplinary teams managing critically ill patients, but not with the competency expected with Level III training. Preliminarily, an additional 3 to 6 months of clinical training within the 3-year cardiovascular medicine fellowship is envisioned to acquire these skills, but at present Level II training in critical care cardiology is not recognized.

4.2.3. Level III Training Requirements

Level III training prepares the physician to specialize in critical care cardiology. Level III requires additional experience beyond the standard 3-year cardiovascular fellowship for the trainee to acquire specialized knowledge and competencies in performing, interpreting, and training others to perform specific critical care functions and procedures or render advanced, specialized critical care at a high level of skill. Trainees should obtain additional critical care medicine training within the department of medicine upon completing a 3-year cardiovascular fellowship. A portion of this advanced training can be spent under supervision in cardiac or cardiac surgical intensive care units, as specified by the critical care medicine fellowship program. Level III training is described here only in broad terms to provide context for trainees and clarify that these advanced competencies are not covered during the general cardiology fellowship. The additional exposure and requirements for Level III training will be addressed in a subsequent, separately published Advanced Training Statement.

5. Evaluation of Competency

Evaluation tools in critical care cardiology include direct observation by instructors, in-training examinations, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, and simulation. Case management, judgment, interpretive and bedside skills must be evaluated in every trainee. Quality of care and follow-up; reliability; judgment, 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 (HIPAA)-compliant electronic database or logbook that meets ACGME reporting standards and summarizes pertinent clinical information (e.g., number of cases, diversity of referral sources, diagnoses, disease severity, outcomes and disposition).

Under the aegis of the program director, the 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 assure achievement of selected training milestones and to identify areas in which additional focused training may be required.

Key Words: ACC Training Statement ▪ COCATS ▪ fellowship training ▪ clinical competence ▪ critical care cardiology.

1

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 13: TRAINING IN CRITICAL CARE CARDIOLOGY

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF13_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 13: TRAINING IN CRITICAL CARE CARDIOLOGY

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ACC= American College of Cardiology

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

COCATS = Core Cardiovascular Training Statement

HIPAA = Health Insurance Portability and Accountability Act

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COCATS 4 Task Force 14: Training in the Care of Adult Patients with Congenital Heart Disease[16]

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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The Writing Committee was selected to represent the American College of Cardiology (ACC) and included a cardiovascular training program director, a training director specializing the in care of adults with congenital heart disease (i.e., adult congenital heart disease [ACHD]), early-career ACHD cardiologists, highly experienced specialists representing both the academic and community-based practice settings, and physicians experienced in defining and applying training standards according to the 6 general competency domains promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialties (ABMS) and endorsed by the American Board of Internal Medicine (ABIM). The ACC determined that relationships with industry or other entities were not relevant to the creation of this cardiovascular training statement. Employment and affiliation details for authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF14_Comprehensive_RWI_Supplement.pdf).

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1.1.2. Document Development and Approval

The Writing Committee developed the document, approved it for review by individuals selected by the ACC, and then addressed the reviewers' comments. A member of the ACC Competency Management Committee served as lead reviewer. The final document was approved by the Task Force and ACC Competency Management Committee and ratified by the ACC Board of Trustees in February 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

Remarkable advances in surgical management of congenital heart disease (CHD) over the last half century have allowed more than 90% of children with CHD to survive to adulthood (1). This has led to a shift in the prevalence of CHD, such that adults comprise two-thirds of the overall CHD population, with an estimated 1.5 million adult survivors in the United States alone. This population includes not only those with mild and moderate forms of CHD, but also, importantly, those with severe forms of CHD. Indeed, approximately 60% of those with severe CHD are now adults (2, 3). The rise in incidence and prevalence is expected to continue, so healthcare delivery for CHD, including the training of cardiologists, must evolve as well to meet this demand. ACHD patients have special healthcare needs and often present complex combinations of problems that are generally unrecognized by those in a traditional, internal medicine-based cardiovascular training program (4). Adult cardiologists are experts in the care of acquired diseases that affect the heart and circulation, but currently most have little or no training in CHD, particularly in complex disorders. Exposure to ACHD patients and clinical experiences for cardiovascular fellows vary widely (3). Many ACHD patients continue to be cared for by pediatric cardiologists for many reasons, including the fact that there are few internal medicine cardiologists specializing in this complicated field and access is therefore limited (5, 6). This report recommends an approach to more systematic training of internal medicine cardiologists in the recognition and care of ACHD patients based on the basis of previous Bethesda Conference descriptions of workforce needs and educational requirements (5). Similar recommendations are made for ACHD training for pediatric cardiovascular trainees, with an emphasis on the importance of ACHD training for all cardiologists who may care for these patients, regardless of specialty (7). In addition, this report addresses the evolving framework of competency-based medical education described by the ACGME Outcomes Project and the 6 general competencies endorsed by ACGME and ABMS. The background and overarching principles governing fellowship training are provided in the Introduction to COCATS, and readers should become familiar with this foundation before considering the details of training in a subdiscipline like adult congenital heart disease. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally over time.

For most areas of cardiovascular medicine, 3 levels of training are delineated:

Level I training, is the basic training required to become a competent cardiovascular consultant, is required of all cardiovascular fellows, and can be accomplished as part of a standard 3-year training program in cardiovascular medicine. This level of training should allow the trainee to develop sufficient knowledge to review and understand consensus-based ACHD care guidelines to determine which ACHD patients a clinician is able to manage and which patients are best cared for in collaboration with an ACHD specialist. Along with guideline-based care, this level of training should also enable the cardiologist to recognize when direct consultation and referral to an ACHD specialist are necessary. In some circumstances, Level I-trained physicians may participate in the care of patients with moderately or severe complex disease in close collaboration with an ACHD specialist.

Level II training refers to the additional training in 1 or more areas that enables some cardiovascular specialists to perform or interpret specific diagnostic tests and procedures or render more specialized care for patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training in selected areas may be achieved by some trainees during the standard 3-year cardiovascular fellowship, depending on the trainee's career goals and use of elective rotations. It is anticipated that during a standard 3-year cardiovascular fellowship training program, sufficient time will be available to receive Level II training in a specific subspecialty. Recognizing the special needs of this complex patient population, the ABMS approved ACHD subspecialty certification in December 2012 (See specific criteria under Level III training.). There is no Level II training curriculum or qualifying examination in ACHD. Thus, only Level I and Level III training apply to ACHD.

Level III training requires additional training and experience beyond the cardiovascular fellowship for the trainee to acquire specialized knowledge and experience in performing, interpreting, and training others to perform specific procedures or render advanced specialized care for specific conditions at a high level of skill. In the case of ACHD, Level III training provides the knowledge needed by graduates wishing to make an advanced clinical and/or academic/research commitment to this field and to not only become competent in the care of the entire spectrum of ACHD patients, but also participate in teaching about ACHD (6). Level III competency requires specific time dedicated to training in pediatric cardiology (as outlined by ACGME) for those with a background in adult cardiolovascular medicine, and requires dedicated time in adult internal medicine and cardiology for those with a background in pediatric cardiology. Level III requires training beyond the 3 years of fellowship (in either pediatric or adult cardiovascular medicine). Such Level III training would be sufficient to clinically manage complex ACHD in a regional or tertiary center, pursue an academic career, train others in the field, and/or direct an ACHD program. ACHD subspecialty certification was approved through the ABMS in December 2012. The first examination in 2015 is available for those who qualify by meeting the practice pathway criteria and is administered by the ABIM in collaboration with the American Board of Pediatrics. Once the practice pathway closes, only those completing an ACGME-approved advanced ACHD fellowship (beyond adult or pediatric cardiovascular fellowship) will qualify for ACHD subspecialty certification. Level III training is described here only in broad terms to provide context for trainees and clarify that these advanced competencies are not covered during the cardiovascular fellowship. The additional exposure and requirements for Level III training will be addressed in a subsequent, separately published Advanced Training Statement.

2. General Standards

The ACC and American Heart Association have produced guidelines for ACHD (8) and educational objectives for fellowship training in ACHD (9). The recommendations are congruent and address faculty, facility requirements, emerging technologies and practice. We recommend strongly that candidates for the ABIM examination for certification in cardiovascular diseases, as well as those seeking certification of added qualifications in ACHD, review the specific requirements of the ABIM. With recent ABMS approval for ACHD subspecialty certification, it is expected that the ACGME will standardize fellowship programs with specific guidelines for faculty, facilities, and curriculum, and that these guidelines will apply to advanced fellowship trainees with either pediatric or adult cardiovascular training.

2.1. Faculty

Ideally, to assure adequate Level I training, a program should have at least 1 faculty member with expertise and commitment to the care of adults with CHD. This faculty member should have achieved the skills equivalent to Level III training by lifelong experience, and/or specific training. In recognition that not all programs have ACHD expert faculty available, Level 1 training may be achieved without ACHD faculty on site, but in such cases other resources, such as online learning modules, visiting professors, “away” rotations, and print or electronic curricula, should be utilized. Affiliation with a pediatric cardiovascular program is an invaluable resource for congenital heart disease education. Advanced training (Level III) requires a critical mass of faculty dedicated to the care of adult patients with CHD, and a program that provides comprehensive diagnostic and management services to patients with a broad array of congenital cardiac disorders. Affiliation with a pediatric cardiovascular program is ideal and will further ensure that the trainee in advanced ACHD is exposed to patients across the entire lifespan. This comprehensive ACHD education includes congenital interventional procedures; congenital electrophysiologic consultation and procedures; congenital cardiac surgery; and training in ACHD echocardiography, CT, and MRI. Organized, deliberate, and developmentally appropriate transition and transfer of patients from pediatric to ACHD programs are necessary; and comprehensive ACHD education should include participation in transition programs. Further training in intervention, electrophysiology, and in some cases, imaging, will be necessary for independent practice of these disciplines. Programs that have interdisciplinary involvement, including with obstetrics, pulmonary hypertension specialists, hematologists, hepatologists, and others, are forming a robust network of interdisciplinary clinicians with experience in caring for the entirety of the ACHD patient experience, and are ideal in providing comprehensive training. This level of expertise may still be evolving at some institutions, but ACHD training should accord with ABIM and ACGME recommended guidelines.

2.2. Facilities, Equipment, Ancillary Support, Program Requirements

To train cardiac fellows to achieve Level III competency, institutions that care for ACHD patients should meet certain program requirements and have essential ancillary support capabilities. Two basic requirements are indicated for a program to train fellows effectively at Level III: 1) the presence of associated formal programs in pediatric cardiology and cardiovascular CHD surgery and 2) a critical mass of faculty who are board eligible/certified in ACHD. Relationships should also be cultivated in obstetrics, general surgery, cardiac anesthesia, hematology, hepatology, nephrology, and other subspecialties, as feasible at a given institution. Because ACHD patients will use noncardiac hospital resources as well, appropriate monitoring should be available and specialty care should be coordinated with the ACHD team.

For comprehensive imaging assessment at a Level III training program, echocardiography labs with sonographers with training and expertise in assessing congenital heart lesions as well as echocardiographers who are expert in and experienced with reading ACHD echocardiograms must be available. Advanced imaging facilities, ACHD-specific MRI and CT protocols, and cardiologists or radiologists with experience in CHD are essential for comprehensive imaging at a Level III training program and, if available, should be leveraged for training and exposure at non-Level III programs. .

At training institutions that perform adult congenital procedures, including but not limited to hemodynamic assessment and potential catheter-based or electrophysiologic interventions, ancillary support is essential to ensure patient safety. This should include laboratories with fluoroscopy and specialized equipment for the safe performance of diagnostic procedures and congenital cardiac interventions or electrophysiologic interventions in an adult. Institutions that intervene on ACHD patients must have cardiologists with the expertise to perform coronary interventions. The ability to perform detailed hemodynamic assessments, including the evaluation of pulmonary vascular disease and the reversibility of pulmonary hypertension, is also important. When available, a biplane room may benefit the ACHD patient. For institutions performing interventions on moderate to complex ACHD, cardiac anesthesia and a clear process for rapid availability of urgent or emergent cardiac surgery should be established. Operating rooms should be fully staffed and should have dedicated cardiac anesthesiologists and the resources necessary for ACHD operations as well as the capability for imaging and percutaneous interventions, as previously discussed.

3. Training Components

3.1. Didactic Program

Didactic instruction may take place in a variety of formats, including but not limited to lectures, conferences, journal clubs, grand rounds, clinical case presentations, and online learning. Such instruction can occur as a part of the fellow’s core curriculum teaching or rotation-specific lectures, or may be incorporated into other subspecialty curricula such as electrophysiology, pulmonary hypertension, cardiac surgery, echocardiography, or noncardiac care (e.g., obstetrics, palliative care). Opportunities such as online learning from approved cardiac educational sites with continuing medical education credit should also be encouraged and included as supplements to hospital-based didactics. Whereas Level I competency can be achieved without an ACHD expert faculty member or substantial ACHD patient volume, Level III training requires both faculty expertise and patient volume that allow direct clinical care in addition to robust didactic education. A comprehensive curriculum is currently being developed by the ACC. Bedside physical exam, whether inpatient or outpatient, is an essential component of Level I training.

3.2. Clinical Experience

Rotation on an ACHD service is an essential component of all levels of ACHD training. For programs with an ACHD service, a rotation is mandatory. Ideally, Level I trainees should gain first-hand experience in both inpatient and outpatient consultation and management of ACHD. Ideally, the ACHD service will have a robust patient mix (including low, moderate, and high complexity) in both inpatient and outpatient settings. The ACHD service should expose trainees to a wide array of ACHD patients and procedures, and should, at a minimum for the Level I trainee, include exposure to ACHD management within the cardiac subspecialties (e.g., arrhythmia, heart failure, pulmonary hypertension, transplant, intervention, surgery).

If a program lacks the necessary expertise and patient volume, patient-based education can be achieved through alternative approaches such as didactic education, with a focus on case-based education. The interpretation of clinical cases should always include the interpretation of testing ranging from electrocardiography (ECG) to echocardiography or advanced imaging, as well as any interventional procedures. Achievement of Level I training must be accomplished with a focused educational experience, as either a dedicated block or adiscrete ACHD clinical experience through the course of other rotations (i.e., regular longitudinal participation in an ACHD outpatient clinic, as either a continuity clinic or component of other rotations).

Fellows seeking more detailed ACHD training than prescribed by the Level 1 minimum recommendations during the clinical cardiovascular fellowship should obtain robust clinical experiences in the outpatient and inpatient consultation settings, as well as experience in cardiac catheterization, arrhythmia and heart failure management, ICU care, appropriate indications for surgical or catheter-based intervention; exposure to operations; and, importantly, perioperative and postoperative intensive care. Management of ACHD patients admitted for noncardiac diagnoses with a special focus on pregnancy, labor, and delivery must also be a component of this extra training. In each of these clinical settings, trainees should assist in patient care in a supervised setting that provides for patient-centered education in all aspects of ACHD management.

3.3. Hands-On Experience

Hands-on experience is important for training in ACHD management. Cardiovascular trainees should have a hands-on clinical experience to acquire the core competencies for Level I training. During this period, and during rotations on the other cardiac services, trainees should review case histories, physical findings, and ECGs, and log echocardiogram reading, arrhythmia management, and percutaneous and surgical cases involving ACHD patients. Interaction with the ACHD team should not be limited to “on-rotation” time, because exposure to the ACHD patient is likely to become pervasive in all cardiac subdisciplines.

4. Summary of Training Requirements

4.1. Development and Evaluation of Core Competencies

Training and requirements in ACHD address the 6 general competencies promulgated by the ACGME/ABMS 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 core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Tables 1 and Table 2 delineate each of the 6 competency domains as well as their associated curricular milestones for training in adult congenital heart disease. The milestones are categorized into Level I and Level III training (as previously defined in this document) and indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Given that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may also vary. Level I competencies may be achieved at earlier or later time points. Acquisition of Level III skills requires training in a dedicated adult congenital heart disease program. The table also describes examples of evaluation tools suitable for assessingcompetence in each domain.

Table 1. Core Competency Components and Curricular Milestones for Training in Adults with Simple Congenital Heart Disease (Atrial Septal Defects, Ventricular Septal Defects, Patent Ductus Arteriosus, Pulmonary Stenosis, Bicuspid Aortic Valve, Coarctation)

Medical Knowledge	Milestones (Months)			
	12	24	36	Add
1. Know the anatomy, pathophysiology, associated lesions, and natural histories of atrial septal defects (primum, secundum, and sinus venosus) and ventricular septal defects.		I		
2. Know the anatomy, pathophysiology, associated lesions, and natural histories of bicuspid aortic valve, pulmonic stenosis, coarctation of the aorta, and patent ductus arteriosus.		I		
3. Know the risk of development and pathophysiology of pulmonary arterial hypertension in adult patients with congenital heart disease, including issues related to noncardiac surgery, pregnancy,		I		

contraception, and exercise.				
4. Know the potential reproductive and genetic implications of basic adult congenital heart disease, both for patients and for potential offspring.			I	
5. Know the indications for patient referral to an adult congenital heart disease center.	I			
6. Know the cardinal symptoms physical examination, electrocardiogram, and chest X-ray findings of patients with simple adult congenital heart disease.		I		
7. Know the indications for noninvasive and invasive testing for the evaluation of simple adult congenital heart disease.		I		
8. Know the indications and contraindications for surgical and percutaneous interventions in adult congenital heart disease.			I	
9. Know the indications for endocarditis prophylaxis based on current guidelines.	I			
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, in-training exam				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to accurately perform a comprehensive history and physical examination in the patient with simple adult congenital heart disease.		I		
2. Skill to appropriately order and integrate the results of imaging with other clinical findings in the evaluation and management of simple adult congenital heart disease patients.		I		
3. Skill to evaluate and manage patients with simple adult congenital heart disease who have undergone reparative intervention.		I		
4. Skill to evaluate and manage the potential cardiovascular complications of pregnant women with simple adult congenital heart disease.			I	
5. Skill to detect the findings of pulmonary arterial hypertension.		I		
6. Skill to appropriately advise patients with simple congenital heart disease regarding exercise, sports participation, and return to play, including the use of testing to evaluate for safety.		I		
7. Skill to evaluate and manage patients with simple congenital heart disease, including appropriate timing for surgical interventions.		I		
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Collaborate and coordinate patient care with an adult congenital heart disease center to provide optimal healthcare for appropriate patients with adult congenital heart disease.		I		
2. Demonstrate the ability to provide primary cardiac longitudinal care for patients with simple adult congenital heart disease in association with an adult congenital heart disease center.			I	
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Locate, appraise, and assimilate evidence from scientific resources, such as adult congenital heart disease clinical practice guidelines.		I		

2. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.			I	
Evaluation Tools: chart-stimulated recall, direct observation, reflection and self-assessment				
Professionalism	**12**	**24**	**36**	**Add**
1. Demonstrate sensitivity and responsiveness to diverse patient populations.	I			
2. Respond to patient needs in a way that supersedes self-interest, including referral of basic adult congenital heart disease patients when appropriate.	I			
Evaluation Tools: direct observation, multisource evaluation				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Effectively educate patients and families across the range of socioeconomic and cultural backgrounds about adult congenital heart disease management, complications, and lifestyle issues.			I	
2. Communicate testing results to physicians and patients in an effective and timely manner.	I			
Evaluation Tools: direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

Table 2. Core Competency Components and Curricular Milestones for Training in Caring for Adults with Complex Congenital Heart Disease (Ebstein's Anomaly, Tetralogy of Fallot, Complex Cyanotic Congenital Heart Disease, Transposition of the Great Arteries, Single Ventricle Physiology/Fontan)

Medical Knowledge	**Milestones (Months)**			
	12	**24**	**36**	**Add**
1. Know the basic anatomy and pathophysiology of the cyanotic congenital heart diseases encountered in adolescents and adults.		I		
2. Know the natural history of cyanotic congenital heart diseases, particularly those with Eisenmenger Syndrome.		I		
3. Know the hematological complications and their management in patients with cyanotic heart disease.		I		
4. Know the risks of cardiac arrhythmias and their management in patients with adult congenital heart disease.		I		
5. Know the renal complications of cyanotic heart disease, including medications and procedures with the potential for precipitating renal failure.		I		
6. Know the other systemic complications of cyanotic heart disease: pulmonary, orthopedic, and neurological.		I		
7. Know the vulnerability these patients have for mortal complications from routine noncardiac surgical procedures and the risks of intravenous lines without air filters.		I		
8. Know the potential for mortal complications in cyanotic patients, particularly those with pulmonary hypertension, from pregnancy or the use of estrogen-based contraception.		I		

9. Transposition of the great arteries: know the basic anatomy, the types of surgical repair and their complications in the adult patient.			I	
10. Single ventricle/Fontan: know the basic anatomy and hemodynamics both in patients with and without surgical repair, and that noncardiac surgery must be performed at an adult congenital heart disease center.			I	
11. Tetralogy of Fallot: know the basic anatomy; the types of surgical repair; and the postoperative residua and sequelae, including indications and timing of reoperation.			I	
12. Know the anatomy, pathophysiology, and associated lesions of Ebstein's anomaly.			I	
13. Know the indications for patient referral to an adult congenital heart disease center.	I			
14. Know the appropriate indications for and timing of medical, surgical, and interventional therapies in all forms of congenital heart disease.				III
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, in-training exam				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to accurately interpret the physical examination, echocardiogram, and electrocardiogram findings in patients with repaired Tetralogy of Fallot.			I	
2. Skill to accurately interpret the physical examination, electrocardiogram, and chest X-ray findings in patients with Eisenmenger physiology.		I		
3. Skill to appropriately use electrocardiography, echocardiography, and other imaging modalities in diagnosis and management of complex adult congenital heart disease.		I		
4. Skill to assure that female patients have received appropriate contraceptive advice.			I	
5. Skill to collaborate with an adult congenital heart disease specialist before prescribing medications and procedures with the potential to affect hemodynamic stability in patients with cyanotic heart disease.		I		
6. Skill to urgently refer patients to an adult congenital heart disease center in the setting of hemoptysis, transient neurological disturbance, syncope, arrhythmia, pregnancy, or anticipated noncardiac surgery.		I		
7. Skill to interpret echocardiograms, including transesophageal echocardiograms, in all forms of complex congenital heart disease, and to select other appropriate imaging modalities when necessary (magnetic resonance imaging, computed tomography).				III
8. Skill to interpret hemodynamic and angiographic data in all types of complex congenital heart disease.				III
9. Skill to appropriately treat complications of complex congenital heart disease, including hemoptysis, arrhythmias, and heart failure.				III
10. Skill to evaluate and manage patients with all forms of complex congenital heart disease, both operated and unoperated, including appropriate timing for surgical interventions.				III
11. Skill to assess preconceptual risk and manage patients during pregnancy.				III
12. Skill to appropriately advise patients with all forms of complex congenital heart disease regarding exercise, sports participation, and return to play, including the use of testing to evaluate for safety.				III

Evaluation Tools: chart-stimulated recall, conference presentation, direct observation				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Establish an ongoing collaborative relationship with an adult congenital heart disease team or center to facilitate prompt access to appropriate advice and urgent admission of cyanotic patients when necessary.	I			
2. Utilize an interdisciplinary team approach with other subspecialists to optimize the care of all patients with moderate and complex congenital heart disease.				III
Evaluation Tools: chart-stimulated recall, conference presentation, direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify strengths, deficiencies, and limits in one's knowledge and expertise in cyanotic heart disease and carry out personalized education to address them.			I	
2. Locate, appraise, and assimilate evidence from scientific resources, such as adult congenital heart disease clinical practice guidelines, and apply that knowledge to the management and care of patients.		I		
3. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.				III
Evaluation Tools: chart-stimulated recall, direct observation, reflection and self-assessment				
Professionalism	**12**	**24**	**36**	**Add**
1. Demonstrate sensitivity and responsiveness to diverse patient populations.	I			
2. Demonstrate a commitment to carry out professional responsibilities, appropriately refer patients, and respond to patient needs in a way that supersedes self-interest.	I			
Evaluation Tools: direct observation, multisource evaluation				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**
1. Effectively educate patients and families across the range of socioeconomic and cultural backgrounds about adult congenital heart disease management, complications, and lifestyle issues.			I	
2. Communicate and work effectively with physicians and other professionals on the healthcare team, including those at an adult congenital heart disease center.	I			
Evaluation Tools: direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship.

4.2. Structure and Duration of Training

Because relatively few centers in the United States have amassed a sufficient number of adult CHD patients who have been followed in an organized manner, regionalization of training in the care of the complex CHD patients is necessary (6). In addition to meeting requirements for training duration and numbers of procedures performed and/or interpreted, the trainee must demonstrate achievement of specific competencies. A brief discussion of the competencies and training requirements for ACHD follows.

The specific competencies for Levels I and III are delineated in Table 1. Level I competencies must be obtained by all fellows during the 3-year cardiovascular disease fellowship training program. There is no Level II training in ACHD. Level III competencies are noted so that fellows are aware of the competencies for which additional, advanced training beyond the standard 3-year fellowship is required. A brief discussion of the competencies and training requirements for Levels I and III follow. Although these minimum training duration and numbers of procedures are typically required to obtain competency, there must also be demonstration of achievement of the competencies as assessed by the outcomes evaluation measures.

4.2.1. Level I Training Requirements

All cardiovascular trainees should be exposed to a core of information regarding adults with CHD. The goal of Level I training is to have the ability to recognize and evaluate common, simple congenital heart lesions and the sequelae of the more commonly repaired congenital heart defects. These graduates should consult and collaborate with a Level III-trained ACHD specialist when major management decisions are made for adults with CHD and for periodic discussions of ongoing care.

We suggest that at least 6 hours of formal lectures within the core curriculum of the training program be devoted to CHD in adults. Table 1 indicates the content suggested for these 6 hours, covering key basic and clinical aspects of these disorders. With the acknowledgment that there are many teaching styles and organizational strategies to teach the necessary concepts, a proposed curriculum is as follows: Hour 1 = basic anatomy, pathology, physiology, hemodynamics and known genetics of common lesions and conditions; Hour 2 = clinical diagnosis (history, clinical examination, electrocardiogram, x-ray) and management of the most common lesions expected to be encountered in adults, operated or not; Hour 3 = specific issues relevant to cyanotic CHD and Eisenmenger syndrome; Hour 4 = a description of the most commonly performed surgical procedures involved in repair and palliation of CHD and a review of the common residua and sequelae encountered in clinical practice; Hour 5 = common echocardiographic features in operated and unoperated adult CHD; and Hour 6 = various topics, which could include management during pregnancy; endocarditis prophylaxis; and basic counseling on genetics and contraception, employment, and exercise. Within those 6 hours of core curriculum, the trainees should be taught the major outpatient management issues in adult CHD and when to consult or refer for more specialized advice. Currently available modes of supplementing this education include readily available

ACC educational products (adult CHD section of the Adult Clinical Cardiology Self-Assessment Program and the Echocardiography Self-Assessment Program) and web-based sites specific to CHD. Additional content could include areas such as preoperative noncardiac surgery assessment, evaluation and management of heart failure, and CHD-related pulmonary hypertension.

In addition to the didactic material in the core curriculum, trainees should be exposed to ACHD patients on a regular basis. This could be done in the context of ongoing weekly case conferences, which may already be part of the cardiovascular training program. In addition, trainees are encouraged to become involved in an ongoing CHD outpatient clinic, to see older children or adolescents with a pediatric cardiology colleague, or both. If not available at the training institution, regional ACHD case conferences may provide an opportunity for fellows to receive exposure to ACHD management at dedicated centers.

Cardiovascular trainees should be exposed to the evaluation of CHD with various diagnostic modalities during the usual clinical rotations (electrocardiography, electrophysiology, transthoracic and transesophageal echocardiography, nuclear cardiology, and the cardiac catheterization laboratory [including invasive transcatheter techniques]). Exposure to other advanced imaging techniques now commonly utilized in CHD (e.g., MRI, CT) as well as cardiopulmonary exercise testing is highly desirable. Didactic material for these rotations should include materials on diagnosis and management of the adult with CHD.

A 4-week rotation is strongly recommended to complete Level I competence if the training program has expertise in ACHD with a board-eligible/board-certified cardiologist on staff (or equivalent experience). If the training program does not have expertise in CHD or have access to CHD locally, partnering with an expert regional adult CHD facility for an elective rotation of 4 weeks total duration may be a valuable supplement. A similar recommendation exists for pediatric cardiovascular trainees. Thus partnership with a pediatric cardiovascular program can facilitate collaboration as well as effective resource utilization.

4.2.3. Level III Training Recommendations

Level III training prepares the cardiologist to specialize in advanced care for the adult with CHD. In order to obtain a comprehensive understanding of all aspects of CHD, a 2-year program (following either internal medicine or pediatric cardiovascular fellowship) is necessary with ongoing participation in clinical practice relating to CHD. The ACGME is currently reviewing the ABIM and ABMS petition and establishing curriculum guidelines; it has defined the essential components of a specialized program for training in adult CHD. Level III training should align with the ACGME curriculum as this is planned per the current timeline to be part of fellowship training in July, 2016. The ABIM will begin to offer an examination for this additional certification in 2015. Information concerning the eligibility requirements for the examination can be obtained from the ABIM. There will be 2 pathways, with the chosen path depending on whether the trainee's background is in adult or pediatric cardiology. Pediatric cardiologists will devote a portion of their training to areas of adult internal medicine and cardiology to fulfill requirements and competencies necessary to care for adults with CHD. Adult cardiologists will complete additional training in pediatric cardiology for the same purposes.

It is therefore expected that trainees should:

1. Participate in a regular outpatient clinic organized for the care of adults with CHD for at least 18 of the 24 months. The Level III trainee should be involved with the care of a minimum of 10 patients per week. Programs that are able to provide Level III training will have clinic more than once a week. The Level III trainee should participate in clinic at least once a week and for much of the training period will need to be in clinic more often to obtain appropriate exposure.
2. Participate in a total block or cumulative equivalent of at least 9 months of inpatient consultative services providing care for ACHD patients. This typically includes consultation for admissions related to heart failure, arrhythmias, preoperative and postoperative care, and noncardiac issues.
3. Participate in at least 3 months of comprehensive imaging methods used in caring for ACHD patients, including direct experience in echocardiography (transthoracic and transesophageal) and advance imaging techniques (MRI and CT).
4. Participate in at least 2 months of cardiac catheterization (diagnostic and interventional) that includes understanding indications for intervention, hemodynamics, diagnostic angiography, and physiologic calculations.
5. Participate in at least 1 month of dedicated cardiothoracic intensive care unit and surgical service for the care of ACHD patients. This includes preoperative assessment and intraoperative (including direct observation of surgical repair) and postoperative care.
6. Participate in at least 3 months of formal rotations in pediatric cardiology (for those following the adult cardiovascular pathway) for either a total block or cumulative equivalent months, including exposure to neonates and children with CHD via conferences, outpatient clinics, diagnostic laboratories (e.g., echocardiography, catheterization laboratory), and inpatient services, including consultations and exposure to children with postoperative CHD in the intensive care unit. Given that such fellows will not likely be experienced in the critical care of pediatric

patients, all inpatient participation should be observed and supervised by experienced pediatric cardiologists.

7. Participate in at least 3 months of formal rotations in adult cardiology (for those following a pediatric cardiology pathway) for either a total block or cumulative equivalent months, including exposure to adults with acquired heart disease through outpatient clinics, diagnostic laboratories (e.g., echocardiography, catheterization laboratory), and inpatient services, including consultations. Trainees with a pediatrics residency background prior to pediatric cardiology will require additional time gaining basic competencies in adult internal medicine and adult comorbidities.
8. Perform and interpret cardiopulmonary exercise testing in CHD individuals and apply that data to clinical assessment as well as exercise prescription.
9. Perform outpatient follow up and inpatient management (with OB/anesthesia) of pregnancy in CHD.
10. Participate in inpatient and outpatient care of CHD individuals with advanced heart failure, including consideration of mechanical support or transplant.
11. Participate in the inpatient and outpatient care of CHD individuals with significant pulmonary arterial hypertension, including specific medical therapies and transplantation.
12. Gain experience with the arrhythmic complications of CHD and the various approaches to their management, both pharmacologic and interventional.

Training should include active participation in clinical and/or laboratory research in conjunction with clinical activities. Direct participation in cardiac catheterization procedures in CHD is necessary to develop and demonstrate a comprehensive understanding of the entire hemodynamic spectrum of anatomic abnormalities in CHD. The specific number of cases and methods of assessing competencies will be developed through the ACGME. Specialized training is necessary to achieve expertise in the appropriate timing of surgical and interventional procedures as well as expertise in the potential complications. Expertise in the management of all complications of a wide variety of simple and complex congenital cardiac lesions, both unrepaired and repaired, is necessary, including the treatment of heart failure, arrhythmias, pulmonary hypertension, and pregnancy, as well as contraception management and knowledge of indications for referral for genetic counseling. Finally, trainees must be competent in the interpretation of transthoracic and transesophageal echocardiograms across the spectrum of CHD as well as the diagnosis of valvular disease and cardiomyopathic conditions. The specific numbers of cases has not yet been determined by the ACGME. It is anticipated that such competence would require at least 300 transthoracic echocardiograms and 50 transesophageal echocardiographic examinations to ensure that adequate exposure and expertise have been acquired in the wide range of complex cardiac pathology that might be encountered in practice. Although Level III MRI or CT training is not required, the advanced trainee should also be trained in the indications for and interpretation of advanced imaging techniques (i.e., MRI and/or CT and angiography in CHD). Trainees who have completed this additional 2-year training will be eligible to take the ABIM subspecialty examination.

5. Evaluation of Competency

Evaluation tools in adult congenital heart disease include direct observation by instructors, in-training exams, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, and reflection and self-assessment. Case management, judgment, interpretive, and bedside skills must be evaluated in every trainee. Quality of care and follow-up; reliability; judgment, 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 (HIPAA)-compliant electronic database or logbook that meets ACGME reporting standards and summarizes pertinent clinical information (e.g., number of cases, diversity of referral sources, diagnoses, disease severity, outcomes and disposition).

Under the aegis of the program director, the 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 for 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.

The ACGME has defined the essential components of a specialized program for training in ACHD; the ABIM will begin to offer an examination for this additional certification in 2015. Information concerning the eligibility requirements for the examination can be obtained from the ABIM.

Key Words: ACC Training Statement ▪ COCATS ▪ fellowship training ▪ clinical competence ▪ congenital heart disease.

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 14: TRAINING IN CARE OF ADULT PATIENTS WITH CONGENITAL HEART DISEASE

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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF14_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELEVANT RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES—COCATS 4 TASK FORCE 14: TRAINING IN CARE OF ADULT PATIENTS WITH CONGENITAL HEART DISEASE

Name	Employment	Representation	Consultant	Speaker's Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
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Dhanunjaya Lakkireddy	Kansas University Cardiovascular Research Institute	Official Reviewer, ACC Board of Governors	None	None	None	None	None	None
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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ACC = American College of Cardiology, ACPC = Adult Congenital and Pediatric Cardiology.

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialities

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

ACHD = adults with congenital heart disease

CHD = congenital heart disease

COCATS = Core Cardiovascular Training Statement

CT = computed tomography

HIPAA = Health Insurance Portability and Accountability Act

MRI = magnetic resonance imaging

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COCATS 4 Task Force 15: Training in Cardiovascular Research and Scholarly Activity[17]

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1. Introduction

1.1. Document Development Process

1.1.1. Writing Committee Organization

The writing committee was selected to represent the American College of Cardiology (ACC) and included a cardiovascular training program director, several active cardiovascular scientists and research methodology experts, early-career cardiologists, highly experienced research experts representing both academic and community-based practice settings, the chair of the ACC's Academic Cardiology Section Leadership Council, and a physician experienced in defining and applying training standards according to the 6 general competency domains promulgated by the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialties (ABMS) and endorsed by the American Board of Internal Medicine (ABIM). The ACC determined that relationships with industry or other entities were not relevant to the creation of this general cardiovascular training statement. Employment and affiliation details for authors and peer reviewers are provided in Appendixes 1 and 2, respectively, along with disclosure reporting categories. Comprehensive disclosure information for all authors, including relationships with industry and other entities, is available as an online supplement to this document (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF15_Comprehensive_RWI_Supplement.pdf).

[17] The American College of Cardiology requests that this document be cited as follows: Harrington RA, Barac A, Brush JE Jr, Hill JA, Krumholz HM, Lauer MS, Sivaram CA, Taubman MB, Williams JL. COCATS 4 task force 15: training in cardiovascular research and scholarly activity. J Am Coll Cardiol. 2015;••:••••–••••.

1.1.2. Document Development and Approval

The writing committee developed the document, approved it for review by individuals selected by the ACC, and then addressed the reviewers' comments. The document was revised and posted for public comment from December 20, 2015 to January 6, 2015. Authors addressed these additional comments from the public to complete the document. The final document was approved by the Task Force, COCATS Steering Committee, and ACC Competency Management Committee, and ratified by the ACC Board of Trustees in February, 2015. This document is considered current until the ACC Competency Management Committee revises or withdraws it.

1.2. Background and Scope

Cardiology is a dynamic clinical field in which knowledge from basic and clinical research is continuously translated into clinical care. Knowledge generation and transfer accelerate as understanding of complex biological processes advances. As the science and process of healthcare delivery progresses, trainees need exposure to broad intellectual and scholarly concepts that have implications for clinical practice. An atmosphere of intellectual inquiry and support for the investigative process is critical to the development of a competent cardiologist. To maintain clinical competence and apply emerging knowledge, it is crucial to appreciate the concepts, methods, and limitations of the research process.

Cardiovascular research is defined broadly because advances in patient care come from diverse areas of medical science. All cardiovascular training institutions should offer opportunities for fellows to participate in research, and every cardiovascular trainee is required to participate directly in some form of cardiovascular research or scholarly activity (CRSA). This should include exposure to the practical aspects of conducting research and the ability to critically evaluate published scientific data. Trainees should understand the elements of research design,; informatics; data analysis; deductive and inductive reasoning; and basic principles of biostatistics, including the concepts of probability, uncertainty, and inference. Experiences in CRSA play a critical role in developing the skills and commitment required of all cardiovascular specialists for lifelong learning. Such experiences also foster integration of scientific investigation into the professional life of the emerging cardiologist and enable him or her to adapt practice as knowledge emerges (1). Additionally, many of the skills and experiences gained in the research domain are applicable to the team-based activities of quality improvement, an area that all clinical cardiologists will need to understand throughout their professional career.

The Task Force was charged with updating previously published guidelines for training cardiovascular fellows in CRSA on the basis of changes in the field since 2008 and as part of a broad effort to standardize training. This document does not provide specific guidelines for training fellows in advanced research techniques but more broadly describes opportunities for training in cardiovascular investigation. The Task Force also updated previously published standards to address the evolving framework of competency-based medical education described by the ACGME Outcomes Project and the 6 general competencies endorsed by the ACGME and ABMS. The background and overarching principles governing fellowship training are provided in the Introduction to COCATS, and readers should become familiar with this foundation before considering the details of training in a subdiscipline like cardiovascular research and scholarly activity. The Steering Committee and Task Force recognize that implementation of these changes in training requirements will occur incrementally.

For most areas of cardiovascular medicine, 3 levels of training are delineated:

Level I training, which is 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 cardiovascular medicine. Level I CRSA training refers to competency in critically interpreting cardiovascular research literature and familiarity with methods used across a broad spectrum of cardiovascular research including but not limited to basic and translational science; molecular, genetic, and cellular research; animal studies; epidemiological studies; clinical trials; and meta-analyses. Level I training also includes participation in such mentored research activities as data collection, analysis, and interpretation; scientific writing; and the evaluation of the quality of medical evidence. This document focuses on CRSA training in cardiovascular medicine regardless of the career objectives of the trainee**.**

Level II training typically refers to the additional training in 1 or more areas that enables some cardiovascular specialists to perform or interpret specific diagnostic tests and procedures or render more specialized care for patients and conditions. This level of training is recognized for those areas in which an accepted instrument or benchmark, such as a qualifying examination, is available to measure specific knowledge, skills, or competence. Level II training in selected areas may be achieved by some trainees during the standard 3-year cardiovascular fellowship, based on the trainees' career goals and use of elective rotations. It is anticipated that during a standard 3-year cardiovascular fellowship training program, sufficient time will be available for the trainee to receive Level II training in a specific subspecialty. In the case of CRSA, there is no defined Level II training, although advanced training (comparable to Level III) is available after the standard fellowship.

Level III training requires additional training and experience beyond the cardiovascular fellowship for the trainee to acquire specialized knowledge and competence. For CRSA, Level III training pertains specifically to those planning careers in cardiovascular investigation. Trainees contemplating careers in investigative cardiology bear a special responsibility to prepare effectively to advance knowledge in cardiovascular science. There are many pathways to a research career, all requiring additional training and experience to develop the skills necessary to conceive, design, implement, conduct, analyze, and communicate the results of laboratory, clinical, or population-based research. The goal of advanced training in research is to develop expertise in an area of investigation that enables the trainee to direct an independent research project or provide expertise in a collaborative research program. In most cases, advanced training should enable trainees to apply for competitive research funding. This advanced training requires experience dedicated to specialized research beyond the 3-year cardiovascular fellowship. Level III training is described here only in broad terms to provide context for trainees and clarify that this advanced knowledge is not addressed during the cardiovascular fellowship.

The duration of exposure at each level of training is based on published competency statements as well as the experience and opinions of the writing group. It is assumed that training is directed by appropriately trained mentors in an ACGME-accredited program and that satisfactory completion of training is documented by the research sponsor and program director. The types and extent of activities and duration of training required are summarized in Section 4.

2. General Standards

The ACC published educational objectives for fellowship training in cardiovascular research in 2008 (2). The 2008 recommendations have been updated and address faculty, facility requirements, research trends, and practice. Cardiovascular fellowship programs should satisfy these requirements. The intensity of training and r resources required varies according to the level of training provided. We recommend strongly that candidates for the ABIM examination for certification in cardiovascular diseases review the specific requirements of the ABIM as they pertain to this aspect of training (3).

2.1. Faculty

The training program faculty must include several proven, skilled investigators who have obtained research funding and published peer-reviewed original research. At least 1 full-time faculty member from each training program should have demonstrated abilities as an independent investigator. The critical mass of faculty actually requires several cardiovascular investigators, however, some of whom may be clinical cardiologists, optimally with expertise and experience in a wide range of fields.

2.2. Facilities

The training institution must provide appropriate staff and facilities to conduct research. Research opportunities for trainees should be available not only in clinical cardiovascular medicine, but also in other departments, including basic biomedical and population health sciences. Expertise in epidemiological methods, outcomes evaluation, clinical trial design and methods, biomedical and clinical informatics, biostatistics, biomedical ethics, and regulatory science is essential for training in patient-oriented investigation. Optimally, cardiovascular training should take place in a university-affiliated teaching hospital or similar institution. When this is not feasible, an active affiliation with an academic CRSA mentor can complement community-based training. The training program should provide access to a medical library; Internet access to online compendia such as PubMed, Medline, and CardioSource; as well as statistical software such as Statistical Analysis System (SAS), Matlab, and Statistical Package for the Social Sciences (SPSS).

Although specific components of the research infrastructure will vary with the type and scope of projects at a given institution and availability of funding, most institutions should have personnel experienced in developing research budgets, reviewing research contracts, ensuring sound financial management of research, and serving on an Institutional Review Board that governs research involving human subjects. Where laboratory animal research is conducted, appropriate facilities include the staff and equipment necessary for safe and humane handling. Clinical research programs should include trained study coordinators. It is highly desirable that trainees engaging in research have access to a biostatistician or other quantitative scientists for collaboration and assistance in planning studies and analyzing research data.

3. Training Components

Trainees should have prior education in and exposure to the biological, physical, quantitative, and informational sciences fundamental to modern medicine. Additional coursework and opportunities for independent study and formal graduate training programs should be available and trainees should be encouraged to avail themselves of these resources.

3.1. Didactic Program

The competent cardiologist must critically assess the scientific literature relevant to patient care. This involves understanding research methodology; fundamental concepts of research design; and the conduct, analysis, and interpretation that form the basis for evidence-based medicine. Because clinical practice guidelines and related documents form an essential basis for contemporary clinical care, training programs must provide trainees with an introduction to evidence assessment and synthesis and to the methodology underlying evaluation of the quality of scientific evidence. Trainees can obtain the required knowledge and skills in a variety of ways, including participation in lecture series (such as Web-based programs) and critical review and discussion of carefully selected articles at journal club conferences attended by both trainees and experienced faculty. The didactic portion of training in research and scholarly activity should incorporate issues of responsible conduct of research such as protection of human and animal subjects, transparent reporting and avoidance of conflicts of interest, independence of data monitoring committees, independence in analyses and publications, and integrity in assigning authorship.

3.2. Interpretation of Cardiovascular Research

The competent clinician must interpret scientific reports that pertain to clinical practice. New data should not be accepted uncritically, nor should the cardiologist fail to recognize and evaluate important scientific advances relevant to clinical practice. As a minimum Level I requirement, the program should provide frequent opportunities for faculty and trainees to review and analyze in depth a broad variety of cardiovascular research reports.

3.3. Hands-On Research Experience

Research in cardiovascular science and medicine takes diverse forms. Although hands-on exposure to research is essential to advanced research training, introductory hands-on research experience is desirable but not mandatory for Level I training. This introductory experience could be as straightforward as learning to obtain informed consent from a patient considering participation in a clinical trial, collecting blood or tissue samples for basic or translational laboratory investigations, or learning to extract information from medical records for entry into a research database. All of these experiences should be conducted under the supervision of experienced research personnel, including faculty expert in the pertinent research methodologies.

3.4.Teaching

Because almost all academic cardiologists devote time and effort to teaching, the trainee should understand the principles of adult learning and acquire the skills necessary to effectively teach others, including patients. Academic practitioners teach medical students, residents, and fellows, whereasclinical cardiologists traditionally direct teaching activities toward advanced practice providers, nurses, and ancillary staff in hospital or outpatient office settings.

4. Summary of Training Requirements

4.1. Development and Evaluation of Core Competencies

Training and requirements in CRSA address the 6 general competencies promulgated by the ACGME/ABMS 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 core 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/ABIM reporting milestones. The ACC has adopted this format for its competency and training statements, career milestones, lifelong learning, and educational programs. Additionally, it has developed tools to assist physicians in assessing, enhancing, and documenting these competencies.

Table 1 delineates each of the 6 competency domains, as well as their associated curricular milestones for training in CRSA. The milestones indicate the stage of fellowship training (12, 24, or 36 months, and additional time points) by which the typical cardiovascular trainee should achieve the designated level. Given that programs may vary with respect to the sequence of clinical experiences provided to trainees, the milestones at which various competencies are reached may also vary. Level I competencies may be achieved at earlier or later time points. Acquisition of Level II skills requires additional training and acquisition of Level III skills requires training in a dedicated cardiovascular research program. The table also describes examples of evaluation tools suitable for assessing competence in each domain.

4.2. Components of Research

During Level I training, trainees should master the practices of:

1. *Literature review*, before undertaking new investigation to ascertain the current state of knowledge and understand a disease or condition, diagnostic technology or therapy; and
2. *Ethical conduct* in carrying out responsible research, including but not limited to the protection of human subjects and recognition, and the disclosure and management of potential conflicts of interest.

Table 1. Core Competency Components and Curricular Milestones for Training in Cardiovascular Research and Scholarly Activity

Medical Knowledge	Milestones (Months)			
	12	24	36	Add

1. Know the roles and functions of DNA, RNA and proteins.			I	
2. Know the principles of genetics, genomics, proteomics, metabolomics and pharmacogenomics.			I	
3. Know the principles of epidemiological methods.			I	
4. Know the principles of outcomes evaluation.			I	
5. Know the basic principles of biostatistics.			I	
6. Know the principles underlying hypothesis formation, specific goals definition, hypothesis testability, and statistical power achievable.			I	
Evaluation Tools: global evaluation, in-training exam, multisource evaluation				
Patient Care and Procedural Skills	**12**	**24**	**36**	**Add**
1. Skill to review published research data and assess the adequacy of research design, data analysis, and logical deduction.			I	
2. Skill to integrate appropriately scientific concepts and research advances in routine clinical encounters.		I		
3. Skill to routinely assess the quality of evidence in clinical decisions.		I		
4. Skill to apply principles of biomedical ethics as they pertain to human subject research in the identification of patients as potential research subjects, presentation of alternatives, obtaining informed consent and assuring the security of clinical data used for research.		I		
Evaluation Tool: multisource evaluation				
Systems-Based Practice	**12**	**24**	**36**	**Add**
1. Effectively access and utilize national registry data for research.		I		
2. Know the role of and how to interact with Institutional Review Boards.		I		
Evaluation Tools: direct observation, multisource evaluation				
Practice-Based Learning and Improvement	**12**	**24**	**36**	**Add**
1. Identify knowledge and performance gaps and engage in opportunities to achieve focused education and performance improvement.		I		
2. Appropriately integrate new or emerging medical evidence.			I	
Evaluation Tools: multisource evaluation, reflection and self-assessment				
Professionalism	**12**	**24**	**36**	**Add**
1. Demonstrate sensitivity to patient autonomy and safety in research.	I			
2. Practice with integrity in the conduct of research, including understanding issues relating to relationships with industry.		I		
3. Interact respectfully with ancillary and support staff.	I			
Evaluation Tools: conference presentation, direct observation, reflection and self-assessment				
Interpersonal and Communication Skills	**12**	**24**	**36**	**Add**

1. Communicate with fellow trainees and faculty about cardiovascular science and how this might impact clinical care (for example, through journal clubs).		I		
2. Effectively communicate study results during presentations.		I		
Evaluation Tools: direct observation, multisource evaluation				

Add = additional months beyond the 3-year cardiovascular fellowship, DNA = deoxyribonucleic acid, and RNA = ribonucleic acid.

4.3. Duration of Research Training

The specific competencies expected to result from Level I training are delineated in Table 1. The minimum lengths of training required for Level I and advanced training in CRSA, are summarized below. A brief discussion of the competencies and training requirements also follows. At more advanced levels, the education of investigators is a continuous process, and research trainees usually remain in an educational institution to participate in both scientific and clinical endeavors. Advanced research training may lead to multiple career paths, ranging from permanent academic appointments to stints in private practice or vice versa.

4.3.1. Level I Training Requirements

Level I trainees planning careers predominantly in clinical practice should devote 6 to 12 months (and up to 24 months) to 1 or more scholarly or research projects. These activities can be undertaken concurrently with clinical training and may not require a dedicated block of time, although in most cases, some period of time should be available to pursue CRSA while unfettered by clinical duties. Although the training duration suggested is required by the typical trainee to obtain competency, trainees must also demonstrate achievement of the competencies as assessed by the outcomes evaluation measures.

4.3.2. Advanced Training Requirements

Trainees preparing for careers in research need an extensive foundation in scientific investigation. Some will have obtained preparation in combined-degree programs (e.g., MD/PhD, MD/MPH, MD/MS) but may lack the specific skills or experience necessary to achieve their research objectives. These advanced skills may be obtained in a postdoctoral research fellowship or as part of cardiovascular training. For additional training, the trainee should join the group or laboratory of a productive and active scientist or clinical investigator (with an MD or PhD degree), in a qualified institution (which is not necessarily where he or she is enrolled for fellowship training).

Trainees seeking careers in investigative cardiology who have not obtained an advanced degree should be encouraged to obtain the necessary scientific analytic coursework and laboratory or clinical research experience to promote a productive research career. Current models of this type of training include the AHA Clinician Scientist Award and the National Heart, Lung, and Blood Institute programs for K08 (Mentored Clinical Scientist Development), K23 (Mentored Patient-Oriented Research Career Development), and K99/R00 (National Institutes of Health Pathway to Independence) awards.

4.3.2.1. Basic Research

For those planning a career in basic laboratory research, 3 years working directly with an experienced mentor—beyond the 2 clinical years—are needed in most cases. Such training constitutes only the beginning of an independent cardiovascular investigator's education.

4.3.2.2. Clinical Research

For trainees planning a substantive commitment to advanced clinical research, at least 2 to 3 full years devoted to mentored clinical research are generally needed, of which 1 or more years can occur during fellowship training. Advanced research training requires didactic training, including formal coursework in research methods. The pursuit of an advanced degree (e.g., PhD, MS, MPH) in a specific scientific field is optional. The advanced degree is especially valuable to trainees considering careers as independent investigators directing a laboratory or leading a scientific research program.

4.3.2.3. Compensation

Compensation during the often prolonged period of research training should be sufficient to support a full-time commitment. In this context, the U.S. Congress passed the Clinical Research Enhancement Act, which eases debt repayment for candidates with MD or MD/PhD degrees engaging in advanced research training (4).

5. Evaluation of Competency

Evaluation tools in cardiovascular research and scholarly activity include direct observation by instructors, in-training exams, case logbooks, conference and case presentations, multisource evaluations, trainee portfolios, and reflection and self-assessment. Analytical, ethical, judgment, interpretive, and, as appropriate, research laboratory skills must be evaluated in every trainee. Reliability; judgment, decisions, or actions that result in questions about data or analytical integrity; interactions with other physicians, researchers, statisticians, patients, or research laboratory support staff; initiative; and the ability to make appropriate decisions and ask appropriate questions independently should be considered. Trainees should, as appropriate, maintain laboratory notebooks, well-annotated statistical code, and records of participation and advancement in the form of a Health Insurance Portability and Accountability Act (HIPAA)-compliant electronic database or logbook that meets ACGME reporting standards and summarizes important research-related information for each project and/or encounter.

Under the aegis of the program director, the 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 for 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.

Key Words: ACC Training Statement ▪ COCATS ▪ fellowship training ▪ clinical competence ▪ research.

APPENDIX 1. AUTHOR RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—COCATS 4 TASK FORCE 15: TRAINING IN CARDIOVASCULAR RESEARCH AND SCHOLARLY ACTIVITY

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
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	Chairman of Medicine						
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For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects author's employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including RWI not pertinent to this document—is available in an online data supplement (http://jaccjacc.acc.org/Clinical_Document/COCATS_TF15_Comprehensive_RWI_Supplement.pdf). Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

APPENDIX 2. PEER REVIEWER RELEVANT RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES—COCATS 4 TASK FORCE 15: TRAINING IN CARDIOVASCULAR RESEARCH AND SCHOLARLY ACTIVITY

Name	Employment	Representation	Consultant	Speaker's Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
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Howard	Thomas Jefferson University Hospital—Director, Division of	Official Reviewer,	None	None	None	None	None	None

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Musunuru	Harvard University	Reviewer, AHA						

For the purpose of developing a general cardiology training statement, the ACC determined that no relationships with industry or other entities were relevant. This table reflects peer reviewers' employment, representation in the review process, as well as reporting categories. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories, relevance, or additional information about the ACC Disclosure Policy for Writing Committees.

ACC = American College of Cardiology, AHA = American Heart Association.

APPENDIX 3. ABBREVIATION LIST

ABIM = American Board of Internal Medicine

ABMS = American Board of Medical Specialties

ACC = American College of Cardiology

ACGME = Accreditation Council for Graduate Medical Education

COCATS = Core Cardiovascular Training Statement

CRSA = cardiovascular research or scholarly activity

HIPAA = Health Insurance Portability and Accountability Act

SAS = Statistical Analysis System

SPSS = Statistical Package for the Social Sciences

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