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TRAINING STATEMENT

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

Endorsed by the Society for Cardiovascular Magnetic Resonance

Christopher M. Kramer, MD, FACC, *Chair*
W. Gregory Hundley, MD, FACC
Raymond Y. Kwong, MD, MPH
Matthew W. Martinez, MD, FACC
Subha V. Raman, MD, FACC*
R. Parker Ward, MD, FACC

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.

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 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; ratified by the ACC Board of Trustees in March, 2015; and endorsed by the SCMR. 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-accredited fellowships (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 COCATS 4 Introduction, 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.

*Society for Cardiovascular Magnetic Resonance Representative.

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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 in the following text.

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 4 Task Force 4 report). 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 (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 examination 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. 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 an ACGME-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

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accredited by an organization such as the Intersocietal Accreditation Commission for Magnetic Resonance Imaging. 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 magnetic resonance 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 individuals 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.

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 magnetic resonance in general and physics that relate to CMR and to 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 1 Classification of Basic Cardiovascular Magnetic Resonance Techniques

Morphological 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 pharmacological stress and at rest
Cine imaging of left ventricular structure/function with exercise or dobutamine
Myocardial tissue characterization
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.

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 in the previous text. 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

TABLE 2 Classification of Common CMR Applications

CMR Study Indications	Cardiac Features of Interest	Key CMR Techniques
Myocardial viability	■ Left ventricular function ■ Infarct transmurality for recovery of systolic function ■ Contractile reserve of heart function	■ Cine imaging ■ LGE imaging ■ 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 and hemorrhage ■ Infarct size and microvascular obstruction ■ Imaging of complications (e.g., ventricular septal defect, pericardial disease, acute mitral regurgitation)	■ Cine imaging ■ T2- and 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-, T2-weighted black blood imaging without and with fat saturation ■ First-pass perfusion imaging at rest and T1-weighted imaging precontrast and postcontrast ■ 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-, T2-weighted black blood imaging ■ MR angiography ■ Velocity-encoded imaging

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

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/American Board of Internal Medicine 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

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I, II, or 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.

4.2. Number of Cases and Duration of Training

Although the training duration and numbers of procedures stated previously are typically required to obtain competency, there must also be a 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 of 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.

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 size
Hardware
Field strength, gradient coil design, receiver coils, and digital sampling
Specialized sequences
T1 and T2 mapping, velocity-encoded imaging, noncontrast 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

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

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

Competency Component		Milestones (Months)			
MEDICAL KNOWLEDGE		**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, and in-training examination.				
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, and logbook.				
SYSTEMS-BASED PRACTICE		**12**	**24**	**36**	**Add**
1	Incorporate risk/benefit and cost considerations in the use of cardiovascular magnetic resonance testing.		I		
2	Participate in cardiovascular magnetic resonance quality monitoring and initiatives.			II	
	EVALUATION TOOLS: chart-stimulated recall, conference presentations, direct observation, and multisource evaluation.				

TABLE 4 Core Competency Components, continued

Competency Component		Milestones (Months)			
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, and 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, and 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 and multisource evaluation.				

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

training program should strive to meet these needs by offering a "multimodality" imaging experience (see COCATS 4 Task Force 4 report). This might include an appreciation for each technique's uses and indications, strengths and limitations, safety issues, and relevant guidelines and appropriate use 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, training technologists, and mentoring other physicians in training. In addition to the requirements for Level I and 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, because 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 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 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 appropriate use 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.

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KEY WORDS ACC Training Statement, cardiovascular imaging, cardiovascular magnetic resonance, COCATS, 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

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
Christopher M. Kramer *(Chair)*	University of Virginia Health System—Ruth C. Heede Professor of Cardiology, Professor of Radiology	None	None	None	None	None	None
W. Gregory Hundley	Wake Forest University School of Medicine—Professor, Internal Medicine (Cardiology) and Radiology	None	None	None	None	None	None
Raymond Y. K. Kwong	Brigham & Women's Hospital Medicine, Cardiovascular Division—Instructor of Medicine	None	None	None	None	None	None
Matthew W. Martinez	Lehigh Valley Health Network—Associate Professor of Medicine	None	None	None	None	None	None
Subha V. Raman	Ohio State University—Professor of Internal Medicine, Biomedical Informatics, and Radiology	None	None	None	None	None	None
R. Parker Ward	University of Chicago Medicine—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 authors' employment and reporting categories. To ensure complete transparency, authors' comprehensive healthcare-related disclosure information—including relationships with industry not pertinent to this document—is available in an online data supplement. 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 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
Richard Kovacs	Indiana University, Krannert Institute of Cardiology—QE 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—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
Michael Emery	Greenville Health System	Content Reviewer, Sports and Exercise Cardiology Section Leadership Council	None	None	None	None	None	None
Brian D. Hoit	University Hospitals Case Medical Center	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 Leadership Council	None	None	None	None	None	None
Nishant Shah	Brigham and Women's Hospital, Harvard Medical School—Cardiovascular Imaging Fellow	Content Reviewer, Imaging Council	None	None	None	None	None	None
Kim Williams	Rush University Medical Center—James B. Herrick Professor and Chief, Division of Cardiology	Content Reviewer, Cardiology Training and Workforce Committee	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; 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