

TRAINING STATEMENT

COCATS 4 Task Force 4: Training in Multimodality Imaging



Jagat Narula, MD, PhD, MACC, *Chair*
Y.S. Chandrashekar, MD, FACC
Vasken Dilsizian, MD, FACC
Mario J. Garcia, MD, FACC
Christopher M. Kramer, MD, FACC

Shaista Malik, MD, PhD, FACC
Thomas Ryan, MD, FACC
Soma Sen, MBBS, FACC
Joseph C. Wu, MD, PhD, 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 included the chairs of the COCATS 4 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 (ABIM), and American Board of Medical Specialties (ABMS). 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.

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 from December 20, 2014, 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-accredited 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 an 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 COCATS 4 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. Yet, because 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 an MMI 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 COCATS 4 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 (see [Table 1](#)).

The individual COCATS 4 Task Force reports emphasize concurrent training and consolidation of common curricula across modalities. Quality and appropriate use 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.

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

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 an 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; CCT = cardiovascular computed tomography; CMR = cardiovascular magnetic resonance; MMI = multimodality imaging.

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 examinations, 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 appropriate use 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 ensure achievement of selected training milestones and to identify areas in which additional focused training may be required.

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KEY WORDS ACC Training Statement, cardiovascular computed tomography, cardiovascular magnetic resonance, clinical competence, COCATS, echocardiography, fellowship training, multimodality imaging, nuclear cardiology

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

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional/ Organizational or Other Financial Benefit	Expert Witness
Jagat Narula (<i>Chair</i>)	Mount Sinai School of Medicine—Philip J. & Harriet L. Goodhart Chair in Cardiology; Professor of Medicine	None	None	None	None	None	None
Y. S. Chandrashekar	University of Minnesota, Division of Cardiology—Professor of Medicine	None	None	None	None	None	None
Vasken Dilsizian	University of Maryland School of Medicine—Professor of Medicine/ Radiology; Director, Division of Nuclear Medicine	None	None	None	None	None	None
Mario J. Garcia	Montefiore Medical Center, Albert Einstein College of Medicine—Chief of Cardiology; Professor of Medicine and Radiology	None	None	None	None	None	None
Christopher M. Kramer	University of Virginia Health System—Ruth C. Heede Professor of Cardiology; Professor of Radiology	None	None	None	None	None	None
Shaista Malik	University of California—Assistant Professor	None	None	None	None	None	None
Thomas Ryan	Ross Heart Hospital—Director, Heart and Vascular Center; John G. and Jeanne Bonnet McCoy Chair in Cardiovascular Medicine	None	None	None	None	None	None
Soma Sen	Park Nicollet Methodist Hospital—Cardiologist	None	None	None	None	None	None
Joseph C. Wu	Stanford University School of Medicine—Professor of Medicine and Radiology; Stanford Cardiovascular Institute—Director	None	None	None	None	None	None

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ACC = American College of Cardiology.

**APPENDIX 2. PEER REVIEWER RELATIONSHIPS WITH INDUSTRY AND OTHER ENTITIES (RELEVANT)—
COCATS 4 TASK FORCE 4: TRAINING IN MULTIMODALITY 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—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
Dennis Calnon	OhioHealth Heart and Vascular Physicians—Director, Cardiac Imaging; Riverside Methodist Hospital	Organizational Reviewer, ASNC	None	None	None	None	None	None
Thomas Gerber	Mayo Clinic—Professor, Medicine and Radiology	Organizational Reviewer, SAIP	None	None	None	None	None	None
John Hodgson	Metrohealth Medical Center	Organizational Reviewer, SCAI	None	None	None	None	None	None
Allan Klein	Cleveland Clinic—Professor, Medicine and Director, Pericardial Center	Organizational Reviewer, ASE	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
Sherif Nagueh	Methodist DeBakey Heart and Vascular Center— Professor of Medicine	Organizational Reviewer, ASE	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
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
Prem Soman	University of Pittsburgh Medical Center—Director, Nuclear Cardiology and Associate Professor, Medicine	Content Reviewer, CV Imaging Summit Steering 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
Kim Williams	Rush University Medical Center— James B. Herrick Professor; Chief, Division of Cardiology	Content Reviewer, Cardiology Training and Workforce Committee	None	None	None	None	None	None

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ACC = American College of Cardiology; ASE = American Society of Echocardiography; ASNC = American Society of Nuclear Cardiology; CV = cardiovascular; SAIP = Society of Atherosclerosis Imaging and Prevention; SCAI = Society for Cardiovascular Angiography and Interventions; 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