

## VIEWPOINT

# A Proposal for an Advanced Cardiovascular Imaging Training Track

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Cardiovascular (CV) imaging has experienced major growth and technological advances with respect to the long-standing traditional cardiac imaging procedures of echocardiography and nuclear cardiology, the emergence of cardiac computed tomography and magnetic resonance imaging in clinical practice, and multimodality and molecular imaging as new technologies. Therefore, it is perhaps timely to change the training paradigm for fellows interested in emphasizing CV imaging as a subspecialty in their professional careers and desiring extensive training in all CV imaging modalities. Proposed is the establishment of a formal fourth year of training leading to board certification in advanced CV imaging. Areas of training would include the acquisition of knowledge of physics and instrumentation related to the various imaging modalities, interpretation and quantitation of imaging variables, multimodality imaging technology, molecular and vascular imaging, and clinical guidelines with appropriateness criteria for all technologies. The training track would lead to an American Board of Internal Medicine examination for a Certificate of Added Qualification, similar to that for subspecialization in electrophysiology and interventional cardiology, with noninvasive cardiologists who have already completed fellowship training given the opportunity to sit for an examination on the basis of predetermined eligibility criteria. One benefit of this CV imaging subspecialty track that provides cardiologists with expertise in all imaging modalities is the capability to select the best modality for the clinical indication and to independently interpret multimodality imaging studies. Its rigorous didactic and procedural requirements would enhance quality of CV imaging, enhance research, and increase the speed with which new discoveries are translated into practice. This ultimately would yield better patient outcomes. (J Am Coll Cardiol 2006;48:1299–303) © 2006 by the American College of Cardiology Foundation

The field of cardiovascular imaging has experienced major growth and technological advances in recent years with respect to the long-standing traditional cardiac imaging procedures of echocardiography and nuclear cardiology and with the emergence of cardiac computed tomography (CT) and cardiac magnetic resonance (CMR) imaging in clinical practice. Some major imaging technologies in these fields include gated single-photon emission computed tomography (SPECT), positron emission tomography (PET), trans-thoracic and transesophageal echocardiography, contrast echocardiography, cardiac and large-vessel magnetic resonance imaging (MRI), CT scanning for coronary calcification, CT coronary angiography, carotid and peripheral vascular imaging with a variety of techniques, and molecular imaging of biologic processes that is still predominantly in the preclinical investigative phase. Multimodality and hybrid imaging yielding fused images employ several of these imaging techniques used simultaneously as with PET-CT and SPECT-CT. An example of multimodality imaging is the display of the uptake of a targeted imaging agent such as radiolabeled fluorodeoxyglucose (FDG) imaged by PET superimposed on the anatomic representation of a carotid

artery as displayed on a vascular CT scan to identify an inflamed macrophage-laden atherosclerotic plaque. All molecular “hot spot” imaging techniques need to be coupled with imaging technologies that can localize the physiologic or metabolic process in recognized areas of the heart or blood vessel, as with the determination of myocardial viability with PET-FDG for metabolic imaging and PET perfusion scans for regional flow assessment to identify regions of perfusion-metabolism mismatch patterns. The future seems to be in the direction of fusing images from disparate imaging technologies like PET-CT for simultaneous determination of anatomic stenosis detection and its physiologic manifestation on stress perfusion scans. In one of his Editor’s Page essays, Dr. Anthony DeMaria (1) discusses the emergence of new types of cardiovascular specialists. He stated that “coupling ultrasound and radioisotope procedures with the new CMR and CT techniques could form the basis for the cardiovascular imaging specialist.” It would seem that now is the time to consider this occurrence and propose a new training paradigm that would lead to a high level of expertise and competence in supervising and performing multiple types of imaging procedures.

## PRESENT IMAGING TRAINING PARADIGM

The present paradigm for training cardiologists in imaging techniques and corresponding clinical applications cited in

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**Abbreviations and Acronyms**

ABIM	= American Board of Internal Medicine
ABMS	= American Board of Medical Subspecialties
ACCF	= American College of Cardiology Foundation
ACGME	= Accreditation Council for Graduate Medical Education
CAQ	= Certificate of Added Qualification
CMR	= cardiac magnetic resonance
CMS	= Centers for Medicare and Medicaid Services
COCATS	= Core Cardiology Training Symposium
CT	= computed tomography
FDG	= fluorodeoxyglucose
MRI	= magnetic resonance imaging
PET	= positron emission tomography
SPECT	= single-photon emission computed tomography

the preceding paragraphs can be gleaned from the training requirements outlined in the Core Cardiology Training Symposium (COCATS) documents (2,3). Training recommendations for echocardiography, nuclear cardiology, cardiac CT, and CMR are organized by levels of training starting from minimum months of training for all cardiology fellows (Level 1) expanding to Level 2 training intended for those fellows who desire to independently supervise and interpret imaging tests and then to Level 3, which is intended for those who want advanced training to direct an imaging laboratory in the clinical setting or who desire to have an imaging technology as a focus of an academic career, including research. Level 3 training also entails more experience in complex imaging technology and the attainment of very high expertise in interpretation of imaging tests, yielding high competency. Table 1 summarizes the number of months recommended for Level 1, 2, and 3 training as provided in the 2006 update of the COCATS 2

Training Statement (3). It should be pointed out that the number of months recommended for Level 3 training is a cumulative number that includes completed months of Level 2 training.

With respect to the current training paradigm, virtually all cardiology fellows get Level 2 training in echocardiography and most obtain Level 2 training in nuclear cardiology. Now, an increasing number of fellows seek Level 2 training in CMR and cardiac CT. Few fellows acquire Level 3 training in more than 1 imaging modality, because presently it takes a cumulative 12 months of training to achieve an advanced level of expertise in echocardiography, nuclear cardiology, and CMR and a total of 6 months of CT training to attain Level 3 status in that discipline (see Table 1). If not taken concurrently, this means that a cardiovascular imaging subspecialist would need to have a substantial number of extra months of imaging training to achieve Level 3 training in all 4 modalities. Thus, fellows interested in cardiovascular imaging emerge from their training experiences with advanced technological and interpretive skills in usually just one of the imaging modalities. With respect to the academic cardiovascular imaging faculty, most are experts in only 1 imaging modality. It is rare for a director of an echocardiography laboratory to also oversee the activities of a nuclear cardiology laboratory. Even most readers of imaging tests in major teaching hospitals rarely are assigned to read both echocardiographic and nuclear cardiology studies. Recently, some nuclear cardiology specialists have acquired skills in cardiac CT mainly because of the potential for multimodality imaging as described previously and because, in new SPECT cameras, CT is incorporated for attenuation correction. Many CMR experts who are cardiologists have major expertise in echocardiography and work in both areas. However, it is rare that a noninvasive faculty member has Level 3 training in all 4 imaging modalities. This is also true for radiologists who have an

**Table 1.** Training Recommendations for Cardiovascular Imaging Procedures From the COCATS Training Statement

Area Level	Minimal Number of Procedures	Cumulative Duration of Training (Months)	Minimal Cumulative Number of Cases
Echocardiography			
1	150	3	150
2	150	6	300
3	450	12	750
Nuclear cardiology			
1	80 hrs	2	80 hrs
2	300 cases	4-6	300+ cases
3	600 cases	12	600+ cases
Cardiovascular magnetic resonance			
1		1*	50 cases
2		3-6	150 cases
3		12	300 cases
Computed tomography			
1		1*	50 cases
2		2	150 cases
3		6	300 cases

Adapted from Appendix 1, p. 896 (3). \*Can be taken as part of 6 months of noninvasive imaging rotation.

interest in cardiovascular imaging. Those who have acquired skills and high expertise in CMR and cardiac CT scanning rarely are engaged in nuclear cardiology, and almost none have specialized training and expertise in echocardiography.

With respect to noninterventional cardiologists engaged in clinical practice in the community hospital or private practice office setting, most engage in some form of noninvasive imaging, but they are not simultaneously involved in advanced echocardiographic, nuclear, CMR, and cardiac CT imaging technologies. Many who have been in practice for many years are seeking training experiences through Continuing Medical Education (CME) offerings and preceptorships to acquire new skills in cardiac CT and CMR because such technologies did not exist when they completed their fellowship training. Because of the shortage of cardiologists in the workforce, it might no longer be appropriate or practical to have noninvasive or general cardiologists possessing expertise in only 1 or 2 of the 4 imaging technologies. It surely would be preferable if newly trained cardiology fellows entering the workforce could provide expert supervisory and interpretive services for all the imaging technologies, particularly when multimodality and fusion imaging approaches become a part of the performance of routine noninvasive diagnostic imaging, as already being observed with SPECT and PET integration with CT scanning. Thus, a new imaging training paradigm is proposed that will permit the training of cardiovascular imaging subspecialists possessing high expertise in both conventional and advanced imaging technologies.

### **NEW IMAGING TRAINING PARADIGM AND NEWLY RECOGNIZED SUBSPECIALTY OF CARDIOVASCULAR IMAGING**

It is now the time to consider changing the training paradigm for cardiology fellows interested in emphasizing cardiovascular imaging in their professional careers, whether in an academic environment or solely in the clinical practice setting. This evolution is similar to what transpired in the subspecialty fields of cardiac electrophysiology and interventional cardiology. It was deemed by the thought leaders in these fields that a unique body of knowledge needed to be learned and high technical proficiency required for the delivery of high-quality care. The pioneers and thought leaders in electrophysiology and interventional cardiology convinced organizations like the American College of Cardiology and the American Heart Association to support the concept of adding a fourth year of fellowship training leading to an examination under the aegis of the Cardiovascular Board of the American Board of Internal Medicine (ABIM). The parent ABIM board and subsequently the American Board of Medical Subspecialties (ABMS) agreed with the proposals from the cardiology community. The fourth year of training with board examinations were thus institutionalized for advanced subspecialty training in these disciplines, where fellows who passed an examination given

under the aegis of the ABIM could acquire a Certificate of Added Qualification (CAQ) in electrophysiology or interventional cardiology.

The proposal would be to establish a formal fourth year of training for fellows desiring to become certified in advanced cardiovascular imaging in which they would acquire extensive training in all the cardiovascular imaging modalities. This training experience would include such areas as the acquisition of knowledge of physics related to the imaging modalities, instrumentation, image processing with sophisticated software programs for image display, analysis and quantitation, multimodality imaging technology, principles of molecular imaging, vascular lumen and wall imaging, clinical practice guidelines, and appropriateness criteria for all the technologies and radiation safety. A training curriculum would be agreed upon by experts in the various imaging fields with significant input coming from the cardiac imaging societies (e.g., American Society of Echocardiography, American Society of Nuclear Cardiology, Society of Cardiac Magnetic Resonance, and the Society of Cardiovascular Computed Tomography). A new subspecialty board in cardiovascular imaging would be created, comprising members representing the various imaging disciplines as well as general cardiology. The Accreditation Council for Graduate Medical Education (ACGME) would be the body to grant approval to fellowship training programs applying for the provision of training to fellows in this advanced training track of cardiovascular imaging, as undertaken for electrophysiology and interventional cardiology. Fellows wishing to remain in academic medicine would most likely take 2 years of additional training in cardiovascular imaging to also acquire research skills with mentoring by faculty members with recognized investigative expertise.

To acquire the cumulative number of months deemed necessary for extensive training in all 4 major imaging technologies, some months in the third year of the 4-year fellowship experience would also be devoted to training in cardiovascular imaging. Clinical and/or basic research training could easily be integrated with the acquisition of clinical imaging expertise. Also, some of the training in several disciplines could be acquired concurrently (e.g., CT scanning with nuclear cardiology). This would reduce the total number of training months for achieving Level 3 status in all imaging disciplines.

### **ADVANTAGES OF A COMPREHENSIVE CARDIOVASCULAR IMAGING SUBSPECIALTY TRAINING TRACK**

One obvious major advantage of making available a fourth-year subspecialty training track with associated board certification is the training of noninvasive cardiologists with knowledge and expertise in all imaging modalities. Such subspecialists are then able to select the best modality for the clinical question being asked. They will have the expertise to employ and interpret multimodality imaging procedures,

such as when radionuclide SPECT or PET perfusion images are fused with cardiac MRI or when images of plaque inflammation are fused with CT or MRI scans displaying the anatomic images of coronary vessels. Having this new training track with its rigorous didactic and procedural requirements will advance the field of cardiovascular imaging in quality, in the speed with which new discoveries will be made, and in improved practice guideline development, all yielding better outcomes for patients. It will elevate the prestige of noninvasive cardiovascular imaging when it has the cache of a CAQ when an exam sponsored by a subspecialty board is offered for certification. It addresses, in part, the shortage of cardiologists in that now all the imaging techniques can be performed and interpreted by a single noninvasive cardiologist. With the designation of a subspecialty status, it could attract more cardiologists into the field. With respect to research applications, it is certainly advantageous to have investigators who are able to use a variety of imaging techniques, particularly with small animals that can be imaged with micro imaging technologies (e.g., microPET).

#### **CONTINUED TRAINING OPPORTUNITIES IN IMAGING FOR CARDIOLOGY FELLOWS NOT DESIRING A FULL FOURTH YEAR OF ADVANCED TRAINING**

Some or many cardiology fellows might wish to merely continue with cardiovascular imaging training as presently recommended by attaining Level 2 expertise in 1 or more of the imaging techniques. Such individuals might wish to only supervise and interpret standard echocardiography or nuclear cardiology procedures and not desire advanced training in multiple imaging modalities, including CMR. That would not change with respect to this proposal. Table 1 shows the number of cumulative months and the number of cases for Level 1, 2, and 3 training in each of the imaging modalities. Certainly, Level 2 training in all can be achieved in the time frame of a 3-year fellowship. It is likely, however, that fellows who want to have imaging as the major focus of their professional lives with associated administrative supervisory capabilities to oversee an integrated clinical imaging program would want this fourth year of training and the opportunity for certification.

#### **OPPORTUNITIES FOR PREVIOUSLY TRAINED CARDIOLOGISTS TO BECOME ELIGIBLE FOR THE CAQ EXAMINATION IN ADVANCED CARDIOVASCULAR IMAGING**

As permitted for electrophysiologists and interventional cardiologists who were already engaged in their chosen subspecialty fields before a fourth year of training was required for a CAQ, eligibility requirements for cardiologists already in practice or on staffs of teaching hospitals to sit for a CAQ examination in advanced cardiovascular

imaging will have to be generated. This is what is referred to as “grandfathering.” Many noninvasive cardiologists have been engaged in high-volume work for many years, and some have undergone additional training in CMR and cardiovascular CT while in practice. Therefore, opportunities will have to be offered to such individuals to take the examination if they fulfill requirements that would have to be established by a new cardiovascular imaging board.

#### **ROLE OF CARDIOVASCULAR IMAGING SOCIETIES**

The role of the cardiovascular imaging societies should remain strong and relevant if this new advanced imaging track comes to fruition. The societies would continue to be advocates for research and development of cardiovascular imaging technologies. They would continue with a strong focus on education in the form of CME offerings, journal publications, annual scientific meetings, and educational materials. Examinations in their specific fields to assess knowledge and interpretive skills would still be offered. These examinations would most likely be taken by general cardiologists or noninvasive cardiologists with Level 2 training. Even those cardiologists completing the fourth year of advanced training might take these individual examinations to test their level of knowledge before taking the ABIM certification examination. The imaging societies would still play a major role in advocating for fair reimbursement from the Centers for Medicare and Medicaid Services (CMS) and from other third party payers. They would surely be asked to recommend candidates for a Cardiovascular Imaging Board of the ABIM. The specialty imaging societies and the American College of Cardiology Foundation (ACCF) would work in collaboration to conduct board review courses. Imaging societies would hopefully sustain their involvement in the practice guideline process and the quality-improvement activities.

#### **POSSIBLE NEXT STEPS**

For this new cardiovascular subspecialty imaging training paradigm to become a reality, a buy-in by the cardiology community is necessary. The first step has already been taken with open discussions having been held with representatives from the various imaging disciplines under the leadership of the American College of Cardiology. An interdisciplinary task force comprising all stakeholders should be formed to debate the merits and drawbacks of such a paradigm leading to formal subspecialty training status for noninvasive cardiovascular imaging similar to what transpired with electrophysiology and interventional cardiology. This proposal for this integrated advanced imaging track was presented at the Cardiology Training Directors Symposium at the 2005 ACCF annual scientific sessions and was met with a positive response. Similarly, the concept was presented and well received by those attending the Association of Professors of Cardiology meeting that year. If the cardiology community embraces this concept,

the next step would be to engage the parent Cardiovascular Board of the ABIM in a dialogue regarding the merits of a fourth year of training for advanced cardiovascular imaging leading to an examination for a CAQ. If the Cardiovascular Board approves the proposal, it would then require approval by the ABIM, which has representatives from all the medical subspecialties. If the full ABIM approves the proposal, it then goes to the ABMS for final approval. The ABMS has 1 year from the time they receive the recommendation from the ABIM to make a decision.

## SUMMARY

In summary, with all the advances seen in the field of cardiovascular imaging and its expanding future role in cardiovascular medicine, the time has perhaps arrived to introduce a fourth year of training with an associated board examination for fellows who desire to become experts in all the imaging modalities, including the emerging technologies of CMR imaging and cardiovascular CT scanning. The established imaging fields of echocardiography and nuclear cardiology are expanding with new indications and new applications. The era of multimodality and molecular imaging has arrived and requires greater expertise to perform than what is necessary for supervising and performing studies that are of a single imaging modality. Imaging variables are being used more and more as surrogate end points in clinical research. With the shortage of cardiologists, having subspecialists who have equivalent to Level 3 training in all major imaging modalities would be advantageous, as opposed to groups having to hire multiple different

cardiologists to supervise and perform echocardiograms, nuclear cardiology procedures, cardiac MRI, and CT studies. Finally, cardiovascular imaging specialists will hopefully work in a collaborative relationship with those radiologists who are also experts in the new modalities of CMR and CT scanning. Some joint training opportunities, particularly in research areas aimed at improving the cardiovascular imaging technologies would be advantageous. The purpose of this Viewpoint is to foster debate on the merits and limitations of proceeding to such an advanced training track. It might take a few years to have this new training paradigm created by the organizations involved in the approval process. Whether the climate is right to lengthen training even more is unsure. Let the debate begin.

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