

ACC Revised Recommendations for Training in Adult Cardiovascular Medicine Core Cardiology Training II (COCATS 2) (Revision of the 1995 COCATS Training Statement)

TASK FORCE AUTHORS (AND SOCIETY REPRESENTATIONS)

Introduction/Steering Committee

Co-Chair: George A. Beller, MD, MACC,
Charlottesville, Virginia

Co-Chair: Robert O. Bonow, MD, FACC, Chicago,
Illinois

Co-Chair: Valentin Fuster, MD, PhD, FACC,
New York, New York

Task Force 1: Training in Clinical Cardiology

Chair: Kenneth L. Baughman, MD, FACC, Baltimore,
Maryland

Charles L. Curry, MD, FACC, Washington, DC

David C. Leach, MD, Chicago, Illinois (*American Council
of Graduate Medical Education Representative*)

Prediman K. Shah, MD, FACC, Los Angeles, California

Laura F. Wexler, MD, FACC, Cincinnati, Ohio
(*American Board of Internal Medicine Representative*)

Task Force 2: Training in Electrocardiography, Ambulatory Electrocardiography and Exercise Testing

Chair: Robert J. Myerburg, MD, FACC, Miami, Florida

Bernard R. Chaitman, MD, FACC, St. Louis, Missouri

Gordon A. Ewy, MD, FACC, Tucson, Arizona

Melvin M. Scheinman, MD, FACC, San Francisco,
California

Task Force 3: Training in Diagnostic Cardiac Catheterization and Interventional Cardiology

Chair: Alice K. Jacobs, MD, FACC, Boston,
Massachusetts

David P. Faxon, MD, FACC, Chicago, Illinois (*Society
for Cardiac Angiography and Intervention Representative*)

John W. Hirshfeld, Jr., MD, FACC, Philadelphia,
Pennsylvania

David R. Holmes, Jr., MD, FACC, Rochester,
Minnesota

Task Force 4: Training In Echocardiography

Chair: Thomas Ryan, MD, FACC, Durham,
North Carolina

William F. Armstrong, MD, FACC, Ann Arbor,
Michigan

Alan S. Pearlman, MD, FACC, Seattle, Washington

William J. Stewart, MD, FACC, Cleveland, Ohio
(*American Society of Echocardiography Representative*)

Task Force 5: Training in Nuclear Cardiology

Chair: Manuel D. Cerqueira, MD, FACC, Washington,
DC (*American Society of Nuclear Cardiology
Representative*)

Heinrich R. Schelbert, MD, PhD, FACC, Los Angeles,
California

Frans J. TH. Wackers, MD, PhD, FACC, New Haven,
Connecticut

Mario S. Verani, MD, FACC, Houston, Texas

Task Force 6: Training in Specialized Electrophysiology, Cardiac Pacing and Arrhythmia Management

Chair: Gerald V. Naccarelli, MD, FACC, Hershey,
Pennsylvania

Jamie B. Conti, MD, FACC, Gainesville, Florida

John P. DiMarco, MD, PhD, FACC, Charlottesville,
Virginia

Philip T. Sager, MD, FACC, Kenilworth, New Jersey
(*North American Society of Pacing and Electrophysiology
Representative*)

Task Force 7: Training in Cardiovascular Research

Chair: Robert Roberts, MD, FACC, Houston, Texas

R. Wayne Alexander, MD, PhD, FACC, Atlanta,
Georgia

Joseph Loscalzo, MD, PhD, FACC, Boston,
Massachusetts

R. Sanders Williams, MD, FACC, Durham,
North Carolina

Task Force 8: Training in Heart Failure and Transplantation

Chair: Sharon A. Hunt, MD, FACC, Palo Alto,
California

Wilson S. Colucci, MD, FACC, Boston, Massachusetts

This document was approved by the ACC Board of Trustees on February 8, 2002.

When citing this document, the American College of Cardiology would appreciate the following citation format: Beller GA, Bonow RO, Fuster V, et al. ACC Revised Recommendations for Training in Adult Cardiovascular Medicine Core Cardiology Training II (COCATS 2) (Revision of the 1995 COCATS Training Statement). *J Am Coll Cardiol* 2002;39:1242-6.

To print a copy of this document or the full-text recommendations, please visit the ACC Web site at www.acc.org. Copies are also available by calling 800-253-4636 (US only) or writing the American College of Cardiology, Resource Center, 9111 Old Georgetown Road, Bethesda, MD 20814-1699.

Arthur M. Feldman, MD, PhD, FACC, Pittsburgh,
Pennsylvania (*Heart Failure Society of America
Representative*)
James B. Young, MD, FACC, Cleveland, Ohio

**Task Force 9: Training in the Care of Adult Patients
with Congenital Heart Disease**

Chair: Carole A. Warnes, MD, MRCP, FACC,
Rochester, Minnesota
Michael D. Freed, MD, FACC, Boston, Massachusetts
Richard R. Liberthson, MD, Boston, Massachusetts
Constantine Mavroudis, MD, FACC, Chicago, Illinois

**Task Force 10: Training in Preventive Cardiovascular
Medicine**

Chair: Philip Greenland, MD, FACC, Chicago, Illinois
Edward D. Frohlich, MD, FACC, New Orleans,
Louisiana
C. Noel Bairey Merz, MD, FACC, Los Angeles,
California
Richard C. Pasternak, MD, FACC, Boston,
Massachusetts

**Task Force 11: Training in Vascular Medicine and
Peripheral Catheter-Based Interventions**

Chair: Mark A. Creager, MD, FACC, Boston,
Massachusetts
John P. Cooke, MD, PhD, FACC, Palo Alto, California
Jeffrey W. Olin, DO, FACC, Morristown, New Jersey
(*Society of Vascular Medicine and Biology Representative*)
Christopher J. White, MD, FACC, New Orleans,
Louisiana

**Task Force 12: Training in Cardiovascular Magnetic
Resonance**

Chair: Gerald M. Pohost, MD, FACC, Los Angeles,
California
Raymond J. Kim, MD, FACC, Durham, North Carolina
Christopher M. Kramer, MD, FACC, Charlottesville,
Virginia
Nathaniel Reichek, MD, FACC, Roslyn, New York
(*Society of Cardiac Magnetic Resonance Representative*)

INTRODUCTION

GEORGE A. BELLER, MD, MACC, Co-Chair
ROBERT O. BONOW, MD, FACC, Co-Chair
VALENTIN FUSTER, MD, PhD, FACC, Co-Chair

In 1995, guidelines for training in adult cardiovascular medicine were published as an outgrowth of a consensus statement emanating from the Core Cardiology Training Symposium (COCATS) held at Heart House, Bethesda, Maryland, June 27 to 28, 1994 (1). Since publication of the proceedings of that consensus conference in the *Journal of the American College of Cardiology*, the term "COCATS" has been used when referring to the American College of Cardiology training guidelines for fellowship programs. Since the first COCATS document was published in 1995, significant advances have been made in cardiovascular science, and new technologies have emerged. This necessitated a revision to these training guidelines.

The current revision was accomplished by the formation of small task forces that included representatives from the subspecialty societies where appropriate. These task forces reviewed the 1995 COCATS task force reports and made revisions, additions, and deletions based on data from the literature and their expert opinion. Major changes were most often related to maturing of either new subspecialty areas in cardiology or the emergence of new technology into accepted practice. Numbers of procedures to be performed, interpreted, or both were made consistent with volume recommendations found in the American College of Cardiology (ACC)/American Heart Association (AHA) practice guidelines, ACC/AHA/American College of Physicians-American Society of Internal Medicine (ACP-ASIM) clinical competence statements, or other relevant consensus documents.

The Task Force reports were peer reviewed by the following ACC committees: Cardiac Catheterization and Intervention Committee (Task Force 3); Echocardiography Committee (Task Force 4); Cardiovascular Imaging Committee (Task Force 5); Clinical Electrophysiology Committee (Task Force 6); Clinical Research Committee (Task Force 7); Heart Failure and Transplant Committee (Task Force 8); Congenital Heart Disease and Pediatric Cardiology Committee (Task Force 9); Prevention of Cardiovascular Disease Committee (Task Force 10); Peripheral Vascular Committee (Task Force 11); Cardiovascular Imaging Committee (Task Force 12), as well as 5 members of the ACC Board of Governors and 10 training directors. Several organizations also reviewed the document including the American Heart Association (entire document); Society for Cardiac Angiography and Interventions (Task Force 3); American Society of Echocardiography (Task Force 4); American Society of Nuclear Cardiology (Task Force 5); North American Society of Pacing and Electrophysiology

(Task Force 6); Heart Failure Society (Task Force 8); Society of Vascular Medicine and Biology (Task Force 11); and the Society of Cardiac Magnetic Resonance (Task Force 12).

The American Board of Internal Medicine (ABIM) subspecialty board on cardiovascular disease still requires 3 years of cardiology fellowship training. An additional year of training is required by the ABIM to sit for the certification examinations for added qualification in clinical cardiac electrophysiology and interventional cardiology. As outlined in this document, additional years of training are also recommended for those trainees who desire advanced expertise in specialized areas, those who want dedicated time for basic and/or clinical research training, or both. Throughout this revision of COCATS, recommendations for such advanced training experiences are proposed relative to the discipline of cardiovascular medicine being addressed.

In the 1995 COCATS guidelines, 10 task force reports pertaining to overall training in clinical cardiology (Task Force 1) and training in specific specialized areas of cardiovascular medicine (e.g., echocardiography, nuclear cardiology, cardiac catheterization, and electrophysiology) were presented. In this revised document, 2 additional task force reports are published. These are entitled "Training in Vascular Medicine and Peripheral Catheter-Based Interventions" and "Training in Cardiovascular Magnetic Resonance." The vascular medicine task force report emphasizes that cardiologists must have adequate basic training in vascular medicine to acquire a sufficient knowledge base to care for the many patients with peripheral vascular disease. The highest level of training in this area is focused on the acquisition of skills for catheter-based vascular interventions. A career track in vascular medicine for cardiology trainees is outlined in detail. The other new task force report relates the significant advances that have been made in the application of magnetic resonance imaging to cardiac and vascular diseases.

Many of the original 10 task force reports have been substantially revised in accordance with advances in those particular training disciplines. The need for a clinical core of 24 months with a minimum of 9 months in nonlaboratory clinical practice activities is sustained in the report from Task Force 1, which deals with overall training in clinical cardiology. The importance of active participation in research activities is again emphasized in this COCATS revision, and the Task Force 7 report outlines various approaches that can be pursued to fulfill this important academic training requirement for cardiology trainees. The

need for core training in long-standing procedural techniques, such as electrocardiography, ambulatory monitoring, and conventional stress testing, is clearly defined, and volumes of tests that must be performed and/or interpreted to achieve competence are again given.

Training in interventional cardiology as described in the Task Force 3 report is now limited to formal training programs in the United States that satisfy the basic standards developed by the American Council for Graduate Medical Education (ACGME) and are accredited by ACGME. These criteria must be met for candidates to be eligible to take the examination to obtain the certificate of added qualification in interventional cardiology from the ABIM (effective July 1, 2002). This Level 3 training must be achieved during a fourth year of dedicated fellowship experience. As described in the Task Force 4 report, which deals with training in echocardiography, exposure to transesophageal echocardiography and other special ultrasound procedures can commence with trainees undergoing Level 2 training. The task force members stated, however, that to become fully competent to perform these techniques independently, the completion of Level 2 training, as well as the supervised performance of the required number of special studies, is necessary. Guidelines for training in myocardial contrast echocardiography are now dealt with in detail in the revised echocardiography guidelines report by the task force. With respect to nuclear cardiology training guidelines in the Task Force 5 report, the importance of becoming knowledgeable in gated single-photon emission computed tomographic imaging is emphasized. With respect to cardiac electrophysiology, new guidelines are introduced regarding training for programming of all types of bradycardia pacing systems and implantable cardioverter-defibrillators (ICDs) and follow-up of patients with these devices. Training in heart failure and transplantation as outlined in the Task Force 8 report has been revised relative to the 1995 report. Recommendations for Level 1 training now include a minimum of 1 month of rotation on a dedicated heart failure service or incorporation of the 1 month in the non-laboratory months of training in those programs that have no separate heart failure service. Level 2 training in heart failure is now designated to encompass a total of 6 months. Details are described in the task force report.

As with the original document (1), in these revised training guidelines, fellow and trainee are used interchangeably, as are cardiovascular medicine and cardiology. Although numbers of procedures that should be completed to achieve levels of training are provided, the mere accomplishment of such numbers of procedures is not synonymous with excellence in their performance and interpretation. It is vital to the excellence of a training program that dedicated

faculty members be available to supervise and critique performance and interpretation of procedures.

Throughout these task force reports, training is suggested at three levels:

Level 1—Basic training required of all trainees to be competent consultant cardiologists.

Level 2—Additional training in one or more specialized areas that enables the cardiologist to perform or interpret (or both) specific procedures at an intermediate skill level or engage in rendering cardiovascular care in specialized areas.

Level 3—Advanced training in a specialized area that enables a cardiologist to perform, interpret, and train others to perform and interpret specific procedures at a high skill level.

Appendix 1 of the Task Force 1 report is included herein to summarize the requirements for the various training programs. Please refer to the individual task force reports for more detailed information.

The ever-expanding knowledge base in basic cardiovascular science and cardiovascular medicine requires that all training programs have a rich assortment of didactic offerings for fellows. Case-based conferences, such as the traditional catheterization laboratory conference, are vital to train fellows and to develop their skills in evidence-based decision-making. Self-learning needs to be emphasized, and Internet-based, online educational programs, many of which are interactive, will play a greater role in a fellow's overall learning experience during fellowship and after training. Such didactic activities are outlined throughout the task force reports.

To view the complete COCATS recommendations, please visit the ACC Web site at <http://www.acc.org/clinical/training/adult.htm>. These recommendations are considered current unless the ACC revises or withdraws them from publication.

Acknowledgments

The steering committee is most appreciative of the time and effort given to this COCATS revision by the Task Force members and reviewers who provided valuable input into the process. Carolyn Lanham, Eva Grace, Sylvia Polk-Burriss, and Dawn Phoubandith of the staff of the American College of Cardiology provided superb administrative support to the COCATS effort, and their contributions are recognized.

REFERENCE

1. COCATS Guidelines. Guidelines for Training in Adult Cardiovascular Medicine, Core Cardiology Training Symposium June 27-28, 1994. American College of Cardiology. *J Am Coll Cardiol* 1995;25:1-34.

APPENDIX

Task Force	Area	Level	Minimal Number of Procedures	Cumulative Duration of Training (mo)	Cumulative Number of Procedures
1	Clinical cardiology	1		36	
2	Electrocardiography	1	500 to 3,500*#		3,500
		2			greater than 3,500
	Ambulatory monitoring	1	150*		150
		2	75		225
	Exercise testing	1	200*		200
		2	100		300
3	Diagnostic catheterization	1	100	4	100
		2	200	8	300
	Interventional catheterization	3	250	20	550
4	Echocardiography	1	150	3	150
		2	150	6	300
		3	450	12	750
5	Nuclear cardiology	1	80 hours	2	80 hours
		2	300 cases	6 to 8	300+ cases
		3	600 cases	18 to 20	600+ cases
6	Electrophysiology, pacing, and arrhythmias	1		2	
		2		6	
		3	150	24	150+ cases
7	Research	1		6 to 12†	
		2		24	
		3		24 to 36	
8	Heart failure and transplantation	1		1†§	
		2		6	
		3		12	
9	Congenital heart disease	1		Core lectures†	
		2		12	
		3		24	40 Cath 300 TTE 50 TEE
	Preventive cardiology	1		1†§	
		2		6 to 12	
		3		12	
11	Vascular medicine and peripheral catheter-based intervention	1		2*	
	<i>Vascular Medicine Specialist</i>	2		14¶	400+ noninvasive cases**
	<i>Peripheral Vascular Intervention</i>	3		20††	160+§§
	<i>Vascular Medicine Specialist plus Vascular Intervention</i>	3		34‡‡	
12	Cardiovascular magnetic resonance imaging	1		1‡	50
		2		3 to 6	150
		3		12	350

*Can be taken throughout the training program.

#The committee strongly recommends that cardiologists achieve Level 2 training in ECG interpretation.

†Can be taken as part of 9 months of required nonlaboratory clinical practice rotation.

‡Can be taken as part of 6 months of noninvasive imaging rotation.

§It is assumed that trainees will obtain additional training in heart failure and preventive cardiology beyond the 1-month core training as part of the experience during other clinical months, such as consult services and CCU.

¶2 months of vascular medicine as defined by Level 1, plus 12 months of Level 2 training. Level 2 training is not a prerequisite for Level 3 training but is intended for individuals who want to become a vascular medicine specialist.

**In addition, observing 25 peripheral angiograms and 25 peripheral interventions

††Including 2 months of vascular medicine training as defined by Level 1, 8 months of diagnostic catheterization training, and 12 months of interventional lab training. Interventional training for Level 3 requires a 4th year. The 12 months of Level 2 training are not required for this interventional training year.

‡‡Including 2 months of Level 1 and 12 months of Level 2 vascular medicine training, 8 months of diagnostic catheterization training, and 12 months of interventional lab training.

§§Including 100 diagnostic peripheral angiograms, 50 peripheral interventions, and 10 thrombolysis/thrombectomies.

Cath = catheterization; TEE = transesophageal echocardiography; and TTE = transthoracic echocardiography.

Task Force 12: Training in Cardiovascular Magnetic Resonance

GERALD M. POHOST, MD, FACC, CHAIR
RAYMOND J. KIM, MD, FACC
CHRISTOPHER M. KRAMER, MD, FACC
NATHANIEL REICHEK, MD, FACC*

Magnetic resonance methods (Table 1), the newest of the cardiovascular imaging modalities, provide useful, sometimes unique information with which all cardiologists should be conversant. Training in magnetic resonance for cardiology fellows should be divided into three levels.

Training Levels

Level 1—General training (1 month) to provide the fellow with a working knowledge of cardiovascular magnetic resonance (CMR) methods.

Level 2—Specialized training (at least 3 months) designed to allow trainees to interpret CMR imaging studies.

Level 3—Advanced training (1 year) for those who ultimately want to pursue an academic career in CMR, including patient care, teaching, and research, and/or those who want to be responsible for the operation of a CMR facility.

Overview of CMR Training

The trainee should be taught the basic types of CMR studies and their indications. Mentored interpretation of CMR studies should be coupled with comparison and integration of test results with other relevant clinical and laboratory data. A mentor in this context is an individual with the equivalent of Level 3 training. This training should be acquired through an Accreditation Council for Graduate Medical Education—approved cardiology or radiology program with expertise in CMR and under the aegis of a qualified mentor or in a laboratory accredited by the Intersocietal Commission on the Accreditation of Magnetic Resonance Laboratories. The trainee should maintain a logbook or other specific records to

document cases reviewed and didactic hours in which the trainee has participated.

The depth of knowledge will increase with increasing levels of training. In the case of the advanced trainee, specialized training and research should be offered as a part of an established broad-based training program; the preceptor should have Level 3 (or the equivalent) training in CMR. CMR training consists of several components (Table 2).

Table 2. Components of CMR Training

1. Didactic activities
 - a. Organized lectures
 - b. Self-study
2. Interpretation of CMR case studies
3. Hands-on experience

CMR indicates cardiovascular magnetic resonance.

Level 1: General Training (1 Month Minimum)

The trainee should have intensive exposure to the methods and the multiple applications of CMR for a period of not less than 1 month or its equivalent when integrated with other activities. This experience should provide a basic background in CMR sufficient for the practice of adult cardiology but not for the practice of CMR. As a practical matter, many fellowship programs may not be able to fulfill CMR training. In these instances, fellows should be encouraged to obtain experience at an alternate program with an appropriate training program in CMR.

Didactic Activities

Interpretation of CMR Studies. During their 1-month rotation, trainees should actively participate in daily CMR study

Table 1. Classification of Cardiovascular Magnetic Resonance Procedures

1. Standard MRI procedures, including:
 - a. Tomographic still-frame MRI for morphology using “bright” and/or “dark blood” methods with and/or without contrast agent
 - b. Cine MRI for ventricular function and other dynamic imaging studies at rest and/or stress (exercise or pharmacologic)
 - c. Magnetic resonance angiography and cine MRI of the great vessels, peripheral vessels, anomalous coronary arteries, and coronary bypass grafts
2. Less common procedures, including:
 - a. Myocardial tagging (approach unique to CMR that allows detailed evaluation of myocardial function)
 - b. Phase-contrast velocity mapping for blood flow quantification
 - c. First-pass, contrast-enhanced MRI (for myocardial perfusion imaging at rest and/or during stress)
 - d. Delayed contrast-enhanced MRI (for myocardial tissue characterization)
 - e. Magnetic resonance angiography of proximal native coronary arteries.

CMR indicates cardiovascular magnetic resonance; MRI, magnetic resonance imaging.

*Society of Cardiac Magnetic Resonance Representative

interpretation under the direction of a qualified physician-mentor in CMR. For all studies in which angiographic or hemodynamic data or both are available, such information should be correlated with CMR studies. Studies should include the range of procedures listed in Table 1. Interpretative experience (a minimum of 50 cases) may include studies from an established teaching file of previous CMR cases.

Lectures and Self-Study in CMR. This component should consist of lectures on the basic aspects of CMR and parallel reading material. The lectures and reading should provide the fellow with an understanding of the applications of CMR. Specificity, sensitivity, diagnostic accuracy, utility in assessing prognosis and interventions, costs, indications, and pitfalls must be emphasized for each patient subset. Such information could be effectively transmitted within a weekly non-invasive or catheterization conference during which CMR imaging data are presented.

A basic understanding of nuclear magnetic resonance physics should be provided, including the following: (1) the physics of magnetic resonance as it relates to image contrast, including flow, T1, T2, and contrast agents; (2) sources of artifacts, including motion, arrhythmias, and metal objects; and (3) safety of devices and the magnet environment.

Hands-On Experience

Hands-on experience is not necessary for Level 1.

Level 2: Specialized Training (3 to 6 Months)

Training for Level 2 should begin with the CMR experience outlined in Level 1. Level 2 is for those trainees who wish to practice the specialty of CMR. Trainees must have at least 3 months of training, including the basic elements listed below. In training institutions with a high volume of CMR procedures, clinical experience may be acquired in as little as 3 months. In institutions with a lower volume of CMR procedures, a total of 6 months or more of clinical experience might be necessary to achieve Level 2 competence. The trainee would be expected to become familiar with the CMR techniques listed in Table 1.

Background

In addition to Level 1 training, understanding of CMR physics would need to be more advanced (see below).

Didactic Activities

Interpretation of CMR Studies. During their 3 to 6 months of experience, trainees should actively participate in daily CMR study interpretation under the direction of a qualified physician in CMR. For all studies in which other cardiac imaging data are available, such information should be correlated with the CMR studies. The trainee should interpret at least 100 CMR examinations during this training period, including 50 in which the trainee is a primary interpreter and operator of the scanner.

Lectures and Self-Study in CMR. Course work should include the components for Level 1 training but will include more advanced lectures and reading material. This work, with parallel reading activities, should continue for the duration of the traineeship. Course work should include the following:

1. Physics: Trainees should receive didactic lectures from a CMR-trained physician and/or physicist on the basic physics of nuclear magnetic resonance in general and CMR in particular. The content should include the same materials as in Level 1 (basic) plus lectures with supportive reading on the following topics:
 - a. Image formation, including k-space, gradient echocardiography, spin echocardiography, echoplanar imaging, spirals, fast spin echocardiography, and three-dimensional echocardiography
 - b. Specialized imaging sequences, including flow and motion, phase imaging, time of flight, contrast agents, and tagging
 - c. Hardware components, including the elements of gradient coil design, receiver coils, and digital sampling
2. Applications and indications: Level 2 didactic activities should include discussion of the sensitivity, specificity, accuracy, utility, costs, and disadvantages of all of the techniques to be reviewed. The following techniques should be covered in the didactic program:
 - a. Imaging of structure and tissue characterization (T1, T2, spin echocardiography, gradient echocardiography, and fat suppression)
 - b. Imaging of function (cine and tagged cine magnetic resonance imaging)
 - c. Volumetric imaging of mass, volumes, and ejection fraction (cine magnetic resonance imaging)
 - d. Flow imaging (velocity encoded techniques)
 - e. First-pass perfusion and delayed contrast-enhancement imaging (gadolinium-enhanced techniques)
 - f. Magnetic resonance angiography (vascular and coronary)
 - g. Basic magnetic resonance, clinically applicable spectroscopy methods, including pulse and acquire, DRESS (depth-resolved surface coil spectroscopy), ISIS (image selected in-vivo spectroscopy), and CSI (chemical shift imaging)
 - h. CMR image analysis

Evaluation

The person responsible for the CMR training program must be responsible for assessing the competence of the trainee in CMR at the completion of the program. This is accomplished

by observing the trainee during the performance of studies and daily reading sessions and may be supplemented by formal testing.

Level 3: Advanced Training (12 Months Minimum)

For trainees who wish to pursue an academic career in CMR or to direct a CMR laboratory, an extended program is required. This can be part of a 4-year cardiology fellowship.

In addition to the recommendation for Level 2, the Level 3 program should include active participation in ongoing laboratory or clinical research or both, with individual responsibility for a specific portion of that research. Focused research projects with writing of one or more manuscripts is strongly encouraged.

In parallel with research activities, the trainee must participate in clinical imaging for the entire 12 months, which should include supervised interpretative experience in 200 cases. The trainee should have hands-on experience in 100 cases as the primary operator. Knowledge of nuclear magnetic resonance and imaging physics must be more advanced than Level 2 and include the following:

1. Analysis of why certain specialized imaging sequences are applicable for specific clinical protocols, including imaging of heart function, coronary arteries, perfusion, and angiography
2. Basic understanding of the clinically applicable spectroscopic methods
3. The rudiments of data collection, including capturing of digital data, the keeping of accurate databases and records, signal processing, and the importance of obtaining quantitative data

Evaluation

Evaluation should be similar to that of Level 2.

Summary of Recommendations

The overall requirements for training in CMR are summarized in Table 3.

Table 3. Summary of Training Requirements for CMR

Level	Duration of Training, mo	Number of Examinations
1	1	50 Mentored interpretations
2	3 to 6	100 Mentored interpretations (50 as primary interpreter and operator)
3	12	200+ Mentored interpretations (100 as primary interpreter and operator)