

Guidelines

Training, competency, and certification in cardiac CT: A summary statement from the Society of Cardiovascular Computed Tomography

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Abstract. Training and competency criteria in cardiac CT were developed to guide practitioners in the process of achieving and maintaining skills in performing and interpreting cardiac CT studies. Appropriate training and eventual certification in cardiac CT angiography may be obtained by adhering to the recommendations for competency as set forth by either the American College of Cardiology Foundation (ACCF) or the American College of Radiology (ACR). Competency under either pathway requires both knowledge and experience-based components, with benchmarks set for level of experience on the basis of the extent of training experience. Although these recommended parameters are substantial, meeting these training criteria does not guarantee competence or expertise, which is the responsibility of the individual practitioner and may require further training and experience. Separate from satisfying initial training for the achievement of competency, certification in cardiac CT may be achieved through formal certification under the Certification Board of Cardiovascular Computed Tomography. Eligibility for certification generally follows the ACCF/American Heart Association Level 2 or ACR competency pathways. The ACR also conducts a certificate program related to advanced proficiency in cardiac CT. This official document of the Society of Cardiovascular Computed Tomography summarizes the present criteria for competency and certification in the field of cardiac CT.

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Introduction

The 2005 American College of Cardiology Foundation (ACCF) Clinical Competence Statement on Cardiac Imaging with Computed Tomography and Magnetic Resonance: A Report of the American College of Cardiology Foundation/American Heart Association/American College of Physicians Task Force on Clinical Competence and Training¹ and the American College of Radiology (ACR) Practice Guideline for the Performance and Interpretation of Cardiac Computed Tomography (CT)² provide the framework and parameters for recommended initial training and maintenance of competency in cardiac CT.¹ This document from the Society of Cardiovascular Computed Tomography (SCCT) summarizes these criteria and provides an overview of the requirements necessary to be a candidate for certification in cardiac CT under the Certification Board of Cardiovascular Computed Tomography (CBCCT). This document identifies criteria related to CT examinations of the heart and related structures, herein generally designated as “cardiac CT.” Note that training and competency in vascular CT comprises a separate discipline that is subject to additional requirements.

Appropriate training and eventual certification in cardiac CT angiography may be obtained by adhering to the ACCF/AHA (American Heart Association) or the ACR recommendations. The ACCF/AHA criteria are separated into two parts. Part one involves recommendations about initial training and experience. Part two deals with the maintenance of competency requirements. Although these recommended parameters are substantial and extensive, meeting these training criteria does not guarantee competence or expertise, which is the responsibility of the individual practitioner and may require further training and experience. The SCCT and ACR provide programs for the verification of training and maintenance of competency. Note that individual institutions, not the SCCT or ACR, are responsible for granting credentials for clinical practice specific to their local rules, regulations, and standards. Finally, the requirements reviewed here apply principally to imaging physicians practicing within the United States.

ACCF/AHA initial training requirements in cardiac CT

Training experience in cardiac CT requires a broad knowledge of cardiovascular physiology and imaging principles. Important topics include, but are not limited to, appropriate indications and contraindications for testing; general knowledge about alternative imaging modalities; principles of radiation and radiation safety; physics of computed tomography; knowledge of scanning equipment; patient preparation (including heart rate control) and safety; contrast agents and complications; protocol development, scan planning, acquisition, reconstruction, and troubleshooting (eg, salvaging a difficult scan); knowledge and

experience with workstation software required to manipulate and interpret datasets; reconstruction and interpretation of 3-dimensional cardiac data and coronary anatomy; and the ability to recognize artifacts and noncardiac findings.

There are three progressive levels of initial training for the purpose of competency in cardiac CT angiography with two general pathways to achieve these levels.¹ The first path (termed **Track 1** in this document) is through formal fellowship training that involves both case experience criteria as well as recommended cumulative time of experience in cardiac CT. The second pathway (termed **Track 2** in this document) is for those already in practice and recognizes the challenges to attaining formal fellowship training while practicing medicine full time. This track requires case experience and continuing medical education (CME) requirements under a program accredited by the American College of Continuing Medical Education but does not mandate a minimum training time.

Experience-based training was originally slated to sunset in 2008; however, this was subsequently revised by the American College of Cardiology with the following statement:

“The present training and competence recommendations (indicated in the 2005 competence training statement¹ as training completed before July 1, 2008) will remain in force indefinitely unless superseded by requirements set forth by the ACGME [Accreditation Council for Graduate Medical Education] within a pathway specific to advanced imaging training.”³ Presently, advanced imaging training does not exist as a pathway within the ACGME.

For the purposes of initial competency and maintenance of competency, several categories of cardiac CT experience are outlined. These are defined below.

Table 1 provides the various ACCF/AHA categories of cardiac CT case experience. **Table 2** summarizes the ACCF/AHA requirements for initial cardiac CT experience by training level.

Categories of cardiac CT experience

Category A includes “live cases” in which the candidate witnesses the cardiac CT angiography examination, including the components of patient preparation, scan planning, scan acquisition, and scan reconstruction. The candidate must also personally manipulate the scan data on a dedicated CT workstation with comparison to an independent expert interpretation. These criteria intend that the training physician makes every effort to actually observe the performance of these studies and to use the experience as an opportunity to discuss and learn concepts about patient preparation and scan performance.

Category A-1 are those cardiac CT examinations observed either on digital media or during a training course in which the recording includes the patient preparation and CT planning, acquisition, and reconstruction along

Table 1 ACCF/AHA cardiac CT case categories

A	<ul style="list-style-type: none"> • Scan acquisition personally witnessed • Scan data independently manipulated and interpreted • Independent interpretation compared to expert read
A-1	<ul style="list-style-type: none"> • Scan acquisition witnessed via a recording • Scan data independently manipulated and interpreted • Independent interpretation compared to expert read
A-2	<ul style="list-style-type: none"> • Scan acquisition witnessed via a recording • No dataset available for personal manipulation • Expert interpretation observed via the recording
B	<ul style="list-style-type: none"> • Library cases (via training course, CD, DVD or online) • Scan acquisition not witnessed • Scan data independently manipulated and interpreted • Independent interpretation compared to expert read
B-1	<ul style="list-style-type: none"> • Library cases (via training course, CD, DVD, on-line, or educational presentation with CME) • Scan acquisition not witnessed • Scan data not independently manipulated and interpreted • Expert interpretation observed
C	<ul style="list-style-type: none"> • Noncontrast, calcium scoring cases

with expert interpretation. These cases also include accompanying datasets that need to be personally manipulated and interpreted on a workstation. The interpretation is compared with the expert read.

Category A-2 are those cardiac CT examinations observed either on digital media, online, or during a training course in which the recording includes the patient preparation and CT planning, acquisition, and reconstruction along with expert interpretation. However, these recorded cases do not possess an accompanying dataset to personally manipulate and interpret. Note that a maximum of 25 category A-2 cases may be applied toward the required number of live cases for Level 2 training, but that they do not contribute to the required number of cases interpreted in the absence of a CT dataset to manipulate.

Category B are those cardiac CT studies evaluated from a library of cases (digital media, online, on-site training course) of which the data may be manipulated but the acquisition of the study is not necessarily witnessed. An independent interpretation is performed and compared with the expert interpretation. These studies are also known as “mentored” cases.

Category B-1 are those cardiovascular CT studies from a library of cases (digital media, online, on-site training

course) for which the interpretation by a level 2 or 3 trained physician is observed. The recording or demonstration does not include the patient preparation, scan planning, scan acquisition, and scan reconstruction, and the dataset is not personally manipulated or interpreted.

Category C are those noncontrast CT studies used for the purpose of calcium scoring.

Level 1 training

Level 1 training provides minimal introductory training in cardiac CT. It is not sufficient for independent performance and interpretation of cardiac CT examinations.

Track 1 (formal fellowship or residency)

The published formal fellowship training requirements include a minimum of one (1) month of cumulative (need not be concurrent) exposure to intensive training defined as 35 hours per week. The trainee must be actively involved in cardiac CT acquisition and interpretation under the direction of a level 2 or 3 trained mentor. A minimum of 50 categories A-1, A-2, or B cases must be experienced.

Track 2 (experience-based training)

This track does not require enrollment in a formal training program nor does it demand a cumulative training time requirement. The same basic knowledge base is expected. Fifty categories A-1, A-2, or B cases are required. Proof of training may be obtained by a letter from the trainee’s laboratory director or level 2 or 3 mentor.

Level 2 training

Level 2 training is intended for those who plan to independently perform and interpret cardiac CT examinations and may be specific to noncontrast calcium scoring only or may encompass cardiac CT angiography in general.

Competency in calcium scoring only

Track 1 (formal fellowship or residency)

Requirements include a valid medical license and board certification in either cardiology, radiology, nuclear medicine, or the foreign equivalent; 4 weeks of cumulative training (defined as 35 hours per week that need not be consecutive whereby the trainee must be actively involved in calcium score scan acquisition and interpretation under the direction of a level 2 or 3 mentor); 150 interpreted noncontrast scans (50 must be personally witnessed); and 20 category I CME hours in general or cardiac CT.

Track 2 (Experience-based training)

The requirements parallel Track 1 but exclude the dedicated 4 weeks of cumulative training. Documentation of training may be obtained by a letter from the laboratory director or a level 2 or 3 mentor.

Table 2 ACCF/AHA initial cardiac CT training criteria

	Track 1 (formal fellowship)	Track 2 (physician in training)
Level 1		
Calcium scoring	<ul style="list-style-type: none"> • No level 1 calcium scoring–only competency track 	<ul style="list-style-type: none"> • No level 1 calcium scoring–only competency track
Cardiac CT	<ul style="list-style-type: none"> • 1 month of cumulative formal training • 50 category B cases • Letter from mentor (must document knowledge base) 	<ul style="list-style-type: none"> • 50 category B cases • Letter from mentor (must document knowledge base)
Level 2		
Calcium scoring	<ul style="list-style-type: none"> • Valid medical license • Board certification (see text) • 1 month of cumulative formal training • 150 calcium scoring scans interpreted <ul style="list-style-type: none"> ○ 50 must be personally witnessed • 20 category I CME hours in general or cardiac CT 	<ul style="list-style-type: none"> • Valid medical license • Board certification (see text) • 150 calcium scoring scans interpreted <ul style="list-style-type: none"> ○ 50 must be personally witnessed • 20 category I CME hours in general or cardiac CT
Cardiac CT	<ul style="list-style-type: none"> • Valid medical license • Board certification (see text) • 2 months of cumulative formal training • 150 total data manipulated cases <ul style="list-style-type: none"> ○ Minimum of 50 category A cases <ul style="list-style-type: none"> ■ 25 may be category A-1 or A-2 (not counted toward 100 total manipulated cases) ○ 100 category B cases <ul style="list-style-type: none"> ■ 50 may be category B-1 cases 	<ul style="list-style-type: none"> • Valid medical license • Board certification (see text) • 20 category I CME hours in cardiac CT • 150 total data manipulated cases <ul style="list-style-type: none"> ○ Minimum of 50 category A cases <ul style="list-style-type: none"> ■ 25 may be category A-1 or A-2 (not counted toward 100 total manipulated cases) ○ 100 category B cases <ul style="list-style-type: none"> ■ 50 may be category B-1 cases
Level 3		
Calcium scoring	<ul style="list-style-type: none"> • No level 3 calcium scoring–only competency criteria 	<ul style="list-style-type: none"> • No level 3 calcium scoring–only competency criteria
Cardiac CT	<ul style="list-style-type: none"> • Valid medical license • Board certification (see text) • 6 months of cumulative formal training • 300 total data manipulated cases <ul style="list-style-type: none"> ○ Minimum of 100 category A cases <ul style="list-style-type: none"> ■ 50 may be category A-1 or A-2 (not counted toward 200 total manipulated cases) ○ 200 category B cases <ul style="list-style-type: none"> ■ 100 may be category B-1 cases 	<ul style="list-style-type: none"> • Valid medical license • Board certification (see text) • Activities in cardiac CT to include: Directing a cardiac CT laboratory Peer recognition to include ≥ 1 of the following (1) faculty lecturer for ≥ 2 CME courses on the topic of cardiac CT, (2) fellowship/residency teaching activities in cardiac CT, or (3) ≥ 3 peer-reviewed publications in cardiac CT • 40 category I CME hours in cardiac CT • 300 total data manipulated cases <ul style="list-style-type: none"> ○ Minimum of 100 category A cases ○ Peer-reviewed publications in the area of CCT.200 category B cases <ul style="list-style-type: none"> ■ 100 may be category B-1 cases

Training in cardiac CT

Track 1 (formal fellowship or residency)

These requirements include a valid medical license; board certification in either cardiology, radiology, nuclear medicine, or the foreign equivalent; 8 cumulative weeks of dedicated cardiac CT training (defined as 35 hours per week that need not be consecutive whereby the trainee must be actively involved in cardiac CT acquisition and interpretation under the direction of a level 2 or 3 mentor); a minimum of 50 live cases (category A) among a total of

150 cases (eg, 100 may be category B cases). In addition, 50 noncontrast calcium scoring (category C) cases must also be interpreted independently. The noncontrast calcium scoring cases may or may not be part of the datasets from the 150 cases noted above. All independent interpretations must be compared with the official expert read.

Track 2 (experience-based training)

These requirements encompass the same case experience as in Track 1 but do not require the 8 cumulative

weeks of intensive training. In its place, the physician in practice must earn 20 category I CME hours in cardiac CT. All independent interpretations must be compared with the official expert read. Documentation of this experience may be obtained from a level 2 or 3 mentor.

For both tracks, a mandatory total of 100 examinations must possess datasets that are personally manipulated and interpreted. In each level 2 cardiac CT training track, a maximum of 25 of the category A (personally witnessed and manipulated) cases may be substituted with category A-1 (witnessed by a recording and manipulated) or category A-2 (witnessed by a recording but not manipulated) studies. Category A-1 cases will be counted toward the total of 100 mandatory cases whose data must be manipulated. Category A-2 cases, however, will only be counted toward the maximum of 25 category A substitutions but will not count toward the total of 100 cases whose data must be personally manipulated. Excess category A (personally witnessed and manipulated) cases may be applied to the category B training requirement. For both level 2 cardiac CT training tracks, a maximum of 50 of the 100 total category B cases may be substituted with category B-1 studies.

Level 3 cardiac CT training

Level 3 training is the highest level of ACCF/AHA training and is primarily intended for those physicians who intend to direct a CT laboratory. There is no level 3 training in calcium scoring only.

Track 1 (formal fellowship)

The training requirements are as follows: valid medical license; board certification in either cardiology, radiology, nuclear medicine, or the foreign equivalent; 6 months of cumulative training (defined as 35 hours per week that need not be consecutive whereby the trainee must be actively involved in cardiac CT acquisition and interpretation under the direction of a level 2 or 3 trained mentor); and a total of 300 cardiac CT examinations must be experienced. Of these 300 cases, 100 must be category A and 200 may be category B. A total of 300 cases must be personally manipulated and independently interpreted and compared with the expert read. In addition, 100 noncontrast calcium scoring category C cases must be interpreted. Furthermore, the training fellow must document ongoing participation in basic or clinical research or in graduate medical teaching. These criteria may be documented by providing a letter from a program director or research mentor that details participation in teaching, research, or scientific publication or by the documentation of publications in peer-reviewed medical journals. Trainees should have exposure to administrative aspects of directing a CT laboratory.

Track 2 (experience-based training)

Track 2 for Level 3 experience is intended for those persons who have been acting in the position of directing a

cardiac CT laboratory. These requirements include valid medical license; board certification in either cardiology, radiology, nuclear medicine, or the foreign equivalent; the exact case experience as Track 1 (double level 2), and 40 cardiac CT-related category I CME hours. In addition, the trainee should have experience in directing a cardiac CT laboratory and peer recognition to include ≥ 1 of the following: (1) faculty lecturer for ≥ 2 CME courses on the topic of cardiac CT, (2) fellowship/residency teaching activities, or (3) three or more peer-reviewed publications in the area of cardiac CT.

For both tracks leading to level 3 cardiac CT competency, a maximum of 25 of the 100 category A cases may be substituted with category A-1 or category A-2 studies. Level 3 cardiac CT training requires a mandatory 300 cases for which the datasets must be personally manipulated. Although category A-1 cases will count toward the mandatory 300 personally manipulated datasets, category A-2 studies will not. Category A-2 cases will only be counted toward the maximum of 25 substituted category A examinations.

Maintenance of competency in cardiovascular CT

This component of the published competency criteria details the recommended ongoing experience necessary to maintain skills in the field. Maintenance of competency requires both ongoing case experience and CME credits.

Table 3 summarizes the ACCF/AHA maintenance of competency criteria.

Level 2 maintenance of competency requires the annual performance and interpretation of 50 cardiac CT studies. In addition, a total of 20 category I CME credits in CT are required over a 3-year period. Level 3 maintenance of competency requires the annual performance and interpretation of 100 cardiac CT cases. In addition, a total of 40 category I CME credits in CT are required over a 3-year period.

ACR cardiac CT training requirements

For those physicians already possessing qualifications in general or thoracic CT, the following are also required: specific training in an ACGME or an American Osteopathic Association (AOA) program which includes a time

Table 3 ACCF/AHA requirements for maintenance of competency in cardiac CT

Level 2	<ul style="list-style-type: none"> ● 50 contrast-enhanced cases performed and interpreted per year ● 20 hours of cardiac CT-related category I CME over 3 years
Level 3	<ul style="list-style-type: none"> ● 100 contrast-enhanced cases performed and interpreted per year ● 40 hours of cardiac CT-related category I CME over 3 years

equivalent of 30 CME hours in cardiac anatomy, physiology, pathology, and interpreting cardiac CT findings and the review of 50 cardiac CT examinations in the preceding 36 months (does not include calcium scoring-only scans). Alternatively, qualification may involve 30 category I CME hours in cardiac CT, cardiac anatomy, physiology, pathology or a combination or documented supervised equivalent activities in a center actively performing cardiac CT and interpretation, reporting, or a supervised review of ≥ 50 cardiac CT cases or a combination (does not include calcium scoring scans).

Physicians without prior qualifications in general or thoracic CT must meet the following criteria: completion of an ACGME-approved training program in the candidate's practiced CT specialty plus 200 hours of category I CME in the performance and interpretation of CT in the practiced subspecialty and supervision, interpretation, and reporting of 500 cases of which ≥ 100 must be a combination of thoracic or thoracic CT angiography in the past 36 months and ≥ 30 hours of category I CME in cardiac imaging, including cardiac CT, anatomy, physiology, pathology, or a combination or the documented equivalent supervised experience and the interpretation and reporting or supervised review of ≥ 50 cardiac CT examinations within the past 36 months (does not include calcium scoring scans). The ACR provides an opportunity for those cardiac imagers meeting their eligibility requirements to undergo a Certificate of Advanced Proficiency examination, incorporating both knowledge-based, multiple choice, and practical examination components.

Maintenance of competence requires 75 cardiac CT examinations every 3 years and 150 CME hours in accordance with the ACR practice guidelines. The portion dedicated to cardiac CT should be "appropriate to the physician's practice needs."

CBCCT requirements

The CBCCT was established in 2006 to offer a practice-based examination for practitioners to document their skills and knowledge.⁴ The purpose of the CBCCT examination is to recognize accepted levels of expertise in the profession with the goal of improving patient care.³ Although the eligibility requirements to sit for the CBCCT examination were based on a review of the current medical literature and published training criteria, the CBCCT requirements differ from the published recommendations in the 2005 ACCF/AHA Clinical Competence Statement. The following paragraphs review the published CBCCT board eligibility requirements in effect when this statement went to press. More information about the CBCCT may be found at <http://www.cbcct.org>.

Medical licensure

At the time of application, applicants must be licensed to practice medicine in the United States or their country of residence.

Board certification

Applicants must hold certification in ≥ 1 of the following: cardiovascular disease, nuclear medicine, or radiology. If not yet certified in cardiovascular disease, nuclear medicine, or radiology, applicants may sit for the CBCCT examination if, at the time of application, the applicant is in one of the final 2 years of fellowship or residency training in these fields. Once the CBCCT examination is successfully completed, Testamur status will be granted until documentation of certification in one of the above-listed specialties is provided, on which time Diplomate status will be awarded. If certification is not achieved after four examination cycles in the applicant's specific specialty, Testamur status will be removed, and the CBCCT examination must be again successfully completed to become a Diplomate.

Applicants trained outside the United States are required to provide evidence of certification from their country's specific equivalent medical specialty board in cardiology, nuclear medicine, or radiology if one exists in the applicant's country of practice.

Initial training experience and maintenance of competency

Documentation of initial cardiac CT training and of maintenance of competency is required to sit for the CBCCT examination.

Cardiology/nuclear medicine

Initial training must satisfy the ACCF/AHA level 2 requirements. In addition, if level 2 initial training was completed >12 months before the CBCCT examination application, 50 contrast-enhanced cardiac CT examinations must be interpreted "in a clinical environment or on a workstation in a supervised teaching environment"³ within the 12 months before applying to sit for the CBCCT examination (continuing experience requirement). Persons who complete a fellowship or residency and continue to train in ACGME- or AOA-accredited programs in another specialized area are exempt from the continuing experience requirement for 12 months after completion of the additional training.

Radiology

Supervision or interpretation or both of a minimum of 50 contrast-enhanced cardiac CT examinations in the 12 months before application for the CBCCT examination are required. In addition, the applicant must be qualified in thoracic CT according to the ACR guidelines. Furthermore, if qualified in thoracic CT as defined by the ACR eligibility criteria, the applicant must also have interpreted ≥ 300 thoracic CT examinations in the preceding 36 months. If not qualified in thoracic CT as defined by the ACR eligibility criteria, the applicant must have also interpreted

500 thoracic CT examinations in the preceding 36 months. Persons who complete a fellowship or residency and continue to train in ACGME- or AOA-accredited programs in other specialized areas are exempt from the continuing experience requirement for 12 months after completion of the additional training. If qualified in thoracic CT, then 30 hours of category I CME is required. If not qualified in thoracic CT, then 200 hours of category I CME is required. Radiologists may also apply with Level 2 training and maintenance of competency (ie, 50 cases in the most recent 12 months and 20 hours of category I CME within the past 3 years).

Summary

This document provides a summary but does not supersede the current criteria^{1,2} for cardiac CT training and competency and for eligibility and certification by the CBCCT. Training and competency criteria in cardiac CT¹ were developed to guide practitioners in the process of achieving and maintaining skills in performing and interpreting cardiac CT studies. The SCCT verification program provides a service to verify that a person's training matches the published competency criteria. Eligibility for certification by the CBCCT generally follows the ACCF/AHA Level 2 or ACR competency pathways. The CBCCT determines the eligibility of certification candidates.

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Appendix A. Guideline Committee of the Society of Cardiovascular Computed Tomography

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