

Training in cardiac computed tomography: EACVI certification process

**Gianluca Pontone¹*, Sarah Moharem-Elgamal², Pal Maurovich-Horvat³,
Oliver Gaemperli⁴, and Francesca Pugliese⁵**

**Document reviewers: Mark Westwood⁶, Alexandros Stefanidis⁷, Kevin F. Fox⁸, and
Bogdan A. Popescu⁹**

¹Centro Cardiologico Monzino, IRCCS, Department of Cardiovascular Imaging, Via Carlo Parea 4, 20138 Milan, Italy; ²National Heart Institute, Cardiology Department, 5 Ibn Nafise Square, Imbaba Giza 11111, Egypt; ³MTA-SE Cardiovascular Imaging Research Group (CIRG), Heart and Vascular Center, Semmelweis University, 8 Varosmajor u. 1122 Budapest, Hungary; ⁴University Heart Center, Ramistrasse 100, CH-8091, Zurich, Switzerland; ⁵NIHR Barts BRC, Barts Heart Centre and William Harvey Research Institute, Queen Mary University of London, Cardiac imaging, 2nd floor Barts Heart Centre, West Smithfield, London EC1A 7BE, UK; ⁶Barts Heart Centre, St Bartholomew's Hospital, West Smithfield, London EC1A 7BE, UK; ⁷1st Department of Cardiology General Hospital of Nikea3 P. Mela str, 184 54, Athens, Greece; ⁸Department of Cardiology, Imperial College Healthcare NHS Trust Charing Cross Hospital, Fulham Palace Road, London W6 8RF, UK; and ⁹Cardiology Department, University of Medicine and Pharmacy 'Carol Davila'-Eurocolab, Institute of Cardiovascular Diseases 'Prof. Dr. C. C. Iliescu', Strada Dionisie Lupu 37, Bucharest, Romania

Online publish-ahead-of-print 11 December 2017

Introduction

The importance of setting a standard of cardiology training and accreditation process in Europe is an ongoing mission of the European Society of Cardiology (ESC). The ESC Core Cardiology Curriculum has been adopted in several countries as a framework for training and competencies to be acquired for general cardiology certification and recertification.¹

The need for competency-based subspecialized training has also been recognized. The European Association of Cardiovascular Imaging (EACVI), a registered branch of the ESC, is committed to maintaining a high standard of professional excellence among cardiologists specialized in cardiovascular imaging (CVI) throughout Europe. To ensure a uniform quality standard of practice and professional excellence, the EACVI embarked on developing and providing an individual certification process for each imaging modality. This certification process is currently available for adult transthoracic echocardiography (<https://www.escardio.org/Education/Career-Development/Certification/Adult-Transthoracic-Echo>), adult transoesophageal echocardiography (<https://www.escardio.org/Education/Career-Development/Certification/Adult-Transesophageal-Echo>), congenital heart disease echocardiography (<https://www.escardio.org/Education/Career-Development/Certification/Congenital-Heart-Disease-Echo>), cardiovascular magnetic resonance (<https://www.escardio.org/Education/Career-Development/Certification/Cardiovascular-Magnetic-Resonance>), soon also for cardiovascular magnetic resonance in congenital and paediatric heart disease and nuclear cardiology.^{2–7}

Starting from 2018, the EACVI will offer a certification process for cardiac computed tomography (CCT) based on the EACVI CCT core

syllabus.⁸ The objective is to certify individuals who demonstrate the knowledge and competency in CCT. The certification process assesses the candidates' knowledge, evaluates training and skills acquired.

At the end of this process, certified individuals will have successfully demonstrated a European standard for competency and to have the 'know how' for acquisition, interpretation, and reporting CCT exams. EACVI certification of CCT competency is not a compulsory or regulatory certificate. An individual's right to report and sign clinical CCT studies in individual countries remains defined by national laws and regulations.

Document development process

The Writing Committee organization

The selected writing committee represents the EACVI Nuclear Cardiology and Cardiac Computed Tomography section and the EACVI Certification and Accreditation Committee. The committee is comprised of highly experienced specialists in CCT.

Document development and approval

The developed document provides an outline for training and certification, continuing medical education (CME), and recertification. The final document developed by the writing committee was reviewed and approved by the EACVI committee for certification and accreditation and the EACVI Committee for Scientific Documents on 1 October 2017. The CCT certification process will inevitably continue to evolve to reflect the rapid developments in technology and evolving clinical applications.

* Corresponding author. Tel: +39 02 58002574; Fax: +39 02 58002231. E-mail: gianluca.pontone@ccfm.it

Published on behalf of the European Society of Cardiology. All rights reserved. © The Author 2017. For permissions, please email: journals.permissions@oup.com.

Benefits of European Certification in CCT

The benefits from EACVI CCT certification are:

- (1) To ensure the performing physician has the necessary expertise in CCT for the welfare of the patients undergoing scans.
- (2) It gives CCT trainees the opportunity to benchmark their knowledge against a common European standard.
- (3) Certification will bring professional credibility to any individual practicing CCT.

CCT training

CCT has emerged as a valuable non-invasive tool. This led to the utilization of CCT for a wide range of clinical indications as defined in the core syllabus. This increasing demand is accompanied by an increased need of capable individuals trained to independently perform and interpret CCT. Indeed, in some countries CCT has now become a first-line investigation in the assessment of patients with chest pain.⁹

To ensure a consistent standard of CCT training, three different levels of competency are defined for the development of the EACVI CCT certification process. The specified criteria for each level of training serve to guide this progress and the educational requirements to be fulfilled for those seeking certification.

Definition of level of competency

Level 1 competency reflects the basic requirements for all cardiology trainees according to the ESC Core Cardiology Curriculum.¹ It should be an integral component of any European training program in cardiology. This entails understanding the basic principles, indications, applications, and technical limitations of CCT, as well as the inter-relationship between CCT and other diagnostic methods. Level 1 competency does not qualify a trainee to perform or interpret CCT studies independently. Level 1 training requirements are not further discussed in this document.

Level 2 competency is the minimum requirement for a candidate wishing to individually report CCT studies. Certification of Level 2 competency fulfills the requirement of sub-specialty training in cardiac imaging as set out in the ESC curricula.¹

Level 3 competency is required for all individuals wishing to lead a CCT laboratory and an accredited CCT training program. At the end of training, Level 3 individuals should be able to independently acquire and interpret scans, review pre-reported exams and train others. Level 3 individuals should also have expertise in running and delivering a CCT service.

Levels 2 and 3 prerequisites

The applying candidate must:

- (1) be a physician
- (2) have sat and passed the European CCT exam
- (3) have completed the training and competency for Levels 2 or 3, respectively (discussed in Requirements for each CCT competency level or have completed a comparable Levels 2 or 3 certification within an internationally recognized certification programme other than the EACVI)
- (4) have completed 30 credits (Level 2) and 50 credits (Level 3) of CME specifically to CCT.

The CT certification application must be submitted no later than 2 years after sitting the exam with caseloads taken from 2 years before up to 2 years after having sat the exam.

Continuing medical training (CME) points

CME credits can be obtained from courses endorsed by the EACVI.

Any course declared by applicants that is not endorsed by EACVI will only be accepted at the discretion of the reviewers. In such cases a copy of the final programme should be enclosed. It is important to note that the primary focus of any course submitted as part of a candidates CME portfolio should be CCT, or it is unlikely that the course will be considered appropriate for the purposes of certification in CCT.

Please note that a maximum 50% (Levels 2, 15 credits and Levels 3, 25 credits) of CME credits can be self-directed. Examples of self-directed learning may include but are not restricted to Reviewer activity for CT related journals/articles, teaching in CT department and self-directed study from CCT texts. In all cases, it is the responsibility of the candidate to submit appropriate evidence of these activities. The decision as to whether such activities can be counted towards a candidates CME portfolio rests solely with the reviewers whose decision in such matters will be final.

EACVI CCT core syllabus

The aim of the EACVI CCT Core Syllabus is to define the educational requirements for individuals who wish to practice cardiac CT. The syllabus will help trainees prepare for knowledge-based assessments and European certification. It will also be incorporated in the development of educational material and teaching events organized throughout Europe.

The European Cardiac CT Certification Exam content will be based on the current EACVI Cardiac CT Syllabus⁸ ([https://www.escardio.org/Sub-specialty-communities/European-Association-of-Cardiovascular-Imaging-\(EACVI\)/Education/Nuclear-Cardiology-Cardiac-CT-Core-Syllabi](https://www.escardio.org/Sub-specialty-communities/European-Association-of-Cardiovascular-Imaging-(EACVI)/Education/Nuclear-Cardiology-Cardiac-CT-Core-Syllabi)). This is to ensure the examination process accurately reflects knowledge in CCT that the candidate needs to know. The standardization of knowledge requirements will promote the delivery of consistent standard of training and education across cardiac imaging.

General standards of training

Trainees

As per the ESC 2013 Core Cardiology Curriculum,¹ all cardiology trainees, irrespective of their subspecialty and level of competency, must:

- (1) know the indications and contraindications for appropriate CCT patient referral
- (2) understand the principles of CCT scan acquisition techniques, ECG synchronization, and dose saving algorithms
- (3) display and interpret cardiac CT images in the clinical context
- (4) be aware of the side-effects of contrast media and radiation risks to patient and personnel.

Supervision

The institution should be led by an EACVI Level 3 supervisor. Clinical cases should be reviewed with trainees during regular, dedicated scheduled reporting sessions. The institution's faculty should provide trainees with at least one scheduled teaching session per week. Teaching sessions should cover all aspects of CCT, including both physics and technical considerations and practical scanning. Institutions providing CCT training and fellowships should have developed an outline of the CCT and multi-modality CVI training program.

Facilities

Facilities providing training must have performed ≥ 400 cardiac CT (contrast enhanced) cases in the previous 12 months. Facilities at the providing institution should ensure a safe, secure, and effective environment for CCT studies. They should be equipped with state-of-the-art high-end CT equipment consisting of a multislice CT device of at least 64-slices or higher, electrocardiographic-gating capabilities; specialized equipment for contrast administration and patient monitoring; and computer network infrastructure for data storage, transmission, processing, study interpretation, and reporting.

Remote training

The authors and reviewers of this document are aware that some candidates may not have access to training at their centre and therefore, should seek on-site training in other centres. If this cannot be achieved, cases and teaching files from EACVI virtual workstation and EACVI ESCeL learning platform can be used to achieve the prerequisites of Level 2 competency.

European CCT exam

An electronic exam will be developed according to the recommendations of the ESC and the Union Européenne des Médecins Spécialistes (UEMS)—Cardiology Section.¹⁰ To assess the candidate's knowledge, the exam will be divided into two parts, both in the multiple choice question (MCQ) format. The first section will consist of 100 MCQs to test the candidate's theoretical knowledge, covering all items included in the syllabus. The second section will be comprised of several clinical cases to assess the practical experience. Candidates are required to pass both parts of the examination to be successful.

Training recommendations

Educational program

The educational program should comprise a series of structured didactic lectures and/or course(s) that cover all the basic aspects of CCT as defined in the core CCT syllabus. This should be accompanied by reading material and viewing of case files. The material presented should cover the physics, technical considerations, and clinical applications of CCT. Different cases should be presented and discussed to guide the trainees in how to manage different clinical scenarios.

To perform CCT scans, educational programs must provide Levels 2 and 3 trainees a good understanding and knowledge of:

- (1) quality parameters and optimization techniques;

- (2) artefact recognition and management;
- (3) patient selection, preparation, and specific protocol modifications.
- (4) radiation dose, its determinants and techniques and strategies to minimize it;
- (5) basic knowledge on iodine contrast media characteristics and adverse reactions.

Practical experience

Practical experience should be obtained through direct training under a Level 3 supervisor (or national equivalent). In case of a lack of sufficient case load or case mix depending on the availability of local resources, a candidates portfolio of cases can be supplemented through online cases available with virtual acquisition and workstations.

Requirements for each CCT competency level

Level 1

The cardiac CT component outlined Level 1 competency in Cardiac CT is a core component of the ESC General Cardiology Curriculum.¹

Level 1 competency in CCT can be achieved by onsite training at a CCT facility, through EACVI endorsed Level 1 courses, EACVI case collections, the European Society of Cardiology ESCeL platform, multimodality conferences, and/or online resources. Level 1 competency is not sufficient for practice or independent clinical interpretation of CCT. Sitting for the EACVI CCT theoretical exam is not required. No formal certification process is provided by EACVI for Level 1 competency.

Levels 2 and 3

EACVI Levels 2 and 3 competency and certification as outlined by Coordination Task Force on Subspecialty Accreditation of the European Board for the Specialty of Cardiology requires three mandatory steps:

- (1) Knowledge Assessment: Passed the European CCT theoretical exam based on the EACVI CCT core syllabus.⁸
- (2) Practical Training and Skills Assessment:
 - i. appraisal from the Training Programme Director;
 - ii. documentation of caseload;
- (3) Lectures and courses: documentation confirming participation of the trainee in an accredited formal training courses.

Level 2 caseload requirements

Level 2 candidates must have interpreted a total of 150 non-contrast enhanced CCT cases and 150 contrast enhanced CCT cases. Listed below are the minimum number of required contrast enhanced cardiac cases in each category.

- (1) The candidate must have been actively involved in the live scanning acquisition of 50 cases.
- (2) The candidate must have been involved in the interactive manipulation of reconstructed datasets using a three-dimensional imaging workstation (either onsite or virtual workstation) and in reporting and clinical interpretation of 150 cases (at least 30 cases assessment of structural and/or congenital heart disease, 50 cases of

revascularized patients, and 50 cases compared with invasive angiography and/or myocardial perfusion imaging).

A trainee may view a maximum of 50 cases from the EACVI virtual three-dimensional imaging workstation that contains clinical information, CCT data, analysis capabilities, and appropriate correlative data.

Level 3 caseload requirements

Level 3 candidates must have interpreted and participated in the acquisition a total of 150 non-contrast enhanced CCT cases and 300 contrast enhanced CCT cases. Listed below are the minimum number of required contrast cardiac cases in each category:

- (1) The candidate must have been actively involved in the scanning acquisition of 150 cases.
- (2) The candidate must have been involved in the interactive manipulation of reconstructed datasets using a three-dimensional imaging workstation (either onsite or virtual workstation) and in reporting and clinical interpretation of 300 cases (at least 60 cases assessment of structural and/or congenital heart disease, 100 cases of revascularized patients, and 150 cases compared with invasive angiography and/or myocardial perfusion imaging).

A trainee may interpret a maximum of 100 cases from the EACVI virtual imaging workstation that contains clinical information, CCT data, analysis capabilities, and appropriate correlative data.

Grandparenting scheme

A grandparenting scheme will be offered for a 2-year period for individuals already practicing CCT and wishing to achieve Level 3 certification. The grandparenting route will require a combination of clinical experience and either evidence of education and proven research record within the field of CCT. The examination board will also accept a combination of research and education.

Individuals wishing to apply under this scheme must demonstrate the following:

- (1) Clinical experience: 5 years or more practice of CCT. Including the performance of greater than 1000 cases in this area. The caseload should reflect the proportions in the logbook required for standard Level 3 certification. The board reserves the right to request to see logbooks for governance purposes.
- (2) CME: 15 h/year average CME over the period of practice.

and either

Education: Presentation of three or more invited talks at CME-accredited international conferences; or EACVI/SCCT or national society endorsed courses in the field of CCT.

or

Research: Publication of five or more (first or last author) original research articles in peer-reviewed journals in the field of CCT.

or

A combination of five presentations and publications total that satisfy the criteria outlined in Education or Research.

Re-certification

A recertification process is not yet available. After certification, it is recommended that Level 2 accredited individuals maintain their skills by documentation of at least 20 h of CME in CCT every 5 years and be actively involved in the acquisition and primary reporting of at least 100 CCT every 3 years. We also recommend that Level 3 accredited individuals Level 2 accredited individuals have documentation of at least 40 h of CME in CCT every 3 years and in acquiring and primary reporting of at least 200 CCT studies every 3 years. These cases have to be new cases acquired within the recertification period under the responsibility of the candidate and must be reported by the candidate as a first or senior reader.

A recertification programme is not currently offered by the EACVI, but may be planned in the future.

Summary

The following check-list should be followed step by step to complete the CT certification process:

Step 1: Link to [https://www.escardio.org/Sub-specialty-communities/European-Association-of-Cardiovascular-Imaging-\(EACVI\)/Education/Nuclear-Cardiology-Cardiac-CT-Core-Syllabi](https://www.escardio.org/Sub-specialty-communities/European-Association-of-Cardiovascular-Imaging-(EACVI)/Education/Nuclear-Cardiology-Cardiac-CT-Core-Syllabi).

Step 2: To include your EACVI Membership number.

Step 3: To upload copies of Board Certifications.

Step 4: To upload the certificate you have passed the European CCT theoretical exam based on the EACVI CCT core syllabus.

Step 5: To fill the template to provide an anonymous patient list identifying the indication and the diagnosis and if invasive evaluation was available (The cases can be collected with direct practical training or with virtual workstation experience).

Step 6: To upload the official appraisal from the Training Programme Director that certify the logbook.

Step 7: To upload copies of CT certificates and publications.

Step 8: To confirm the process and submit.

Conflict of interest: None declared.

References

1. Gillette TC, Brooks N, Fontes-Carvalho R, Fras Z, Gueret P, Lopez-Sendon J et al. ESC core curriculum for the general cardiologist (2013). *Eur Heart J* 2013;34:2381–411.
2. Popescu BA, Andrade MJ, Badano LP, Fox KF, Flachskampf FA, Lancellotti P et al. European Association of Echocardiography recommendations for training, competence, and quality improvement in echocardiography. *Eur J Echocardiogr* 2009; 10:893–905 (11 November 2017, date last accessed).
3. <https://www.escardio.org/Education/Career-Development/Certification/Adult-Transepophageal-Echo> (11 November 2017, date last accessed).
4. <https://www.escardio.org/Education/Career-Development/Certification/Adult-Transthoracic-Echo> (11 November 2017, date last accessed).
5. <https://www.escardio.org/Education/Career-Development/Certification/Congenital-Heart-Disease-Echo> (11 November 2017, date last accessed).
6. <https://www.escardio.org/Education/Career-Development/Certification/Cardiovascular-Magnetic-Resonance> (11 November 2017, date last accessed).
7. <https://www.escardio.org/Education/Career-Development/Certification/Congenital-heart-disease-CMR>.
8. Nieman K, Achenbach S, Pugliese F, Cosyns B, Lancellotti P, Kitsiou A. Cardiac computed tomography core syllabus of the European Association of Cardiovascular Imaging (EACVI). *Eur Heart J Cardiovasc Imaging* 2015;16:351–2.
9. <https://www.nice.org.uk/guidance/cg95>.
10. Lopez-Sendon J, Mills P, Weber H, Michels R, Mario CD, Filippatos GS et al. Recommendations on sub-specialty accreditation in cardiology: the Coordination Task Force on Sub-specialty Accreditation of the European Board for the Speciality of Cardiology. *Eur Heart J* 2007;28:2163–71.