



President: Dr Roger Bury  
Secretary: Dr Mark Hamilton  
Treasurer: Dr Giles Roditi

[www.bsci.org.uk](http://www.bsci.org.uk)

## **Recommended Standards in ECG Gated Cardiac CT Training: British Society of Cardiac Imaging (BSCI)**

### **Background**

The British Society of Cardiovascular Imaging (BSCI) is a multi-specialty society that brings together members from radiology and cardiology. It is a special interest group of Royal College of Radiologists (RCR) and is affiliated to the British Cardiovascular Society (BCS). The BSCI is a multi-modality cardiac imaging group that works closely with other cardiac imaging societies such as the British societies of cardiac magnetic resonance (BSCMR), nuclear cardiology (BNCS) and echocardiography (BSE). It has an important role to ensure and promote good practice in all aspects of cardiac imaging as one of the cardiac imaging societies. The BSCI has particular responsibility for the setting of training standards and accreditation for cardiac CT in the UK.

Cardiac Computed Tomography (CCT) has become integral to the clinical imaging pathway in many centres due to rapid technological advances in the past few years.

This document provides guidance to both cardiologist and radiologists, as well as to others in specific circumstances, who wish to practice cardiac CT and aims to support good practice. This document provides the framework of training requirements that allows individual radiologists and cardiologists to obtain accreditation to suit their appropriate level of practice.

This document defines the aspects of training and continuing professional education required for good clinical practice and aims to promote a high quality of cardiac CT service to patients. In exceptional circumstances individuals who do not meet the stated eligibility criteria may achieve the appropriate levels of competence from other backgrounds and career paths and such individuals can approach the BSCI to obtain level 2 and 3 training accreditation. These cases will be considered on an individual basis.

### **Introduction**

The latest generation of CT scanners allow images of coronary arteries and other cardiac structures to be obtained with an acceptable temporal and spatial resolution (1). Recent studies have demonstrated both high sensitivity and specificity of CT coronary angiography (CTA) when compared against conventional invasive angiography for the diagnosis of significant coronary artery disease (CAD). Additionally it has been shown to be more accurate than existing non-invasive

techniques (2, 3). The primary strength of ECG gated CTA is a high negative predictive value, making it a highly reliable investigation for ruling out significant CAD. This is particularly true in patients with low to intermediate pre-test probability of coronary artery disease. However, it should be noted that these studies have been performed in centres of excellence with large experience. Both national and international consensus documents regarding the current indications for clinical use of cardiac CT have recently been published (4-6).

Data obtained during ECG-gated contrast acquisition allows non-invasive assessment of coronary arteries but additionally also provides the opportunity to assess the size of cardiac chambers, myocardium, pericardium, pulmonary arteries, surrounding lung parenchyma, and other structures. If retrospectively gated, functional information, such as ejection fraction and valve function can be gained. This technique however comes at a higher radiation burden. The spectrum of information available within the scan data provides challenges in interpretation as well as a wealth of information about the disease process and adequate training is required to allow accurate analysis (1).

CT scanning has been an essential part of Radiology training since the 1980's and forms a part of routine practice such that radiologists are familiar with the presentation of CT image data and the workstation tools used for its analysis. Radiology training in the UK includes cardiac imaging in the core curriculum (6). However, the exposure to this training has been variable. Although radiologists have traditionally used cardiac CT to diagnose pericardial and myocardial pathology on non-ECG gated scans, exposure to imaging of the coronary arteries and assessment of cardiac function with this technique has been limited. Cardiologists are familiar with coronary artery imaging from their extensive experience with invasive angiography and cardiac function assessment through the use of echocardiography, myocardial perfusion scintigraphy (MPS) and cardiac MRI; however, they are likely to have limited exposure to CT scanning, the analysis of CT image data and the interpretation of non-cardiac structures. Again, cardiology training in the UK includes cardiac CT in its core curriculum.

The radiation exposure from CCTA poses another important challenge. Radiation exposure from medical practice accounts for the majority of the UK population dose from artificial sources, of which CT imaging contributes almost half (7). The use of CT has doubled in the last 10 years and following the introduction of CT colonography and cardiac CT angiography and further increases in radiation exposure are being predicted. The recent PROTECTION 1 study demonstrated Cardiac CTA with retrospective gating is a relatively high radiation dose procedure with doses ranging from 8.5 to 43.3 mSv (8), it also showed that higher radiation exposure to the patient is associated with inexperience of the operator. The Ionising Radiation (Medical Exposures) Regulations 2000 (IRMER) state the legal requirement for exposures to be optimised and justified, due to the lifetime attributable increased risk of cancer incidence associated with medical exposure.

Cardiac CT is a technically demanding procedure, which can only be optimally performed with detailed knowledge and training. This must include the physical principles of ECG gated CT, image optimization with minimum radiation dose, cardiac anatomy & physiology, plus knowledge of the cardiac disease processes to allow appropriate diagnosis and enhance clinical management.

## Training Standards in Cardiac CT

Radiologists and Cardiologists receive core training in cardiovascular physiology and imaging. However, as cardiac CT remains an emerging technique it is unlikely that sufficient experience will have been obtained during basic training in either specialty, and specific training should therefore be obtained prior to independently performing cardiac CT. To this end international levels of clinical competency have recently been established (9). These have been widely accepted as being appropriate.

The BSCI endorses the principle that high standards of clinical training and competency are vital to ensure the appropriate use of cardiac CT at acceptable radiation dosage and in this document sets out the standards required to support best practice. Based upon this guidance the BSCI will offer accreditation for individual clinicians. In addition, the BSCI offers guidance as to how such training can be achieved and provides a forum for support and guidance for specific issues around the implementation, training and practice of cardiac CT, including advice on equipment use and protocol optimisation.

The BSCI recognizes three levels of training & competency in Cardiac CT.

### Level 1 Training

---

**Objective:** Introductory level training to give familiarity with cardiac CT techniques and insight about its role in cardiac imaging with respect to other existing cardiac imaging modalities. **This level is not sufficient for independent practice or reporting.**

**Eligibility:**

- Consultant Radiologists and Cardiologists
- Specialist Registrars/ST trainees in Radiology (ST2+), Cardiology (ST3+) or allied specialities such as cardiac surgery.

**Training requirements:** This training should ideally be delivered by accredited Level 3 trainers. After January 2011 any training must be delivered by level 3 accredited trainers if it is to be recognised by the BSCI as counting towards accreditation.

- A. Lectures: equivalent to 8 hours of CPD covering following topics
1. Technical principles of multi-slice CT and its application to imaging the heart
  2. Different gating techniques, their advantages and limitations
  3. Radiation dose inherent in cardiac CT as well as dose reduction strategies.
  4. Contrast kinetics, administration, contraindications and complications
  5. Cardiac anatomy and physiology as applicable to CT
  6. Techniques of image reconstruction and post-processing

7. Techniques to minimize and reduce image artefacts
8. Cardiovascular risk assessment
9. Current indications and applications of cardiac CT
10. Basics of cardiac CT interpretation
11. Normal anatomy of the heart & thorax

B. Hands-on Training:

Exposure to at least 50 CT coronary angiograms with the opportunity to perform supervised/mentored interpretation. The cases analysed should have no more than 5 non-contrast examinations and correlation with catheter angiography should be available in at least half the cases. Ideally this training should be obtained on dedicated workstations, but teaching cases on CD/DVD or on-line training through a Level 3 trainer may also be acceptable.

***Obtaining Level 1 training and its duration:***

1. Dedicated Level 1 course (minimum 3 days) delivered by SCCT/BSCI certified Level 3 trainer
- OR
2. Training at a hospital that provides exposure to the required number of cases in addition to 8 hours of CPD in cardiac CT.

**Level 2 Training & Competency**

---

***Objective:*** This is the minimum recommended training for independent performance and interpretation of cardiac CT. Whilst this level of training can be considered an extension of Level 1 training, **it is required that the applicant will have a regular and on-going commitment to the reporting of scans post-accreditation.** Therefore emphasis is placed on the demonstration of education in performing and optimising studies as well as being able to interpret and report commonly encountered pathologies.

***Eligibility:***

- Consultants Radiologists and Cardiologists
- Specialist Trainees within the final two years of training who wish to undertake advanced training in cardiac imaging

***Training requirements:*** This should include the following

- A. Lectures: As in Level 1 (equivalent to 8 hours of CPD) Additional advanced lectures equivalent to a further 8 hours of CPD to include
  1. Image optimization, radiation dose reduction, and advanced post-processing
  2. Functional assessment with cardiac CT and correlation with other modalities. Identification of wall motion and perfusion abnormalities

3. Bypass graft anatomy and assessment
4. Coronary artery stent assessment
5. Role of stress imaging techniques and when to use them.
6. Assessment of valvular heart disease and role of CT.
7. Role of CT in patients with heart failure
8. Role of CT in pericardial diseases and cardiac masses
9. The role of CT in the evaluation of congenital heart disease
10. Identifying non-cardiac pathologies on a cardiac CT scan, particularly lung pathology

AND

B. Hands-on Training:

Applicants should also have a much wider exposure to cardiac CT examinations than required for level 1 training and should have had the opportunity to independently report at least 150 contrast cardiac CT examinations over a wide range of conditions encountered in clinical practice in which correlation to other investigations or clinical outcomes are known. Case mix should include:

- No more than 50 non-enhanced examinations
- At least 50 cases of coronary analysis (of which at least 75% should have coronary pathology, ideally correlated to catheter angiography or follow-up)
- At least 25 cases of other cardiac pathology, ideally correlated with other investigations or follow-up
- At least 25 cases of patients who have undergone coronary artery bypass grafting, ideally with correlation or follow-up
- At least 10 cases of patients with coronary artery stents, ideally with correlation or follow-up

The applicant must also demonstrate that they have been involved in the decision making process for at least 50 cases (which can include the above). It is recognised that some experience can in part be obtained by the use of pre-recorded “live cases” using video/ DVD clips. This can be a very effective learning tool, as long as real cases are used and the specific scanning parameters are discussed. **However, the applicant should be in the scanner control room and involved in the decision making process (including post-processing and interpretation of images) for at least 25 cases occurring in real time. This should ideally occur at a BSCI recognised exemplar site under the guidance of an accredited level 3 trainer.**

*Obtaining Level 2 training and its duration:*

- 1 Dedicated Level 2 course (minimum 5 days) delivered by SCCT/BSCI certified Level 3 trainer supplemented by on site training

OR

- 2 Training at a hospital where one has had exposure to the required number of cases and total of 16 hours of CPD in cardiac CT.

**Continuing experience:** 100 cardiac CT angiograms performed and interpreted per year.

**Continuing Education:** 20 hours of Category 1 CPD every 60 months.

It is possible that there are a number of Centres who are already performing cardiac CT as independent practitioners. Should they wish to obtain level 2 accreditation, they should be able to demonstrate they have achieved the appropriate level of CPD in the last 3 years and provide evidence of 200 cases that have been performed within the last 3 years including information of DLP and CTDI measurements. In addition, they should provide letters from their heads of Cardiology and Radiology to confirm that such a service has been delivered and is valued.

---

### **Level 3 Training & Competency**

---

**Objective:**

Applicants should be able to demonstrate not only considerable expertise in performing and interpreting cardiac CT, but also of running a successful academic or clinical cardiac CT unit. The individual would be directly responsible for quality assurance and training of radiographers besides being able to train other physicians.

**Eligibility:**

Consultants in Radiology and Cardiology.

**Training requirements:** This should include all the following

- A. Lectures: Total of 32 hours of CPD
  - a. All basic and advanced lectures as in Level 1 and 2 equivalents (16 hours of CPD related to CT and cardiac CT).
  - b. Additional lectures/courses on other aspects of cardiac imaging and clinical cardiology equivalent to 16 hours of CPD.
- B. Hands-on Training: A level 3 applicant should be able to demonstrate that they have performed at least 300 contrast enhanced CT coronary angiograms and 50 non-contrast enhanced exams in the last 3 years and been physically present for at least 100 of these.
- C. Demonstration of active and on-going participation in basic or clinical research and teaching in cardiac CT/Imaging by at least one of the following:

- a. Lecturer for at least two CME accredited courses on the topic of cardiac CT, or
- b. Three or more peer-reviewed publications in cardiac CT in past three years

***Duration of training:***

For existing consultant radiologists/cardiologists above level can be reached after Level 2 by achieving the above training criteria over a period of 3 years.

***Continuing experience:*** 100 cardiac CT angiograms performed and interpreted per year.

***Continuing Education:*** 40 hours of Category 1 CPD every 60 months.

## **Accreditation of Cardiac CT Training & Competence**

Based upon the above training guidance, BSCI wishes to offer an accreditation process for individual clinicians in order to verify that appropriate recommended training in cardiac CT has been obtained.

It is appreciated that there are a small number of practitioners who have considerable expertise in cardiac CT, which was gained prior to suitable courses/training being available. Such practitioners can apply for accreditation on an individual basis, but would be expected to be able to demonstrate the same minimum standards outlined above.

The application process would involve submitting the following documents:

1. BSCI Cardiac CT accreditation application form
2. Following documents or certificates 'appropriate to the level' applied
  - a. Letter verifying the status as a Consultant or Specialist Registrar from Head of Department, Human Resources, Medical Director, etc
  - b. Letter or certificate verifying the lectures (appropriate CPD level) attended covering the topics relevant to Cardiac CT
  - c. Letter or certificate verifying that appropriate number and duration of 'hands on' training has been obtained including the live cases where required.

After 2011 all training should have been obtained under the guidance of a Level 3 (BSCI or SCCT) trainer.

Applications should be accompanied by the following fee to cover the administrating and processing charges:

Level 1	£100
Level 2	£150 for members BSCI, £250 for non members

Level 3            £200 for BSCI members, £350 for non members

Please send your application form (available on the BSCI website) with relevant certificates, letters and anonymised clinical reports and fees to BSCI.

### **Transfer of SCCT Accreditation**

For individuals who have Level 1 and 2 SCCT Accreditation BSCI will issue a UK Accreditation certificate on receipt of an original SCCT letter of verification. This will be free of charge for BSCI members until 1 Jan 2011 and will incur a £35 administration charge for non-members. From Jan 2011 a £35 administration charge will be levied to cover administration costs.

For individuals with SCCT Level 3 Accreditation the BSCI requires copies of all supporting documentation in addition to the original SCCT letter of verification. Evidence of ongoing clinical leadership, teaching or academic research will be required before the BSCI will issue a Level 3 certificate. This will be free of charge for BSCI members until 1 Jan 2011 and will incur a £35 administration charge for non-members. From Jan 2011 a £35 administration charge will be levied to cover administration costs.

### **References:**

- Budoff MJ, Achenbach S, Blumenthal RS, et al. Assessment of coronary artery disease by cardiac computed tomography: a scientific statement from the American Heart Association Committee on Cardiovascular Imaging and Intervention, Council on Cardiovascular Radiology and Intervention, and Committee on Cardiac Imaging, Council on Clinical Cardiology. *Circulation* 2006; 114:1761-1791.
2. Mowatt G, Cummins E, Waugh N, et al. Systematic review of the clinical effectiveness and cost-effectiveness of 64-slice or higher computed tomography angiography as an alternative to invasive coronary angiography in the investigation of coronary artery disease. *Health Technol Assess* 2008; 12:1-164.
3. Heijenbroek-Kal MH, Fleischmann KE, Hunink MGM. Stress echocardiography, stress single-photon-emission computed tomography and electron beam computed tomography for the assessment of coronary artery disease: A meta-analysis of diagnostic performance. *American Heart Journal* 2007; 154:415-423.
4. Salvatore C, Todd CV, Järnig H, Patrick JD, Thomas CG, Allen JT. International, multidisciplinary update of the 2006 Appropriateness Criteria for cardiac computed tomography. *Journal of Cardiovascular Computed Tomography* 2009; 3:224-232.
5. Greenland P, Bonow RO, Brundage BH, et al. ACCF/AHA 2007 clinical expert consensus document on coronary artery calcium scoring by computed tomography in global cardiovascular risk assessment and in evaluation of patients with chest pain: a report of the American College of Cardiology Foundation Clinical Expert Consensus Task Force (ACCF/AHA Writing

- Committee to Update the 2000 Expert Consensus Document on Electron Beam Computed Tomography). *Circulation* 2007; 115:402-426.
6. The Royal College of Radiologists. In: *Making the best use of clinical radiology services* 6ed, 2007; CC10.
  7. The Royal College of Radiologists In: *Structured Training Curriculum for Clinical Radiology*, 2007.
  8. Hart D, Wall BF. UK population dose from medical X-ray examinations. *Eur J Radiol* 2004; 50:285-291.
  9. Hausleiter J, Meyer T, Hermann F, et al. Estimated radiation dose associated with cardiac CT angiography. *JAMA* 2009; 301:500-507.
  10. Budoff MJ, Cohen MC, Garcia MJ, et al. ACCF/AHA clinical competence statement on cardiac imaging with computed tomography and magnetic resonance. *Circulation* 2005; 112:598-617.