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The American College of Radiology will periodically define new practice parameters and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice parameters and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice parameter and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review and approval. The practice parameters and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice parameter and technical standard by those entities not providing these services is not authorized.

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ACR–NASCI–SPR PRACTICE PARAMETER FOR THE PERFORMANCE AND INTERPRETATION OF CARDIAC COMPUTED TOMOGRAPHY (CT)

PREAMBLE

This document is an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. Practice Parameters and Technical Standards are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care¹. For these reasons and those set forth below, the American College of Radiology and our collaborating medical specialty societies caution against the use of these documents in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the practitioner in light of all the circumstances presented. Thus, an approach that differs from the guidance in this document, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in this document when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of this document. However, a practitioner who employs an approach substantially different from the guidance in this document is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to the guidance in this document will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of this document is to assist practitioners in achieving this objective.

¹ *Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing*, ___ N.W.2d ___ (Iowa 2013) Iowa Supreme Court refuses to find that the *ACR Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures* (Revised 2008) sets a national standard for who may perform fluoroscopic procedures in light of the standard's stated purpose that ACR standards are educational tools and not intended to establish a legal standard of care. See also, *Stanley v. McCarver*, 63 P.3d 1076 (Ariz. App. 2003) where in a concurring opinion the Court stated that "published standards or guidelines of specialty medical organizations are useful in determining the duty owed or the standard of care applicable in a given situation" even though ACR standards themselves do not establish the standard of care.

I. INTRODUCTION

This practice parameter was revised collaboratively by the American College of Radiology (ACR), the North American Society of Cardiovascular Imaging (NASCI), and the Society for Pediatric Radiology (SPR).

Cardiac computed tomography (CT) is a noninvasive cross-sectional imaging modality that in addition to evaluating the anatomy and pathology of the pericardium and cardiac chambers can assess the central great vessels and the function of the heart, including the cardiac valves [1-8]. CT is a proven and useful procedure for detecting and characterizing cardiac and pericardial disorders. With contemporary technology, CT can also assess the coronary arteries and veins and can evaluate cardiac function [9-23]. This practice parameter attempts to maximize the probability of detecting cardiac abnormalities with cardiac CT.

Cardiac CT involves the exposure of patients to ionizing radiation and should only be performed under the supervision of a physician with the necessary training in radiation protection to optimize examination safety (for more information, see section IV.A). A Qualified Medical Physicist (QMP) and trained technical staff must be available [24].

Cardiac CT should be performed only for a valid medical indication and with the minimum radiation exposure that provides diagnostic image quality.

Although important abnormalities of the heart and associated structures can be detected on chest CT performed for other reasons, these practice parameters are written specifically for dedicated examinations designed to detect cardiac pathology.

For further information on CT imaging of other structures within the chest and of the noncardiac vasculature, the reader should see the [ACR–SCBT–MR–SPR Practice Parameter for the Performance of Thoracic Computed Tomography \(CT\)](#) [25].

II. DEFINITIONS

A. Cardiac CT

Cardiac CT is performed primarily for the morphologic evaluation of the cardiac chambers, valves, ventricular myocardium, coronary arteries and veins, aortic root, central pulmonary arteries and veins, and pericardium. However, noncardiac structures included in the field of view (FOV) must be evaluated and reported [26-37].

B. Unenhanced Cardiac CT

Unenhanced cardiac CT is performed primarily for detecting and evaluating calcification, eg, of the coronary arteries (coronary calcium scoring), ascending aorta, cardiac valves, pericardium, or cardiac masses. Electrocardiogram (ECG) synchronization reduces motion artifact and is required for coronary calcium quantification [26,27,31,34]. It may also be performed for cardiac surgical planning in reoperative patients [38].

C. Contrast-Enhanced Cardiac CT

1. Contrast-enhanced cardiac CT is performed after intravenous (IV) administration of iodinated contrast to allow evaluation of the cardiac chambers, myocardium, valves, pericardium, and central great vessels.
2. CT coronary arteriography is performed to characterize the origin and course of the coronary arteries and/or bypass grafts and to assess stenosis, aneurysm, and/or atherosclerotic plaque formation.
3. CT cardiac venography is performed to assess the cardiac or pulmonary veins.

III. INDICATIONS [29,32,36,37,39]

Unenhanced ECG-synchronized cardiac CT may be indicated for detecting and quantifying coronary artery calcium (“calcium scoring”). Although the role of coronary artery calcium scoring is currently being refined, data support its use for risk stratification and therapeutic decision making in select patients with intermediate risk for a significant ischemic cardiac event. An additional indication is the localization of myocardial, valvular, aortic, and pericardial calcium.

Indications for contrast-enhanced cardiac CT include, but are not limited to, the diagnosis, characterization, and/or surveillance of:

1. Coronary atherosclerotic disease
2. Arterial dissection and intramural hematoma
3. Arterial and venous aneurysms
4. Traumatic injuries of arteries and veins
5. Arterial and venous thromboembolism
6. Cardiac and vascular congenital anomalies and variants
7. Cardiac interventions (eg, for congenital heart disease, myocardial ablation for hypertrophic cardiomyopathy)
8. Vascular interventions (endovascular and surgical, eg, angioplasty, coronary stenting, coronary artery bypass grafts [CABGs], pulmonary vein ablation therapy for cardiac dysrhythmia, valve replacement, aortic root replacement, planning for aortic endovascular valve replacement, pacemaker placement planning)
9. Vascular infection, vasculitis, and collagen vascular diseases
10. Sequelae of ischemic coronary disease (myocardial scarring, ventricular aneurysms, thrombi)
11. Primary or metastatic cardiac tumors and thrombi
11. Pericardial diseases
12. Cardiac functional evaluation, especially in patients who are not candidates for magnetic resonance imaging (MRI) (eg, if they have automatic implantable defibrillators, pacemakers, or other MRI contraindications) or for echocardiography (eg, if there is a poor acoustic window)

Specific congenital cardiovascular anomalies and variants may include the following:

1. Coronary anomalies
2. Systemic and pulmonary venous anomalies
3. Aortic and pulmonary anomalies
4. Right-sided cardiac obstructive disorders
5. Left-sided cardiac obstructive disorders
6. Atrial and ventricular septal defects
7. Other complex structural disorders of the cardiac chambers, morphology, and valves

For additional indications see the Cardiac Imaging section of the ACR [Appropriateness Criteria®](#) [40].

For the pregnant or potentially pregnant patient, see the [ACR–SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation](#) [41].

IV. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

A. Physician

1. See the [ACR Practice Parameter for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#) [42].

In addition to the qualifications listed in the [ACR Practice Parameter for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#) [42], the physician should also meet the following qualifications:

- a. For a physician with prior qualifications in general and/or thoracic CT interpretation, additional qualifications should include:

- i. Cardiac CT Category I CME or Training in Cardiac CT in a training program approved by the Accreditation Council for Graduate Medical Education (ACGME), the Royal College of Physicians and Surgeons of Canada (RCPSC), the Collège des Médecins du Québec, or the American Osteopathic Association (AOA),
 - including
 - ii. Education in cardiac anatomy, physiology, pathology, and cardiac CT imaging for a time equivalent to at least 30 hours of CME
 - and including
 - iii. Supervision, interpretation, or reporting of at least 50 cardiac CT examinations in the last 36 months. Coronary artery calcium scoring does not qualify as meeting these requirements.
- b. For any physician or any other physician who assumes responsibilities for cardiac CT imaging, additional qualifications should include:
 - i. Completion of an ACGME-approved training program in the specialty practice plus 200 hours of Category I CME in the performance and interpretation of CT in the subspecialty where CT reading occurs,
 - and
 - ii. Supervision, interpretation, or reporting of 500 cases in cardiothoracic imaging. These must include at least 50 cardiac CT examinations during the past 36 months in a supervised situation and at least 450 additional thoracic CT or thoracic CT angiography cases. Coronary artery calcium scoring does not qualify as meeting these requirements,
 - including
 - iii. Completion of at least 30 hours of Category I CME in cardiac imaging, including cardiac CT, anatomy, physiology, and/or pathology, or documented equivalent supervised experience in a facility actively performing cardiac CT

2. Administration of pharmacologic agents

The supervising physician must be knowledgeable about the administration, risks, and contraindications of the pharmacologic agents commonly used in cardiac CT imaging, such as heart rate–lowering medications and coronary vasodilators.

3. Maintenance of competence

All physicians performing cardiac CT examinations should demonstrate evidence of continuing competence in the interpretation and reporting of those examinations. If competence is assured primarily on the basis of continuing experience, performance and interpretation of a minimum of 75 examinations every 3 years is recommended in order to maintain the physician’s skills.

4. Continuing medical education

The physician’s continuing medical education should be in accordance with the [ACR Practice Parameter for Continuing Medical Education \(CME\)](#) [43] of 150 hours of approved education every 3 years and should include CME in cardiac CT as is appropriate to the physician’s practice needs.

6. Additional training recommendations

B. Qualified Medical Physicist

See the [ACR–AAPM Technical Standard for Medical Physics Performance Monitoring of Computed Tomography \(CT\) Equipment](#) [44].

A Qualified Medical Physicist is an individual who is competent to practice independently one or more of the subfields in medical physics. The American College of Radiology considers certification, continuing education, and experience to demonstrate that an individual is competent to practice one or more of the subfields in medical physics, and to be a Qualified Medical Physicist. The ACR strongly recommends that the individual be certified in the appropriate subfield(s) by the American Board of Radiology (ABR), the Canadian College of Physics in Medicine, or by the American Board of Medical Physics (ABMP).

A Qualified Medical Physicist should meet the [ACR Practice Parameter for Continuing Medical Education \(CME\)](#). (ACR Resolution 17, 1996 – revised 2012, Resolution 42) [43]

The appropriate subfield of medical physics for this practice parameter is Diagnostic Medical Physics. (Previous medical physics certification categories including Radiological Physics, Diagnostic Radiological Physics, and Diagnostic Imaging Physics are also acceptable.)

C. Registered Radiologist Assistant

A registered radiologist assistant is an advanced level radiographer who is certified and registered as a radiologist assistant by the American Registry of Radiologic Technologists (ARRT) after having successfully completed an advanced academic program encompassing an ACR/ASRT (American Society of Radiologic Technologists) radiologist assistant curriculum and a radiologist-directed clinical preceptorship. Under radiologist supervision, the radiologist assistant may perform patient assessment, patient management and selected examinations as delineated in the Joint Policy Statement of the ACR and the ASRT titled “Radiologist Assistant: Roles and Responsibilities” [24] and as allowed by state law. The radiologist assistant transmits to the supervising radiologists those observations that have a bearing on diagnosis. Performance of diagnostic interpretations remains outside the scope of practice of the radiologist assistant. (ACR Resolution 34, adopted in 2006)

The radiologist assistant’s continuing education credits should include continuing education in cardiac CT performance as is appropriate to the radiologist assistant’s practice needs. Basic life support (BLS) and automatic defibrillator (AED) training is recommended.

D. Radiologic Technologist

See the [ACR Practice Parameter for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#) [42].

In addition to the qualifications listed in the [ACR Practice Parameter for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#) [42], the technologist should participate in the proper positioning of the ECG leads. The technologist’s continuing education credits should include continuing education in cardiac CT performance as is appropriate to the technologist’s practice needs. Basic life support (BLS) and automatic defibrillator (AED) training is recommended.

V. SPECIFICATIONS OF THE CONTRAST-ENHANCED CARDIAC CT EXAMINATION

The written or electronic request for cardiac CT should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). Additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient’s clinical problem or question and consistent with the state’s scope of practice requirements. (ACR Resolution 35, adopted in 2006)

The supervising physician must have complete understanding of the indications, risks, and benefits of the examination, as well as alternative imaging procedures. The physician must be familiar with potential hazards associated with CT, including potential adverse reactions to contrast media [45]. The physician should be familiar with relevant ancillary studies that the patient may have undergone, including echocardiography, MRI, or nuclear medicine studies. The physician performing CT interpretation must have a clear understanding and knowledge of the anatomy and congenital and acquired pathophysiology relevant to the CT examination.

Standard imaging protocols may be established and varied on a case-by-case basis when necessary. These protocols should be reviewed and updated periodically.

A. Patient Selection and Preparation

The appropriate guidelines for patient selection for a contrast-enhanced cardiac CT examination will continue to evolve with the introduction of new scanner and ancillary supportive technology that may affect cardiac CT performance (eg, sensitivity, specificity, and positive and negative predictive values). Cardiac CT is generally used in patients with a low to intermediate pretest probability for coronary, cardiac structural, and thoracic vascular congenital and acquired disease based upon clinical, laboratory, and/or prior imaging findings. Higher-risk coronary artery disease patients are more likely to need invasive coronary catheter studies and interventions.

Patient selection for cardiac CT and coronary CT angiography should be in accordance with evidence-based clinical algorithms:

1. Coronary Arteries
 - a. Suspected coronary anomaly following echocardiography or cardiac MRI
 - b. Evaluation of a reimplanted coronary artery
 - c. Diagnosis or follow-up of Kawasaki disease
 - d. Unexplained or atypical chest pain with low or intermediate risk for coronary artery atherosclerotic disease based on gender, age, and risk factors
 - e. Unexplained or atypical chest pain with low risk for coronary artery atherosclerotic disease and possible coronary artery anomaly
 - f. Typical or atypical chest pain with normal or equivocal stress test and normal or equivocal ECG findings
 - g. Unexplained acute chest pain in a patient with or without coronary disease risk factors who has negative cardiac enzymes and normal or equivocal ECG findings
 - h. Unexplained acute chest pain in which the clinical presentation requires exclusion of coronary artery disease versus other thoracic vascular causes of chest pain, such as pulmonary embolism and acute aortic pathology (eg, dissection). The patient may or may not have coronary artery disease risk factors. Cardiac enzymes should be negative and ECG findings normal or equivocal.
 - i. Evaluation of ischemic etiology for a newly diagnosed cardiomyopathy and/or heart failure
 - j. Preoperative or preprocedural evaluation of the coronary arteries and/or cardiac structure including, but not limited to, systemic and pulmonary veins, pulmonary valve and proximal pulmonary arteries, and aortic root and proximal aorta
 - k. Postendovascular or surgical evaluation of the coronary arteries, possible bypass grafts, and/or cardiac structure including, but not limited to, systemic and pulmonary veins, pulmonary valve and proximal pulmonary arteries, and aortic root and proximal aorta. Those post-coronary intervention patients may:
 - i. Have new or recurrent symptoms or chest pain or chest pain equivalent
 - ii. Be scheduled for additional cardiovascular interventions
2. Cardiac Structure (subsequent to prior imaging, eg, echocardiography)
 - a. Systemic and pulmonary venous anomalies
 - b. Aortic and pulmonary arterial anomalies
 - c. Right-sided chamber obstructive disorders

- d. Left-sided chamber obstructive disorders
 - e. Complex congenital structural disorders
 - f. Cardiac and pericardial masses
 - g. Chronic pericarditis
3. Cardiac Function (subsequent to echocardiography)
- a. Ventricular volume
 - b. Valve (native and mechanical)

Patients scheduled for CT coronary arteriography must have tolerance for necessary administration of medications as needed (eg, beta-blockers or nitroglycerin/nitrates), adequate peripheral venous access, and adequate respiratory function to enable cooperation with breath holding. Patients with irregular heart rhythms may not be appropriate candidates and should be evaluated on an individual basis for the examination. All patients referred for cardiac CT should be first evaluated by an appropriate health care provider knowledgeable of congenital and acquired cardiac and thoracic vascular disease. Cardiac CT angiography should be used with caution in patients with borderline or compromised renal function. Cardiac CT may be suboptimal for evaluation of atherosclerosis in patients whose BMI is 40 kg/m² or greater.

Patients should have a liquid-only diet for 3 hours and abstain from caffeine for at least 6 hours prior to the study. When a patient has a relative contraindication to the administration of IV iodinated contrast media, measures to reduce the possibility of contrast media reactions or nephrotoxicity should be followed as defined in the [ACR–SPR Practice Parameter for the Use of Intravascular Contrast Media](#) [45] and the [ACR Manual on Contrast Media](#) [46]. A physician should also be available to treat adverse reactions to IV contrast media.

An appropriate sized antecubital IV catheter (20 gauge or larger in an adult) is the preferred administration route of iodinated contrast media for CT coronary arteriography. To minimize the risk of contrast media extravasations, all catheters used for cardiac CT angiography should first be tested with a rapidly injected bolus of sterile saline to ensure that the venous access is secure and effective. Trained medical personnel should monitor the injection site for signs for IV extravasation. Departmental procedures for treating IV extravasations should be documented.

Because faster heart rates tend to degrade image quality [47-49], patients may need to be medicated with rate-controlling drugs (beta-blockers, calcium channel blockers), unless contraindicated, prior to proceeding with the cardiac CT arteriogram. Nitroglycerin/nitrates may also be administered just prior to the CT angiogram acquisition, unless contraindicated. Physicians performing CT coronary arteriography should be knowledgeable of the administration, risks, and contraindications of these medications. Blood pressure and heart rate should be monitored prior to and following the cardiac CT when medications are administered.

Pediatric patients or patients suffering from anxiety or claustrophobia may require sedation or additional assistance. Administration of moderate sedation or general anesthesia may enable achievement of the examination, particularly in young children. If moderate sedation is necessary, refer to the [ACR–SIR Practice Parameter for Sedation/Analgesia](#) [50].

B. Examination Technique

A coronary artery calcium scoring study may be acquired prior to contrast injection. This is typically performed with prospective ECG triggering and 2.5- to 3-mm-thick sections beginning at or just below the carina and extending inferior to the heart.

Because of substantial variations in the time required for an IV contrast media injection to reach the targeted vascular anatomy, an assessment of patient-specific circulation time is required in protocols that include the administration of IV contrast media. Circulation timing can be performed using either of 2 techniques:

1. Test bolus technique. IV injection of a small bolus (eg, 10 to 20 mL) of contrast media at the flow rate and via the IV site that will be used for the examination. Sequential stationary CT images are acquired at the anatomic level of interest during the test bolus. The timing of the contrast delivery and ensuing

enhancement of the vessel lumen of interest are then plotted to create a time-density curve. The time of the peak of vascular enhancement is used to determine the scanning delay.

2. Bolus track and trigger technique. Following the initiation of the full dose of contrast media injection, automated triggering CT software monitors the attenuation within the cardiac structure of interest. The CT is automatically started when the enhancement in the monitored vessel or structure reaches a predetermined operator-selected level. Note: For pediatric patients, in whom reduction of both contrast media and radiation dose is preferable, either an appropriate scan delay time can be determined using low-dose detection techniques or an empiric delay time after the initiation of the contrast injection may be used.

A right arm injection is preferable to avoid artifacts from undiluted contrast media in the left brachiocephalic vein as it crosses the mediastinum. A bolus of saline following the iodinated contrast media injection should be used to reduce the volume of contrast media required to achieve adequate vascular opacification and reduce artifacts from high concentration of contrast media in the superior vena cava and right atrium. An intermediate phase of mixed iodine and saline between the full contrast and saline boluses can also be used to attenuate the contrast in the right heart. Contrast injection parameters should be modified on an individual patient basis whenever possible. The administration of iodinated contrast media for the contrast-enhanced cardiac CT should ideally be performed with a minimum flow rate of 3 mL per second in any patient weighing 50 or more kilograms. Higher flow rates of 5 mL per second or greater are frequently required for larger patients and in general are required for shorter acquisition scan times. Use of low tube voltage (kVp), especially in children, may achieve satisfactory vascular contrast enhancement with slower flow rates and lower radiation dose. In children, contrast media dosing should be scaled by body weight, with injection rate scaled similarly. Whenever possible, the contrast should be delivered via powered injection. The volume of contrast media should be selected in consideration of the patient's weight and comorbidities that might increase the risk of nephrotoxicity.

The contrast-enhanced cardiac CT acquisition should be performed with a section thickness of ≤ 1.5 mm, depending on the cardiac structure to be assessed. If performed for function or cardiac morphology only, 1.25 to 1.5 mm section thickness may be adequate. The field of view (FOV) should span from below the tracheal carina through the apex of the heart. If the patient has had previous CABG surgery, the FOV should span from the top of the clavicular heads to the apex of the heart, to include the entire length of internal mammary grafts using breath holding and cardiac synchronization. Multisector reconstruction associated with lower pitch values may improve the effective temporal resolution of the reconstructed images, depending on the heart rate and the CT scanner. Prospective ECG triggering and prospectively ECG-triggered high-pitch helical scanning may be used as a radiation dose reduction method when this technology is available. Other radiation dose reduction methods, such as low-kVp, ECG-dependent, tube current modulation, and iterative reconstruction techniques, should be used when appropriate and available [51-55].

For CT coronary arteriography, oral and/or IV rate-controlling drugs, beta-blockers, if not contraindicated, may be used during the scan to obtain a stable heart rate of approximately 50 to 70 beats per minute. A sublingual nitroglycerin tablet or spray may be used to vasodilate the coronary arteries for better visualization, provided that the patient's blood pressure is adequate. Scan data acquired with retrospective ECG gating should be reconstructed at various phases of the cardiac cycle, and all acquisitions should be reconstructed with overlapping sections at a maximum slice increment of 50% of the effective section thickness and a FOV of approximately 25 cm. Thin section reconstruction during the most optimal temporal window is recommended to improve conspicuity of the structures of interest. Thicker section reconstructions that span the entire cardiac cycle can be performed to assess cardiac contractility. For prospective ECG triggering, a single point in the cardiac cycle, typically during diastole, is selected for image acquisition and subsequent reconstruction.

Postprocessing of the cardiac CT data should be performed by physicians, registered radiology technologists, or other experienced personnel knowledgeable of cardiovascular anatomy and pathophysiology. Images from calcium scoring studies should be reviewed to ensure that only calcifications within the coronary arteries are included as part of the scoring. The cardiac CT data are formatted and presented using various display techniques,

including multiplanar reformations (MPRs), curved planar reformations (CPRs), maximum-intensity projections (MIPs), 3-D volume renderings (VRs), 3-D shaded surface displays, and/or 4-D dynamic reconstructions.

Images are to be labeled at the minimum with the following: a) patient identification, b) facility identification, c) examination date, and d) the anatomic location. Postprocessed images should be recorded and archived in a manner similar to the source CT sections.

C. Interpretation

Cardiac CT data should be interpreted on a computer workstation that displays axial, reformatted, and postprocessed images. Interpretation of the CT coronary arteriogram includes assessment of intraluminal plaques to include segmental vascular location, attenuation characteristics, and degree of luminal narrowing; vascular anomalies; the presence and status of stents and/or coronary bypass grafts; and abnormalities of the cardiac chambers, myocardium, and pericardium. Frequently, reconstructions from different phases of the cardiac cycle may be required to fully interpret the examination. For functional cardiac assessment, multiple phases should be examined. Interpretation of the noncardiac portion of the examination should include use of proper windowing and leveling for adequate visualization of the soft tissues, mediastinum, pulmonary, and bony portions of the chest. Comparison with previous chest or cardiac CT images should be performed if available.

VI. DOCUMENTATION

Reporting should be in accordance with the [ACR Practice Parameter for Communication of Diagnostic Imaging Findings](#) [56]. In addition to examining the cardiac structures of interest, the CT sections should be examined for extracardiac abnormalities that may have clinical relevance. These abnormalities should also be described in the formal report of the examination.

VII. EQUIPMENT SPECIFICATIONS

Technology in this area is changing rapidly, and with the advent of new-generation CT scanners such as the volume and dual-source scanner, there are added benefits of providing reliable high-quality images at reduced doses as well as the ability to perform dynamic vascular/airway imaging. The following specifications should therefore be regarded as the minimum standard for CT scanners to perform cardiac CT exams.

For diagnostic-quality cardiac CT, the CT scanner should meet or exceed the following specifications:

1. ECG synchronization for all scans, with the ability to perform prospective triggering and retrospective gating
2. Setup for bolus tracking of the administered contrast material for appropriate timing of contrast-enhanced cardiac CT exams
3. Automated tube modulation during image acquisition for dose reduction
4. Contrast-enhanced cardiac CT by MDCT (should meet or exceed a 64-detector scanner), including CT coronary arteriography, a scanner capable of achieving in-plane spatial resolution $\leq 0.5 \times 0.5$ mm axial, z-axis spatial resolution ≤ 1 mm longitudinal, and temporal resolution ≤ 0.25 second
5. Non-contrast-enhanced MDCT for coronary artery calcium scoring may be adequately performed on a scanner with a temporal resolution of 0.50 second using prospectively ECG-triggered “step and shoot” sequential acquisition.
6. Minimum section thickness: should be ≤ 5 mm, but ≤ 3 mm for coronary calcium scoring and ≤ 1.5 mm for CT coronary arteriography
7. Volumetric computed tomography dose index (CTDI vol) and dose length product (DLP) must be available after each scan for transfer to individual PACS workstations

For adequate contrast-enhanced cardiac CT, including CT coronary arteriography, a power injector capable of delivering a programmed volume of a contrast agent at a steady flow rate of at least 3 cc per second for delivery of ≥ 300 mg of iodine/mL is necessary. A dual-chambered power injector is preferred if a saline flush will be administered immediately after the intravenous contrast material injection.

A workstation capable of creating straight or curved multiplanar reformations, maximum-intensity projections, volume renderings that can be compared across multiple cardiac phases, and 4-D dynamic reconstructions should be available for coronary CTA and for other applications as appropriate. The coronary postprocessing package should include vessel/lumen analysis, cardiac calcium scoring, and cardiac function analysis.

For pediatric facilities, sufficient space should be available for anesthesia equipment in the room where the scanner is housed. Appropriate algorithm must be available for treating soft-tissue infiltration of intravenously administered iodinated contrast material. Appropriate emergency equipment and medications must be immediately available to treat adverse reactions, an acute coronary syndrome, and cardiac arrest. The equipment and medications should be monitored for inventory and drug expiration dates on a regular basis. The equipment, medications, and other emergency support must also be appropriate for the range of ages and sizes in the patient population.

VIII. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, registered radiologist assistants, radiologic technologists, and all supervising physicians have a responsibility for safety in the workplace by keeping radiation exposure to staff, and to society as a whole, “as low as reasonably achievable” (ALARA) and to assure that radiation doses to individual patients are appropriate, taking into account the possible risk from radiation exposure and the diagnostic image quality necessary to achieve the clinical objective. All personnel that work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection and application of dose limits) and the principles of proper management of radiation dose to patients (justification, optimization and the use of dose reference levels)

http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1578_web-57265295.pdf

Nationally developed guidelines, such as the ACR’s [Appropriateness Criteria®](#), should be used to help choose the most appropriate imaging procedures to prevent unwarranted radiation exposure.

Facilities should have and adhere to policies and procedures that require varying ionizing radiation examination protocols (plain radiography, fluoroscopy, interventional radiology, CT) to take into account patient body habitus (such as patient dimensions, weight, or body mass index) to optimize the relationship between minimal radiation dose and adequate image quality. Automated dose reduction technologies available on imaging equipment should be used whenever appropriate. If such technology is not available, appropriate manual techniques should be used.

Additional information regarding patient radiation safety in imaging is available at the Image Gently® for children (www.imagegently.org) and Image Wisely® for adults (www.imagewisely.org) websites. These advocacy and awareness campaigns provide free educational materials for all stakeholders involved in imaging (patients, technologists, referring providers, medical physicists, and radiologists).

Radiation exposures or other dose indices should be measured and patient radiation dose estimated for representative examinations and types of patients by a Qualified Medical Physicist in accordance with the applicable ACR technical standards. Regular auditing of patient dose indices should be performed by comparing the facility’s dose information with national benchmarks, such as the ACR Dose Index Registry, the NCRP Report No. 172, Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States or the Conference of Radiation Control Program Director’s National Evaluation of X-ray Trends. (ACR Resolution 17 adopted in 2006 – revised in 2009, 2013, Resolution 52).

IX. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control,

and Patient Education appearing under the heading *Position Statement on QC & Improvement, Safety, Infection Control, and Patient Education* on the ACR website (<http://www.acr.org/guidelines>).

Equipment performance monitoring should be in accordance with the [ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography \(CT\) Equipment](#) [44].

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Committee Practice Parameters – Pediatric Radiology

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