2008 (Resolution 22)*

ACR–SPR PRACTICE GUIDELINE FOR THE PERFORMANCE OF PEDIATRIC COMPUTED TOMOGRAPHY (CT)

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines 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 physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, 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 the guidelines 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 the guidelines. However, a practitioner who employs an approach substantially different from these guidelines 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 these guidelines 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 these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

This guideline was developed collaboratively by the American College of Radiology (ACR) and the Society for Pediatric Radiology (SPR).

Computed tomography (CT) is a radiologic modality that provides clinical information in the detection, differentiation, and demarcation of disease. It is the primary diagnostic modality for a variety of presenting problems and is widely accepted as a supplement to other imaging techniques.

CT is a form of medical imaging that involves the exposure of patients to ionizing radiation. It should only be performed under the supervision of a physician with the necessary training in radiation protection to optimize examination safety. Medical physicists and trained technical staff must be available to evaluate the equipment and perform the examinations.

CT examinations should be performed only for a valid medical reason and with the minimum exposure that provides the image quality necessary for adequate diagnostic information.

Because children are more sensitive than adults to the effects of ionizing radiation, it is particularly important to tailor CT examinations to minimize exposure while providing diagnostic quality examinations. Protocols should include the sequence of studies, with and/or without contrast administration, and should specify CT radiation dose ranges based on the child's size, whether or not contrast is used, and the information required from the examination [1].

II. INDICATIONS

Primary indications for CT include, but are not limited to:

A. Chest

1. Evaluation of chest wall abnormalities [2-9], including:
   a. Extent of chest wall developmental deformities, such as pectus excavatum, pectus carinatum, and thoracic insufficiency syndrome secondary to scoliosis or rib anomalies.
   b. Chest wall injury, including penetrating trauma and injuries that are not adequately addressed by radiography such as sternal fractures, sternoclavicular dislocation, and occult rib fractures.
   c. Chest wall mass and mass-like conditions including chest wall inflammatory/infectious processes. This also includes evaluation of post treatment complications and residual or recurrent mass.

2. Suspected extracardiac vascular disorder [10-16], including:
   a. Congenital and syndromic vascular abnormalities such as vascular rings, pulmonary slings, pulmonary vein abnormalities (e.g., anomalous course), systemic-to-pulmonary collateral vessels, coarctation of the aorta, or other congenital processes including known or suspected bronchopulmonary sequestration.
   b. Acquired disorders of the great vessels (e.g., medium or large vessels vasculitides, aneurysms, and stenoses, infectious or other inflammatory conditions) and posttraumatic evaluation. Assessment includes aortic dissection, transection, and pulmonary embolism.

   For cardiac evaluation, see the ACR–NASCI–SPR Practice Guideline for the Performance and Interpretation of Cardiac Computed Tomography.

3. Suspected tracheobronchial anomalies and stenoses, including tracheobronchial narrowing secondary to vascular anomaly, mass, inflammatory/infectious process, suspected foreign body, or congenital anomaly (such as tracheobronchus) [17-21].

4. Mediastinum – CT is used in the workup for a mediastinal mass to assess its anatomy as well as to indicate a specific diagnosis or differential diagnosis [22, 23].
   a. Neoplastic conditions can be evaluated by CT. These include but are not restricted to germ cell tumors, lymphoma, or thymic tumors. Posterior mediastinal neurogenic tumors can also be imaged by CT, particularly with multidetector technology and reformats, but magnetic resonance imaging (MRI) is often more useful to depict neural foraminal, intraspinal, or vertebral/chest wall involvement.
   b. CT is used in the evaluation of congenital abnormalities such as ectopic thymic tissue and bronchopulmonary foregut malformations that affect the mediastinum. The latter include bronchogenic cyst, esophageal duplication cyst, and neuroenteric cyst (although MRI is often necessary for any mass, cystic or solid, in a paraspinal location to assess for potential neural foraminal intraspinal or vertebral/ chest wall component).
   c. Infectious or inflammatory processes affecting the mediastinum can also be assessed, such as mediastinitis, abscess, or sternal osteomyelitis. The distribution of lymphadenopathy due to an infectious or inflammatory cause is evaluated by CT.
   d. CT is used in the setting of trauma that is not adequately assessed by radiography.

5. Lung – CT is the primary cross-sectional imaging modality to evaluate the lung parenchyma [24-40].
   a. These include imaging of infection/ pneumonia complicated by involvement of the pleural space (such as parapneumonic effusion, empyema, or broncho-pleural fistula), the lung (such as cavitation/necrosis or abscess), or the pericardium (such as purulent pericarditis). In patients with persistent or recurrent pneumonias or whose plain film is atypical for pneumonia, CT is used to assess for possible underlying congenital lesion or mass. CT is also used to assess the sequelae of respiratory infections (such as bronchiectasis and bronchiolitis obliterans). In immunocompromised patients

CT can be used in the absence of definite plain film abnormality to detect early manifestations of opportunistic infections.

b. CT is used in the evaluation of interstitial lung disease, and "high-resolution" examinations are often utilized in this setting. This includes imaging of the various primary pulmonary interstitial lung diseases, as well as interstitial lung disease related to systemic processes such as collagen vascular, connective tissue, or autoimmune diseases. Some patients with cystic fibrosis may benefit from thoracic imaging by CT.

c. Congenital pulmonary abnormalities are also well assessed by CT. Bronchopulmonary foregut or congenital pulmonary airway malformations (CPAM) that affect the lung are well depicted by CT, such as congenital lobar emphysema, congenital cystic adenomatoid malformation, bronchogenic cyst, and pulmonary sequestration. CT can also be used to assess pulmonary agenesis, hypoplasia, and aplasia, and other hypogenetic lung complexes, bronchial atresia, horseshoe lung, and pulmonary arteriovenous malformation.

d. Neoplastic conditions (benign or malignant) affecting the lungs are imaged by CT. CT is the mainstay for surveillance in patients with a known underlying primary malignancy that metastasizes to lung. In immuno-compromised patients, CT is used in the evaluation for lymphproliferative disorder. Less commonly, due to the infrequency of these disorders, CT evaluates primary pulmonary neoplasms such as pulmonary blastoma.

e. CT is used in the setting of trauma that is not adequately assessed by radiography. Lung contusions and traumatic pneumatocoeles are better seen on CT than on radiography.

f. CT is also used in assessing other nonspecific but clinically significant signs or symptoms in the respiratory system not adequately addressed by radiography.

B. Abdomen and Pelvis

1. Hollow viscera [41-58]

a. Suspected inflammatory or infectious processes affecting the GI tract, including the gastroesophageal junction, stomach, small intestine, colon, or appendix. These processes include, but are not limited to, appendicitis, infectious enteritis, inflammatory bowel disease, infectious, neutropenic colitis or radiation enteritis.

b. Known or suspected congenital abnormalities, including gastrointestinal duplication cysts, and complications of omphalomesenteric duct remnants, such as Meckel diverticulitis.

c. Benign and malignant neoplastic tumors, including but not limited to lymphoma (particularly Burkitt's lymphoma), gastrointestinal stromal tumor (GIST), lipoma, and postradiation enteritis.

d. CT is frequently used in the setting of blunt or penetrating abdominal trauma. It can evaluate for primary or secondary signs of bowel injury in the setting of penetrating abdominal trauma or blunt trauma, or in nonaccidental injury to the duodenum or small bowel.

e. CT can be used to further evaluate patients presenting with bowel obstruction.

2. Liver and gallbladder [59-69]

a. Evaluation of patients with neoplastic processes associated with primary hepatic malignancies (benign or malignant), including but not limited to hemangio-endothelioma, hepatoblastoma, and hepatocelluar carcinoma, as well as liver metastases to evaluate for the presence and extent of tumor in the liver.

b. Evaluation of blunt or penetrating abdominal trauma with suspected hepatic trauma to further assess the extent of parenchymal and hepatic vascular injury.

c. Suspected hepatic infection, including pyogenic or amebic liver abscesses.

d. Evaluation of disorders of the gallbladder and biliary tract to supplement ultrasound including gallbladder anomalies, thickening bile duct dilation or stenosis, and bile leak.

e. Evaluation of congenital abnormalities of the liver and biliary tree, including heterotaxy and associated anomalies, and all types of choledochal cyst.

3. Pancreas [70-75]

a. CT can be used as a supplement to ultrasound or as the primary imaging tool to evaluate for complications of pancreatitis, including pancreatic hemorrhage or necrosis, peripancreatic vascular thrombosis, psuedocyst formation, secondary inflammation of hollow visceral structures within the anterior pararenal space, regional vessel thrombosis, or duct abnormalities, including stones or dilation.

b. CT can be used in evaluating pancreatic tumors to further characterize the extent of

lesion, staging, and involvement of adjacent structures.

c. CT can be used in the setting of blunt or penetrating abdominal trauma with possible or suspected pancreatic trauma to evaluate the integrity of the gland, the extent of pancreatic injury including fracture and/or pancreatic ductal injury, and injury to adjacent solid or hollow visceral structures.

4. Kidneys [76-84]
   a. Diagnosis of suspected renal, ureteral, or bladder stones in the setting of hematuria. In children, CT should be used when ultrasound and radiographs do not provide enough information for optimal management.
   b. Evaluation of renal and/or ureteral trauma. Delayed imaging may be useful if injury to the collecting system is suspected.
   c. Detection and staging of renal tumors (benign and malignant), including vascular invasion, frequently as a supplement to ultrasonography.
   d. Congenital anomalies of the genitourinary tract.
   e. Obstruction of the genitourinary (GU) tract secondary to congenital anomalies, mass, infection/inflammation, or trauma.
   f. Suspected or known infection of the GU tract, including focal or generalized pyelonephritis or abscess.
   g. For renovascular evaluation in the setting of traumatic injury, hypertension, renal donor transplant evaluation, or regional masses, CT angiography is typically performed in the evaluation of hypertension and transplant donor assessment.

5. Adrenal gland [85-91]
   a. Evaluation of suspected adrenal hemorrhage as a potential supplement to ultrasound.
   b. Evaluation of suspected adrenal trauma in the setting of blunt or penetrating trauma to the upper abdomen.
   c. Primary evaluation of adrenal neoplasms, often as a supplement to ultrasound for suspected neuroblastoma or adrenocortical carcinoma.

6. Spleen [92-98]
   a. Primary evaluation of suspected splenic injury in the setting of blunt or penetrating trauma.
   b. Further characterization of primary cystic or solid lesions of the spleen.
   c. Other conditions such as infarction, sequestration (sickle cell disease), granulomatous disease, wandering spleen/ torsion.

7. Abdomen and pelvis
   a. Mass or mass-like conditions of the pelvis organs including inflammatory/infectious processes and vascular malformations, and evaluation of lymph nodes.
   b. Anomalies of the genital tract not adequately assessed by ultrasound where MRI is contraindicated or not available.
   c. Evaluation of bladder rupture after trauma or bladder surgery.

8. Mesentery/omentum/peritoneum/abdominal wall/diaphragm [90-103]
   a. Suspected inflammatory or infectious processes affecting the mesentery, peritoneum, or omentum, including but not limited to abscess or generalized peritonitis.
   b. Evaluation of peritoneal fluid in appropriate clinical circumstances.
   c. Possible pneumoperitoneum.
   d. Evaluation of cystic malformations, including mesenteric cyst and lymphangioma.
   e. Benign or malignant neoplastic processes, including teratoma, sarcoma, and peritoneal spread of disease.
   f. Focal omental infarction (cause of abdominal pain).
   g. Post-traumatic processes.
   h. Evaluation of congenital or post-traumatic abnormalities of the anterior abdominal wall.
   i. Evaluation of congenital or post-traumatic abnormalities/defects of the diaphragm.

C. Extremities/Musculoskeletal [104-135]

CT should be used for the evaluation of bone lesions when the radiologist believes it is the proper modality or where MRI is contraindicated or not readily available. Some of the primary indications for CT in musculoskeletal imaging are further anatomic characterization of certain fractures, particularly those involving a joint or growth plate, and further evaluation of the internal characteristics of bone lesions seen by plain-film radiography.

1. Pelvis
   a. Inflammatory conditions such as osteomyelitis of pelvic bones, myositis, or complex inflammatory conditions where MRI is contraindicated or not available.
   b. Evaluation of the extent of trauma to the pelvic bones or internal organs, and of hemorrhage.

2. Shoulder
    a. Evaluation of glenoid morphology, glenoid dysplasia, asymmetry of rotator cuff musculator, and acquired gelohumeral deformity such as in patients with residual brachial plexus injury after birth.
    b. Further characterization of fractures of the humerus, scapula and/or clavicle in or around the shoulder region where radiography is insufficient.
    c. Diagnosis, further characterization and/or follow-up of benign and malignant bone tumors and infections if not adequately evaluated by MRI.
    d. Assessment for radiodense foreign body.

3. Elbow
    a. Further characterization of fractures of the humerus, ulna, and/or radius in or around the elbow joint.
    b. Follow-up of fracture complications (such as premature growth plate fusion and intra-articular loose bodies).
    c. Diagnosis and/or follow-up of osteochondritis dissecans.
    d. Diagnosis, further characterization, and/or follow-up of benign and malignant bone tumors if not adequately evaluated by MRI, or supplemental to MRI.
    e. Evaluation of suspected osteoid osteoma or treated osteoid osteoma around the elbow joint or long bones of the upper extremities.
    f. Congenital malformations and infections not adequately assessed by conventional radiographs or ultrasound.

4. Hand and wrist
    a. Further characterization of fractures in the hand or wrist related to acute trauma.
    b. Evaluation of acute or chronic scaphoid fracture.
    c. Evaluation of fracture complications (such as premature growth plate fusion).
    d. Diagnosis and/or follow-up of osteochondritis dissecans.
    e. Diagnosis and/or follow-up of osteoid osteoma.
    f. Diagnosis and/or follow-up of benign and malignant bone tumors and infections if not adequately evaluated by MRI, or supplemental to MRI.

5. Hip and thigh
    a. Further characterization of fractures in the bony pelvis and proximal femora.
    b. Evaluation of patients with developmental dysplasia of the hip, including evaluation of relationship of femoral head and triradiate cartilage in patients in a SPICA cast.
    c. Measurement of femoral anteversion according to Murphy protocol.
    d. Evaluation of complications of prior trauma (including loose bodies and chondrolysis).
    e. Often used to supplement MRI in setting of deformity related to avascular necrosis (including Legg-Calve-Perthes).
    f. Congenital malformations not adequately assessed by conventional radiographs or sonography, including postoperative assessment of reduction of congenital hip dislocation.
    g. Diagnosis and/or follow-up of benign and malignant bone tumors and infections if not adequately evaluated by MRI, or supplemental to MRI.
    h. Persistent pain and/or swelling unexplained by other methods.

6. Knee
    a. Further characterization of fractures in the knee related to acute trauma.
    b. Follow-up of fracture complications (such as premature growth plate fusion and intra-articular loose bodies).
    c. Diagnosis and/or follow-up of osteochondritis dissecans.
    d. Diagnosis and/or follow-up of osteoid osteoma.
    e. Diagnosis and/or follow-up of benign and malignant bone tumors if not adequately evaluated by MRI, or supplemental to MRI.
    f. Congenital malformations not adequately assessed by conventional radiographs.

D. Foot and Ankle

1. Further characterization of fractures in the foot or ankle related to acute trauma, including, but not limited to, triplane fracture of the ankle, and fracture involving the tibial plafond.
2. Follow-up of fracture complications (such as premature growth plate fusion and intra-articular loose bodies).
3. Diagnosis of tarsal coalition and follow-up of surgically corrected tarsal coalition.
4. Diagnosis and/or follow-up of osteochondritis dissecans.
5. Diagnosis and/or follow-up of benign and malignant bone tumors if not adequately evaluated by MRI, or supplemental to MRI.
6. Congenital malformations not adequately assessed by conventional radiographs.

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography (CT).

IV. SPECIFICATIONS OF THE EXAMINATION

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

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). The provision of 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 scope of practice requirements. (ACR Resolution 35, adopted in 2006)

Images should be labeled with the following: a) patient identification, b) facility identification, c) examination date, and d) the side (right or left) of the anatomic site imaged.

Additionally, an attempt should be made to obtain and review prior studies.

A. General Considerations

Pediatric CT may require different examination preparation and performance than in adults. Preparation includes ensuring appropriate NPO status if moderate sedation or general anesthesia is potentially necessary and adequate hydration and assessment of pediatric specific renal function prior to intravenous (IV) contrast media administration. For scan performance, single-phase scanning is the standard rather than the exception. Only the necessary scan coverage should be obtained, and changes in scan parameters — including beam collimation — tube current, gantry cycle time, and peak kilovoltage should be adjusted for the size of the child, the region scanned, and the clinical indications.

The physician responsible for the examination shall supervise patient selection and preparation, and be available in person or by phone for consultation.

Certain indications require administration of IV contrast media. IV contrast enhancement should be performed using appropriate injection protocols and in accordance with the institution's policy on IV contrast utilization. (See the ACR–SPR Practice Guideline for the Use of Intravascular Contrast Media and the ACR Manual on Contrast Media.)

Appropriate emergency equipment and medications must be immediately available to treat adverse reactions associated with administered medications. 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.

B. Examination Technique [136,137]

1. Chest
   a. Scanning parameters should be optimized to obtain diagnostic image quality while adhering to the as low as reasonably achievable (ALARA) principle. The scan area should be minimized according to the clinical indication. The scanning parameters, including kVp, tube current, and exposure time (mAs), should be changed according to body size, area of interest and clinical indication. This can be achieved by using weight-based tables or by using automatic exposure control (see the following Web site: www.imagegently.org). In addition, mAs can be further reduced if noncontrast scans are performed to evaluate calcifications only, or in cases in which only gross bony relationships are being evaluated, such as scans done for preoperative pectus excavatum evaluation. Consideration should be given to shielding superficial structures in the scan region such as breast and thyroid, depending on the specific equipment and protocols used [138].
   b. The examination may be conducted with or without IV contrast as clinically indicated. IV contrast may be necessary, based on the clinical indication for the imaging study. A dosage of 2 mL/kg (not to exceed the usual adult dose) is used routinely. Volume of contrast, rate of injection, scan delayed time, and hand/power injection should be determined according to the location, size, and type of the IV access, the child's body size, the underlying disease (such as congestive heart failure), and the clinical indication [139].
   c. High resolution scans may be useful if the primary indication is for the evaluation of

interstitial lung disease, as sharper algorithms are helpful in the evaluation of lung parenchyma in older children. The original data set can be reconstructed with both routine and high-resolution algorithms if both soft tissue and pulmonary parenchymal information is needed, without need to rescan the patient. It is important to remember that not all diagnostic chest CT studies in infants and children require imaging of the entire anatomy of the chest. In certain clinical situations, if only a sampling of the lung parenchyma is required to answer a specific clinical question (i.e., to rule out bronchiectasis or interstitial disease), a limited number (e.g., 4 to 6 slices) of 1 to 1.25 mm axial slices can be performed in a high resolution bone algorithm. The distance between the limited axial images increases incrementally as patient size increases. Sequential thin slices with primary lung algorithm scanning may be needed in some patients, and these additional images are typically acquired with nonsequential increments.

d. Postprocessing 2D reformations and 3D reconstructions or 3D volume rendering may be useful adjuncts in displaying the anatomy**.** If this is anticipated, CT technique providing the thinnest original (usual axial) dataset should be used.

2. Abdomen
   a. Scanning parameters should be optimized to obtain diagnostic image quality while adhering to the ALARA principle. The scan area should be minimized according to the clinical indication. The scanning parameters, including kVp, tube current, and exposure time (mAs), should be changed according to body size, area of interest, and clinical indication. This can be achieved by using weight based tables or by using automatic exposure control (see www.imagegently. org). The testicles should not be included in the scanned area unless absolutely necessary for the clinical indication. Consideration should be given to shielding superficial structures in the scan region such as the testes. If precontrast images are needed solely to determine whether calcification is present, these can be done with additional decrease in mAs.
   b. IV contrast injection is usually used in the CT evaluation of the pediatric abdomen, since vascular structures and internal organs are much better visualized due to the paucity of body fat in many pediatric patients. There are some exceptions, including renal stone evaluation. A routine dose of 2 mL/kg is generally used. Volume of contrast, rate of injection, scan delayed time, and hand/power injection should be determined according to the location, size, and type of the IV access, the child's body size, the underlying disease (such as congestive heart failure), and the clinical indication.
   c. Enteric contrast may be used in the CT evaluation of the pediatric abdomen. Exceptions would include, but are not limited to, renal stone protocol, CT angiography, and acute trauma.
   d. In the evaluation of the pediatric patient for suspected appendicitis, IV contrast is typically used, particularly to avoid repeat scans due to equivocal findings. Precontrast scans and delayed scans are not necessary, unless a renal anomaly requiring evaluation of the collecting system is incidentally identified. Some centers use oral or rectal enteric contrast material. If oral contrast is given, sufficient time should be allowed to elapse for the contrast to reach the right lower quadrant prior to scanning.
   e. Postprocessing 2D reformations and 3D reconstructions or 3D volume rendering may be useful adjuncts in displaying the anatomy.

3. Extremities
   a. Scanning parameters should be optimized to obtain diagnostic image quality while adhering to the ALARA principle. The scan area should be minimized according to the clinical indication. The scanning parameters, including kVp, tube current, and exposure time (mAs), should be changed according to body size, area of interest, patient age and size, and clinical indication.
   b. IV contrast may not be necessary if only evaluation of the bone structure is important. IV contrast should be used if indicated to assess vessels and soft tissues.
   c. Sharper reconstruction algorithms are needed for better spatial resolution and bone detail. Smoother (softer) algorithms are better for soft tissue evaluation and 3D postprocessing.

V. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings.

VI. EQUIPMENT SPECIFICATIONS

In the interest of pediatric patient safety, it is necessary to have a general knowledge of the CT equipment including the use of weight adjusted mA and kVp, slice thickness, pitch, display field of view (DFOV) and dose modulation techniques. The equipment should be in good working order, meet manufacturer and regulatory standards, and be operated safely. The equipment needs to be tested for spatial and low-contrast resolution and be well-calibrated at all times. Technologists and radiologists should be aware of important artifacts and know how to avoid problems associated with them.

A. Performance Standards

To achieve acceptable clinical CT scans of body, the CT scanner should meet or exceed the following specifications:

1. Gantry rotation times: ≤ 2 seconds.
2. Slice thickness: ≤ 5 mm (≤ 2 mm is preferred).
3. Limiting spatial resolution: 8 lp/cm for ≥ 32 cm DFOV and ≥ 10 lp/cm for < 24 cm DFOV.
4. Table pitch: no greater than 2:1 for single-row-detector helical scanners.

B. Patient monitoring equipment and facilities for cardiopulmonary resuscitation, including vital signs monitoring equipment, support equipment, and an emergency crash cart, should be immediately available. Radiologists, technologists, and staff members should be able to assist with procedures, patient monitoring, and patient support. A written policy should be in place for dealing with emergencies such as cardiopulmonary arrest.

VII. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, radiologic technologists, and all supervising physicians have a responsibility to minimize radiation dose to individual patients, to staff, and to society as a whole, while maintaining the necessary diagnostic image quality. This concept is known as "as low as reasonably achievable (ALARA)."

Facilities, in consultation with the medical physicist, should have in place and should adhere to policies and procedures, in accordance with ALARA, to vary examination protocols to take into account patient body habitus, such as height and/or weight, body mass index or lateral width. The dose reduction devices that are available on imaging equipment should be active; if not, manual techniques should be used to moderate the exposure while maintaining the necessary diagnostic image quality. Periodically, radiation exposures should be measured and patient radiation doses estimated by a medical physicist in accordance with the appropriate ACR Technical Standard. (ACR Resolution 17, adopted in 2006 – revised in 2009, Resolution 11)

A medical physicist and radiologist together should verify that any dose reduction devices or utilities maintain acceptable image quality while actually reducing radiation dose.

Dose estimates for typical examinations should be compared against reference levels described in the ACR Practice Guideline for Diagnostic Reference Levels in Medical X-Ray Imaging.

VIII. 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 web page (http://www.acr.org/guidelines).

Equipment monitoring and the continuous quality control program should be in accordance with the ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography (CT) Equipment.

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