

ACR–ASER–SCBT-MR–SPR PRACTICE PARAMETER FOR THE PERFORMANCE OF PEDIATRIC COMPUTED TOMOGRAPHY (CT)

The American College of Radiology, with more than 40,000 members, is the principal organization of radiologists, radiation oncologists, and clinical medical physicists in the United States. The College is a nonprofit professional society whose primary purposes are to advance the science of radiology, improve radiologic services to the patient, study the socioeconomic aspects of the practice of radiology, and encourage continuing education for radiologists, radiation oncologists, medical physicists, and persons practicing in allied professional fields.

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.

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 considering 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 variables such as the condition of the patient, limitations of available resources, or advances in knowledge or technology after publication of this document. However, a practitioner who employs an approach substantially different from the guidance in this document may consider documenting in the patient record information sufficient to explain the approach taken.

The practice of medicine involves the science, and 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 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*, 831 N.W.2d 826 (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 developed collaboratively by the American College of Radiology (ACR), the American Society of Emergency Radiology (ASER), the Society of Computed Body Tomography and Magnetic Resonance (SCBT-MR), 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. In selected cases, CT is used for guidance of interventional procedures.

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 examination.

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 [1]. Protocols should include CT scan parameters, contrast administration, and anatomical coverage. CT scan parameters (eg, rotation time, pitch, peak kilovoltage (kVp), milliampere-seconds (mAs), tube current modulation, beam collimation) should be tailored to the child's body size. If contrast is used, the type of contrast, volume, method of administration (intravenous [IV], oral, rectal, intravesical), scan delay time, and rate of contrast injection should be specified [2-6].

Nonionizing imaging studies, such as ultrasound (US) and magnetic resonance imaging (MRI) should be considered in some cases as an alternative to CT when appropriate. Reasons to consider using CT over MRI include the availability of CT, higher spatial resolution, shorter examination, less need for sedation, and the presence of contraindications for MRI.

II. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the [ACR Practice Parameter for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#) [7].

III. INDICATIONS

A. Chest

CT is the preferred cross-sectional imaging modality for detailed evaluation of anatomy and pathology of the lung and tracheobronchial tree. In addition to US and MRI, CT may also be used for evaluation of certain thoracic bony, mediastinal, and cardiac abnormalities.

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

1. Chest wall abnormalities [8-15]
 - a. Extent of chest wall developmental deformities, such as pectus excavatum, pectus carinatum, and thoracic insufficiency syndrome secondary to scoliosis or rib anomalies. CT scan for some chest wall deformities (eg, pectus excavatum) may be limited to the area of deformity using very low dose technique, although MRI is increasingly being used in these instances [16].
 - 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 that include inflammatory/infectious processes. This also includes evaluation of posttreatment complications and residual or recurrent mass.
2. Extracardiac vascular disorder [17-23]
 - a. Congenital and syndromic vascular abnormalities, such as vascular rings, pulmonary slings, pulmonary vein abnormalities (eg, anomalous course), systemic-to-pulmonary collateral vessels, coarctation of the aorta, or other congenital lesions with anomalous blood supply (eg, bronchopulmonary sequestration)
 - b. Acquired disorders of the great vessels (eg, medium- or large-vessel vasculitides, aneurysms, stenoses, infectious or other inflammatory conditions) and posttraumatic evaluation. Assessment includes aortic dissection, transection, and pulmonary embolism.

3. Cardiac disease. See the [ACR–NASCI–SPR Practice Parameter for the Performance and Interpretation of Cardiac Computed Tomography \(CT\)](#) [7].
4. Tracheobronchial abnormalities, including tracheal rings; tracheobronchial narrowing secondary to vascular anomaly, mass, inflammatory/infectious process, suspected foreign body, or congenital anomaly; postoperative complications of lung transplant [23-28]; and dynamic evaluation of the airway for the assessment of congenital or acquired tracheobronchomalacia [29].
5. Mediastinal congenital abnormalities and masses [30-32].
 - a. Neoplasms—These include, but are not restricted to, germ cell tumors, lymphoma, or thymic tumors. Posterior mediastinal neurogenic tumors can also be imaged by CT, although MRI is often more useful to depict chest wall, vertebral, neural foraminal, or intraspinal involvement.
 - b. 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. Congenital abnormalities in a paraspinal location may be better evaluated with MRI to assess for potential chest wall, vertebral, neural foraminal, or intraspinal disease.
 - c. Infectious or inflammatory processes affecting the mediastinum, such as lymphadenitis, mediastinitis, abscess, or sternal osteomyelitis.
 - d. Trauma that is not adequately assessed by radiography. CT angiography can be considered for evaluation of suspected major thoracic vascular injury.
6. Lung—CT is the primary cross-sectional imaging modality to evaluate the lung parenchyma [33-51].
 - a. Infection/pneumonia complicated by involvement of the pleural space (such as parapneumonic effusion, empyema, or bronchopleural fistula), the lung (such as cavitation/necrosis or abscess), or the pericardium (such as purulent pericarditis). For evaluation of parapneumonic effusion and empyema, US should be considered as the first and primary imaging modality, with CT reserved for evaluation of aerated portions of the lung and more complicated cases with parenchymal complications. In patients with persistent or recurrent pneumonias or whose plain radiography 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-radiography abnormality to detect early manifestations of opportunistic infections.
 - b. Diffuse/interstitial lung disease, either primary or related to systemic processes, such as collagen vascular, connective tissue, or autoimmune diseases. These studies may include inspiratory and expiratory scans. Additional limited imaging in a prone or decubitus position may help differentiate between dependent atelectasis and lung parenchymal abnormality. Some patients with cystic fibrosis may be followed with limited reduced-dose high-resolution CT.
 - c. Congenital pulmonary abnormalities that include bronchopulmonary foregut malformation, congenital pulmonary airway malformations (CPAM), congenital lung hyperinflation, pulmonary sequestration, bronchial atresia, tracheal diverticula, tracheal bronchus, pulmonary agenesis or hypoplasia, and related conditions, such as horseshoe lung and pulmonary arteriovenous malformation.
 - d. Malignancy, including patients with underlying extrapulmonary primary malignancy that may metastasize to lung and primary lung neoplasms, including inflammatory myofibroblastic tumor (plasma cell granuloma), pleuropulmonary blastoma, bronchial carcinoid, and mucoepidermoid carcinoma. In immunocompromised patients, CT is used in the evaluation for lymphoproliferative disease or smooth-muscle (spindle cell) tumors.
 - e. Traumatic injuries not adequately assessed by radiography, such as pulmonary contusions and lacerations.

III. INDICATIONS

B. Abdomen and Pelvis

CT of the abdomen and pelvis is the preferred cross-sectional imaging for evaluation of abdominal and pelvic trauma. MRI may be used as an alternative method for many abdominopelvic indications. CT can be used as an alternative study to MRI in evaluation of solid viscus and bowel. CT is often used as an adjunct or follow-up to US when findings are equivocal or when there is a need for additional anatomic detail or other information (eg, nephrolithiasis, solid viscus, bowel, and vascular pathology).

1. Hollow viscera [[52-67](#)]

- a. Inflammatory or infectious processes affecting the gastrointestinal (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, neutropenic colitis, or radiation enteritis, although MRI may also be used in some of these instances [[68](#)].
- b. Congenital abnormalities, including gastrointestinal duplication cysts, and complications of omphalomesenteric duct remnants, such as Meckel diverticulitis.
- c. Benign and malignant neoplasms, including, but not limited to, lymphoma (particularly Burkitt lymphoma), gastrointestinal stromal tumor (GIST), lipoma, and large polyps.
- d. Trauma, blunt or penetrating abdominal trauma, to demonstrate bowel injury including intramural hematoma and perforation.
- e. Bowel obstruction.

2. Liver and gallbladder [[69-76](#)]

- a. Primary or secondary hepatic neoplasms, including, but not limited to, hepatoblastoma and hepatocellular carcinoma, as well as liver metastases to evaluate for the presence and extent of tumor in the liver
- b. Blunt or penetrating trauma, including nonaccidental trauma, to assess the extent of parenchymal and hepatic vascular injury.
- c. Hepatic infection, including pyogenic or amebic liver abscesses.
- d. Congenital abnormalities of the liver and biliary tree, including heterotaxy and associated anomalies.
- e. Gallbladder and biliary tract disorders are typically best evaluated with US, MRI, and nuclear medicine studies. CT may be used in selected cases to supplement US in the evaluation of gallbladder and biliary tract disorders.

3. Pancreas [[77-82](#)]

- a. Complications of pancreatitis, including pancreatic hemorrhage or necrosis, peripancreatic vascular thrombosis, pseudocyst formation, secondary inflammation of hollow visceral structures, or duct abnormalities, including stones or dilation.
- b. Pancreatic tumors to further characterize the extent of lesion, staging, and involvement of adjacent structures.
- c. Blunt or penetrating abdominal trauma to evaluate the integrity of the gland, the extent of pancreatic injury, including fracture or pancreatic ductal injury, and injury to adjacent solid or hollow visceral structures.

4. Kidneys [[83-92](#)]

- a. Urinary tract stones in children with hematuria. CT may be used when US and radiographs do not provide enough information for optimal management.
- b. Renal or ureteral trauma. Additional delayed imaging may be useful if injury to the collecting system is suspected. Split-dose IV contrast in suspected renal trauma can demonstrate both parenchymal and collecting system injury with one imaging acquisition.
- c. Detection and staging of renal tumors (benign and malignant), including vascular invasion.
- d. Congenital anomalies of the genitourinary tract.
- e. Obstruction of the urinary tract secondary, but not limited to, nephrolithiasis, mass, infection/inflammation, or trauma.
- f. Complications of infection of the urinary tract (eg, acute pyelonephritis), including renal/perirenal abscess.
- g. Renovascular evaluation in the setting of traumatic injury, renal donor transplant evaluation, or

regional masses. CT angiography can also be used in selected patients to evaluate for renovascular hypertension

5. Adrenal gland [\[93-97\]](#)

- a. Evaluation of blunt or penetrating trauma with suspected adrenal hemorrhage.
- b. Adrenal neoplasms, such as neuroblastoma, ganglioneuroma, ganglioneuroblastoma, and adrenocortical neoplasms (adenoma and carcinoma).

6. Spleen [\[98-104\]](#)

- a. Splenic injury in the setting of blunt or penetrating trauma.
- b. Primary cystic or solid lesions of the spleen.
- c. Other conditions, such as infarction, sequestration (sickle cell disease), granulomatous disease, wandering spleen/torsion.

7. Pelvis [\[105-107\]](#)

- a. Mass or mass-like conditions of the pelvic organs, including inflammatory/infectious processes, vascular malformations, and evaluation of lymph nodes.
- b. Anomalies of the genital tract not adequately assessed by US or genitogram, or where MRI is contraindicated or not available.
- c. Bladder rupture after trauma or bladder surgery. Dedicated CT cystography techniques can be performed as indicated.

8. Mesentery/omentum/peritoneum/retroperitoneum/vascular/abdominal wall/diaphragm [\[108-112\]](#)

- a. Inflammatory or infectious processes affecting the mesentery, peritoneum, or omentum, such as an abscess and generalized peritonitis.
- b. Peritoneal fluid characterization and quantification, when appropriate.
- c.
- d. Cystic malformations, including mesenteric/omental cyst and lymphatic malformation.
- e. Benign or malignant neoplastic processes, including teratoma, sarcoma, and spread of disease to the peritoneum and/or retroperitoneum.
- f. Omental infarction.
- g. Posttraumatic abnormalities of the mesentery, abdominal wall, or diaphragm.
- h. Congenital abnormalities of the abdominal wall or diaphragm.
- i. Arterial and venous abnormalities, such as vasculitis, thrombosis, narrowing, aneurysm, dissection, and varices.

III. INDICATIONS

C. Extremities/Musculoskeletal

CT may supplement plain radiography for characterization and evaluation of extent of bone lesions and fractures, evaluation of orthopedic implant complications, and assessment of alignment deformities. CT is better than MRI in assessment of cortical and trabecular bone abnormalities. CT has lower contrast resolution and less sensitivity compared with MRI in evaluation of bone marrow and soft-tissues pathology, but CT can be used in selected cases where MRI is contraindicated or not readily available.

1. General indications [\[113-138\]](#)

- a. Bone abnormality not adequately assessed by radiographs
- b. Congenital bone malformations
- c. Inflammatory conditions, such as osteomyelitis and myositis, when MRI is contraindicated or unavailable
- d. Fractures and follow-up of fracture complications (such as premature growth plate fusion and intra-articular loose bodies)
- e. Tumors of the bone or soft tissues
- f. Osteochondral lesions, when MRI is contraindicated or unavailable

g. Foreign bodies

2. Shoulder [123-125]

Evaluation of glenoid morphology, glenoid dysplasia, and acquired glenohumeral deformity related to perinatal brachial plexus injury, although MRI is being increasingly used in these instances.

3. Pelvis, hip, and thigh [126-131]

- a. Congenital malformations not adequately assessed by radiographs or sonography, including postoperative assessment of reduction of developmental dysplasia of the hip
- b. Measurement of femoral and acetabular version
- c. Deformity related to epiphyseal osteonecrosis (including Legg-Calve-Perthes)
- d. Femoral head impingement syndrome
- e. Sacroiliitis
- f. Apophysitis

4. Knee and leg [132-134]

- a. Kinematic assessment of patellofemoral joint
- b. Preoperative tibial tuberosity trochlear groove assessment in patients with patellar tracking abnormalities
- c. Tibial torsion

III. INDICATIONS

D. Foot and ankle [135-138]

1. Fractures in the foot or ankle not optimally assessed by radiographs, including, but not limited to, Tillaux and triplane fractures of the ankle or other fractures involving the tibial plafond
2. Tarsal coalition, diagnosis, and follow-up after surgery

III. INDICATIONS

E. Head and spine

See the [ACR–ASNR–SPR Practice Parameter for the Performance of Computed Tomography \(CT\) of the Brain \[139\]](#) and the [ACR–ASNR–ASSR–SPR Practice Parameter for the Performance of Computed Tomography \(CT\) of the Spine \[140\]](#).

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 – revised in 2016, Resolution 12-b)

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.

IV. SPECIFICATIONS OF THE EXAMINATION

A. General Considerations [2-6]

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.

With the advent of faster CT scanner technology, general anesthesia or sedation can be avoided in many children. Patient/parent preparation, well-trained technologists, child life specialists, and distraction techniques/equipment are helpful in this regard. Additionally, reduced use of IV contrast when appropriate (eg, follow-up of lung metastatic disease) may allow for easier performance and greater acceptance of nonsedated CT scans.

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 Parameter for the Use of Intravascular Contrast Media \[141\]](#) and the [ACR Manual on Contrast Media \[142\]](#).)

For scan performance, single-phase scanning is the standard rather than the exception. Only the necessary scan coverage should be obtained, and scan parameters including beam collimation, tube current, gantry cycle time, pitch, and kVp—should be adjusted for the size of the child, the region scanned, and the clinical indications. The physician responsible for the examination must supervise patient selection and preparation and be available for consultation. All personnel who inject intravascular contrast media (ICM) should be prepared to (1) recognize the variety of adverse events that may occur following ICM administration and (2) institute appropriate measures to manage the reaction. These measures include notifying the supervising radiologist (or his/her designee), monitoring the patient, administering certain medications, and/or calling for additional assistance (emergency service providers, "code team," etc). (See the [ACR–SPR Practice Parameter for the Use of Intravascular Contrast Media \[141\]](#) and the [ACR Manual on Contrast Media \[142\]](#).)

Appropriate emergency equipment and medications must be immediately available for consultation or to treat adverse reactions associated with administered medications. See Table 6 of the [ACR Manual on Contrast Media \[142\]](#).

IV. SPECIFICATIONS OF THE EXAMINATION

B. Examination Technique [2-6,143-163]

General Observations:

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 restricted according to the clinical indication, with areas not involved in the clinical problem excluded from the scan. The scanning parameters, including kVp and exposure time product (mAs), should be changed according to body size, regions of interest, and clinical indication. This can be achieved by using weight-based or cross-sectional size tables and by using automatic exposure control (see www.imagegently.org). In addition, mAs should be further reduced if noncontrast scans are performed only to evaluate calcifications or for cases in which only gross bony relationships are being evaluated, such as scans done for preoperative pectus excavatum evaluation. Noise-reducing reconstruction technique (eg, iterative reconstruction), if available, can be used to improve image quality and allow use of decrease dose [143].

IV. SPECIFICATIONS OF THE EXAMINATION

B. Examination Technique [2-6,143-163]

1. Chest [2-6,152-159]

- a. Use of cutting-edge technologies for reducing exposure, such as dose modulation and iterative reconstruction, are preferred, if available [164,165]. The use of bismuth shields is controversial. Shielding can reduce dose to anterior organs, such as breast, lens of the eye, and thyroid in CT scanning. There are disadvantages associated with the use of bismuth shields. Bismuth shields may induce image artifacts and increased image noise, which limits measurements of attenuation. If used, the shield needs to be elevated from the anterior chest wall (eg, by laying it on several towels or a sponge), and it should be flat without

internal bends to decrease artifacts. In order to avoid increased radiation dose to the patient, the shielding should NOT be in place during scout image acquisition when using automatic exposure control or tube current modulation because the radiation dose to the patient may increase. Other techniques, including automated tube current modulation or kilovoltage selection, can provide the same level of anterior dose reduction at equivalent or superior image quality.

- b. The examination may be conducted with or without IV contrast as clinically indicated. A contrast dosage of 1.5 to 2 mL/kg (to a maximum not exceeding the usual adult dose) is used routinely. Volume of contrast, rate of injection, scan delay 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. The use of dual-energy CT and low-kilovoltage imaging may allow further reduction in the volume of contrast needed, particularly for angiographic applications [[166,167](#)].
- c. High-resolution algorithms for reconstruction of CT data 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 dataset 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 (eg, to rule out bronchiectasis or diffuse/interstitial lung disease), a limited number (eg, 4-6 slices) of 1 to 1.25 mm noncontiguous axial slices can be obtained and reconstructed in a high-resolution algorithm. The gap between the noncontiguous axial images may be increased incrementally as patient size increases. Expiratory images at larger intervals can be useful for evaluation of diseases of the small bronchi.
- d. Postprocessing 2-D reformations, maximum intensity projection (MIP) reconstructions, and 3-D volume rendering may be useful adjuncts in displaying the anatomy. The 2-D reformation and sliding thin-slab MIP techniques have been found to increase sensitivity in the detection of lung nodules and arteriovenous malformations, and 3-D volume rendered images may also add value to presurgical planning and patient/family education, tumor and/or lung volume measurements, as well as be used for 3-D printing of illustrative models.

IV. SPECIFICATIONS OF THE EXAMINATION

B. Examination Technique [2-6,143-163]

2. Abdomen [2-6,160-163]

- 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 or dimension-based tables or by using automatic exposure control (see imagegently.org). The testicles should not be included in the scanned area unless absolutely necessary for the clinical indication. If dual-energy CT is used, noncontrast scans can be reconstructed after the scan, avoiding the use on precontrast scans.
- b. IV contrast injection is usually used in the CT evaluation of the pediatric abdomen because of the paucity of body fat in many pediatric patients. There are some exceptions, including renal stone evaluation. A routine dose of 1.5 to 2 mL/kg is generally used. Volume of contrast, rate of injection, scan delay 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, and the clinical indication.
- c. Enteric contrast may be used in the CT evaluation of the pediatric abdomen. Choices of administration route (eg, oral, rectal, or enteric tube) and type of contrast (eg, positive or neutral attenuation) will depend

on factors such as the clinical questions to be answered and patient age. Enteric contrast is not typically used in renal stone protocol, CT angiography, or acute trauma.

- d. In the evaluation of the pediatric patient for suspected appendicitis, IV contrast is typically used, particularly to avoid potential repeat scans that are due to equivocal findings. Precontrast scans and delayed scans are usually not necessary. Some centers use oral 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. Rectal contrast is rarely used.
- e. Postprocessing 2-D reformations, MIP reconstructions, and 3-D volume rendering may be useful adjuncts in displaying the anatomy, especially in evaluation of vascular anatomy. The 3-D volume rendered images may be used for presurgical planning and patient/family education, tumor volume tracking measurements, as well as 3-D printing of illustrative models.

IV. SPECIFICATIONS OF THE EXAMINATION

B. Examination Technique [2-6,143-163]

3. Extremities

- a. IV contrast is usually not necessary if only evaluation of the bone structure is needed. IV contrast may be necessary for assessment of blood vessels and soft tissues when indicated.
- b. Sharper reconstruction algorithms are needed for better spatial resolution and bone detail. Smoother algorithms are better for soft-tissue evaluation and 3-D postprocessing.

V. DOCUMENTATION

Reporting should be in accordance with the [ACR Practice Parameter for Communication of Diagnostic Imaging Findings \[168\]](#).

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- or dimension-adjusted mA and kVp, beam collimation, slice thickness, pitch, rotation time, matrix, image filter, noise-reducing reconstruction technique (eg, iterative reconstruction), display field of view (DFOV), and tube current modulation techniques (longitudinal and angular). In some CT scanners, the tube current can be automatically adjusted by a predetermined selection of the quality (eg, noise level or reference mAs) of the study. Other dose-reduction techniques include automatic exposure control or organ-based angular modulation that reduces mA to anterior organs, such as the breasts. Optimal kVp can be achieved by manual charts according to patient size and type of study (eg, routine or CT angiography) or with automated selection technology. 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 [178]. Technologists and radiologists should be aware of important artifacts and know how to avoid problems associated with them. [[2-6](#),[144-147](#),[149-151](#),[156](#),[162](#)]

A. Performance Standards

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

1. Gantry rotation time: =1 second
2. Detector width: =1 mm
3. Tube voltage: ranging from 70 to 120 kVp

4. Limiting spatial resolution: 8 lp/cm for ≥32 cm DFOV and ≥10 lp/cm for <24 cm DFOV

With the advent of dual-energy CT and spectral CT [169-172], which can be performed with doses comparable to single-energy CT [173], more centers are making use of this technology in the diagnosis of pediatric disease [174,175], as the process of material decomposition allows for:

- A.
 - 1. Virtual noncontrast scans that can avoid dual-phase imaging and can show calcifications in kidneys, tumors, pancreatitis, and mural plaques in the presence of contrast. Virtual noncontrast images permit automated bone subtraction, improving visualization of vessels.
 - 2. Low monoenergetic images, which improve CT angiography by boosting iodine signal-to-noise ratio (SNR), can salvage mistimed or poor bolus studies, and allow use of less iodine contrast in CT examinations.
 - 3. Low monoenergetic images improve contrast-to-noise ratio (CNR) in soft tissues and thus lesion detection.
 - 4. Low monoenergetic images to improve head CT gray-white matter differentiation and help in detection of low-contrast lesions and cerebral ischemia/stroke.
 - 5. The use of virtual monoenergetic images allows to suppress artifact in the posterior fossa [176] and in the presence of metallic implants and surgical hardware.
 - 6. Perfusion imaging iodine maps improve detection of pulmonary embolism, flow following repair of congenital heart disease, arteriovenous malformations, myocardial ischemia, and solid organ perfusion defects, such as pyelonephritis, and likewise demonstrate regions of hyperenhancement.
 - 7. Iodine overlays are helpful to characterize indeterminate lesions and assess tumor vascularity.
 - 8. Renal mass/cyst characterization. This technology can evaluate lesions "too small to characterize," discriminate hyperdense or protein-laden cysts from solid lesions, identify renal calculi within contrast material, and gauge tumor vascularity/viability and treatment response.
 - 9. Renal stone characterization
- B. Appropriate emergency equipment and medications must be immediately available to treat adverse reactions associated with administered medications. See Table 6 of the [ACR Manual on Contrast Media \[142\]](#). The equipment, medications, and other emergency support must be appropriate for the range of age and size in the patient populations.

VII. RADIATION SAFETY IN IMAGING

Radiologists, medical physicists, non-physician radiology providers, 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 who work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection, application of dose constraints and limits) and the principles of proper management of radiation dose to patients (justification, optimization including the use of dose reference levels). https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1775_web.pdf

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

Facilities should have and adhere to policies and procedures that require ionizing radiation examination protocols (radiography, fluoroscopy, interventional radiology, CT) to vary according to diagnostic requirements and patient body habitus to optimize the relationship between appropriate radiation dose and adequate image quality. Automated dose reduction technologies available on imaging equipment should be used, except when inappropriate for a specific exam. If such technology is not available, appropriate manual techniques should be used.

Additional information regarding patient radiation safety in imaging is available from the following websites – Image Gently® for children (www.imagegently.org) and Image Wisely® for adults (www.imagewisely.org). 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 periodically measured by a Qualified Medical Physicist in accordance with the applicable ACR Technical Standards. Monitoring or regular review of dose indices from patient imaging should be performed by comparing the facility's dose information with national benchmarks, such as the ACR Dose Index Registry and relevant publications relying on its data, applicable ACR Practice Parameters, 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; 2006, 2009, amended 2013, revised 2023 (Res. 2d).

A Qualified 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–AAPM–SPR Practice Parameter for Diagnostic Reference Levels and Achievable Doses in Medical X-Ray Imaging \[177\]](#).

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 website (<https://www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Quality-Control-and-Improvement>).

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 \[178\]](#).

ACKNOWLEDGEMENTS

This practice parameter was revised according to the process described under the heading *The Process for Developing ACR Practice Parameters and Technical Standards* on the ACR website (<https://www.acr.org/Clinical-Resources/Practice-Parameters-and-Technical-Standards>) by the Committee on Practice Parameters – Pediatric Radiology of the ACR Commissions on Pediatric Radiology in collaboration with the ASER, SCBT-MR, and SPR. Collaborative Committee

Members represent their societies in the initial and final revision of this practice parameter.

ACR

Monica Epelman, MD, Chair
Dorothy Leigh Gilbertson-Dahdal, MD
Kerri Highmore, MD

ASER

Michael Aquino, MD
Susan John, MD
George Koberlein, MD

SCBT-MR

Marilyn J Siegel, MD, FACR

SPR

Tushar Chandra, MBBS
Richard Southard, MD
Sjirk Westra, MD

Committee on Practice Parameters – Pediatric Radiology

(ACR Committee responsible for sponsoring the draft through the process)

Beverley Newman, MB, BCh, BSc, FACR, Chair
Timothy J. Carmody, MD, FACR
Tara M. Catanzano, MB, BCh
Lee K. Collins, MD

Kerri A. Highmore, MD
Sue C. Kaste, DO
Terry L. Levin, MD, FACR
Matthew P. Lungren, MD, MPH

Committee on Practice Parameters – Pediatric Radiology

Kassa Darge, MD, PhD	Helen R. Nadel, MD
Monica S. Epelman, MD	Sumit Pruthi, MBBS
Dorothy L. Gilbertson-Dahdal, MD	Pallavi Sagar, MD
Safwan S. Halabi, MD	Richard B. Towbin, MD, FACR

Richard A. Barth, MD, FACR, Chair, Commission on Pediatric Radiology
Jacqueline Anne Bello, MD, FACR, Chair, Commission on Quality and Safety
Matthew S. Pollack, MD, FACR, Chair, Committee on Practice Parameters and Technical Standards
Mary S. Newell, MD, FACR, Vice Chair, Committee on Practice Parameters and Technical Standards

Comments Reconciliation Committee

Daniel Ortiz, MD, Chair	Kerri Highmore, MD
Greg Nicola, MD, FACR, Co-Chair	Susan John, MD
Michael Aquino, MD	George Koberlein, MD
Richard A. Barth, MD, FACR	Mary S. Newell, MD, FACR
Jacqueline A. Bello, MD, FACR	Beverley Newman, MB, BCh, BSc, FACR
Priscilla Butler, MS, FACR	Matthew S. Pollack, MD, FACR
Tushar Chandra, MBBS	Marilyn J Siegel, MD, FACR
Joo Cho, MD	Richard Southard, MD
Richard Duszak, Jr., MD, FACR	Timothy L. Swan, MD, FACR
Monica Epelman, MD	Sjirk Westra, MD
Dorothy Leigh Gilbertson-Dahdal, MD	

1. Brenner DJ, Hall EJ. Computed tomography an increasing source of radiation exposure. *N Engl J Med*. 2007;357:2277-2284.
2. Cody DD, Moxley DM, Krugh KT, O'Daniel JC, Wagner LK, Eftekhari F. Strategies for formulating appropriate MDCT techniques when imaging the chest, abdomen, and pelvis in pediatric patients. *AJR Am J Roentgenol*. 2004;182(4):849-859.
3. Donnelly LF, Frush DP. Pediatric multidetector body CT. *Radiol Clin North Am*. 2003;41(3):637-655.
4. Paterson A, Frush DP. Dose reduction in paediatric MDCT: general principles. *Clin Radiol*. 2007;62(6):507-517.
5. Siegel MJ. *Pediatric Body CT*. 2nd ed. Philadelphia, Pa: Lippincott, Williams and Wilkins; 2007.
6. Siegel MJ FD, Brody AS. Multidetector CT in pediatrics (RSP1504RC). RSNA refresher course; 2005; Oak Brook, IL.
7. American College of Radiology. ACR practice parameter for performing and interpreting diagnostic computed tomography (ct). 2017; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CT-Perf-Interpret.pdf>. Accessed January 9, 2018.
8. Donnelly LF. Use of three-dimensional reconstructed helical CT images in recognition and communication of chest wall anomalies in children. *AJR Am J Roentgenol*. 2001;177(2):441-445.
9. Emans JB, Caubet JF, Ordonez CL, Lee EY, Ciarlo M. The treatment of spine and chest wall deformities with fused ribs by expansion thoracostomy and insertion of vertical expandable prosthetic titanium rib: growth of thoracic spine and improvement of lung volumes. *Spine*. 2005;30(17 Suppl):S58-68.
10. Haller JA, Jr., Kramer SS, Lietman SA. Use of CT scans in selection of patients for pectus excavatum surgery: a preliminary report. *J Pediatr Surg*. 1987;22(10):904-906.
11. Miller LA. Chest wall, lung, and pleural space trauma. *Radiol Clin North Am*. 2006;44(2):213-224, viii.
12. Morris BS, Maheshwari M, Chalwa A. Chest wall tuberculosis: a review of CT appearances. *Br J Radiol*. 2004;77(917):449-457.
13. Schulman H, Newman-Heinman N, Kurtzbar E, Maor E, Zirkon H, Laufer L. Thoracoabdominal peripheral

- primitive neuroectodermal tumors in childhood: radiological features. *Eur Radiol.* 2000;10(10):1649-1652.
14. Shamberger RC, Grier HE. Chest wall tumors in infants and children. *Semin Pediatr Surg.* 1994;3(4):267-276.
 15. Wong KS, Hung IJ, Wang CR, Lien R. Thoracic wall lesions in children. *Pediatr Pulmonol.* 2004;37(3):257-263.
 16. Marcovici PA, LoSasso BE, Kruk P, Dwek JR. MRI for the evaluation of pectus excavatum. *Pediatr Radiol.* 2011;41(6):757-758.
 17. Bruckner BA, DiBardino DJ, Cumbie TC, et al. Critical evaluation of chest computed tomography scans for blunt descending thoracic aortic injury. *Ann Thorac Surg.* 2006;81(4):1339-1346.
 18. Kim TH, Kim YM, Suh CH, et al. Helical CT angiography and three-dimensional reconstruction of total anomalous pulmonary venous connections in neonates and infants. *AJR Am J Roentgenol.* 2000;175(5):1381-1386.
 19. Lee EY, Siegel MJ, Hildebolt CF, Gutierrez FR, Bhalla S, Fallah JH. MDCT evaluation of thoracic aortic anomalies in pediatric patients and young adults: comparison of axial, multiplanar, and 3D images. *AJR Am J Roentgenol.* 2004;182(3):777-784.
 20. Melton SM, Kerby JD, McGiffin D, et al. The evolution of chest computed tomography for the definitive diagnosis of blunt aortic injury: a single-center experience. *J Trauma.* 2004;56(2):243-250.
 21. Qanadli SD, Hajjam ME, Mesurolle B, et al. Pulmonary embolism detection: prospective evaluation of dual-section helical CT versus selective pulmonary arteriography in 157 patients. *Radiology.* 2000;217(2):447-455.
 22. Stein PD, Fowler SE, Goodman LR, et al. Multidetector computed tomography for acute pulmonary embolism. *N Engl J Med.* 2006;354(22):2317-2327.
 23. Siegel MJ. Multiplanar and three-dimensional multi-detector row CT of thoracic vessels and airways in the pediatric population. *Radiology.* 2003;229(3):641-650.
 24. Choo KS, Lee HD, Ban JE, et al. Evaluation of obstructive airway lesions in complex congenital heart disease using composite volume-rendered images from multislice CT. *Pediatr Radiol.* 2006;36(3):219-223.
 25. Heyer CM, Nuesslein TG, Jung D, et al. Tracheobronchial anomalies and stenoses: detection with low-dose multidetector CT with virtual tracheobronchoscopy--comparison with flexible tracheobronchoscopy. *Radiology.* 2007;242(2):542-549.
 26. Honnef D, Wildberger JE, Das M, et al. Value of virtual tracheobronchoscopy and bronchography from 16-slice multidetector-row spiral computed tomography for assessment of suspected tracheobronchial stenosis in children. *Eur Radiol.* 2006;16(8):1684-1691.
 27. Long FR. Imaging evolution of airway disorders in children. *Radiol Clin North Am.* 2005;43(2):371-389.
 28. Pacharn P, Poe SA, Donnelly LF. Low-tube-current multidetector CT for children with suspected extrinsic airway compression. *AJR Am J Roentgenol.* 2002;179(6):1523-1527.
 29. Greenberg SB, Dyamenahalli U. Dynamic pulmonary computed tomography angiography: a new standard for evaluation of combined airway and vascular abnormalities in infants. *Int J Cardiovasc Imaging.* 2014;30(2):407-414.
 30. Franco A, Mody NS, Meza MP. Imaging evaluation of pediatric mediastinal masses. *Radiol Clin North Am.* 2005;43(2):325-353.
 31. Kato M, Hara M, Ozawa Y, Shimizu S, Shibamoto Y. Computed tomography and magnetic resonance imaging features of posterior mediastinal ganglioneuroma. *J Thorac Imaging.* 2012;27(2):100-106.
 32. McAdams HP, Kirejczyk WM, Rosado-de-Christenson ML, Matsumoto S. Bronchogenic cyst: imaging features with clinical and histopathologic correlation. *Radiology.* 2000;217(2):441-446.
 33. Brody AS. Imaging considerations: interstitial lung disease in children. *Radiol Clin North Am.* 2005;43(2):391-403.
 34. Cooper P, MacLean J. High-resolution computed tomography (HRCT) should not be considered as a routine assessment method in cystic fibrosis lung disease. *Paediatr Respir Rev.* 2006;7(3):197-201.
 35. Copley SJ. Application of computed tomography in childhood respiratory infections. *Br Med Bull.* 2002;61:263-279.
 36. Donnelly LF. Imaging in immunocompetent children who have pneumonia. *Radiol Clin North Am.* 2005;43(2):253-265.
 37. Fan LL, Deterding RR, Langston C. Pediatric interstitial lung disease revisited. *Pediatr Pulmonol.* 2004;38(5):369-378.
 38. Hall A, Johnson K. The imaging of paediatric thoracic trauma. *Paediatr Respir Rev.* 2002;3(3):241-247.
 39. Daltro P, Fricke BL, Kuroki I, Domingues R, Donnelly LF. CT of congenital lung lesions in pediatric patients.

AJR Am J Roentgenol. 2004;183(5):1497-1506.

40. Lee EY, Tracy DA, Mahmood SA, Weldon CB, Zurakowski D, Boisselle PM. Preoperative MDCT evaluation of congenital lung anomalies in children: comparison of axial, multiplanar, and 3D images. *AJR Am J Roentgenol.* 2011;196(5):1040-1046.
41. Lim GY, Newman B, Kurland G, Webber SA. Posttransplantation lymphoproliferative disorder: manifestations in pediatric thoracic organ recipients. *Radiology.* 2002;222(3):699-708.
42. Mott LS, Park J, Murray CP, et al. Progression of early structural lung disease in young children with cystic fibrosis assessed using CT. *Thorax.* 2012;67(6):509-516.
43. Newman B. Congenital bronchopulmonary foregut malformations: concepts and controversies. *Pediatr Radiol.* 2006;36(8):773-791.
44. O'Connor OJ, Vandeleur M, McGarrigle AM, et al. Development of low-dose protocols for thin-section CT assessment of cystic fibrosis in pediatric patients. *Radiology.* 2010;257(3):820-829.
45. Orazi C, Inserra A, Schingo PM, et al. Pleuropulmonary blastoma, a distinctive neoplasm of childhood: report of three cases. *Pediatr Radiol.* 2007;37(4):337-344.
46. Paterson A. Imaging evaluation of congenital lung abnormalities in infants and children. *Radiol Clin North Am.* 2005;43(2):303-323.
47. Thomas KE, Owens CM, Britto J, Nadel S, Habibi P, Nicholson R. Efficacy of chest CT in a pediatric ICU: a prospective study. *Chest.* 2000;117(6):1697-1705.
48. Tiddens HA. Chest computed tomography scans should be considered as a routine investigation in cystic fibrosis. *Paediatr Respir Rev.* 2006;7(3):202-208.
49. Brody AS, Tiddens HA, Castile RG, et al. Computed tomography in the evaluation of cystic fibrosis lung disease. *Am J Respir Crit Care Med.* 2005;172(10):1246-1252.
50. Hernanz-Schulman M. CT as an outcome surrogate in patients with cystic fibrosis: does the effort justify the risks? *Radiology.* 2012;262(3):746-749.
51. Islam S, Calkins CM, Goldin AB, et al. The diagnosis and management of empyema in children: a comprehensive review from the APSA Outcomes and Clinical Trials Committee. *J Pediatr Surg.* 2012;47(11):2101-2110.
52. Bennett GL, Birnbaum BA, Balthazar EJ. CT of Meckel's diverticulitis in 11 patients. *AJR Am J Roentgenol.* 2004;182(3):625-629.
53. Brandon JL, Schroeder S, Furuta GT, Capocelli K, Masterson JC, Fenton LZ. CT imaging features of eosinophilic colitis in children. *Pediatr Radiol.* 2013;43(6):697-702.
54. Callahan MJ, Rodriguez DP, Taylor GA. CT of appendicitis in children. *Radiology.* 2002;224(2):325-332.
55. Chen JJ, Lee HC, Yeung CY, Chan WT, Jiang CB, Sheu JC. Meta-analysis: the clinical features of the duodenal duplication cyst. *J Pediatr Surg.* 2010;45(8):1598-1606.
56. Davis JS, Ryan ML, Fields JM, Neville HL, Perez EA, Sola JE. Use of CT enterography for the diagnosis of lower gastrointestinal bleeding in pediatric patients. *J Pediatr Surg.* 2013;48(3):681-684.
57. Fischerauer E, Zotsch S, Capito C, et al. Paediatric and adolescent traumatic gastrointestinal injuries: results of a European multicentre analysis. *Acta Paediatr.* 2013.
58. Garcia K, Hernanz-Schulman M, Bennett DL, Morrow SE, Yu C, Kan JH. Suspected appendicitis in children: diagnostic importance of normal abdominopelvic CT findings with nonvisualized appendix. *Radiology.* 2009;250(2):531-537.
59. Hammer MR, Podberesky DJ, Dillman JR. Multidetector computed tomographic and magnetic resonance enterography in children: state of the art. *Radiol Clin North Am.* 2013;51(4):615-636.
60. Kaiser S, Finnbogason T, Jorulf HK, Soderman E, Frenckner B. Suspected appendicitis in children: diagnosis with contrast-enhanced versus nonenhanced Helical CT. *Radiology.* 2004;231(2):427-433.
61. Kamona AA, El-Khatib MA, Swaidan MY, et al. Pediatric Burkitt's lymphoma: CT findings. *Abdom Imaging.* 2007;32(3):381-386.
62. Karmazyn B, Ash S, Goshen Y, Yaniv I, Horev G, Kornreich L. Significance of residual abdominal masses in children with abdominal Burkitt's lymphoma. *Pediatr Radiol.* 2001;31(11):801-805.
63. Kaste SC, McCarville MB. Imaging pediatric abdominal tumors. *Semin Roentgenol.* 2008;43(1):50-59.
64. Kharbanda AB, Taylor GA, Bachur RG. Suspected appendicitis in children: rectal and intravenous contrast-enhanced versus intravenous contrast-enhanced CT. *Radiology.* 2007;243(2):520-526.
65. Liu Y, Peng Y, Li J, Zeng J, Sun G, Gao P. MSCT manifestations with pathologic correlation of abdominal gastrointestinal tract and mesenteric tumor and tumor-like lesions in children: a single center experience.

Eur J Radiol. 2010;75(3):293-300.

66. Olson DE, Kim YW, Ying J, Donnelly LF. CT predictors for differentiating benign and clinically worrisome pneumatosis intestinalis in children beyond the neonatal period. *Radiology.* 2009;253(2):513-519.
67. Wang Q, Chavhan GB, Babyn PS, Tomlinson G, Langer JC. Utility of CT in the diagnosis and management of small-bowel obstruction in children. *Pediatr Radiol.* 2012;42(12):1441-1448.
68. Bruining DH, Zimmermann EM, Loftus EV, Jr., et al. Consensus Recommendations for Evaluation, Interpretation, and Utilization of Computed Tomography and Magnetic Resonance Enterography in Patients With Small Bowel Crohn's Disease. *Radiology.* 2018;286(3):776-799.
69. Adeyiga AO, Lee EY, Eisenberg RL. Focal hepatic masses in pediatric patients. *AJR Am J Roentgenol.* 2012;199(4):W422-440.
70. Guo WL, Huang SG, Wang J, Sheng M, Fang L. Imaging findings in 75 pediatric patients with pancreaticobiliary maljunction: a retrospective case study. *Pediatr Surg Int.* 2012;28(10):983-988.
71. Hilmes MA, Hernanz-Schulman M, Greeley CS, Piercey LM, Yu C, Kan JH. CT identification of abdominal injuries in abused pre-school-age children. *Pediatr Radiol.* 2011;41(5):643-651.
72. Joyner BL, Jr., Levin TL, Goyal RK, Newman B. Focal nodular hyperplasia of the liver: a sequela of tumor therapy. *Pediatr Radiol.* 2005;35(12):1234-1239.
73. Mishra K, Basu S, Roychoudhury S, Kumar P. Liver abscess in children: an overview. *World J Pediatr.* 2010;6(3):210-216.
74. Towbin AJ, Luo GG, Yin H, Mo JQ. Focal nodular hyperplasia in children, adolescents, and young adults. *Pediatr Radiol.* 2011;41(3):341-349.
75. Yen TY, Huang LM, Lee PI, Lu CY, Shao PL, Chang LY. Clinical characteristics of hepatosplenic fungal infection in pediatric patients. *J Microbiol Immunol Infect.* 2011;44(4):296-302.
76. Zhang DY, Ji ZF, Shen XZ, Liu HY, Pan BJ, Dong L. Caroli's disease: a report of 14 patients and review of the literature. *J Dig Dis.* 2012;13(9):491-495.
77. Berrocal T, Pajares MP, Zubillaga AF. Pancreatic cystosis in children and young adults with cystic fibrosis: sonographic, CT, and MRI findings. *AJR Am J Roentgenol.* 2005;184(4):1305-1309.
78. Fabre A, Petit P, Gaudart J, et al. Severity scores in children with acute pancreatitis. *J Pediatr Gastroenterol Nutr.* 2012;55(3):266-267.
79. Lautz TB, Turkel G, Radhakrishnan J, Wyers M, Chin AC. Utility of the computed tomography severity index (Balthazar score) in children with acute pancreatitis. *J Pediatr Surg.* 2012;47(6):1185-1191.
80. Hu S, Lin X, Song Q, Chen K. Solid pseudopapillary tumour of the pancreas in children: clinical and computed tomography manifestation. *Radiol Med.* 2012;117(7):1242-1249.
81. van den Akker M, Angelini P, Taylor G, Chami R, Gerstle JT, Gupta A. Malignant pancreatic tumors in children: a single-institution series. *J Pediatr Surg.* 2012;47(4):681-687.
82. Yamana I, Kawamoto S, Kamitani T, Ishikura H, Yamashita Y. Pancreatic injury in children: review of 7 cases and the pertinent literature. *Hepatogastroenterology.* 2012;59(114):574-577.
83. Agrons GA, Wagner BJ, Davidson AJ, Suarez ES. Multilocular cystic renal tumor in children: radiologic-pathologic correlation. *Radiographics.* 1995;15(3):653-669.
84. Fernbach SK, Feinstein KA, Donaldson JS, Baum ES. Nephroblastomatosis: comparison of CT with US and urography. *Radiology.* 1988;166(1 Pt 1):153-156.
85. Weinberger E, Rosenbaum DM, Pendergrass TW. Renal involvement in children with lymphoma: comparison of CT with sonography. *AJR Am J Roentgenol.* 1990;155(2):347-349.
86. Johnson EK, Faerber GJ, Roberts WW, et al. Are stone protocol computed tomography scans mandatory for children with suspected urinary calculi? *Urology.* 2011;78(3):662-666.
87. Kurian J, Epelman M, Darge K, Meyers K, Nijs E, Hellinger JC. The role of CT angiography in the evaluation of pediatric renovascular hypertension. *Pediatr Radiol.* 2013;43(4):490-501; quiz 487-499.
88. Bartley JM, Santucci RA. Computed tomography findings in patients with pediatric blunt renal trauma in whom expectant (nonoperative) management failed. *Urology.* 2012;80(6):1338-1343.
89. Cheng CH, Tsau YK, Chen SY, Lin TY. Clinical courses of children with acute lobar nephronia correlated with computed tomographic patterns. *Pediatr Infect Dis J.* 2009;28(4):300-303.
90. Jacobs MA, Hotaling JM, Mueller BA, Koyle M, Rivara F, Voelzke BB. Conservative management vs early surgery for high grade pediatric renal trauma--do nephrectomy rates differ? *J Urol.* 2012;187(5):1817-1822.
91. Karmazyn B, Frush DP, Applegate KE, Maxfield C, Cohen MD, Jones RP. CT with a computer-simulated dose reduction technique for detection of pediatric nephroureterolithiasis: comparison of standard and reduced

- radiation doses. *AJR Am J Roentgenol*. 2009;192(1):143-149.
92. Kawashima A, LeRoy AJ. Radiologic evaluation of patients with renal infections. *Infect Dis Clin North Am*. 2003;17(2):433-456.
93. Berdon WE, Ruzal-Shapiro C, Abramson SJ, Garvin J. The diagnosis of abdominal neuroblastoma: relative roles of ultrasonography, CT, and MRI. *Urol Radiol*. 1992;14(4):252-262.
94. Burks DW, Mirvis SE, Shanmuganathan K. Acute adrenal injury after blunt abdominal trauma: CT findings. *AJR Am J Roentgenol*. 1992;158(3):503-507.
95. Sivit CJ, Ingram JD, Taylor GA, Bulas DI, Kushner DC, Eichelberger MR. Posttraumatic adrenal hemorrhage in children: CT findings in 34 patients. *AJR Am J Roentgenol*. 1992;158(6):1299-1302.
96. Westra SJ, Zaninovic AC, Hall TR, Kangaroo H, Boechat MI. Imaging of the adrenal gland in children. *Radiographics*. 1994;14(6):1323-1340.
97. Balassy C, Navarro OM, Daneman A. Adrenal masses in children. *Radiol Clin North Am*. 2011;49(4):711-727, vi.
98. Wadsworth DT, Newman B, Abramson SJ, Carpenter BL, Lorenzo RL. Splenic lymphangiomatosis in children. *Radiology*. 1997;202(1):173-176.
99. Davies DA, Ein SH, Pearl R, et al. What is the significance of contrast "blush" in pediatric blunt splenic trauma? *J Pediatr Surg*. 2010;45(5):916-920.
100. Ferrozzi F, Bova D, Draghi F, Garlaschi G. CT findings in primary vascular tumors of the spleen. *AJR Am J Roentgenol*. 1996;166(5):1097-1101.
101. Gayer G, Zissin R, Apter S, Atar E, Portnoy O, Itzhak Y. CT findings in congenital anomalies of the spleen. *Br J Radiol*. 2001;74(884):767-772.
102. Paterson A, Frush DP, Donnelly LF, Foss JN, O'Hara SM, Bisset GS, 3rd. A pattern-oriented approach to splenic imaging in infants and children. *Radiographics*. 1999;19(6):1465-1485.
103. St Peter SD, Keckler SJ, Spilde TL, Holcomb GW, 3rd, Ostlie DJ. Justification for an abbreviated protocol in the management of blunt spleen and liver injury in children. *J Pediatr Surg*. 2008;43(1):191-193; discussion 193-194.
104. van der Vlies CH, Saltzherr TP, Wilde JC, van Delden OM, de Haan RJ, Goslings JC. The failure rate of nonoperative management in children with splenic or liver injury with contrast blush on computed tomography: a systematic review. *J Pediatr Surg*. 2010;45(5):1044-1049.
105. Chan DP, Abujudeh HH, Cushing GL, Jr., Novelline RA. CT cystography with multiplanar reformation for suspected bladder rupture: experience in 234 cases. *AJR Am J Roentgenol*. 2006;187(5):1296-1302.
106. Shah RU, Lawrence C, Fickenscher KA, Shao L, Lowe LH. Imaging of pediatric pelvic neoplasms. *Radiol Clin North Am*. 2011;49(4):729-748, vi.
107. Sivit CJ, Cutting JP, Eichelberger MR. CT diagnosis and localization of rupture of the bladder in children with blunt abdominal trauma: significance of contrast material extravasation in the pelvis. *AJR Am J Roentgenol*. 1995;164(5):1243-1246.
108. Hamrick-Turner JE, Chiechi MV, Abbitt PL, Ros PR. Neoplastic and inflammatory processes of the peritoneum, omentum, and mesentery: diagnosis with CT. *Radiographics*. 1992;12(6):1051-1068.
109. Pickhardt PJ, Siegel MJ. Abdominal manifestations of posttransplantation lymphoproliferative disorder. *AJR Am J Roentgenol*. 1998;171(4):1007-1013.
110. Al-Salem AH. Traumatic diaphragmatic hernia in children. *Pediatr Surg Int*. 2012;28(7):687-691.
111. Ruess L, Frazier AA, Sivit CJ. CT of the mesentery, omentum, and peritoneum in children. *Radiographics*. 1995;15(1):89-104.
112. Tang V, Daneman A, Navarro OM, Miller SF, Gerstle JT. Internal hernias in children: spectrum of clinical and imaging findings. *Pediatr Radiol*. 2011;41(12):1559-1568.
113. Chapman V, Grottkau B, Albright M, Elaini A, Halpern E, Jaramillo D. MDCT of the elbow in pediatric patients with posttraumatic elbow effusions. *AJR Am J Roentgenol*. 2006;187(3):812-817.
114. Chapman VM, Grottkau BE, Albright M, Salamipour H, Jaramillo D. Multidetector computed tomography of pediatric lateral condylar fractures. *J Comput Assist Tomogr*. 2005;29(6):842-846.
115. Fayad LM, Johnson P, Fishman EK. Multidetector CT of musculoskeletal disease in the pediatric patient: principles, techniques, and clinical applications. *Radiographics*. 2005;25(3):603-618.
116. Fayad LM, Carrino JA, Fishman EK. Musculoskeletal infection: role of CT in the emergency department. *Radiographics*. 2007;27(6):1723-1736.
117. Laurence N, Epelman M, Markowitz RI, Jaimes C, Jaramillo D, Chauvin NA. Osteoid osteomas: a pain in the

- night diagnosis. *Pediatr Radiol*. 2012;42(12):1490-1501; quiz 1540-1492.
118. Satake H, Takahara M, Harada M, Maruyama M. Preoperative imaging criteria for unstable osteochondritis dissecans of the capitellum. *Clin Orthop Relat Res*. 2013;471(4):1137-1143.
 119. Silber JS, Flynn JM, Katz MA, Ganley TJ, Koffler KM, Drummond DS. Role of computed tomography in the classification and management of pediatric pelvic fractures. *J Pediatr Orthop*. 2001;21(2):148-151.
 120. Stiletto RJ, Baacke M, Gotzen L. Comminuted pelvic ring disruption in toddlers: management of a rare injury. *J Trauma*. 2000;48(1):161-164.
 121. Viani RM, Bromberg K, Bradley JS. Obturator internus muscle abscess in children: report of seven cases and review. *Clin Infect Dis*. 1999;28(1):117-122.
 122. Vo NJ, Gash J, Browning J, Hutson RK. Pelvic imaging in the stable trauma patient: is the AP pelvic radiograph necessary when abdominopelvic CT shows no acute injury? *Emerg Radiol*. 2004;10(5):246-249.
 123. Cho TJ, Choi IH, Chung CY, Hwang JK. The Sprengel deformity. Morphometric analysis using 3D-CT and its clinical relevance. *J Bone Joint Surg Br*. 2000;82(5):711-718.
 124. Sibinski M, Wozniakowski B, Drobniewski M, Synder M. Secondary gleno-humeral joint dysplasia in children with persistent obstetric brachial plexus palsy. *Int Orthop*. 2010;34(6):863-867.
 125. Waters PM, Smith GR, Jaramillo D. Glenohumeral deformity secondary to brachial plexus birth palsy. *J Bone Joint Surg Am*. 1998;80(5):668-677.
 126. Akiyama M, Nakashima Y, Fujii M, et al. Femoral anteversion is correlated with acetabular version and coverage in Asian women with anterior and global deficient subgroups of hip dysplasia: a CT study. *Skeletal Radiol*. 2012;41(11):1411-1418.
 127. Eggli KD, King SH, Boal DK, Quiogue T. Low-dose CT of developmental dysplasia of the hip after reduction: diagnostic accuracy and dosimetry. *AJR Am J Roentgenol*. 1994;163(6):1441-1443.
 128. Jia J, Li L, Zhang L, Zhao Q, Liu X. Three dimensional-CT evaluation of femoral neck anteversion, acetabular anteversion and combined anteversion in unilateral DDH in an early walking age group. *Int Orthop*. 2012;36(1):119-124.
 129. Monazzam S, Bomar JD, Dwek JR, Hosalkar HS, Pennock AT. Development and prevalence of femoroacetabular impingement-associated morphology in a paediatric and adolescent population: a CT study of 225 patients. *Bone Joint J*. 2013;95-B(5):598-604.
 130. Stevens MA, El-Khoury GY, Kathol MH, Brandser EA, Chow S. Imaging features of avulsion injuries. *Radiographics*. 1999;19(3):655-672.
 131. Chin MS, Betz BW, Halanski MA. Comparison of hip reduction using magnetic resonance imaging or computed tomography in hip dysplasia. *J Pediatr Orthop*. 2011;31(5):525-529.
 132. Delgado-Martinez AD, Rodriguez-Merchan EC, Ballesteros R, Luna JD. Reproducibility of patellofemoral CT scan measurements. *Int Orthop*. 2000;24(1):5-8.
 133. Kristiansen LP, Gunderson RB, Steen H, Reikeras O. The normal development of tibial torsion. *Skeletal Radiol*. 2001;30(9):519-522.
 134. Pandya NK, Edmonds EW, Roocroft JH, Mubarak SJ. Tibial tubercle fractures: complications, classification, and the need for intra-articular assessment. *J Pediatr Orthop*. 2012;32(8):749-759.
 135. Crim J. Imaging of tarsal coalition. *Radiol Clin North Am*. 2008;46(6):1017-1026, vi.
 136. Liporace FA, Yoon RS, Kubiak EN, et al. Does adding computed tomography change the diagnosis and treatment of Tillaux and triplane pediatric ankle fractures? *Orthopedics*. 2012;35(2):e208-212.
 137. Wuerz TH, Gurd DP. Pediatric physeal ankle fracture. *J Am Acad Orthop Surg*. 2013;21(4):234-244.
 138. Brown SD, Kasser JR, Zurakowski D, Jaramillo D. Analysis of 51 tibial triplane fractures using CT with multiplanar reconstruction. *AJR Am J Roentgenol*. 2004;183(5):1489-1495.
 139. American College of Radiology. ACR–ASNR–SPR practice parameter for the performance of computed tomography (ct) of the brain. 2015; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CT-Brain.pdf>. Accessed January 9, 2018.
 140. American College of Radiology. ACR–ASNR–ASSR–SPR practice parameter for the performance of computed tomography (ct) of the spine. 2016; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CT-Spine.pdf>. Accessed January 9, 2018.
 141. American College of Radiology. ACR-SPR practice parameter for the use of intravascular contrast media. 2017; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/ivcm.pdf>. Accessed January 9, 2018.
 142. American College of Radiology. ACR Manual on Contrast Media. 2017; Available at: <https://www.acr.org/->

[/media/ACR/Files/Clinical-Resources/Contrast_Media.pdf](#). Accessed January 9, 2018.

143. Schindera ST, Diedrichsen L, Muller HC, et al. Iterative reconstruction algorithm for abdominal multidetector CT at different tube voltages: assessment of diagnostic accuracy, image quality, and radiation dose in a phantom study. *Radiology*. 2011;260(2):454-462.
144. Lungren MP, Yoshizumi TT, Brady SM, et al. Radiation dose estimations to the thorax using organ-based dose modulation. *AJR Am J Roentgenol*. 2012;199(1):W65-73.
145. Mievil FA, Berteloot L, Grandjean A, et al. Model-based iterative reconstruction in pediatric chest CT: assessment of image quality in a prospective study of children with cystic fibrosis. *Pediatr Radiol*. 2013;43(5):558-567.
146. Siegel MJ, Hildebolt C, Bradley D. Effects of Automated Kilovoltage Selection Technology on Contrast-enhanced Pediatric CT and CT Angiography. *Radiology*. 2013;268(2):538-547.
147. Smith EA, Dillman JR, Goodsitt MM, Christodoulou EG, Keshavarzi N, Strouse PJ. Model-Based Iterative Reconstruction (MBIR): Effect on Patient Radiation Dose and Image Quality in Pediatric Body CT. *Radiology*. 2013 (In Press).
148. Coursey C, Frush DP, Yoshizumi T, Toncheva G, Nguyen G, Greenberg SB. Pediatric chest MDCT using tube current modulation: effect on radiation dose with breast shielding. *AJR Am J Roentgenol*. 2008;190(1):W54-61.
149. Lee SH, Kim MJ, Yoon CS, Lee MJ. Radiation dose reduction with the adaptive statistical iterative reconstruction (ASIR) technique for chest CT in children: an intra-individual comparison. *Eur J Radiol*. 2012;81(9):e938-943.
150. Singh S, Kalra MK, Shenoy-Bhangle AS, et al. Radiation dose reduction with hybrid iterative reconstruction for pediatric CT. *Radiology*. 2012;263(2):537-546.
151. Greess H, Lutze J, Nomayr A, et al. Dose reduction in subsecond multislice spiral CT examination of children by online tube current modulation. *Eur Radiol*. 2004;14(6):995-999.
152. Mansour JC, Schwartz L, Pandit-Taskar N, et al. The utility of F-18 fluorodeoxyglucose whole body PET imaging for determining malignancy in cystic lesions of the pancreas. *J Gastrointest Surg*. 2006;10(10):1354-1360.
153. Geleijns J, Wang J, McCollough C. The use of breast shielding for dose reduction in pediatric CT: arguments against the proposition. *Pediatr Radiol*. 2010;40(11):1744-1747.
154. Kim S, Frush DP, Yoshizumi TT. Bismuth shielding in CT: support for use in children. *Pediatr Radiol*. 2010;40(11):1739-1743.
155. McCollough CH, Wang J, Berland LL. Bismuth shields for CT dose reduction: do they help or hurt? *J Am Coll Radiol*. 2011;8(12):878-879.
156. Kim JE, Newman B. Evaluation of a radiation dose reduction strategy for pediatric chest CT. *AJR Am J Roentgenol*. 2010;194(5):1188-1193.
157. Kawel N, Seifert B, Luetolf M, Boehm T. Effect of slab thickness on the CT detection of pulmonary nodules: use of sliding thin-slab maximum intensity projection and volume rendering. *AJR Am J Roentgenol*. 2009;192(5):1324-1329.
158. Peloschek P, Sailer J, Weber M, Herold CJ, Prokop M, Schaefer-Prokop C. Pulmonary nodules: sensitivity of maximum intensity projection versus that of volume rendering of 3D multidetector CT data. *Radiology*. 2007;243(2):561-569.
159. Siegel MJ, Bhalla S, Gutierrez FR, Hildebolt C, Sweet S. Post-lung transplantation bronchiolitis obliterans syndrome: usefulness of expiratory thin-section CT for diagnosis. *Radiology*. 2001;220(2):455-462.
160. Bae KT, Shah AJ, Shang SS, et al. Aortic and hepatic contrast enhancement with abdominal 64-MDCT in pediatric patients: effect of body weight and iodine dose. *AJR Am J Roentgenol*. 2008;191(5):1589-1594.
161. Chan FP, Rubin GD. MDCT angiography of pediatric vascular diseases of the abdomen, pelvis, and extremities. *Pediatr Radiol*. 2005;35(1):40-53.
162. Karmazyn B, Liang Y, Klahr P, Jennings SG. Effect of tube voltage on CT noise levels in different phantom sizes. *AJR Am J Roentgenol*. 2013;200(5):1001-1005.
163. Reid J, Gamberoni J, Dong F, Davros W. Optimization of kVp and mAs for pediatric low-dose simulated abdominal CT: is it best to base parameter selection on object circumference? *AJR Am J Roentgenol*. 2010;195(4):1015-1020.
164. Colletti PM, Micheli OA, Lee KH. To shield or not to shield: application of bismuth breast shields. *AJR Am J Roentgenol*. 2013;200(3):503-507.

165. Strauss KJ, Gingold EL, Frush DP. Reconsidering the Value of Gonadal Shielding During Abdominal/Pelvic Radiography. *J Am Coll Radiol*. 2017;14(12):1635-1636.
166. Wichmann JL, Hu X, Kerl JM, et al. 70 kVp computed tomography pulmonary angiography: potential for reduction of iodine load and radiation dose. *J Thorac Imaging*. 2015;30(1):69-76.
167. Manneck S, Hurwitz LM, Seaman DM, Heye T, Boll DT. Whole-Body High-Pitch CT Angiography: Strategies to Reduce Radiation Dose and Contrast Volume. *AJR Am J Roentgenol*. 2017;209(6):1396-1403.
168. American College of Radiology. ACR practice parameter for communication of diagnostic imaging findings. 2014; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CommunicationDiag.pdf>. Accessed January 9, 2018.
169. Silva AC, Morse BG, Hara AK, Paden RG, Hongo N, Pavlicek W. Dual-energy (spectral) CT: applications in abdominal imaging. *Radiographics*. 2011;31(4):1031-1046; discussion 1047-1050.
170. Patino M, Prochowski A, Agrawal MD, et al. Material Separation Using Dual-Energy CT: Current and Emerging Applications. *Radiographics*. 2016;36(4):1087-1105.
171. Coursey CA, Nelson RC, Boll DT, et al. Dual-energy multidetector CT: how does it work, what can it tell us, and when can we use it in abdominopelvic imaging? *Radiographics*. 2010;30(4):1037-1055.
172. McCollough CH, Leng S, Yu L, Fletcher JG. Dual- and Multi-Energy CT: Principles, Technical Approaches, and Clinical Applications. *Radiology*. 2015;276(3):637-653.
173. Siegel MJ, Curtis WA, Ramirez-Giraldo JC. Effects of Dual-Energy Technique on Radiation Exposure and Image Quality in Pediatric Body CT. *American Journal of Roentgenology*. 2016;207(4):826-835.
174. Zhu X, McCullough WP, Mecca P, Servaes S, Darge K. Dual-energy compared to single-energy CT in pediatric imaging: a phantom study for DECT clinical guidance. *Pediatr Radiol*. 2016;46(12):1671-1679.
175. Siegel MJ, Curtis WA, Ramirez-Giraldo JC. Effects of Dual-Energy Technique on Radiation Exposure and Image Quality in Pediatric Body CT. *AJR Am J Roentgenol*. 2016:1-10.
176. Neuhaus V, Abdullayev N, Grosse Hokamp N, et al. Improvement of Image Quality in Unenhanced Dual-Layer CT of the Head Using Virtual Monoenergetic Images Compared With Polyenergetic Single-Energy CT. *Invest Radiol*. 2017;52(8):470-476.
177. American College of Radiology. ACR-AAPM practice parameter for diagnostic reference levels and achievable doses in medical x-ray imaging. 2018; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/diag-ref-levels.pdf>. Accessed January 9, 2018.
178. American College of Radiology. ACR-AAPM technical standard for diagnostic medical physics performance monitoring of computed tomography (ct) equipment. 2017; Available at: <https://www.acr.org/-/media/ACR/Files/Technical-Standards/MonitorCTEquipment.pdf?la=en>. Accessed January 9, 2018.

REFERENCES

1. Brenner DJ, Hall EJ. Computed tomography--an increasing source of radiation exposure. *N Engl J Med*. 2007;357(22):2277-2284.
2. CodyDianna DDDDivision of Diagnostic Imaging, University of Texas M. D. Anderson Cancer Center, 1515 Holcombe Blvd., Unit 56, Houston, TX 77030, USA., MoxleyDonna MDM, KrughKerry TKT, O'DanielJennifer CJC, WagnerLouis KKL, EftekhariFarzinF. Strategies for formulating appropriate MDCT techniques when imaging the chest, abdomen, and pelvis in pediatric patients. *AJR Am J Roentgenol* 182:849-59, .
3. DonnellyLane FLDepartment of Radiology, Cincinnati Children's Hospital Medical Center, 3333 Burnet Avenue, Cincinnati, OH 45229-3039, USA. Lane.Donnelly@cchmc.org, FrushDonald PDP. Pediatric multidetector body CT. *Radiol Clin North Am* 41:637-55, .
4. PatersonAARadiology Department, Royal Belfast Hospital for Sick Children, Belfast, UK. anniep@unbowed-adsl.demon.co.uk, FrushD PDP. Dose reduction in paediatric MDCT: general principles. *Clin Radiol* 62:507-17, .
5. Siegel MJ. Pediatric Body CT. 2nd ed. Philadelphia, Pa: Lippincott, Williams and Wilkins; 2007.
6. Siegel MJ FD, Brody AS. Multidetector CT in pediatrics (RSP1504RC). RSNA refresher course; 2005; Oak Brook, IL.
7. American College of Radiology. ACR–SPR Practice Parameter for Performing and Interpreting Diagnostic Computed Tomography (CT). Available at <https://gravitas.acr.org/PPTS/GetDocumentView?docId=132+&releaseId=2>
8. DonnellyL FLDepartment of Radiology, Children's Hospital Medical Center, 3333 Burnet Ave., Cincinnati, OH 45229-3039, USA.. Use of three-dimensional reconstructed helical CT images in recognition and communication of

chest wall anomalies in children. *AJR Am J Roentgenol* 177:441-5, .

9. Emans John BJB Department of Orthopaedic Surgery, Children's Hospital, Harvard Medical School, Boston, MA 02115, USA. john.emans@childrens.harvard.edu, Caubet Jean François JF, Ordonez Claudia LCL, Lee Edward YEY, Ciarlo Michelle M. The treatment of spine and chest wall deformities with fused ribs by expansion thoracostomy and insertion of vertical expandable prosthetic titanium rib: growth of thoracic spine and improvement of lung volumes. *Spine (Phila Pa 1976)* 30:S58-68, .

10. Haller J AJA Jr Division of Pediatric Surgery, Johns Hopkins Hospital, Baltimore, MD 21205., Kramer S SSS, Lietman S ASA. Use of CT scans in selection of patients for pectus excavatum surgery: a preliminary report. *J Pediatr Surg* 22:904-6, .

11. Miller Lisa ALA Department of Radiology, Shock Trauma Center, University of Maryland School of Medicine, Baltimore, MD 21201, USA. lmiller1@umm.edu. Chest wall, lung, and pleural space trauma. *Radiol Clin North Am* 44:213-24, viii, .

12. Morris B SBS Department of Radiology, King Edward VII Memorial Hospital, Parel, Mumbai 400 012, India., Maheshwari MM, Chalwa AA. Chest wall tuberculosis: a review of CT appearances. *Br J Radiol* 77:449-57, .

13. Schulman HH Department of Radiology, Soroka University Medical Center, Ben-Gurion University of the Negev, Beer-Sheva, Israel., Newman-Heinman NN, Kurtzbaart EE, Maor EE, Zirk HH, Laufer LL. Thoracoabdominal peripheral primitive neuroectodermal tumors in childhood: radiological features. *Eur Radiol* 10:1649-52, .

14. Shamberger R CRC Department of Surgery, Children's Hospital, Boston, MA 02115., Grier H EHE. Chest wall tumors in infants and children. *Semin Pediatr Surg* 3:267-76, .

15. Wong Kin-Sun KS Department of Pediatrics, Chang Gung Children's Hospital, Taiwan, ROC. pchest@adm.cgmh.org.tw, Hung Lou Jih IJ, Wang Chao Ran CR, Lien Reyn R. Thoracic wall lesions in children. *Pediatr Pulmonol* 37:257-63, .

16. Marcovici Peter APA Department of Radiology, University of California, San Diego, 200 W. Arbor Dr., San Diego, CA 92103-8756, USA. pmarcovici@ucsd.edu, Lo Sasso Barry EBE, Kruk Peter P, Dwek Jerry RJR. MRI for the evaluation of pectus excavatum. *Pediatr Radiol* 41:757-8, .

17. Bruckner BA, DiBardino DJ, Cumbie TC, et al. Critical evaluation of chest computed tomography scans for blunt descending thoracic aortic injury. *Ann Thorac Surg*. 2006;81(4):1339-1346.

18. Kim TH, Kim YM, Suh CH, et al. Helical CT angiography and three-dimensional reconstruction of total anomalous pulmonary venous connections in neonates and infants. *AJR Am J Roentgenol* 2000;175:1381-6.

19. Lee EY, Siegel MJ, Hildebolt CF, Gutierrez FR, Bhalla S, Fallah JH. MDCT evaluation of thoracic aortic anomalies in pediatric patients and young adults: comparison of axial, multiplanar, and 3D images. *AJR Am J Roentgenol*. 182(3):777-84, 2004 Mar.

20. Melton Sherry MSM Department of Surgery, Section of Trauma, Burns, and Surgical Critical Care, Division of General Surgery, School of Medicine, University of Alabama at Birmingham, Birmingham, Alabama 35294-0016, USA. sherry.melton@ccc.uab.edu, Kerby Jeffrey DJD, McGiffin David D, et al. The evolution of chest computed tomography for the definitive diagnosis of blunt aortic injury: a single-center experience. *J Trauma* 56:243-50, .

21. Qanadli S DSD Department of Radiology, Ambroise Paré Hospital-René Descartes Paris V University, 9 avenue Charles de Gaulle, 92104 Boulogne, France. salah.qanadii@apr.ap-hop-paris.fr, Hajjam M EME, Mesurolle BB, et al. Pulmonary embolism detection: prospective evaluation of dual-section helical CT versus selective pulmonary arteriography in 157 patients. *Radiology* 217:447-55, .

22. Stein PD, Fowler SE, Goodman LR, et al. Multidetector computed tomography for acute pulmonary embolism. *N Engl J Med*. 354(22):2317-27, 2006 Jun 01.

23. Siegel Marilyn MJ Edward Mallinckrodt Institute of Radiology, Washington University School of Medicine, 510 S Kingshighway Blvd, St Louis, MO 63110, USA. siegelm@mir.wustl.edu. Multiplanar and three-dimensional multidetector row CT of thoracic vessels and airways in the pediatric population. *Radiology* 229:641-50, .

24. Choo Ki Seok KS Department of Diagnostic Radiology, Pusan National University Hospital, Pusan National University School of Medicine, 10 1-Ga, Ami-Dong, Seo-Gu, 602-739 Busan, Korea., Lee Hyoun Doo HD, Ban Ji Eun JE, et al. Evaluation of obstructive airway lesions in complex congenital heart disease using composite volume-rendered images from multislice CT. *Pediatr Radiol* 36:219-23, .

25. Heyer CM, Nuesslein TG, Jung D, et al. Tracheobronchial anomalies and stenoses: detection with low-dose multidetector CT with virtual tracheobronchoscopy--comparison with flexible tracheobronchoscopy. *Radiology*. 2007;242(2):542-549.

26. Honnef Dagmar DD Department of Diagnostic Radiology, University Hospital RWTH Aachen, Pauwelsstrasse 30, 52057 Aachen, Germany. honnef@rad.rwth-aachen.de, Wildberger Joachim EJE, Das Marco M, et al. Value of virtual tracheobronchoscopy and bronchography from 16-slice multidetector-row spiral computed tomography for assessment of suspected tracheobronchial stenosis in children. *Eur Radiol* 16:1684-91, .

- 27.** LongFrederick RFRBody CT/MR Imaging, Department of Radiology, Columbus Children's Hospital, 700 Children's Drive, A-1010, Columbus, OH 43205, USA. flong@chi.osu.edu. Imaging evolution of airway disorders in children. *Radiol Clin North Am* 43:371-89, .
- 28.** PacharnPreeyachaPDepartment of Radiology, Children's Hospital Medical Center, 3333 Burnet Ave., Cincinnati, OH 45229-3039, USA., PoeStacy ASA, DonnellyLane FLF. Low-tube-current multidetector CT for children with suspected extrinsic airway compression. *AJR Am J Roentgenol* 179:1523-7, .
- 29.** Greenberg SB, Dyamenahalli U. Dynamic pulmonary computed tomography angiography: a new standard for evaluation of combined airway and vascular abnormalities in infants. *Int J Cardiovasc Imaging*. 30(2):407-14, 2014 Feb.
- 30.** FrancoArieADepartment of Radiology, Children's Hospital of Pittsburgh, Pittsburgh, PA 15213, USA. arie.franco@chp.edu, ModyNeeta SNS, MezaManuel PMP. Imaging evaluation of pediatric mediastinal masses. *Radiol Clin North Am* 43:325-53, .
- 31.** Kato M, Hara M, Ozawa Y, Shimizu S, Shibamoto Y. Computed tomography and magnetic resonance imaging features of posterior mediastinal ganglioneuroma. *Journal of Thoracic Imaging*. 27(2):100-6, 2012 Mar.
- 32.** McAdams HP, Kirejczyk WM, Rosado-de-Christenson ML, Matsumoto S. Bronchogenic cyst: imaging features with clinical and histopathologic correlation. *Radiology*. 217(2):441-6, 2000 Nov.
- 33.** BrodyAlan SASThoracic Imaging, Department of Radiology, MLC-5031, Cincinnati Children's Hospital and Medical Center, 3333 Burnet Avenue, Cincinnati, OH 45229-3039, USA. alan.brody@cchmc.org. Imaging considerations: interstitial lung disease in children. *Radiol Clin North Am* 43:391-403, .
- 34.** CooperPeterPDepartment of Respiratory Medicine, The Children's Hospital at Westmead, Sydney, Australia. PeterC@chw.edu.au, MacLeanJoannaJ. High-resolution computed tomography (HRCT) should not be considered as a routine assessment method in cystic fibrosis lung disease. *Paediatr Respir Rev* 7:197-201, .
- 35.** CopleyS JSJDepartment of Radiology, Hammersmith Hospital, London, UK.. Application of computed tomography in childhood respiratory infections. *Br Med Bull* 61:263-79, .
- 36.** DonnellyLane FLFDepartment of Radiology, Cincinnati Children's Hospital Medical Center, 3333 Burnet Avenue, Cincinnati, OH 45229-3039, USA. Lane.Donnelly@cchmc.org. Imaging in immunocompetent children who have pneumonia. *Radiol Clin North Am* 43:253-65, .
- 37.** FanLeland LLLPediatric Pulmonary Section, Department of Pediatrics, Baylor College of Medicine, Texas Children's Hospital, Houston 77030-2399, USA. lfann@texaschildrenshospital.org, DeterdingRobin RRR, LangstonClaireC. Pediatric interstitial lung disease revisited. *Pediatr Pulmonol* 38:369-78, .
- 38.** HallAARadiology Department, Birmingham Children's Hospital, Steelhouse Lane, Birmingham, UK., JohnsonKK. The imaging of paediatric thoracic trauma. *Paediatr Respir Rev* 3:241-7, .
- 39.** DaltroPedroPClinica de Diagnostico por Imagem, Barra da Tijuca, Rio de Janeiro, Brazil., FrickeBradley LBL, KurokilugiroI, DominguesRomeuR, DonnellyLane FLF. CT of congenital lung lesions in pediatric patients. *AJR Am J Roentgenol* 183:1497-506, .
- 40.** Lee EY, Tracy DA, Mahmood SA, Weldon CB, Zurakowski D, Boiselle PM. Preoperative MDCT evaluation of congenital lung anomalies in children: comparison of axial, multiplanar, and 3D images. *AJR. American Journal of Roentgenology*. 196(5):1040-6, 2011 May.
- 41.** LimGye YeonGYDepartment of Radiology, Children's Hospital of Pittsburgh, University of Pittsburgh School of Medicine, 3705 Fifth Ave at DeSoto St, Pittsburgh, PA 15213-2583, USA., NewmanBeverleyB, KurlandGeoffreyG, WebberSteven AlanSA. Posttransplantation lymphoproliferative disorder: manifestations in pediatric thoracic organ recipients. *Radiology* 222:699-708, .
- 42.** Mott LS, Park J, Murray CP, et al. Progression of early structural lung disease in young children with cystic fibrosis assessed using CT. *Thorax*. 67(6):509-16, 2012 Jun.
- 43.** NewmanBeverleyBUUniversity of Pittsburgh School of Medicine and Children's Hospital of Pittsburgh, 3705 Fifth Ave, Pittsburgh, PA 15213, USA. beverley.newman@chp.edu. Congenital bronchopulmonary foregut malformations: concepts and controversies. *Pediatr Radiol* 36:773-91, .
- 44.** O'ConnorOwen JOJDepartment of Radiology, University College Cork and Cork University Hospital, Wilton, Cork 1111, Ireland., VandeleurMoyaM, McGarrigleAnne MarieAM, et al. Development of low-dose protocols for thin-section CT assessment of cystic fibrosis in pediatric patients. *Radiology* 257:820-9, .
- 45.** Orazi C, Insera A, Schingo PM, et al. Pleuropulmonary blastoma, a distinctive neoplasm of childhood: report of three cases. *Pediatr Radiol*. 37(4):337-44, 2007 Apr.
- 46.** PatersonAnneARadiology Department, Royal Belfast Hospital for Sick Children, 180 Falls Road, Belfast BT12 6BE, UK. annie.paterson@royalhospitals.n-i.nhs.uk. Imaging evaluation of congenital lung abnormalities in infants and children. *Radiol Clin North Am* 43:303-23, .
- 47.** ThomasK EKEDepartments of Diagnostic Radiology, Imperial College School of Medicine at St. Mary's Hospital,

- London, United Kingdom. karenthomas5@yahoo.com, OwensC MCM, BrittoJJ, NadelSS, HabibiPP, NicholsonRR. Efficacy of chest CT in a pediatric ICU: a prospective study. *Chest* 117:1697-705, .
- 48.** TiddensHarm A W MHAErasmus MC-Sophia, Department of Pediatric Pulmonology and Allergology, Dr Molewaterplein 60, 3015 GJ, Rotterdam, The Netherlands. h.tiddens@erasmusmc.nl. Chest computed tomography scans should be considered as a routine investigation in cystic fibrosis. *Paediatr Respir Rev* 7:202-8, .
- 49.** BrodyAlan SASDepartment of Radiology, MLC-5031, Cincinnati Children's Hospital Medical Center, 3333 Burnet Avenue, Cincinnati, Ohio 45229-3039, USA. alan.brody@cchmc.org, TiddensHarm A W MHA, CastileRobert GRG, et al. Computed tomography in the evaluation of cystic fibrosis lung disease. *Am J Respir Crit Care Med* 172:1246-52, .
- 50.** Hernanz-SchulmanMartaM. CT as an outcome surrogate in patients with cystic fibrosis: does the effort justify the risks?. *Radiology* 262:746-9, .
- 51.** Islam S, Calkins CM, Goldin AB, et al. The diagnosis and management of empyema in children: a comprehensive review from the APSA Outcomes and Clinical Trials Committee. [Review]. *J Pediatr Surg* 47(11):2101-10, 2012 Nov.
- 52.** BennettGenevieve LGLDepartment of Abdominal Radiology, Tisch Hospital, New York University Medical Center, 560 First Avenue, New York, NY 10016, USA. genevieve.bennett@med.nyu.edu, BirnbaumBernard ABA, BalthazarEmil JEJ. CT of Meckel's diverticulitis in 11 patients. *AJR Am J Roentgenol* 182:625-9, .
- 53.** BrandonJonathan LJLDepartment of Radiology, Children's Hospital Colorado, 13123 E. 16th Ave., Aurora, CO 80045, USA. jonbra@gmail.com, SchroederShaunaS, FurutaGlenn TGT, CapocelliKelleyK, MastersonJoanne CJC, FentonLaura ZLZ. CT imaging features of eosinophilic colitis in children. *Pediatr Radiol* 43:697-702, .
- 54.** CallahanMichael JMJDepartment of Radiology, Children's Hospital, 300 Longwood Ave, Boston, MA 02115, USA., RodriguezDiana PDP, TaylorGeorge AGA. CT of appendicitis in children. *Radiology* 224:325-32, .
- 55.** ChenJeng-JungJJDepartment of Pediatrics, Mackay Memorial Hospital, Taipei 10449, Taiwan., LeeHung-ChangHC, YeungChun-YanCY, ChanWai-TaoWT, JiangChuen-BinCB, SheuJin-CherngJC. Meta-analysis: the clinical features of the duodenal duplication cyst. *J Pediatr Surg* 45:1598-606, .
- 56.** Davis JS, Ryan ML, Fields JM, Neville HL, Perez EA, Sola JE. Use of CT enterography for the diagnosis of lower gastrointestinal bleeding in pediatric patients. *J Pediatr Surg*. 2013 Mar;48(3):S0022-3468(13)00007-9.
- 57.** FischerauerE EEEDepartment of Pediatric- and Adolescent Surgery, Medical University of Graz, Graz, Austria., ZötschSS, CapitoCC, et al. Paediatric and adolescent traumatic gastrointestinal injuries: results of a European multicentre analysis. *Acta Paediatr* 102:977-81, .
- 58.** Garcia K, Hernanz-Schulman M, Bennett DL, Morrow SE, Yu C, Kan JH. Suspected appendicitis in children: diagnostic importance of normal abdominopelvic CT findings with nonvisualized appendix. *Radiology*. 250(2):531-7, 2009 Feb.
- 59.** Hammer MR, Podberesky DJ, Dillman JR. Multidetector computed tomographic and magnetic resonance enterography in children: state of the art. [Review]. *Radiol Clin North Am*. 51(4):615-36, 2013 Jul.
- 60.** KaiserSylvieSDepartment of Pediatric Radiology, Astrid Lindgren Children's Hospital, Karolinska Hospital, SE-171 76 Stockholm, Sweden. sylvie.kaiser@ks.se, FinnbogasonThrösturT, JorulfHåkan KHK, SödermanErike, FrencknerBjörnB. Suspected appendicitis in children: diagnosis with contrast-enhanced versus nonenhanced Helical CT. *Radiology* 231:427-33, .
- 61.** KamonaAtheel AAADiagnostic Radiology, King Hussein Cancer Center, Amman, Jordan., El-KhatibMaan AMA, SwaidanMaisa YMY, et al. Pediatric Burkitt's lymphoma: CT findings. *Abdom Imaging* 32:381-6, .
- 62.** KarmazynBBDepartment of Diagnostic Radiology, Schneider Children's Medical Center of Israel, 14 Kaplan Street, Petah-Tikva 49202, Israel. bkar@Netvision.net.il, AshSS, GoshenYY, YanivII, HorevGG, KornreichLL. Significance of residual abdominal masses in children with abdominal Burkitt's lymphoma. *Pediatr Radiol* 31:801-5, .
- 63.** KasteSue CSCDepartment of Radiological Sciences, St. Jude Children's Research Hospital, Memphis, Tennessee 38105-2794, USA. sue.kaste@stjude.org, McCarvilleM BethMB. Imaging pediatric abdominal tumors. *Semin Roentgenol* 43:50-9, .
- 64.** Kharbanda AB, Taylor GA, Bachur RG. Suspected appendicitis in children: rectal and intravenous contrast-enhanced versus intravenous contrast-enhanced CT. *Radiology*. 243(2):520-6, 2007 May.
- 65.** LiuYueYDepartment of Radiology, Beijing Children's Hospital Affiliated to Capital Medical University. 56 Nanlishi Road, West District, Beijing 100045, PR China. liuyue20036@yahoo.com.cn, PengYunY, LiJianyingJ, ZengJinjinJ, SunGuoqiangG, GaoPeiyiP. MSCT manifestations with pathologic correlation of abdominal gastrointestinal tract and mesenteric tumor and tumor-like lesions in children: a single center experience. *Eur J Radiol* 75:293-300, .
- 66.** OlsonDoug EDEDepartment of Radiology, Cincinnati Children's Hospital Medical Center, 3333 Burnet Ave, MLC

5031, Cincinnati, OH 45229-3039, USA., KimYong-WooYW, YingJunJ, DonnellyLane FLF. CT predictors for differentiating benign and clinically worrisome pneumatosis intestinalis in children beyond the neonatal period. *Radiology* 253:513-9, .

67. Wang Q, Chavhan GB, Babyn PS, Tomlinson G, Langer JC. Utility of CT in the diagnosis and management of small-bowel obstruction in children. *Pediatr Radiol*. 42(12):1441-8, 2012 Dec.

68. Bruining DH, Zimmermann EM, Loftus EV Jr, et al. Consensus Recommendations for Evaluation, Interpretation, and Utilization of Computed Tomography and Magnetic Resonance Enterography in Patients With Small Bowel Crohn's Disease. *Radiology*. 286(3):776-799, 2018 Mar.

69. Adeyiga AO, Lee EY, Eisenberg RL. Focal hepatic masses in pediatric patients. *AJR Am J Roentgenol*. 199(4):W422-40, 2012 Oct.

70. GuoWan-liangWLRadiology Department, The Children's Hospital Affiliated to Soochow University, Suzhou, 215003, China., HuangShun-genSG, WangJianJ, ShengMaoM, FangLinL. Imaging findings in 75 pediatric patients with pancreaticobiliary maljunction: a retrospective case study. *Pediatr Surg Int* 28:983-8, .

71. Hilmes MA, Hernanz-Schulman M, Greeley CS, Piercey LM, Yu C, Kan JH. CT identification of abdominal injuries in abused pre-school-age children. *Pediatr Radiol*. 2011; 41(5):643-651.

72. JoynerBenny LBLrDepartment of Pediatrics, Albert Einstein College of Medicine, Montefiore Medical Center, Bronx, NY 10467, USA., LevinTerry LTL, GoyalRakesh KRK, NewmanBeverleyB. Focal nodular hyperplasia of the liver: a sequela of tumor therapy. *Pediatr Radiol* 35:1234-9, .

73. MishraKirtisudhaKDepartment of Paediatrics, Kalawati Saran Children's Hospital, Lady Hardinge Medical College, New Delhi 110001, India., BasuSrikantaS, RoychoudhurySubhasisS, KumarPraveenP. Liver abscess in children: an overview. *World J Pediatr* 6:210-6, .

74. TowbinAlexander JAJDepartment of Radiology, Cincinnati Children's Hospital Medical Center, 3333 Burnet Ave., ML# 5031, Cincinnati, OH 45229, USA. Alexander.Towbin@cchmc.org, LuoGuangju GGG, YinHongH, MoJun QJQ. Focal nodular hyperplasia in children, adolescents, and young adults. *Pediatr Radiol* 41:341-9, .

75. Yen TY, Huang LM, Lee PI, Lu CY, Shao PL, Chang LY. Clinical characteristics of hepatosplenic fungal infection in pediatric patients. *J Microbiol Immunol Infect*. 44(4):296-302, 2011 Aug.

76. ZhangDan YingDYDepartment of Gastroenterology, Zhongshan Hospital, Fudan University, Shanghai, China., JiZong FeiZF, ShenXi ZhongXZ, LiuHou YuHY, PanBao JianBJ, DongLingL. Caroli's disease: a report of 14 patients and review of the literature. *J Dig Dis* 13:491-5, .

77. BerrocalTeresaTDepartment of Pediatric Radiology, University Hospital La Paz, Paseo de la Castellana, 261, Madrid 28046, Spain. tberrocal.hulp@salud.madrid.org, PajaresManuel ParrónMP, ZubillagaAmelia FernándezAF. Pancreatic cystosis in children and young adults with cystic fibrosis: sonographic, CT, and MRI findings. *AJR Am J Roentgenol* 184:1305-9, .

78. Fabre A, Petit P, Gaudart J, et al. Severity scores in children with acute pancreatitis. *J Pediatr Gastroenterol Nutr*. 55(3):266-7, 2012 Sep.

79. Lautz TB, Turkel G, Radhakrishnan J, Wyers M, Chin AC. Utility of the computed tomography severity index (Balthazar score) in children with acute pancreatitis. [Review]. *J Pediatr Surg*. 47(6):1185-91, 2012 Jun.

80. HuSSDepartment of Radiology, Ruijin Hospital, Shanghai Jiao tong University, School of Medicine, No. 197, Ruijin Er Road, Shanghai, 200025, China., LinXX, SongQQ, ChenKK. Solid pseudopapillary tumour of the pancreas in children: clinical and computed tomography manifestation. *Radiol Med* 117:1242-9, .

81. van den Akker M, Angelini P, Taylor G, Chami R, Gerstle JT, Gupta A. Malignant pancreatic tumors in children: a single-institution series. *J Pediatr Surg*. 47(4):681-7, 2012 Apr.

82. YamanaIppeilDepartment of Gastroenterological Surgery, Fukuoka University School of Medicine, Fukuoka, Japan. 3949noex@jcom.home.ne.jp, KawamotoShunjiS, KamitaniTakanoriT, IshikuraHiroyasuH, YamashitaYuichiY. Pancreatic injury in children: review of 7 cases and the pertinent literature. *Hepatogastroenterology* 59:574-7, .

83. AgronsG AGADepartment of Radiologic Pathology, Armed Forces Institute of Pathology, Washington, DC 20306-6000, USA., WagnerB JBJ, DavidsonA JAJ, SuarezE SES. Multilocular cystic renal tumor in children: radiologic-pathologic correlation. *Radiographics* 15:653-69, .

84. FernbachS KSKDepartments of Radiology, Children's Memorial Hospital, Chicago, IL 60614., FeinsteinK AKA, DonaldsonJ SJS, BaumeE SES. Nephroblastomatosis: comparison of CT with US and urography. *Radiology* 166:153-6, .

85. WeinbergerEEDepartment of Radiology, University of Washington School of Medicine, Seattle 98105., RosenbaumD MDM, PendergrassT WTW. Renal involvement in children with lymphoma: comparison of CT with sonography. *AJR Am J Roentgenol* 155:347-9, .

86. Johnson EK, Faerber GJ, Roberts WW, et al. Are stone protocol computed tomography scans mandatory for children with suspected urinary calculi? *Urology*. 2011; 78(3):662-666.

- 87.** Kurian J, Epelman M, Darge K, Meyers K, Nijs E, Hellinger JC. The role of CT angiography in the evaluation of pediatric renovascular hypertension. *Pediatr Radiol.* 43(4):490-501; quiz 487-9, 2013 Apr.
- 88.** Bartley JM, Santucci RA. Computed tomography findings in patients with pediatric blunt renal trauma in whom expectant (nonoperative) management failed. *Urology.* 80(6):1338-43, 2012 Dec.
- 89.** ChengChi-HuiCHDivision of Pediatric Nephrology, Department of Pediatrics, Chang Gung Children's Hospital, Chang Gung Memorial Hospital, Taoyuan, Taiwan., TsauYong-KweiYK, ChenShih-YuSY, LinTzou-YienTY. Clinical courses of children with acute lobar nephronia correlated with computed tomographic patterns. *Pediatr Infect Dis J* 28:300-3, .
- 90.** JacobsMicah AMACHildren's Medical Center Dallas, 2350 Stemmons Frwy., Suite D-4300, Mail Code F4.04, Dallas, Texas 75207, USA. micah.jacobs@aya.yale.edu, HotalingJames MJM, MuellerBeth ABA, KoyleMartinM, RivaraFrederickF, VoelzkeBryan BBB. Conservative management vs early surgery for high grade pediatric renal trauma--do nephrectomy rates differ?. *J Urol* 187:1817-22, .
- 91.** Karmazyn B, Frush DP, Applegate KE, Maxfield C, Cohen MD, Jones RP. CT with a computer-simulated dose reduction technique for detection of pediatric nephroureterolithiasis: comparison of standard and reduced radiation doses. *AJR.* 2009; 192(1):143-149.
- 92.** Kawashima A, LeRoy AJ. Radiologic evaluation of patients with renal infections. *Infect Dis Clin North Am.* 2003; 17(2):433-456.
- 93.** BerdonW EWEDepartment of Pediatric Radiology, Babies Hospital, Columbia-Presbyterian Medical Center, Columbia College of Physicians & Surgeons, New York, New York 10032., Ruzal-ShapiroCC, AbramsonS JSJ, GarvinJJ. The diagnosis of abdominal neuroblastoma: relative roles of ultrasonography, CT, and MRI. *Urol Radiol* 14:252-62, .
- 94.** Burks DW, Mirvis SE, Shanmuganathan K. Acute adrenal injury after blunt abdominal trauma: CT findings. *AJR Am J Roentgenol.* 158(3):503-7, 1992 Mar.
- 95.** SivitC JCJDepartment of Diagnostic Imaging and Radiology, Children's National Medical Center, Washington, DC 20010., IngramJ DJD, TaylorG AGA, BulasD IDI, KushnerD CDC, EichelbergerM RMR. Posttraumatic adrenal hemorrhage in children: CT findings in 34 patients. *AJR Am J Roentgenol* 158:1299-302, .
- 96.** WestraS JSJDepartment of Radiological Sciences, UCLA School of Medicine 90024-1721., ZaninovicA CAC, HallT RTR, KangarooHH, BoechatM IMI. Imaging of the adrenal gland in children. *Radiographics* 14:1323-40, .
- 97.** BalassyCsillaCDepartment of Diagnostic Imaging, The Hospital for Sick Children, 555 University Avenue, Toronto, ON M5G 1X8, Canada., NavarroOscar MOM, DanemanAlanA. Adrenal masses in children. *Radiol Clin North Am* 49:711-27, vi, .
- 98.** WadsworthD TDTMallinckrodt Institute of Radiology, St Louis, Mo, USA., NewmanBB, AbramsonS JSJ, CarpenterB LBL, LorenzoR LRL. Splenic lymphangiomatosis in children. *Radiology* 202:173-6, .
- 99.** DaviesDafydd ADADepartment of Pediatric Surgery, The Hospital for Sick Children, Toronto, Canada M5G 1X8., EinSigmund HSH, PearlRichardR, et al. What is the significance of contrast "blush" in pediatric blunt splenic trauma?. *J Pediatr Surg* 45:916-20, .
- 100.** FerrozziFFIstituto di Scienze Radiologiche, Università degli Studi di Parma, Italy., BovaDD, DraghiFF, GarlaschiGG. CT findings in primary vascular tumors of the spleen. *AJR Am J Roentgenol* 166:1097-101, .
- 101.** GayerGGDepartment of Diagnostic Imaging, The Chaim Sheba Medical Center, Sackler Faculty of Medicine, Tel Aviv University, Israel., ZissinRR, ApterSS, AtarEE, PortnoyOO, ItzhakYY. CT findings in congenital anomalies of the spleen. *Br J Radiol* 74:767-72, .
- 102.** PatersonAADepartment of Radiology, Duke University Medical Center, Durham, NC 27710, USA., FrushD PDP, DonnellyL FLF, FossJ NJN, O'HaraS MSM, BissetG SGS3rd. A pattern-oriented approach to splenic imaging in infants and children. *Radiographics* 19:1465-85, .
- 103.** St PeterShawn DSDCenter for Prospective Clinical Trials, The Children's Mercy Hospital, Kansas City, MO 64108, USA., KecklerScott JSJ, SpildeTroy LTL, HolcombGeorge WGW3rd, OstlieDaniel JDJ. Justification for an abbreviated protocol in the management of blunt spleen and liver injury in children. *J Pediatr Surg* 43:191-3; discussion 193-4, .
- 104.** van der VliesCornelis HCHTrauma Unit, Department of Surgery, Academic Medical Center, 1105 AZ Amsterdam, The Netherlands., SaltzherrTeun PTP, WildeJim C HJC, van DeldenOtto MOM, de HaanRob JRJ, GoslingsJ CarelJC. The failure rate of nonoperative management in children with splenic or liver injury with contrast blush on computed tomography: a systematic review. *J Pediatr Surg* 45:1044-9, .
- 105.** Chan DP, Abujudeh HH, Cushing GL, Novelline RA. CT cystography with multiplanar reformation for suspected bladder rupture: experience in 234 cases. *AJR Am J Roentgenol.* 2006 Nov;187(5):1296-302.
- 106.** Shah RU, Lawrence C, Fickenscher KA, Shao L, Lowe LH. Imaging of pediatric pelvic neoplasms. [Review]. *Radiol Clin North Am.* 49(4):729-48, vi, 2011 Jul.

- 107.** Sivit CJ, Cutting JP, Eichelberger MR. CT diagnosis and localization of rupture of the bladder in children with blunt abdominal trauma: significance of contrast material extravasation in the pelvis. *AJR*. 1995; 164(5):1243-1246.
- 108.** Hamrick-Turner J. Department of Radiology, University of Florida College of Medicine, Gainesville., Chiechi M VMV, Abbitt P LPL, Ros P RPR. Neoplastic and inflammatory processes of the peritoneum, omentum, and mesentery: diagnosis with CT. *Radiographics* 12:1051-68, .
- 109.** Pickhardt P JPJ, Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis, MO 63118, USA., Siegel M JMJ. Abdominal manifestations of posttransplantation lymphoproliferative disorder. *AJR Am J Roentgenol* 171:1007-13, .
- 110.** Al-Salem Ahmed HA. Department of Pediatric Surgery, Maternity and Children Hospital, Dammam, Qatif, Saudi Arabia. ahsalsalem@hotmail.com. Traumatic diaphragmatic hernia in children. *Pediatr Surg Int* 28:687-91, .
- 111.** Ruess LL. Department of Diagnostic Imaging and Radiology, Children's National Medical Center, Washington, DC 20010., Frazier A AAA, Sivit C JCJ. CT of the mesentery, omentum, and peritoneum in children. *Radiographics* 15:89-104, .
- 112.** Tang Vivian V. Department of Medical Imaging, University of Toronto, Toronto, ON, Canada., Daneman Alan A, Navarro Oscar M OM, Miller Stephen FSF, Gerstle J Ted JT. Internal hernias in children: spectrum of clinical and imaging findings. *Pediatr Radiol* 41:1559-68, .
- 113.** Chapman Vernon V. The Children's Hospital of Denver, 7136 S Hudson Ct., Centennial, CO 80122, USA. vernon.chapman@riaco.com, Grottkau Brian B, Albright Maurice M, Elaini Ahmed A, Halpern Elkan E, Jaramillo Diego D. MDCT of the elbow in pediatric patients with posttraumatic elbow effusions. *AJR Am J Roentgenol* 187:812-7, .
- 114.** Chapman Vernon M VM. Department of Radiology, Massachusetts General Hospital for Children, Boston, MA, USA. vernon.Chapman@riaco.com, Grottkau Brian EBE, Albright Maurice M, Salamipour Hamid H, Jaramillo Diego D. Multidetector computed tomography of pediatric lateral condylar fractures. *J Comput Assist Tomogr* 29:842-6, .
- 115.** Fayad Laura M LM, Russell H. Morgan Department of Radiology and Radiological Science, Johns Hopkins Medical Institutions, 601 N Wolfe St, JHOC 3171-C, Baltimore, MD 21287, USA. lfayad1@jhmi.edu, Johnson Pamela P, Fishman Elliot KEK. Multidetector CT of musculoskeletal disease in the pediatric patient: principles, techniques, and clinical applications. *Radiographics* 25:603-18, .
- 116.** Fayad LM, Carrino JA, Fishman EK. Musculoskeletal infection: role of CT in the emergency department. *Radiographics*. 2007;27(6):1723-1736.
- 117.** Laurence N, Epelman M, Markowitz RI, Jaimes C, Jaramillo D, Chauvin NA. Osteoid osteomas: a pain in the night diagnosis. [Review]. *Pediatr Radiol*. 42(12):1490-501; quiz 1540-2, 2012 Dec.
- 118.** Satake Hiroshi H. Department of Orthopaedic Surgery, Yamagata University Faculty of Medicine, Yamagata, Japan., Takahara Masatoshi M, Harada Miki M, Maruyama Masahiro M. Preoperative imaging criteria for unstable osteochondritis dissecans of the capitellum. *Clin Orthop Relat Res* 471:1137-43, .
- 119.** Silber J SJS. Children's Hospital of Philadelphia, Philadelphia, USA., Flynn J MJM, Katz M AMA, Ganley T JTJ, Koffler K MKM, Drummond D SDS. Role of computed tomography in the classification and management of pediatric pelvic fractures. *J Pediatr Orthop* 21:148-51, .
- 120.** Stiletto R JRJ. Department of Trauma Surgery, Philipps-University Marburg, Germany., Baacke M MM, Gotzen L L. Comminuted pelvic ring disruption in toddlers: management of a rare injury. *J Trauma* 48:161-4, .
- 121.** Viani R MR. Division of Pediatric Infectious Diseases, University of California at San Diego, USA., Bromberg K K, Bradley J SJS. Obturator internus muscle abscess in children: report of seven cases and review. *Clin Infect Dis* 28:117-22, .
- 122.** Vo NJ, Gash J, Browning J, Hutson RK. Pelvic imaging in the stable trauma patient: is the AP pelvic radiograph necessary when abdominopelvic CT shows no acute injury? *Emerg Radiol* 2004;10:246-9.
- 123.** Cho T JTJ. Department of Orthopaedic Surgery, Seoul National University Children's Hospital, Korea., Choi H HH, Chung C YCY, Hwang J KJK. The Sprengel deformity. Morphometric analysis using 3D-CT and its clinical relevance. *J Bone Joint Surg Br* 82:711-8, .
- 124.** Sibinski Marcin M. Clinic of Orthopedic and Pediatric Orthopedics, Medical University of Lodz, Lodz, Poland. sibinek@poczta.onet.pl, Wozniakowski Bartlomiej B, Drobniowski Marek M, Synder Marek M. Secondary glenohumeral joint dysplasia in children with persistent obstetric brachial plexus palsy. *Int Orthop* 34:863-7, .
- 125.** Waters P MP. Department of Orthopedic Surgery, Children's Hospital, Boston, Massachusetts 02115, USA. waters@a1.harvard.tch.edu, Smith G RGR, Jaramillo DD. Glenohumeral deformity secondary to brachial plexus birth palsy. *J Bone Joint Surg Am* 80:668-77, .
- 126.** Akiyama Mio M. Department of Orthopaedic Surgery, Graduate School of Medical Sciences, Kyushu University, 3-1-1 Maidashi, Higashi-ku, Fukuoka, 812-8582, Japan., Nakashima Yasuharu Y, Fujii Masanori M, et al. Femoral anteversion is correlated with acetabular version and coverage in Asian women with anterior and global deficient

subgroups of hip dysplasia: a CT study. *Skeletal Radiol* 41:1411-8, .

127. EgglIK DKDDepartment of Radiology, Milton S. Hershey Medical Center, Pennsylvania State University, Hershey 17033., KingS HSH, BoalD KDK, QuiogueTT. Low-dose CT of developmental dysplasia of the hip after reduction: diagnostic accuracy and dosimetry. *AJR Am J Roentgenol* 163:1441-3, .

128. JialingYuJDepartment of Paediatric Orthopaedics, Shengjing Hospital of China Medical University, Shenyang City, 110004 Liaoning Province, China., LiLianYongL, ZhangLiJunL, ZhaoQunQ, LiuXiJuanX. Three dimensional-CT evaluation of femoral neck anteversion, acetabular anteversion and combined anteversion in unilateral DDH in an early walking age group. *Int Orthop* 36:119-24, .

129. MonazzamSSRady Children's Hospital and Health Center, Department of Orthopedic Surgery, 3030 Children's Way, MOB Suite 410, San Diego, California 92123, USA., BomarJ DJD, DwekJ RJR, HosalkarH SHS, PennockA TAT. Development and prevalence of femoroacetabular impingement-associated morphology in a paediatric and adolescent population: a CT study of 225 patients. *Bone Joint J* 95-B:598-604, .

130. StevensM AMADepartment of Radiology, University of Iowa Hospitals and Clinics, Iowa City 52242, USA., El-KhouryG YGY, KatholIM HMH, BrandserE AEA, ChowSS. Imaging features of avulsion injuries. *Radiographics* 19:655-72, .

131. Chin MS, Betz BW, Halanski MA. Comparison of hip reduction using magnetic resonance imaging or computed tomography in hip dysplasia. *J Pediatr Orthop.* 2011; 31(5):525-529.

132. Delgado-MartínezA DADService of Traumatology and Orthopaedic Surgery, Hospital Princesa de España, University of Jaén, Spain. adelgado@ctv.es, Rodríguez-MerchánE CEC, BallesterosRR, LunaJ DJD. Reproducibility of patellofemoral CT scan measurements. *Int Orthop* 24:5-8, .

133. KristiansenL PLPNational Hospital Orthopaedic Center, University of Oslo, Norway., GundersonR BRB, SteenHH, ReikeråsOO. The normal development of tibial torsion. *Skeletal Radiol* 30:519-22, .

134. Pandya NK, Edmonds EW, Roocroft JH, Mubarak SJ. Tibial tubercle fractures: complications, classification, and the need for intra-articular assessment. *J Pediatr Orthop.* 32(8):749-59, 2012 Dec.

135. Crim J.. Imaging of tarsal coalition. [Review] [39 refs]. *Radiol Clin North Am.* 46(6):1017-26, vi, 2008 Nov.

136. Liporace FA, Yoon RS, Kubiak EN, et al. Does adding computed tomography change the diagnosis and treatment of Tillaux and triplane pediatric ankle fractures?. *Orthopedics.* 35(2):e208-12, 2012 Feb 17.

137. WuerzThomas HTHCleveland Clinic Foundation, Cleveland, OH, USA., GurdDavid PDP. Pediatric physeal ankle fracture. *J Am Acad Orthop Surg* 21:234-44, .

138. Brown SD, Kasser JR, Zurakowski D, Jaramillo D. Analysis of 51 tibial triplane fractures using CT with multiplanar reconstruction. *AJR Am J Roentgenol.* 183(5):1489-95, 2004 Nov.

139. American College of Radiology. ACR-ASNR-SPR Practice Parameter for the Performance of Computed Tomography (CT) of the Head. Available at <https://gravitas.acr.org/PPTS/GetDocumentView?docId=76+&releasId=2>

140. American College of Radiology. ACR-ASNR-ASSR-SPR Practice Parameter for the Performance of Computed Tomography (CT) of the Spine. Available at <https://gravitas.acr.org/PPTS/GetDocumentView?docId=133+&releasId=2>

141. American College of Radiology. ACR-SPR Practice Parameter for the use of Intravascular Contrast Media. Available at <https://gravitas.acr.org/PPTS/GetDocumentView?docId=142+&releasId=2>

142. American College of Radiology. ACR Committee on Drugs and Contrast Media. Manual on Contrast Media. Available at: <https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Contrast-Manual>.

143. SchinderaSebastian TSTUniversity Institute of Diagnostic, Interventional and Pediatric Radiology, University Hospital Bern, University of Bern, Freiburgstrasse 10, CH-3010 Bern, Switzerland. sschindera@aol.com, DiedrichsenLarsL, MüllerHubert CHC, et al. Iterative reconstruction algorithm for abdominal multidetector CT at different tube voltages: assessment of diagnostic accuracy, image quality, and radiation dose in a phantom study. *Radiology* 260:454-62, .

144. LungrenMatthew PMPDepartment of Radiology, Duke University Medical Center, Box 3808, Durham, NC 27710, USA. matthew.lungren@duke.edu, YoshizumiTerry TTT, BradySamuel MSM, et al. Radiation dose estimations to the thorax using organ-based dose modulation. *AJR Am J Roentgenol* 199:W65-73, .

145. MiévilleFrédéric AFAInstitute of Radiation Physics, Lausanne University Hospital, Grand-Pré 1, 1007, Lausanne, Switzerland. frederic.mieville@gmail.com, BertelootLaurelineL, GrandjeanAlbaneA, et al. Model-based iterative reconstruction in pediatric chest CT: assessment of image quality in a prospective study of children with cystic fibrosis. *Pediatr Radiol* 43:558-67, .

146. Siegel MJ, Hildebolt C, Bradley D. Effects of automated kilovoltage selection technology on contrast-enhanced pediatric CT and CT angiography. *Radiology.* 2013 Aug;268(2):538-47.

147. Smith EA, Dillman JR, Goodsitt MM, Christodoulou EG, Keshavarzi N, Strouse PJ. Model-based iterative

reconstruction: effect on patient radiation dose and image quality in pediatric body CT. *Radiology*. 270(2):526-34, 2014 Feb.

148. Coursey Courtney C Division of Pediatric Radiology, Department of Radiology, Box 3808, Duke University Medical Center, Durham, NC 27710, USA., Frush Donald PDP, Yoshizumi Terry T, Toncheva Greta G, Nguyen Giao G, Greenberg S Bruce SB. Pediatric chest MDCT using tube current modulation: effect on radiation dose with breast shielding. *AJR Am J Roentgenol* 190:W54-61, .

149. Lee Seung Hyun SH Department of Radiology and Research Institute of Radiological Science, Severance Children's Hospital, Yonsei University, College of Medicine, Seoul, Republic of Korea. circle1128@yuhs.ac, Kim Myung-Joon MJ, Yoon Choon-Sik CS, Lee Mi-Jung MJ. Radiation dose reduction with the adaptive statistical iterative reconstruction (ASIR) technique for chest CT in children: an intra-individual comparison. *Eur J Radiol* 81:e938-43, .

150. Singh S, Kalra MK, Shenoy-Bhangle AS, et al. Radiation dose reduction with hybrid iterative reconstruction for pediatric CT. *Radiology*. 2012 May;263(2):537-46.

151. Greess HH Institute of Radiology, University of Erlangen, Maximiliansplatz 1, 91054 Erlangen, Germany. holger.greess@idr.imed.uni-erlangen.de, Lutze JJ, Nömayr AA, et al. Dose reduction in subsecond multislice spiral CT examination of children by online tube current modulation. *Eur Radiol* 14:995-9, .

152. Mansour John CJ Department of Surgery, Memorial Sloan-Kettering Cancer Center, New York, New York 10021, USA., Schwartz Lawrence L, Pandit-Taskar Neeta N, et al. The utility of F-18 fluorodeoxyglucose whole body PET imaging for determining malignancy in cystic lesions of the pancreas. *J Gastrointest Surg* 10:1354-60, .

153. Geleijns Jacob J Department of Radiology, Leiden University Medical Center, P O Box 9600, 2300 RC, Leiden, The Netherlands. k.geleijns@lumc.nl, Wang Jia J, McCollough Cynthia C. The use of breast shielding for dose reduction in pediatric CT: arguments against the proposition. *Pediatr Radiol* 40:1744-7, .

154. Kim Sangroh S Medical Physics Graduate Program, Duke University Medical Center, Durham, NC, USA., Frush Donald PDP, Yoshizumi Terry TTT. Bismuth shielding in CT: support for use in children. *Pediatr Radiol* 40:1739-43, .

155. McCollough Cynthia HCH Department of Radiology, Mayo Clinic, Rochester, Minnesota 55905, USA. mccollough.cynthia@mayo.edu, Wang Jia J, Berland Lincoln LLL. Bismuth shields for CT dose reduction: do they help or hurt?. *J Am Coll Radiol* 8:878-9, .

156. Kim Jee-Eun JE Department of Radiology, Lucile Packard Children's Hospital, Stanford University School of Medicine, 725 Welch Rd, Stanford, CA 94304-5913, USA., Newman Beverley B. Evaluation of a radiation dose reduction strategy for pediatric chest CT. *AJR Am J Roentgenol* 194:1188-93, .

157. Kawel Nadine N Department of Radiology, Kantonsspital Graubünden, Chur, Switzerland. nadine.kawel@gmx.de, Seifert Burkhardt B, Luetolf Marcus M, Boehm Thomas T. Effect of slab thickness on the CT detection of pulmonary nodules: use of sliding thin-slab maximum intensity projection and volume rendering. *AJR Am J Roentgenol* 192:1324-9, .

158. Peloschek P, Sailer J, Weber M, Herold CJ, Prokop M, Schaefer-Prokop C. Pulmonary nodules: sensitivity of maximum intensity projection versus that of volume rendering of 3D multidetector CT data. *Radiology* 2007;243:561-9.

159. Siegel M JM Mallinckrodt Institute of Radiology, Washington University School of Medicine, 510 S Kingshighway Blvd, St Louis, MO 63110, USA. siegelm@mir.wustl.edu, Bhalla SS, Gutierrez F RFR, Hildebolt CC, Sweet SS. Post-lung transplantation bronchiolitis obliterans syndrome: usefulness of expiratory thin-section CT for diagnosis. *Radiology* 220:455-62, .

160. Bae Kyongtae TKT Department of Radiology, University of Pittsburgh School of Medicine, 3362 Fifth Ave., Pittsburgh, PA 15213, USA. baek@upmc.edu, Shah Amisha JAJ, Shang Sherry SSS, et al. Aortic and hepatic contrast enhancement with abdominal 64-MDCT in pediatric patients: effect of body weight and iodine dose. *AJR Am J Roentgenol* 191:1589-94, .

161. Chan Frandics PFP Department of Radiology, Stanford University Medical Center, Stanford, CA 94305-5105, USA. frandics@stanford.edu, Rubin Geoffrey DGD. MDCT angiography of pediatric vascular diseases of the abdomen, pelvis, and extremities. *Pediatr Radiol* 35:40-53, .

162. Karmazyn Boaz B Department of Pediatric Radiology, Indiana University School of Medicine, Indianapolis, IN, USA. bkarmazy@iupui.edu, Liang Yun Y, Klahr Paul P, Jennings S Gregory SG. Effect of tube voltage on CT noise levels in different phantom sizes. *AJR Am J Roentgenol* 200:1001-5, .

163. Reid Janet J Department of Radiology, Section of Pediatric Radiology, Children's Hospital, Cleveland Clinic, Cleveland, OH 44195, USA. reidj@ccf.org, Gamberoni Jessica J, Dong Frank F, Davros William W. Optimization of kVp and mAs for pediatric low-dose simulated abdominal CT: is it best to base parameter selection on object circumference?. *AJR Am J Roentgenol* 195:1015-20, .

- 164.** CollettiPatrick MPMDepartment of Radiology, University of Southern California Keck School of Medicine, LAC+USC Medical Center, 1200 N State St, Los Angeles, CA 90033, USA. Colletti@usc.edu, MicheliOrlando AOA, LeeKai HKH. To shield or not to shield: application of bismuth breast shields. *AJR Am J Roentgenol* 200;503-7, .
- 165.** StraussKeith JKJDepartment of Radiology, Cincinnati Children's Hospital Medical Center, University of Cincinnati School of Medicine, Cincinnati, Ohio. Electronic address: keith.strauss@cchmc.org., GingoldEric LELDepartment of Radiology, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania., FrushDonald PDPDepartment of Radiology, Duke University Medical Center, Durham, North Carolina.. Reconsidering the Value of Gonadal Shielding During Abdominal/Pelvic Radiography. *J Am Coll Radiol* 14:1635-1636, .
- 166.** Wichmann JL, Hu X, Kerl JM, et al. 70 kVp computed tomography pulmonary angiography: potential for reduction of iodine load and radiation dose. *J Thorac Imaging*. 30(1):69-76, 2015 Jan.
- 167.** ManneckSebastianS1 Department of Radiology, University Hospital of Basel, Basel, Switzerland., HurwitzLynne MLM2 Department of Radiology, Duke University Medical Center, Erwin Rd, Box 3808, Durham, NC 27710., SeamanDanielle MDM2 Department of Radiology, Duke University Medical Center, Erwin Rd, Box 3808, Durham, NC 27710., HeyeTobiasT1 Department of Radiology, University Hospital of Basel, Basel, Switzerland., BollDaniel TDT1 Department of Radiology, University Hospital of Basel, Basel, Switzerland.2 Department of Radiology, Duke University Medical Center, Erwin Rd, Box 3808, Durham, NC 27710.. Whole-Body High-Pitch CT Angiography: Strategies to Reduce Radiation Dose and Contrast Volume. *AJR Am J Roentgenol* 209:1396-1403, .
- 168.** American College of Radiology. ACR Practice Parameter for Communication of Diagnostic Imaging Findings. Available at <https://gravitas.acr.org/PPTS/GetDocumentView?docId=74+&releaseId=2>
- 169.** American College of Radiology. ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography (CT) Equipment. Available at <https://gravitas.acr.org/PPTS/GetDocumentView?docId=131+&releaseId=2>
- 170.** SilvaAlvin CACDepartment of Radiology, Mayo Clinic, Scottsdale, AZ 85259, USA. silva.alvin@mayo.edu, MorseBrian GBG, HaraAmy KAK, PadenRobert GRG, HongoNorioN, PavlicekWilliamW. Dual-energy (spectral) CT: applications in abdominal imaging. *Radiographics* 31:1031-46; discussion 1047-50, .
- 171.** PatinoManuelMFrom the Division of Abdominal Imaging, Department of Radiology (M.P., A.P., M.D.A., F.J.S., R.G., D.V.S.), and Department of Abdominal Imaging and Intervention (P.F.H.), Massachusetts General Hospital and Harvard Medical School, 55 Fruit St, Boston, MA 02114., ProchowskiAndreaAFrom the Division of Abdominal Imaging, Department of Radiology (M.P., A.P., M.D.A., F.J.S., R.G., D.V.S.), and Department of Abdominal Imaging and Intervention (P.F.H.), Massachusetts General Hospital and Harvard Medical School, 55 Fruit St, Boston, MA 02114., AgrawalMukta DMDFrom the Division of Abdominal Imaging, Department of Radiology (M.P., A.P., M.D.A., F.J.S., R.G., D.V.S.), and Department of Abdominal Imaging and Intervention (P.F.H.), Massachusetts General Hospital and Harvard Medical School, 55 Fruit St, Boston, MA 02114., et al. Material Separation Using Dual-Energy CT: Current and Emerging Applications. *Radiographics* 36:1087-105, .
- 172.** CourseyCourtney ACADepartment of Radiology, Duke University Medical Center, Durham, NC, USA. courtney.coursey@emoryhealthcare.org, NelsonRendon CRC, BollDaniel TDT, et al. Dual-energy multidetector CT: how does it work, what can it tell us, and when can we use it in abdominopelvic imaging?. *Radiographics* 30:1037-55, .
- 173.** McCollough CH, Leng S, Yu L, Fletcher JG. Dual- and Multi-Energy CT: Principles, Technical Approaches, and Clinical Applications. *Radiology*. 2015;276(3):637-653.
- 174.** SiegelMarilyn JMJ1 Mallinckrodt Institute of Radiology, Washington University School of Medicine, 510 S Kingshighway Blvd, Saint Louis, MO 63110., CurtisWill AWA1 Mallinckrodt Institute of Radiology, Washington University School of Medicine, 510 S Kingshighway Blvd, Saint Louis, MO 63110., Ramirez-GiraldoJuan CJC2 Siemens Healthcare USA, Malvern, PA.. Effects of Dual-Energy Technique on Radiation Exposure and Image Quality in Pediatric Body CT. *AJR Am J Roentgenol* 207:826-835, .
- 175.** ZhuXiaoweiXDepartment of Radiology, The Children's Hospital of Philadelphia, Philadelphia, PA, USA.The Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA, USA., McCulloughWilliam PWPDepartment of Radiology and Medical Imaging, University of Virginia Health System, P.O. Box 800170, Charlottesville, VA, 22908-0170, USA. wpm2k@virginia.edu., MeccaPatriciaPDepartment of Radiology, The Children's Hospital of Philadelphia, Philadelphia, PA, USA., ServaesSabahSDepartment of Radiology, The Children's Hospital of Philadelphia, Philadelphia, PA, USA.The Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA, USA., DargeKassaKDepartment of Radiology, The Children's Hospital of Philadelphia, Philadelphia, PA, USA.The Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA, USA.. Dual-energy compared to single-energy CT in pediatric imaging: a phantom study for DECT clinical guidance. *Pediatr Radiol* 46:1671-1679, .
- 177.** NeuhausVictorVFrom the Institute of Diagnostic and Interventional Radiology, University Hospital Cologne,

Cologne, Germany., AbdullayevNuranN, Große HokampNilsN, et al. Improvement of Image Quality in Unenhanced Dual Layer CT of the Head Using Virtual Monoenergetic Images Compared With Polyenergetic Single-Energy CT. Invest Radiol 52:470-476, .

178. American College of Radiology. ACR–AAPM–SPR Practice Parameter for Diagnostic Reference Levels and Achievable Doses in Medical X-Ray Imaging. Available at <https://gravitas.acr.org/PPTS/GetDocumentView?docId=16+&releaseId=2>