American College of Radiology
ACR Appropriateness Criteria®
Chest Pain-Child

Variant: 1 Child. Chest pain. Limited to the chest wall. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
Radiography chest	Usually Appropriate	☢
US chest	May Be Appropriate	O
Radiography rib views	May Be Appropriate	☢
MRI chest without and with IV contrast	Usually Not Appropriate	O
MRI chest without IV contrast	Usually Not Appropriate	O
CT chest with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 2 Child. Chest pain. Suspected pneumothorax or pneumomediastinum. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
Radiography chest	Usually Appropriate	☢
Radiography chest decubitus view	Usually Not Appropriate	☢
US chest	Usually Not Appropriate	O
US echocardiography transthoracic resting	Usually Not Appropriate	O
Fluoroscopy upper GI series	Usually Not Appropriate	☢☢☢
MRI chest without and with IV contrast	Usually Not Appropriate	O
MRI chest without IV contrast	Usually Not Appropriate	O
CT chest with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 3 Child. Chest pain. Suspected pulmonary embolism. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
Radiography chest	Usually Appropriate	☢
CTA pulmonary arteries with IV contrast	Usually Appropriate	☢☢☢☢
V/Q scan lung	May Be Appropriate	☢☢☢
US chest	Usually Not Appropriate	O
US duplex Doppler lower extremity	Usually Not Appropriate	O
US echocardiography transesophageal	Usually Not Appropriate	O
US echocardiography transthoracic resting	Usually Not Appropriate	O
Arteriography pulmonary with right heart catheterization	Usually Not Appropriate	☢☢☢☢
MRA pulmonary arteries without and with IV contrast	Usually Not Appropriate	O
MRA pulmonary arteries without IV contrast	Usually Not Appropriate	O
CT chest with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢☢

CT chest without IV contrast	Usually Not Appropriate	☢☢☢☢
CTA chest with IV contrast with CTV lower extremities	Usually Not Appropriate	☢☢☢☢

Variant: 4 Child. Chest pain. Known or suspected cardiac disease. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
US echocardiography transthoracic resting	Usually Appropriate	O
Radiography chest	Usually Appropriate	☢
CTA chest with IV contrast	May Be Appropriate	☢☢☢☢
CTA coronary arteries with IV contrast	May Be Appropriate	☢☢☢☢
CT heart function and morphology with IV contrast	May Be Appropriate	☢☢☢☢
US chest	Usually Not Appropriate	O
US echocardiography transesophageal	Usually Not Appropriate	O
US echocardiography transthoracic stress	Usually Not Appropriate	O
Arteriography coronary with ventriculography	Usually Not Appropriate	☢☢☢☢
Arteriography pulmonary	Usually Not Appropriate	☢☢☢☢
MRA chest without and with IV contrast	Usually Not Appropriate	O
MRA chest without IV contrast	Usually Not Appropriate	O
MRI heart function and morphology without and with IV contrast	Usually Not Appropriate	O
MRI heart function and morphology without IV contrast	Usually Not Appropriate	O
MRI heart function with stress without and with IV contrast	Usually Not Appropriate	O
MRI heart function with stress without IV contrast	Usually Not Appropriate	O
CT chest with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without IV contrast	Usually Not Appropriate	☢☢☢☢
V/Q scan lung	Usually Not Appropriate	☢☢☢
FDG-PET/CT heart	Usually Not Appropriate	☢☢☢☢
SPECT or SPECT/CT MPI rest and stress	Usually Not Appropriate	☢☢☢☢☢

Variant: 5 Child. Chest pain. History of sickle cell disease. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level
Radiography chest	Usually Appropriate	☢
US abdomen	Usually Not Appropriate	O
US chest	Usually Not Appropriate	O
US echocardiography transthoracic resting	Usually Not Appropriate	O
US echocardiography transthoracic stress	Usually Not Appropriate	O
MRI chest without and with IV contrast	Usually Not Appropriate	O
MRI chest without IV contrast	Usually Not Appropriate	O
CT chest with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without IV contrast	Usually Not Appropriate	☢☢☢☢
CTA chest with IV contrast	Usually Not Appropriate	☢☢☢☢

Variant: 6 Child. Chest pain. Suspected panic attack. Initial imaging.

Procedure	Appropriateness Category	Peds Relative Radiation Level

Radiography chest	May Be Appropriate	☢
US chest	Usually Not Appropriate	O
US echocardiography transthoracic resting	Usually Not Appropriate	O
US echocardiography transthoracic stress	Usually Not Appropriate	O
MRI chest without and with IV contrast	Usually Not Appropriate	O
MRI chest without IV contrast	Usually Not Appropriate	O
CT chest with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without and with IV contrast	Usually Not Appropriate	☢☢☢☢
CT chest without IV contrast	Usually Not Appropriate	☢☢☢☢

Panel Members

Scott R. Dorfman, MD[a], Sherwin S. Chan, MD, PhD[b], Siraj Amanullah, MD, MPH[c], Brandon P. Brown, MD, MA[d], John Smith Hokanson, MD[e], George Koberlein, MD[f], Morgan P. McBee, MD[g], Anh-Vu H. Ngo, MD[h], HaiThuy N. Nguyen, MD[i], Emily S. Orscheln, MD[j], Elizabeth J. Snyder, MD[k], Shawn D. St. Peter, MD[l], George S. Wu, MD[m], Ramesh S. Iyer, MD, MBA[n]

Summary of Literature Review

Introduction/Background

Chest pain is a common complaint in children and adolescents. The causes of chest pain are varied and include musculoskeletal, pulmonary or pleural, gastrointestinal, psychogenic, and cardiac etiologies. The etiology of pediatric chest pain is often benign but typically generates evaluation in the emergency room, urgent care, or outpatient setting.

Nontraumatic musculoskeletal etiologies are the most common causes for chest pain and account for 40% to 80% of cases of pediatric chest pain [1-3]. Musculoskeletal causes can be diagnosed by careful physical examination. Palpation eliciting chest wall tenderness, aggravation of pain during inspiration, and development of pain with movement and tenderness on palpation over the ribs or costochondral junctions all are compatible with a musculoskeletal etiology for chest pain [1].

Psychogenic causes represent the second-most common etiology and can be elicited by careful evaluation of the patient's history, including a history of depression, generalized anxiety disorder, and panic disorder.

Pneumonia or airways disease is also a leading etiology for pediatric chest pain [4]. However, this topic is discussed in the ACR Appropriateness Criteria® topic on "Pneumonia in the Immunocompetent Child" [5].

Pneumothorax and pneumomediastinum often present with chest pain accompanied by the sudden onset of shortness of breath.

Cardiac etiologies are the primary concern for parents, patients, and providers but account for <1% of cases [6]. Because of the potential severity of heart disease and the emotional impact on families, chest pain often leads to an extensive evaluation with low yield.

In the setting of sickle cell disease, acute chest syndrome (ACS) is a common etiology for chest pain [7]. Recognition of this condition is critical because ACS is a leading cause of morbidity and mortality in patients with sickle cell disease. ACS can occur with all phenotypes of sickle cell disease but can be more severe in hemoglobin S disease [8]. ACS can occur in children and adults of all ages [9].

Special Imaging Considerations

Dual-energy CT is used with increasing frequency in pediatric imaging and can be particularly useful in the setting of suspected pulmonary embolism (PE). When used as an adjunct to CT pulmonary arteries with intravenous (IV) contrast, dual-energy scanning with iodine mapping can add diagnostic value without increasing radiation dose, scan times, or contrast volume [10]. Dual-energy CT allows for the evaluation of quantitative and qualitative pulmonary perfusion [11,12].

The ACR defines practice parameters and technical standards for ultrasound (US) examinations. These US examinations are ordered by clinicians and performed in radiology departments with interpretation by radiologists. For the purposes of this document, the examination, listed on the variant tables and described in the variants below, is the US procedure as defined by the ACR practice parameters and technical standards.

Deviations from these examinations include but are not limited to targeted Point-of-Care US (POCUS), Focused Assessment with Sonography (FAST), and extended-FAST (E-FAST). These examinations are often performed at bedside as part of a clinical examination, are fundamentally different from comprehensive diagnostic US examinations, and are not performed in the radiology department or interpreted by radiologists.

POCUS performed by nonradiologists may have a role in the diagnosis of chest pain limited to the chest wall [13]. POCUS may also be used to detect a pneumothorax or pleural effusion.

Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously wherein each procedure provides unique clinical information to effectively manage the patient's care).

Discussion of Procedures by Variant

Variant 1: Child. Chest pain. Limited to the chest wall. Initial imaging.

Nontraumatic musculoskeletal chest pain is the most common identifiable cause of chest pain in

children and adolescents. Initial imaging is driven by localizing findings on physical examination or in the patient's history. Nearly all musculoskeletal causes are benign, and imaging has a limited role in evaluation with costochondritis, the most common diagnosis. With more diffuse chest wall pain, history and physical examination are usually sufficient to make a diagnosis. Imaging can be helpful with palpable abnormalities with initial imaging limited to chest radiographs and chest wall US.

Variant 1: Child. Chest pain. Limited to the chest wall. Initial imaging.
A. CT chest with IV contrast

CT chest with IV contrast is not a useful initial imaging study in this variant. Although CT chest with IV contrast can detect rib fractures, bone, and soft tissue tumors, it should be reserved for secondary imaging if clinically indicated and initial radiographs are normal.

Variant 1: Child. Chest pain. Limited to the chest wall. Initial imaging.
B. CT chest without and with IV contrast

There is no relevant literature to support the use of CT chest without and with IV contrast as an initial imaging study.

Variant 1: Child. Chest pain. Limited to the chest wall. Initial imaging.
C. CT chest without IV contrast

There is no relevant literature to support the use of CT chest without IV contrast as an initial imaging study.

Variant 1: Child. Chest pain. Limited to the chest wall. Initial imaging.
D. MRI chest without and with IV contrast

MRI chest without and with IV contrast is not a useful initial imaging study in this variant. Due to the superior soft tissue contrast of MRI, this modality can be useful as a secondary imaging study in the setting of a suspected mass.

Variant 1: Child. Chest pain. Limited to the chest wall. Initial imaging.
E. MRI chest without IV contrast

There is no relevant literature to support the use of MRI chest without IV contrast as an initial imaging study.

Variant 1: Child. Chest pain. Limited to the chest wall. Initial imaging.
F. Radiography chest

A chest radiograph is a useful initial imaging study in the setting of chest pain, limited to the chest wall. A chest radiograph can evaluate for rib fractures, infection, or a neoplasm and can look for causes of chest pain that may mimic chest wall pathology [14,15].

Variant 1: Child. Chest pain. Limited to the chest wall. Initial imaging.
G. Radiography rib views

Specific rib views may be used as an initial imaging study when there is high clinical suspicion for specific rib pathology such as a rib fracture, osteochondroma, or neoplasm [16].

Variant 1: Child. Chest pain. Limited to the chest wall. Initial imaging.
H. US chest

Although palpable chest wall masses are often painless, US of the chest wall can be a useful initial imaging study in the setting of a palpable abnormality of the chest wall [15] or if slipping rib syndrome is suspected [15-17].

Variant 2: Child. Chest pain. Suspected pneumothorax or pneumomediastinum. Initial imaging.

Patients with spontaneous pneumothorax or pneumomediastinum often present with chest or neck pain or sore throat, cough, and dyspnea. Spontaneous pneumomediastinum often presents in the context of underlying airways disease with alveolar rupture and the tracking of air into the mediastinum inciting the event [18]. Pneumomediastinum is almost never caused by rupture of the esophagus, even when there is a history of forceful coughing or vomiting. Therefore, an esophagram or CT examination of the chest are rarely indicated. On physical examination, there is palpable subcutaneous air within the soft tissues of the neck in two-thirds of patients at the time of presentation. Approximately 10% of patients with spontaneous pneumomediastinum have a concomitant pneumothorax [18]. Spontaneous pneumothorax is a more common occurrence and may be primary or secondary (associated with underlying lung disease) [19].

Variant 2: Child. Chest pain. Suspected pneumothorax or pneumomediastinum. Initial imaging.
A. CT chest with IV contrast

There is no relevant literature to support the use of CT chest with IV contrast as an initial imaging study in the setting of chest pain with suspected pneumothorax or pneumomediastinum.

Variant 2: Child. Chest pain. Suspected pneumothorax or pneumomediastinum. Initial imaging.
B. CT chest without and with IV contrast

There is no relevant literature to support the use of CT chest without and with IV contrast as an initial imaging study in the setting of chest pain with suspected pneumothorax or pneumomediastinum.

Variant 2: Child. Chest pain. Suspected pneumothorax or pneumomediastinum. Initial imaging.
C. CT chest without IV contrast

There is no relevant literature to support the use of CT chest without IV contrast a as an initial imaging study in this variant. However, patients with pneumothorax or pneumomediastinum often will have a CT chest without IV contrast as a secondary imaging study.

Variant 2: Child. Chest pain. Suspected pneumothorax or pneumomediastinum. Initial imaging.
D. Fluoroscopy upper GI series

There is no relevant literature to support the use of fluoroscopy upper gastrointestinal series as an initial imaging study in the setting of chest pain with suspected pneumothorax or pneumomediastinum. Numerous retrospective studies confirm that esophageal perforation is a rare etiology for spontaneous pneumomediastinum [20-22].

Variant 2: Child. Chest pain. Suspected pneumothorax or pneumomediastinum. Initial imaging.
E. MRI chest without and with IV contrast

There is no relevant literature to support the use of MRI chest without and with IV contrast as an initial imaging study in the setting of chest pain with suspected pneumothorax or pneumomediastinum.

Variant 2: Child. Chest pain. Suspected pneumothorax or pneumomediastinum. Initial

imaging.
F. MRI chest without IV contrast

There is no relevant literature to support the use of MRI chest without IV contrast as an initial imaging study in the setting of chest pain with suspected pneumothorax or pneumomediastinum.

Variant 2: Child. Chest pain. Suspected pneumothorax or pneumomediastinum. Initial imaging.
G. Radiography chest

Chest radiographs are useful as an initial imaging study when a pneumothorax or pneumomediastinum is suspected. Radiography offers high sensitivity and specificity for the presence of extrapulmonary air and can evaluate for alternative etiologies that present with similar symptoms [23].

Variant 2: Child. Chest pain. Suspected pneumothorax or pneumomediastinum. Initial imaging.
H. Radiography chest decubitus view

Although decubitus views of the chest may be helpful when a subtle pneumothorax is suspected, there is no relevant literature that supports the use of this specific radiographic view for initial imaging.

Variant 2: Child. Chest pain. Suspected pneumothorax or pneumomediastinum. Initial imaging.
I. US chest

Although US can be used to evaluate a suspected pneumothorax, it is not useful for initial imaging [24,25]. There is no relevant literature to support the use of US in evaluation of pneumomediastinum.

Variant 2: Child. Chest pain. Suspected pneumothorax or pneumomediastinum. Initial imaging.
J. US echocardiography transthoracic resting

There is no relevant literature that supports the use of transthoracic echocardiography (TTE) resting as an initial imaging study in the setting of chest pain with suspected pneumothorax or pneumomediastinum.

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.

The incidence of PE in children is estimated at 1 per 100,000 and is associated with mortality rates of up to 10% [26]. The incidence of PE is even higher in hospitalized pediatric patients [27]. Presenting symptoms include chest pain, shortness of breath, cough, fever, and hemoptysis, although pediatric patients can have mild or nonspecific symptoms due to high cardiopulmonary reserve [10,28]. Risk factors for pediatric thromboembolism, in order of importance, include immobilization, indwelling central venous catheter, prior PE and/or deep venous thrombosis, hypercoagulable conditions, and excess estrogen state, as can be seen with oral contraceptive use [10,28,29]. Although clinical assessment tools such as quantitative analysis of the D-dimer assay have been well studied in adults, there is a lack of evidence due to limited research to support their use in the pediatric population [10]. Because PE can be a fatal condition if untreated, diagnostic imaging that is highly sensitive and specific for the condition is critical in assessing which patients need anticoagulation.

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.

A. Arteriography pulmonary with right heart catheterization

There is no relevant literature to support the use of arteriography pulmonary with right heart catheterization as an initial imaging study in the setting of chest pain with suspected PE.

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.
B. CT chest with IV contrast

There is no relevant literature to support the use of CT chest with IV contrast as an initial imaging study in the setting of chest pain with suspected PE.

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.
C. CT chest without and with IV contrast

There is no relevant literature to support the use of CT chest without and with IV contrast as an initial imaging study in the setting of chest pain with suspected PE.

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.
D. CT chest without IV contrast

There is no relevant literature to support the use of CT chest without IV contrast as an initial imaging study in the setting of chest pain with suspected PE.

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.
E. CTA chest with IV contrast with CTV lower extremities

There is no relevant literature to support the use of CT angiography (CTA) chest with IV contrast with CT venography (CTV) lower extremities as an initial imaging study in the setting of chest pain with suspected PE.

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.
F. CTA pulmonary arteries with IV contrast

CTA pulmonary arteries with IV contrast is the most important imaging study for evaluation of suspected PE and can be used as an initial imaging study [28,30,31]. Imaging findings include complete or partial filling of a pulmonary artery with a filling defect that is of lower attenuation than the surrounding contrast-enhanced blood. Postprocessing techniques such as dual-energy iodine map analysis have been studied in adults [32,33], but there is limited literature to support its use in the pediatric population.

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.
G. MRA pulmonary arteries without and with IV contrast

Although MR angiography (MRA) pulmonary arteries without and with IV contrast could be considered as an alternative to CTA pulmonary arteries in some clinical settings, the longer scan times and the necessity for breath holding represent limitations.

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.
H. MRA pulmonary arteries without IV contrast

MRA pulmonary arteries without IV contrast may be helpful in the assessment of central and large pulmonary arteries, but the technique is limited for smaller and segmental arteries. There is no relevant literature to support the use of this modality for initial imaging [28].

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.
I. Radiography chest

Chest radiographs have a low sensitivity and specificity for PE but are often used as initial imaging

in the setting of chest pain with suspected PE to exclude other causes that can present with similar symptoms [28,34].

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.
J. US chest

There is no relevant literature that supports the use of US chest for initial imaging in the setting of chest pain with suspected PE.

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.
K. US duplex Doppler lower extremity

Although lower extremity thrombus is a risk factor for PE, there is no relevant literature to support the use of US duplex Doppler lower extremity as an initial imaging study.

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.
L. US echocardiography transesophageal

There is no relevant literature that supports the use of transesophageal echocardiography (TEE) for initial imaging in the setting of chest pain with suspected PE.

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.
M. US echocardiography transthoracic resting

There is no relevant literature that supports the use of TTE resting for initial imaging in the setting of chest pain with suspected PE.

Variant 3: Child. Chest pain. Suspected pulmonary embolism. Initial imaging.
N. V/Q scan lung

Prior to the adoption of CT pulmonary arteries with IV contrast, nuclear medicine ventilation-perfusion (V/Q) lung scans were the primary imaging study for the diagnosis of PE. V/Q scintigraphy offers relative low sensitivity and specificity and requires patient cooperation that may be challenging in the pediatric population.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.

Cardiac disease as an etiology for chest pain causes the greatest concern for parents and patients. Due to the serious nature of cardiac disease, evaluation is resource-intensive, but its diagnosis is infrequent [1,3,6,35-38]. In fact, cardiac pathology is found in only 1% to 2% of pediatric patients who present with chest pain. Differentiation of cardiac from noncardiac causes requires careful clinical assessment, often from a pediatric cardiologist. However, imaging is a frequent component of the workup. Diagnostic imaging may be more frequently employed in younger children in whom localization and accurate history may be more difficult. Cardiac pathology presenting as chest pain includes cardiac arrythmias, mitral valve prolapse, myocarditis, cardiomyopathy, and rarely coronary artery pathology. Although physical examination and history are usually sufficient to diagnose a cardiac cause for chest pain, chest radiographs are typically obtained for initial imaging.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
A. Arteriography coronary with ventriculography

There is no relevant literature that supports the use of arteriography coronary with ventriculography as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.

B. Arteriography pulmonary

There is no relevant literature that supports the use of arteriography pulmonary as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
C. CT chest with IV contrast

There is no relevant literature that supports the use of CT chest with IV contrast as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
D. CT chest without and with IV contrast

There is no relevant literature that supports the use of CT chest without and with IV contrast as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
E. CT chest without IV contrast

There is no relevant literature that supports the use of CT chest without IV contrast as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
F. CT heart function and morphology with IV contrast

There is no relevant literature that supports the use of CT heart function and morphology with IV contrast as an initial imaging study in the setting of chest pain with suspected cardiac disease. With a known diagnosis of congenital heart disease or following surgical treatment, CT heart function and morphology with IV contrast is often a first-line test.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
G. CTA chest with IV contrast

There is no relevant literature that supports the use of CTA chest with IV contrast as an initial imaging study in the setting of chest pain with suspected cardiac disease. With a known diagnosis of congenital heart disease or following surgical treatment, CTA chest with IV contrast may be an appropriate initial examination.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
H. CTA coronary arteries with IV contrast

There is no relevant literature that supports the use of CT coronary arteries with IV contrast as an initial imaging study in the setting of chest pain with suspected cardiac disease. With a known diagnosis of anomalous coronary arteries or following surgical treatment, CT coronary arteries with IV contrast may be a first-line test.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
I. FDG-PET/CT heart

There is no relevant literature that supports the use of fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/CT heart as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
J. MRA chest without and with IV contrast

There is no relevant literature that supports the use of MRA chest without and with IV contrast as

an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
K. MRA chest without IV contrast

There is no relevant literature that supports the use of MRA chest without IV contrast as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
L. MRI heart function and morphology without and with IV contrast

There is no relevant literature that supports the use of MRI heart function and morphology without and with IV contrast as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
M. MRI heart function and morphology without IV contrast

There is no relevant literature that supports the use MRI heart function and morphology without IV contrast as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
N. MRI heart function with stress without and with IV contrast

There is no relevant literature that supports the use of MRI heart function with stress without and with IV contrast as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
O. MRI heart function with stress without IV contrast

There is no relevant literature that supports the use of MRI heart function with stress without IV contrast as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
P. Radiography chest

Due to the high sensitivity of chest radiographs for the evaluation of cardiac size, pulmonary vascularity, and pulmonary edema, as well as alternative diagnoses such as pneumonia or pneumothorax, radiography chest is appropriate for initial imaging in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
Q. SPECT or SPECT/CT MPI rest and stress

There is no relevant literature that supports the use of single-photon emission CT (SPECT) or SPECT/CT myocardial perfusion imaging (MPI) rest and stress as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
R. US chest

There is no relevant literature that supports the use of US chest as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.

S. US echocardiography transesophageal

There is little relevant literature that supports the use of TEE as an initial imaging study in the setting of chest pain with suspected cardiac disease. However, TEE may be useful for follow-up of known congenital heart disease, during cardiac surgery, or for guidance of a cardiac procedure [39].

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
T. US echocardiography transthoracic resting

TTE resting is useful as an initial imaging study in the setting of chest pain with known or suspected cardiac disease [40].

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
U. US echocardiography transthoracic stress

There is no relevant literature that supports the use of TTE stress as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 4: Child. Chest pain. Known or suspected cardiac disease. Initial imaging.
V. V/Q scan lung

There is no relevant literature that supports the use of V/Q scan lung as an initial imaging study in the setting of chest pain with known or suspected cardiac disease.

Variant 5: Child. Chest pain. History of sickle cell disease. Initial imaging.

ACS is a common reason for hospitalization and the leading cause of death in patients with sickle cell disease. ACS is the cause of up to 25% of deaths, and approximately 50% of patients with sickle cell disease will have ACS in their lifetime [8]. ACS often presents with chest pain, cough, wheezing, rales, and fever [41]. In children, the most common cause of ACS is infection, followed by bone marrow fat embolism and pulmonary infarction from sequestration of sickled erythrocytes [8]. The hallmark of the diagnosis is a new opacity noted on a chest radiograph [7].

Variant 5: Child. Chest pain. History of sickle cell disease. Initial imaging.
A. CT chest with IV contrast

There is no relevant literature that supports the use of CT chest with IV contrast for initial imaging in the setting of chest pain with a history of sickle cell disease.

Variant 5: Child. Chest pain. History of sickle cell disease. Initial imaging.
B. CT chest without and with IV contrast

There is no relevant literature that supports the use of CT chest without and with IV contrast for initial imaging in the setting of chest pain with a history of sickle cell disease.

Variant 5: Child. Chest pain. History of sickle cell disease. Initial imaging.
C. CT chest without IV contrast

There is no relevant literature that supports the use of CT chest without IV contrast for initial imaging in the setting of chest pain with a history of sickle cell disease.

Variant 5: Child. Chest pain. History of sickle cell disease. Initial imaging.
D. CTA chest with IV contrast

There is no relevant literature that supports the use of CTA chest with IV contrast for initial imaging in the setting of chest pain with a history of sickle cell disease.

Variant 5: Child. Chest pain. History of sickle cell disease. Initial imaging.

E. MRI chest without and with IV contrast

There is no relevant literature that supports the use of MRI chest without and with IV contrast for initial imaging in the setting of chest pain with a history of sickle cell disease.

Variant 5: Child. Chest pain. History of sickle cell disease. Initial imaging.
F. MRI chest without IV contrast

There is no relevant literature that supports the use of MRI chest without IV contrast for initial imaging in the setting of chest pain with a history of sickle cell disease.

Variant 5: Child. Chest pain. History of sickle cell disease. Initial imaging.
G. Radiography chest

Chest radiography is used as the initial imaging modality in the setting of chest pain in patients with a known diagnosis of sickle cell disease. Chest radiographs are sensitive for detecting parenchymal opacities and pleural effusions, which are the hallmark of ACS [41].

Variant 5: Child. Chest pain. History of sickle cell disease. Initial imaging.
H. US abdomen

There is no relevant literature that supports the use of US abdomen for initial imaging in the setting of chest pain with a history of sickle cell disease.

Variant 5: Child. Chest pain. History of sickle cell disease. Initial imaging.
I. US chest

There is no relevant literature that supports the use of US chest for initial imaging in the setting of chest pain with a history of sickle cell disease.

Variant 5: Child. Chest pain. History of sickle cell disease. Initial imaging.
J. US echocardiography transthoracic resting

There is no relevant literature that supports the use of TTE resting for initial imaging in the setting of chest pain with a history of sickle cell disease.

Variant 5: Child. Chest pain. History of sickle cell disease. Initial imaging.
K. US echocardiography transthoracic stress

There is no relevant literature that supports the use of TTE stress for initial imaging in the setting of chest pain with a history of sickle cell disease.

Variant 6: Child. Chest pain. Suspected panic attack. Initial imaging.

Although psychogenic causes of pediatric chest pain represent the second-most common cause, the diagnosis can be made by a careful history and physical examination. There is no relevant literature to support the use of imaging in the evaluation of chest pain from a psychogenic etiology.

Variant 6: Child. Chest pain. Suspected panic attack. Initial imaging.
A. CT chest with IV contrast

There is no relevant literature that supports the use of CT chest with IV contrast for initial imaging in the setting of chest pain, suspected panic attack.

Variant 6: Child. Chest pain. Suspected panic attack. Initial imaging.
B. CT chest without and with IV contrast

There is no relevant literature that supports the use of CT chest without and with IV contrast for initial imaging in the setting of chest pain, suspected panic attack.

Variant 6: Child. Chest pain. Suspected panic attack. Initial imaging.
C. CT chest without IV contrast

There is no relevant literature that supports the use of CT chest without IV contrast for initial imaging in the setting of chest pain, suspected panic attack.

Variant 6: Child. Chest pain. Suspected panic attack. Initial imaging.
D. MRI chest without and with IV contrast

There is no relevant literature that supports the use of MRI chest without and with IV contrast for initial imaging in the setting of chest pain, suspected panic attack.

Variant 6: Child. Chest pain. Suspected panic attack. Initial imaging.
E. MRI chest without IV contrast

There is no relevant literature that supports the use of MRI chest without IV contrast for initial imaging in the setting of chest pain, suspected panic attack.

Variant 6: Child. Chest pain. Suspected panic attack. Initial imaging.
F. Radiography chest

Although there is no role for imaging in the setting of chest pain, suspected panic attack, chest radiography is reasonable for initial imaging to exclude the possibility of another diagnosis that presents with similar symptoms such as infection, pneumomediastinum, or a pneumothorax.

Variant 6: Child. Chest pain. Suspected panic attack. Initial imaging.
G. US chest

There is no relevant literature that supports the use of US chest for initial imaging in the setting of chest pain, suspected panic attack.

Variant 6: Child. Chest pain. Suspected panic attack. Initial imaging.
H. US echocardiography transthoracic resting

There is no relevant literature that supports the use of TTE resting for initial imaging in the setting of chest pain, suspected panic attack.

Variant 6: Child. Chest pain. Suspected panic attack. Initial imaging.
I. US echocardiography transthoracic stress

There is no relevant literature that supports the use of TTE stress for initial imaging in the setting of chest pain, suspected panic attack.

Summary of Highlights

This is a summary of the key recommendations from the variant tables. Refer to the complete narrative document for more information.

- **Variant 1**: Chest radiographs are useful as an initial imaging study in the setting of chest pain, limited to the chest wall. A chest radiograph can evaluate for rib or pleural pathology or other causes that may mimic chest wall pain. US of the chest wall may be appropriate if there is a palpable abnormality.

- **Variant 2**: Chest radiographs are useful as an initial imaging study when a pneumothorax or pneumomediastinum are suspected as the cause for chest pain. Radiographs of the chest with a decubitus view may be useful as an adjunct study when a subtle pneumothorax is suspected on

initial imaging.

- **Variant 3**: CTA pulmonary arteries with IV contrast is the most important imaging study for evaluation of chest pain with suspected PE and is useful as an initial imaging study. Chest radiographs are appropriate in the setting of chest pain with a suspected PE only to exclude other causes that can present with similar symptoms.

- **Variant 4**: Because of the high sensitivity of chest radiographs for the evaluation of cardiac size, pulmonary vascularity, and pulmonary edema, as well as alternative causes of chest pain, chest radiographs are appropriate for initial imaging in the setting of chest pain from suspected cardiac disease. TTE resting is also useful as an initial imaging study in the setting of chest pain with suspected cardiac disease. When a known diagnosis of heart disease is present or following surgical intervention, CT heart function and morphology with IV contrast may be appropriate as a primary imaging study.

- **Variant 5**: Chest radiographs are appropriate as initial imaging in the setting of chest pain in patients with known sickle cell disease to evaluate for ACS, a leading cause of morbidity and mortality in this patient population.

- **Variant 6**: There is no specific role for imaging in the setting of chest pain from a suspected psychogenic etiology, as careful history and physical examinations are sufficient for the diagnosis. However, chest radiographs may be appropriate to exclude another diagnosis that may present with similar symptoms.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents, please go to the ACR website at https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria.

Gender Equality and Inclusivity Clause

The ACR acknowledges the limitations in applying inclusive language when citing research studies that predates the use of the current understanding of language inclusive of diversity in sex, intersex, gender, and gender-diverse people. The data variables regarding sex and gender used in the cited literature will not be changed. However, this guideline will use the terminology and definitions as proposed by the National Institutes of Health.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.

May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

References

1. Aygun E, Aygun ST, Uysal T, Aygun F, Dursun H, Irdem A. Aetiological evaluation of chest pain in childhood and adolescence. Cardiol Young. 30(5):617-623, 2020 May.
2. Huang SW, Liu YK. Pediatric Chest Pain: A Review of Diagnostic Tools in the Pediatric Emergency Department. Diagnostics (Basel). 2024 Mar 01;14(5):526.

3. Powell AW, Pater CM, Chin C, et al. Implementation of a Pediatric Chest Pain Local Consensus Guideline Decreases the Total Tests Performed Without Negatively Affecting the Yield of Abnormal Cardiac Results. Pediatr Cardiol. 41(8):1580-1586, 2020 Dec.
4. Majerus CR, Tredway TL, Yun NK, Gerard JM. Utility of Chest Radiographs in Children Presenting to a Pediatric Emergency Department With Acute Asthma Exacerbation and Chest Pain. Pediatr Emerg Care. 37(7):e372-e375, 2021 Jul 01.
5. Chan SS, Kotecha MK, Rigsby CK, et al. ACR Appropriateness Criteria® Pneumonia in the Immunocompetent Child. J Am Coll Radiol 2020;17:S215-S25.
6. Kane DA, Friedman KG, Fulton DR, Geggel RL, Saleeb SF. Needles in Hay II: Detecting Cardiac Pathology by the Pediatric Chest Pain Standardized Clinical Assessment and Management Plan. Congenit. heart dis.. 11(5):396-402, 2016 Sep.
7. Creary SE, Krishnamurti L. Prodromal illness before acute chest syndrome in pediatric patients with sickle cell disease. J Pediatr Hematol Oncol. 36(6):480-3, 2014 Aug.
8. Bhasin N, Sarode R. Acute Chest Syndrome in Sickle Cell Disease. Transfus Med Rev 2023;37:150755.
9. Assad Z, Valtuille Z, Rybak A, et al. Unique Changes in the Incidence of Acute Chest Syndrome in Children With Sickle Cell Disease Unravel the Role of Respiratory Pathogens: A Time Series Analysis. Chest 2024;165:150-60.
10. Thacker PG, Lee EY. Advances in Multidetector CT Diagnosis of Pediatric Pulmonary Thromboembolism. [Review]. Korean J Radiol. 17(2):198-208, 2016 Mar-Apr.
11. Goo HW. Dual-energy lung perfusion and ventilation CT in children. Pediatr Radiol 2013;43:298-307.
12. Rapp JB, Ho-Fung VM, Ramirez KI, White AM, Otero HJ, Biko DM. Dual-source computed tomography protocols for the pediatric chest - scan optimization techniques. Pediatr Radiol 2023;53:1248-59.
13. Schleifer J, Liteplo AS, Kharasch S. Point-of-Care Ultrasound in a Child with Chest Wall Pain and Rib Osteomyelitis. J Emerg Med 2019;57:550-53.
14. Ayloo A, Cvengros T, Marella S. Evaluation and treatment of musculoskeletal chest pain. [Review]. Prim Care. 40(4):863-87, viii, 2013 Dec.
15. Ngo AV, Kim HHR, Maloney E, et al. Palpable pediatric chest wall masses. [Review]. Pediatr Radiol. 52(10):1963-1973, 2022 09.
16. Aboughalia HA, Ngo AV, Menashe SJ, Kim HHR, Iyer RS. Pediatric rib pathologies: clinicoimaging scenarios and approach to diagnosis. [Review]. Pediatr Radiol. 51(10):1783-1797, 2021 Sep.
17. Van Tassel D, McMahon LE, Riemann M, Wong K, Barnes CE. Dynamic ultrasound in the evaluation of patients with suspected slipping rib syndrome. Skeletal Radiol. 48(5):741-751, 2019 May.
18. Gasser CR, Pellaton R, Rochat CP. Pediatric Spontaneous Pneumomediastinum: Narrative Literature Review. [Review]. Pediatr Emerg Care. 33(5):370-374, 2017 May.
19. Ozkale Yavuz O, Ayaz E, Ozcan HN, Oguz B, Haliloglu M. Spontaneous pneumothorax in children: a radiological perspective. Pediatr Radiol 2024;54:1864-72.

20. Bakhos CT, Pupovac SS, Ata A, Fantauzzi JP, Fabian T. Spontaneous pneumomediastinum: an extensive workup is not required. J Am Coll Surg 2014;219:713-7.

21. Richer EJ, Sanchez R. Are esophagrams indicated in pediatric patients with spontaneous pneumomediastinum? J Pediatr Surg 2016;51:1778-81.

22. Roby K, Barkach C, Studzinski D, Novotny N, Akay B, Brahmamdam P. Spontaneous Pneumomediastinum is Not Associated With Esophageal Perforation: Results From a Retrospective, Case-Control Study in a Pediatric Population. Clin Pediatr (Phila) 2023;62:1568-74.

23. Yamada A, Taiji R, Nishimoto Y, et al. Pictorial Review of Pleural Disease: Multimodality Imaging and Differential Diagnosis. Radiographics 2024;44:e230079.

24. Trinavarat P, Riccabona M. Potential of ultrasound in the pediatric chest. [Review]. Eur J Radiol. 83(9):1507-18, 2014 Sep.

25. Volpicelli G, Boero E, Sverzellati N, et al. Semi-quantification of pneumothorax volume by lung ultrasound. Intensive Care Med. 40(10):1460-7, 2014 Oct.

26. Basaran AE, Basaran A, Durmus SY, Kazli T, Keven A, Bingol A. Analysis of predictive factors in children with high suspicion of pulmonary embolism. Pediatr Pulmonol. 59(2):274-280, 2024 Feb.

27. Sharaf N, Sharaf VB, Mace SE, Nowacki AS, Stoller JK, Carl JC. D-dimer in Adolescent Pulmonary Embolism. Acad Emerg Med. 25(11):1235-1241, 2018 11.

28. Degerstedt SG, Winant AJ, Lee EY. Pediatric Pulmonary Embolism: Imaging Guidelines and Recommendations. [Review]. Radiol Clin North Am. 60(1):69-82, 2022 Jan.

29. Lee EY, Tse SK, Zurakowski D, et al. Children suspected of having pulmonary embolism: multidetector CT pulmonary angiography--thromboembolic risk factors and implications for appropriate use. Radiology. 262(1):242-51, 2012 Jan.

30. Rajpurkar M, Biss T, Amankwah EK, et al. Pulmonary embolism and in situ pulmonary artery thrombosis in paediatrics. A systematic review. Thromb Haemost 2017;117:1199-207.

31. Woodard PK, Ho VB, Akers SR, et al. ACR Appropriateness Criteria® Known or Suspected Congenital Heart Disease in the Adult. J Am Coll Radiol 2017;14:S166-S76.

32. Li X, Chen GZ, Zhao YE, et al. Radiation Optimized Dual-source Dual-energy Computed Tomography Pulmonary Angiography: Intra-individual and Inter-individual Comparison. Acad Radiol. 24(1):13-21, 2017 01.

33. Weidman EK, Plodkowski AJ, Halpenny DF, et al. Dual-Energy CT Angiography for Detection of Pulmonary Emboli: Incremental Benefit of Iodine Maps. Radiology. 289(2):546-553, 2018 11.

34. Kirsch J, Brown RKJ, Henry TS, et al. ACR Appropriateness Criteria® Acute Chest Pain-Suspected Pulmonary Embolism. J Am Coll Radiol 2017;14:S2-S12.

35. Angoff GH, Kane DA, Giddins N, et al. Regional implementation of a pediatric cardiology chest pain guideline using SCAMPs methodology. Pediatrics. 132(4):e1010-7, 2013 Oct.

36. Harahsheh AS, O'Byrne ML, Pastor B, Graham DA, Fulton DR. Pediatric Chest Pain-Low-Probability Referral: A Multi-Institutional Analysis From Standardized Clinical Assessment and Management Plans (SCAMPs R), the Pediatric Health Information Systems Database,

and the National Ambulatory Medical Care Survey. Clin Pediatr (Phila). 56(13):1201-1208, 2017 Nov.

37. Nguyen T, Fundora MP, Welch E, et al. Application of the Pediatric Appropriate Use Criteria for Chest Pain. Journal of Pediatrics. 185:124-128, 2017 06.J Pediatr. 185:124-128, 2017 06.

38. Chamberlain RC, Pelletier JH, Blanchard S, Hornik CP, Hill KD, Campbell MJ. Evaluating Appropriate Use of Pediatric Echocardiograms for Chest Pain in Outpatient Clinics. J Am Soc Echocardiogr. 30(7):708-713, 2017 Jul.

39. Kamra K, Russell I, Miller-Hance WC. Role of transesophageal echocardiography in the management of pediatric patients with congenital heart disease. Paediatr Anaesth 2011;21:479-93.

40. Tessitore A, Caiffa T, Bobbo M, D'Agata Mottolese B, Barbi E, Chicco D. Anomalous aortic origin of coronary artery: For a challenging diagnosis, a transthoracic echocardiogram is recommended. [Review]. Acta Paediatr. 111(2):265-268, 2022 Feb.

41. Eisenbrown K, Nimmer M, Ellison AM, Simpson P, Brousseau DC. Which Febrile Children With Sickle Cell Disease Need a Chest X-Ray? Acad Emerg Med 2016;23:1248-56.

42. Measuring Sex, Gender Identity, and Sexual Orientation.

43. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: https://edge.sitecorecloud.io/americancoldf5f-acrorgf92a-productioncb02-3650/media/ACR/Files/Clinical/Appropriateness-Criteria/ACR-Appropriateness-Criteria-Radiation-Dose-Assessment-Introduction.pdf.

Disclaimer

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

[a]Texas Children's Hospital, Houston, Texas. [b]Panel Chair, Children's Mercy Hospital, Kansas City, Missouri. [c]Alpert Medical School of Brown University and Rhode Island Hospital/Hasbro Children's Hospital, Providence, Rhode Island; American College of Emergency Physicians. [d]Riley Hospital for Children at IU Health and Indiana University School of Medicine, Indianapolis, Indiana. [e]University of Wisconsin School of Medicine & Public Health, Madison, Wisconsin; American Academy of Pediatrics. [f]Nemours Children's Hospital, Orlando, Florida; Committee on Emergency Radiology-GSER.

[g]Medical University of South Carolina, Charleston, South Carolina. [h]Seattle Children’s Hospital, Seattle, Washington. [i]Children’s Hospital Los Angeles and Keck School of Medicine USC, Los Angeles, California. [j]Children's Mercy Hospital, Kansas City, Missouri. [k]Vanderbilt University Medical Center, Nashville, Tennessee. [l]Children's Mercy Hospital, Kansas City, Missouri, Pediatric Surgeon. [m]Geisinger Health System, Danville, Pennsylvania. [n]Specialty Chair, Seattle Children’s Hospital, Seattle, Washington.