

**American College of Radiology
ACR Appropriateness Criteria®
Sinusitis–Child**

Variant 1: Child. Uncomplicated acute sinusitis. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT paranasal sinuses with IV contrast	Usually Not Appropriate	☼☼☼
CT paranasal sinuses without and with IV contrast	Usually Not Appropriate	☼☼☼☼
CT paranasal sinuses without IV contrast	Usually Not Appropriate	☼☼☼
MRI paranasal sinuses without and with IV contrast	Usually Not Appropriate	○
MRI paranasal sinuses without IV contrast	Usually Not Appropriate	○
X-ray paranasal sinuses	Usually Not Appropriate	☼

Variant 2: Child. Persistent sinusitis (worsening course or severe presentation, or not responding to treatment), or recurrent sinusitis, or chronic sinusitis, or define paranasal sinus anatomy before functional endoscopic sinus surgery. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT paranasal sinuses without IV contrast	Usually Appropriate	☼☼☼
CT paranasal sinuses with IV contrast	Usually Not Appropriate	☼☼☼
CT paranasal sinuses without and with IV contrast	Usually Not Appropriate	☼☼☼☼
MRI paranasal sinuses without and with IV contrast	Usually Not Appropriate	○
MRI paranasal sinuses without IV contrast	Usually Not Appropriate	○
X-ray paranasal sinuses	Usually Not Appropriate	☼

Variant 3:**Child. Sinusitis with clinical concern of orbital or intracranial complications. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT head and paranasal sinuses with IV contrast	Usually Appropriate	☼☼☼
MRI head and paranasal sinuses without and with IV contrast	Usually Appropriate	○
MR venography head with IV contrast	May Be Appropriate	○
CT venography head with IV contrast	May Be Appropriate	☼☼☼☼
CTA head with IV contrast	May Be Appropriate	☼☼☼☼
MR venography head without and with IV contrast	May Be Appropriate	○
MR venography head without IV contrast	May Be Appropriate	○
MRA head without IV contrast	May Be Appropriate	○
MRA head with IV contrast	May Be Appropriate	○
CT head and paranasal sinuses without and with IV contrast	Usually Not Appropriate	☼☼☼☼
CT head and paranasal sinuses without IV contrast	Usually Not Appropriate	☼☼☼
MRI head and paranasal sinuses without IV contrast	Usually Not Appropriate	○
X-ray paranasal sinuses	Usually Not Appropriate	☼

Variant 4:**Child. Suspected invasive fungal sinusitis. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT paranasal sinuses with IV contrast	Usually Appropriate	☼☼☼
MRI paranasal sinuses without and with IV contrast	Usually Appropriate	○
CT venography head with IV contrast	May Be Appropriate	☼☼☼☼
CTA head with IV contrast	May Be Appropriate	☼☼☼☼
MR venography head with IV contrast	May Be Appropriate	○
MR venography head without and with IV contrast	May Be Appropriate (Disagreement)	○
MR venography head without IV contrast	May Be Appropriate	○
MRA head without IV contrast	May Be Appropriate	○
MRA head with IV contrast	May Be Appropriate	○
CT paranasal sinuses without and with IV contrast	Usually Not Appropriate	☼☼☼☼
CT paranasal sinuses without IV contrast	Usually Not Appropriate	☼☼☼
MRI paranasal sinuses without IV contrast	Usually Not Appropriate	○
X-ray paranasal sinuses	Usually Not Appropriate	☼

SINUSITIS–CHILD

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Summary of Literature Review

Introduction/Background

Acute sinusitis is defined as an acute inflammatory process involving the paranasal sinuses. Acute sinusitis is common in children and usually resolves spontaneously, although it can result in serious complications [1-9]. Acute sinusitis may be viral, bacterial, or fungal. Viral upper respiratory tract infections occur with an incidence of six episodes per patient year, and 8% of these viral infections are complicated by acute viral sinusitis [2]. Inflammation of the mucosal lining of the nose and paranasal sinuses secondary to viral infection sets the stage for bacterial superinfection [10], thus making viral infections the most common predisposing factor for acute bacterial sinusitis, followed by allergic rhinitis [1,3-5]. Other noninfectious factors that may lead to sinusitis in children include nasal airway obstruction, immunodeficiency, ciliary dysfunction, cystic fibrosis, and odontogenic infections [1,3-9,11-13].

The American Academy of Pediatrics (AAP) defines acute bacterial sinusitis as a persistent illness with nasal discharge of any quality and/or daytime cough lasting for >10 days without improvement, a worsening clinical course, a severe onset of symptoms with concurrent fever (temperature $\geq 39^{\circ}\text{C}$), and purulent nasal discharge for at least 3 consecutive days [14]. The diagnosis of acute bacterial sinusitis is based on clinical presentation and physical examination findings [1]. The clinical differentiation between viral and bacterial sinusitis and the decision to treat with antibiotics may be difficult; however, imaging is not recommended in this context as it does not change management [1]. Neither nasopharyngeal cultures nor sinus aspirates are useful or necessary for the diagnosis of acute sinusitis [10]. Imaging of the paranasal sinuses in children with acute bacterial sinusitis and without signs suggesting associated complication is not recommended [14].

Imaging abnormalities alone are not sufficient for the diagnosis of acute sinusitis because paranasal sinus opacification is often present in healthy children or in children having a computed tomography (CT) scan for other reasons. CT performed on young adults recovering from a cold illustrated that 87% had significant maxillary sinus abnormalities. One study showed that >50% of children with viral upper respiratory tract infection had abnormal maxillary sinus radiographs [2]. Further research showed that 68% of symptomatic children with upper respiratory tract infection and 42% of healthy children had significant sinus abnormalities on magnetic resonance imaging (MRI) [2]. This incidence is even higher in very young patient populations and reached 97% in a study of infants who had a cold in the 2 weeks preceding a head CT done for other reasons [15].

The AAP defines subacute bacterial sinusitis as a sinusitis that lasts between 30 and 90 days and whose symptoms resolve completely. Recurrent acute bacterial sinusitis is defined by episodes lasting <30 days each and separated by intervals of at least 10 asymptomatic days. Chronic sinusitis lasts >90 days, and is defined by persistent residual respiratory symptoms, such as cough, rhinorrhea, or nasal obstruction [1]. In patients with recurrent or chronic sinusitis, one must consider other underlying causes such as asthma, gastroesophageal reflux, cystic

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The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document.

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fibrosis, obstructive sleep apnea, or allergic rhinitis [1,14,16,17]. The most serious complication of chronic sinusitis is intracranial extension of infection [16,17].

Infection of specific paranasal sinuses can lead to characteristic symptoms and associated complications. Orbital and intracranial complications of sinusitis are uncommon but may cause significant morbidity and mortality. Low socioeconomic status and poor access to healthcare appear to have a positive correlation with intracranial complications of sinusitis [18]. Intracranial complications include meningitis, encephalitis, epidural and subdural empyema, orbital abscess, and, less commonly, brain abscess, and dural sinus thrombophlebitis [19-23]. Isolated sphenoid sinusitis is rare in children (1%–3% of sinonasal diseases); however, mortality and morbidity are quite high if diagnosis is delayed. Clinical diagnosis is difficult because of the vague and nonspecific symptoms of sphenoid sinusitis. Headache, severe ocular signs, or oculomotor palsy can be the initial presentation due to involvement of the orbital apex and/or cavernous sinuses. [17,24] .

Intracranial complications most commonly result from spread of primary infection within the frontal sinuses [19-23,25]. This typically occurs via progression of septic thrombi through the valveless diploic veins of the skull that penetrate the dura, or, less commonly, through direct intracranial extension of osteomyelitis [21]. Symptoms that suggest intracranial complications include Pott puffy tumor, altered consciousness, seizures, hemiparesis, and cranial nerve palsy [19-23]. Ethmoid sinusitis can lead to spread of infection through the lamina papyracea, a thin bone that separates the medial orbital wall from the ethmoid sinuses [26]. Manifestations of orbital involvement include medial orbital wall subperiosteal abscess, periorbital cellulitis, and ocular findings (eg, abnormal visual examination, ophthalmoplegia, or proptosis) [21,22,26-32]. Cavernous sinus thrombosis is another rare but potentially fatal intracranial complication that can arise from infection of either the sphenoid or ethmoid sinuses [33].

Although rare, increasing frequency of fungal sinusitis has been reported in children within the past 3 decades [34]. Fungal sinusitis can be invasive and noninvasive and has 5 subtypes. Invasive subtypes include acute invasive fungal sinusitis, chronic invasive fungal sinusitis, and chronic granulomatous invasive fungal sinusitis; noninvasive subtypes include allergic fungal sinusitis and fungus ball (fungal mycetoma). The treatment strategies for the subtypes are different, as are their prognoses [35].

Acute invasive fungal sinusitis is the most lethal subtype with mortality rates reaching 50% to 80%; therefore, a high level of clinical suspicion is critical [36]. It is typically seen in immunocompromised children, often times with hematological malignancies with low neutrophil counts. Painless nasal septal necrosis is the classical clinical presentation [34,35,37].

Allergic fungal sinusitis occurs in atopic children with refractory sinus disease, which requires a high index of suspicion for evaluation and aggressive treatment [38]. Allergic fungal sinusitis is more aggressive in children with increased fungal load and higher incidence of proptosis when compared with adults [39]. Allergic fungal sinusitis in children is also less responsive to treatment with increased recurrence rates [40].

Discussion of Procedures by Variant

Variant 1: Child. Uncomplicated acute sinusitis. Initial imaging.

CT

CT of the paranasal sinuses without or with contrast is not recommended in children as the diagnosis of uncomplicated acute sinusitis is based on clinical criteria alone.

MRI

MRI of paranasal sinuses without or with intravenous (IV) contrast is not recommended in children, as the diagnosis of uncomplicated acute sinusitis is based on clinical criteria alone.

Radiography

Radiographs are not recommended in uncomplicated acute sinusitis in children as the diagnosis of uncomplicated acute sinusitis is based on clinical criteria alone.

Variant 2: Child. Persistent sinusitis (worsening course or severe presentation, or not responding to treatment), or recurrent sinusitis, or chronic sinusitis, or define paranasal sinus anatomy before functional endoscopic sinus surgery. Initial imaging.

CT

CT is considered the gold standard for the imaging evaluation of sinusitis because it allows for the accurate depiction of sinus anatomy, soft-tissue changes, and potential associated complications [1,9,19,20,23,41-52]. With the advent of multidetector CT volume isometric imaging, it is possible to obtain images in the axial plane and reconstruct them into the coronal and sagittal planes [17,53,54]. CT volume isometric imaging is especially advantageous in young children who may not be able to cooperate for direct coronal plane image acquisition and avoids direct radiation to the orbits [55]. Low-dose CT of the paranasal sinuses has a radiation dose similar to two radiographic views of the paranasal sinuses [56]. CT is the study of choice in children with recurrent or chronic sinusitis before functional endoscopic sinus surgery as it provides a road map for surgery [49,57]. CT of the sinuses was not found to be superior to a clinical symptom score questionnaire in diagnosing chronic sinusitis [58], highlighting the importance of clinical presentation and physical examination findings in diagnoses. When CT of the paranasal sinuses is primarily performed for defining sinus anatomy or confirming clinically suspected recurrent or chronic sinusitis, contrast administration is not recommended.

MRI

MRI of the paranasal sinuses is a radiation-free, high-resolution imaging modality. It has the advantage of being able to differentiate mucosal thickening from sinus secretions [59,60]. However, MRI may require sedation or general anesthesia in order to be performed in young children [61]. Furthermore, MRI does not demonstrate the bony detail of the osteomeatal complex well and is less sensitive to bony erosions, making it less well suited than CT to evaluate for underlying anatomic abnormalities that may predispose to and from chronic sinusitis.

Radiography

Radiography is limited in the evaluation of persistent sinusitis because the views traditionally used in the evaluation of the paranasal sinuses are difficult to perform in young children and have low sensitivity and specificity for sinus disease as compared to CT because of a lack of anatomical detail [45-47,61-63]. The Water projection is the single best view for the evaluation of the maxillary antra. In patients with chronic sinusitis, the Water view reveals a sensitivity of 84.2% and specificity of 76.6% for the detection of sinus disease as compared to the gold standard of nasal endoscopy [16,17]. However, the Water view has also been shown to have a 32% false-negative rate and a 49.2% false-positive rate as compared to CT. In addition, most of the abnormalities in the ethmoid and sphenoid sinuses are not detected on the Water view [64]. The Caldwell and Water projections have also been shown to be limited in the detection of ethmoid disease [54].

Variant 3: Child. Sinusitis with clinical concern of orbital or intracranial complications. Initial imaging.

Symptoms at presentation that suggest intracranial complications include Pott puffy tumor, altered consciousness, seizures, hemiparesis, and cranial nerve palsy [19-23]. Complications include meningitis, encephalitis, epidural and subdural suppuration, orbital abscess, and, less commonly, brain abscess and dural sinus thrombophlebitis [19-23]. Cross-sectional imaging should therefore include the paranasal sinuses and head.

CT

Noncontrast CT examination utilizing the routine head CT or paranasal sinus CT protocol alone may not provide sufficient anatomical coverage for evaluation for complications. In addition, potential complications such as orbital or preseptal/periorbital cellulitis, subperiosteal abscess, or subdural/epidural collections are inadequately visualized and may be missed in the absence of IV contrast administration. Therefore CT with IV contrast of the sinuses to include the orbits and brain is recommended [23,65]. A reported benefit of contrast-enhanced CT for detection of sinusitis-related complications versus MRI is its significantly shorter scan time, decreasing the need for sedation or general anesthesia in very young children.

CTV

When clinical or imaging findings point to potential vascular complications of sinusitis such as venous thrombosis, CT venography (CTV) can be performed, either as a follow-up study or as part of the initial CT imaging protocol [22,23,25]. CTV is not recommended as a standalone study but rather a complementary examination to standard head and sinus CT because other potential complications may be missed if CTV alone is used.

CTA

When clinical or imaging findings point to potential vascular complications of sinusitis, such as mycotic aneurysm, CT angiography (CTA) can be performed, either as a follow-up study or as part of the initial CT imaging protocol [66]. CTA is not recommended as a standalone study but rather a complementary examination to standard head and sinus CT because other potential complications may be missed when only CTA is used.

MRV

When clinical or imaging findings point to potential vascular complications of sinusitis such as venous thrombosis, MR venography (MRV) can be performed, either as a follow-up study or as part of the initial MRI protocol. Noncontrast MRV techniques should be reserved for patients with contraindication to IV contrast or those patients who otherwise did not need IV contrast for the cross-sectional part of the examination. MRV is not recommended as a standalone study but rather a complementary examination to standard head and sinus MRI because other potential complications may be missed with when only MRV is used.

Symptoms at presentation that suggest intracranial complications include Pott puffy tumor, altered consciousness, seizures, hemiparesis, and cranial nerve palsy [19-23]. Complications include meningitis, encephalitis, epidural and subdural suppuration, orbital abscess, and, less commonly, brain abscess and dural sinus thrombophlebitis [19-23].

MRA

When clinical or imaging findings point to potential vascular complications of sinusitis such as mycotic aneurysm, MR angiography (MRA) can be performed, either as a follow-up study or as part of the initial MRI protocol [66]. MRA for the brain can be performed without IV contrast administration. MRA is not recommended as a standalone study but rather a complementary examination to standard head and sinus MRI because other potential complications may be missed when only MRA is used.

MRI

MRI of the paranasal sinuses and head with IV contrast are complementary imaging studies that should be performed to evaluate for complications of sinusitis. MRI is a radiation-free, high-contrast resolution imaging modality. The primary role of MRI in the clinical setting of sinusitis is to detect intracranial and orbital complications. It is more sensitive than CT with IV contrast (93% versus 63%) for detecting intracranial complications of sinusitis [21,25]. Studies have shown that MRI is significantly more accurate than CT (97% versus 87%) and clinical findings (82%) in diagnosing meningitis [25]. Diffusion-weighted imaging (DWI) can localize or confirm presence of purulent material as they typically present with restricted diffusion. Although MRI is also more sensitive than CT in diagnosing the presence of osteomyelitis, it does not demonstrate the bony detail of the osteomeatal complex well and is less sensitive to bony erosions. MRI may require sedation or general anesthesia in order to be performed in young children [61].

Radiography

Radiography is not sensitive for the relatively subtle soft-tissue changes or vascular complications related to the intraorbital or intracranial extension of sinusitis.

Variant 4: Child. Suspected invasive fungal sinusitis. Initial imaging.

CT

Immunocompromised children, particularly those with hematological malignancies, are vulnerable to development of acute invasive sinusitis, and paranasal sinus CT is more frequently used in this population to rule out the source of infection. If clinical suspicion for complicated sinusitis exists, CT with IV contrast of the sinuses to include the orbits and brain is indicated [23,65]. A reported benefit of contrast-enhanced CT for detection of sinusitis-related complications is its significantly shorter scan time, decreasing the need for sedation or general anesthesia in young children. CT of the paranasal sinuses without and with contrast is not recommended as it doubles the radiation exposure without additional significant diagnostic yield. Fungal sinusitis can be correctly diagnosed on CT with high accuracy [67,68]. Obliteration of the normal fat density within the periantral regions, osseous erosion, orbital, cavernous sinus, or brain involvement in an immunocompromised individual should raise the possibility of acute invasive fungal sinusitis [69].

CTV

When clinical or imaging findings point to potential vascular complications of sinusitis (mycotic aneurysm, venous thrombosis), CTV can be performed, either as follow-up studies or as part of the initial CT imaging

protocol. CTV is not recommended as a standalone study but rather a complementary examination to standard head and sinus CT because other potential complications may be missed when only CTV is used.

CTA

When clinical or imaging findings point to potential vascular complications of sinusitis (mycotic aneurysm, venous thrombosis), CTA can be performed, either as a follow-up study or as part of the initial CT imaging protocol. CTA is not recommended as a standalone study but rather a complementary examination to standard head and sinus CT because other potential complications may be missed when only CTA is used.

MRV

When clinical or imaging findings point to potential vascular complications of sinusitis (venous thrombosis), MRV can be performed either as a follow-up study or as part of the initial CT imaging protocol. One relevant downside in the pediatric population is that this may increase imaging time of already lengthy MRI protocols, slightly increasing the need for or the duration of sedation. MRV is not recommended as a standalone study but rather a complementary examination to standard head and sinus MRI because other potential complications may be missed when only MRV is used.

MRA

When clinical or imaging findings point to potential vascular complications of sinusitis (mycotic aneurysm), MRA can be performed either as a follow-up study or as part of the initial MRI protocol. One relevant downside in the pediatric population is that this may slightly increase imaging time of already lengthy MRI protocols, increasing the need for or the duration of sedation. MRA is not recommended as a standalone study but rather a complementary examination to standard head and sinus MRI because other potential complications may be missed when only MRA is used.

MRI

MRI of the paranasal sinuses is a radiation-free, high-resolution imaging modality. MRI is more sensitive than IV contrast-enhanced CT (93% versus 63%) for detecting intracranial complications of sinusitis [21,25]. Studies have shown that MRI is significantly more accurate than CT (97% versus 87%) and clinical findings (82%) in diagnosing meningitis [25]. Although MRI is also more sensitive than CT in diagnosing the presence of osteomyelitis, it does not demonstrate the bony detail of the osteomeatal complex well and is less sensitive to bony erosions. MRI may require sedation or general anesthesia in order to be performed in young children [61]. Contrast-enhanced MRI evaluation can be helpful in delineating the presence and extent of suspected complications of sinusitis.

The initial stages of fungal infection may not be apparent by imaging. MRI is more sensitive for detecting early changes of fungal sinusitis than CT. Perisinus invasion detected by MRI was found to be the most sensitive and specific single finding indicating invasive fungal sinusitis [70].

Radiography

Radiography is not sensitive for the soft-tissue changes or intracranial complications related to invasive fungal sinusitis.

Summary of Recommendations

- Child. Uncomplicated acute sinusitis: imaging studies are not recommended.
- Child. Persistent sinusitis (worsening course or severe presentation, or not responding to treatment), or recurrent sinusitis, or chronic sinusitis, or define paranasal sinus anatomy before functional endoscopic sinus surgery: CT of the paranasal sinuses without IV contrast is recommended.
- Child. Sinusitis with clinical concern of orbital or intracranial complications: CT or MRI of the head and paranasal sinuses with IV contrast is recommended. CTA or MRA/MRV may be complementary in cases with suspected vascular complications.
- Child. Suspected invasive fungal sinusitis: CT or MRI of the head and paranasal sinuses with IV contrast is recommended. CTA or MRA/MRV may be complementary in cases with suspected vascular complications.

Summary of Evidence

Of the 71 references cited in the *ACR Appropriateness Criteria[®] Sinusitis-Child* document, 1 is categorized as a therapeutic reference. Additionally, 70 references are categorized as diagnostic references including 4 good-

quality studies, and 11 quality studies that may have design limitations. There are 56 references that may not be useful as primary evidence.

The 71 references cited in the *ACR Appropriateness Criteria® Sinusitis-Child* document were published from 1977-2016.

Although there are references that report on studies with design limitations, 15 well-designed or good-quality studies provide good evidence.

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, both because of 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 to 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 [71].

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
○	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 (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies”.

Supporting Documents

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

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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.