

# ACR Appropriateness Criteria<sup>®</sup> Sinus Disease

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## Abstract

Imaging of sinonasal pathology may occur for assessment of rhinosinusitis or mass lesions. Rhinosinusitis is prevalent in up to 16% of the US population with annual economic burdens estimated at 22 billion dollars. Rhinosinusitis is characterized as acute or chronic based on symptom duration; if four or more episodes occur annually, the term *recurrent acute rhinosinusitis* (RARS) is used. In acute uncomplicated rhinosinusitis when inflammatory change remains in the paranasal sinuses and nasal cavity, imaging may not be required. Distinction between viral or bacterial rhinosinusitis is a clinical diagnosis, and imaging should be interpreted in conjunction with clinical and endoscopic findings. Sinus CT imaging is appropriate per clinical judgment in associated complications including headache, facial pain, swelling, orbital proptosis, or cranial nerve palsies. In maxillary sinusitis, teeth may require assessment because 20% may be odontogenic in origin. MRI may be complementary in aggressive infections with intraocular/intracranial complications, invasive fungal sinusitis, or sinonasal masses.

The American College of Radiology Appropriateness Criteria are evidence-based guidelines for specific clinical conditions that are reviewed annually by a multidisciplinary expert panel. The guideline development and revision include an extensive analysis of current medical literature from peer reviewed journals and the application of well-established methodologies (RAND/UCLA Appropriateness Method and Grading of Recommendations Assessment, Development, and Evaluation or GRADE) to rate the appropriateness of imaging and treatment procedures for specific clinical scenarios. In those instances where evidence is lacking or equivocal, expert opinion may supplement the available evidence to recommend imaging or treatment.

**Key Words:** Appropriateness Criteria, Appropriate Use Criteria, AUC, CT, Fungal nitis, Intracranial or intraorbital complications, MRI, Nonasal mass, Rhinosinusitis

*J Am Coll Radiol 2017;14:S550-S559. Copyright © 2017 American College of Radiology*

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Dr. Conley reports personal fees from Xoran, outside the submitted work. Dr. Marek Bykowski reports personal fees from Impact Biomedicines, outside the submitted work. The other authors have no conflicts of interest related to the material discussed in this article.

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.

**Variant 1.** Acute (<4 weeks) uncomplicated rhinosinusitis.

Radiologic Procedure	Rating	Comments	RRL
CT paranasal sinuses without IV contrast	4		⊗⊗
CT cone beam paranasal sinuses without contrast	4		⊗⊗
CT paranasal sinuses with IV contrast	2		⊗⊗
CT paranasal sinuses without and with IV contrast	1		⊗⊗⊗
MRI maxillofacial without IV contrast	1		○
MRI maxillofacial without and with IV contrast	1		○
X-ray paranasal sinuses	1		⊗

Note: Rating scale: 1, 2, 3 = usually not appropriate; 4, 5, 6 = may be appropriate; 7, 8, 9 = usually appropriate. IV = intravenous; RRL = relative radiation level.

**Variant 2.** Possible surgical candidate. Recurrent acute rhinosinusitis, chronic rhinosinusitis, sinonasal polyposis, or noninvasive fungal sinusitis.

Radiologic Procedure	Rating	Comments	RRL
CT paranasal sinuses without IV contrast	9		⊗⊗
CT cone beam paranasal sinuses without contrast	7		⊗⊗
CT paranasal sinuses with IV contrast	5		⊗⊗
MRI maxillofacial without IV contrast	4		○
MRI maxillofacial without and with IV contrast	4		○
CT paranasal sinuses without and with IV contrast	1		⊗⊗⊗
X-ray paranasal sinuses	1		⊗
Tc-99m SPECT paranasal sinuses	1		⊗⊗⊗

Note: Rating scale: 1, 2, 3 = usually not appropriate; 4, 5, 6 = may be appropriate; 7, 8, 9 = usually appropriate. IV = intravenous; RRL = relative radiation level; SPECT = single-photon emission computed tomography.

**Variant 3.** Acute rhinosinusitis. Suspected orbital or intracranial complication.

Radiologic Procedure	Rating	Comments	RRL
MRI maxillofacial without and with IV contrast	9	This procedure is complementary to CT paranasal sinuses without contrast.	○
MRI head without and with IV contrast	8	This procedure is complementary to MRI maxillofacial without and with contrast.	○
CT paranasal sinuses with IV contrast	8	This procedure is complementary to MRI maxillofacial without and with contrast.	⊗⊗
CT paranasal sinuses without IV contrast	7	This procedure is complementary to MRI maxillofacial without and with contrast.	⊗⊗
CT head with IV contrast	6		⊗⊗⊗
MRI maxillofacial without IV contrast	6		○
MRI head without IV contrast	6		○
CT head without IV contrast	4		⊗⊗⊗
CT head without and with IV contrast	4		⊗⊗⊗
CT paranasal sinuses without and with IV contrast	2		⊗⊗⊗
CT cone beam paranasal sinuses without contrast	1		⊗⊗

Note: Rating scale: 1, 2, 3 = usually not appropriate; 4, 5, 6 = may be appropriate; 7, 8, 9 = usually appropriate. IV = intravenous; RRL = relative radiation level.

**Variant 4. Sinonasal obstruction. Suspected mass.**

Radiologic Procedure	Rating	Comments	RRL
MRI maxillofacial without and with IV contrast	9	This procedure is complementary to CT paranasal sinuses without contrast.	○
CT paranasal sinuses without IV contrast	8	This procedure is complementary to MRI maxillofacial without and with contrast.	☼☼
CT paranasal sinuses with IV contrast	7		☼☼
MRI maxillofacial without IV contrast	6		○
CTA head with IV contrast	4	Consultation with radiologist is recommended to ensure adequate coverage.	☼☼☼
CTA neck with IV contrast	4	Consultation with radiologist is recommended to ensure adequate coverage.	☼☼☼
MRA head with IV contrast	4	Consultation with radiologist is recommended to ensure adequate coverage.	○
MRA head without IV contrast	4	Consultation with radiologist is recommended to ensure adequate coverage.	○
MRA neck with IV contrast	4	Consultation with radiologist is recommended to ensure adequate coverage.	○
Arteriography craniofacial	4		☼☼☼
FDG-PET/CT skull base to mid-thigh	4		☼☼☼☼
MRA neck without and with IV contrast	3	Consultation with radiologist is recommended to ensure adequate coverage.	○
CT cone beam paranasal sinuses without contrast	2		☼☼
CT paranasal sinuses without and with IV contrast	2		☼☼☼

Note: Rating scale: 1, 2, 3 = usually not appropriate; 4, 5, 6 = may be appropriate; 7, 8, 9 = usually appropriate. CTA = CT angiography; FDG-PET; PET using fluorine-18-2-fluoro-2-deoxy-D-glucose imaging; IV = intravenous; MRA = MR angiography; RRL = relative radiation level.

**Variant 5. Suspected invasive fungal sinusitis.**

Radiologic Procedure	Rating	Comments	RRL
MRI maxillofacial without and with IV contrast	9	This procedure is complementary to CT paranasal sinuses without contrast.	○
CT paranasal sinuses without IV contrast	8	This procedure is complementary to MRI maxillofacial without and with contrast.	☼☼
CT paranasal sinuses with IV contrast	8	This procedure is an alternative to MRI maxillofacial (if patient cannot get MRI).	☼☼
MRI maxillofacial without IV contrast	6		○
MRA head without IV contrast	5		○
CTA head with IV contrast	4		☼☼☼
MRA head with IV contrast	4		○
Arteriography craniofacial	3		☼☼☼
CT paranasal sinuses without and with IV contrast	2		☼☼☼
CT cone beam paranasal sinuses without contrast	1		☼☼

Note: Rating scale: 1, 2, 3 = usually not appropriate; 4, 5, 6 = may be appropriate; 7, 8, 9 = usually appropriate. CTA = CT angiography; IV = intravenous; MRA = MR angiography; RRL = relative radiation level.

Table 1. Relative Radiation Level Designations

Relative Radiation Level	Adult Effective Dose Estimate Range (mSv)	Pediatric Effective Dose Estimate Range (mSv)
○	0	0
⊛	<0.1	<0.03
⊛⊛	0.1-1	0.03-0.3
⊛⊛⊛	1-10	0.3-3
⊛⊛⊛⊛	10-30	3-10
⊛⊛⊛⊛⊛	30-100	10-30

Note: Relative radiation level (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.”

## SUMMARY OF LITERATURE REVIEW

### Introduction/Background

Rhinosinusitis is one of the most commonly diagnosed diseases, with a prevalence of up to 16% in the United States and an overall annual economic burden estimated at 22 billion dollars [1-3]. The indirect costs of rhinosinusitis are staggering, with the number of annual work-loss days estimated at 12.5 million [4]. Studies performed in the 1990s found there were 73 million restricted-activity days related to chronic sinusitis over a 2-year period [3,5,6].

As the nasal cavity is involved in nearly all cases, the term *rhinosinusitis* is preferred. By definition, uncomplicated rhinosinusitis is symptomatic inflammatory change involving the nasal cavity and paranasal sinuses without extension beyond the paranasal sinuses or nasal cavity at time of diagnosis [7,8]. Symptoms may include congestion, stuffiness, facial or periorbital pain, fullness and pressure, and progression from serous to mucopurulent drainage. Assessment of the maxillary teeth is important because up to 20% of maxillary sinus infections may originate from underlying dental disease [9].

Rhinosinusitis is further characterized into acute and chronic classifications based on the duration of symptoms, detailed in the variants below. If four or more episodes of acute bacterial rhinosinusitis (ABRS) occur annually, the term *recurrent acute rhinosinusitis* (RARS) is used.

The most common imaging finding is mucosal thickening. Involvement is usually bilateral. Acutely infected sinuses may demonstrate air-fluid levels, as well as associated bone rarefaction. In chronic phases, there may be a reactive sclerosis indicating osteitis, which may require antibiotics. In other cases, reactive osteosclerotic changes may have sinus margin contraction that does not reverse over time [9]. The absence of bone erosion or destruction favors an inflammatory process rather than neoplasm.

Because rhinosinusitis is a clinical diagnosis, imaging should be interpreted in conjunction with the clinical and endoscopic findings [10-17]. Up to 3% to 40% of asymptomatic adults may have abnormalities on sinus CT scans, as do more than 80% with minor upper respiratory tract infections [18-20].

### Special Imaging Considerations

Sinus CT imaging may be performed using either multidetector CT scanners or cone-beam CT (CBCT). Multidetector CT of the paranasal sinuses utilizes parallel linear detector arrays to detect the incident x-ray beams as 1-D projections that are stacked to create sinus imaging volumes. In contrast, CBCT utilizes a flat-panel detector to detect incident photons from the x-ray beam as multiple 2-D projections [21]. CBCT scans can be obtained in an office setting or intraoperatively.

## DISCUSSION OF PROCEDURES BY VARIANT

### Variant 1: Acute (<4 weeks) uncomplicated rhinosinusitis

Acute rhinosinusitis (ARS) of <4 weeks is subdivided into ABRS or viral rhinosinusitis. ABRS is a clinical diagnosis made when symptoms of ARS, namely purulent nasal discharge associated with nasal obstruction, facial pain, or pressure, are present without improvement for at least 10 days after the onset of upper respiratory symptoms or recur and worsen within 10 days after initial improvement [8]. In acute viral rhinosinusitis, symptoms last <10 days without worsening. The distinction between a viral rhinosinusitis and ABRS is a clinical one determined by illness pattern and length of occurrence [8]. Patients experiencing four or more discrete episodes of ABRS per year are classified as RARS [8]. ARS lasting between 4 and 12 weeks should be assessed on an individual clinical basis to determine if the pattern is acute or chronic, because timeline definitions are consensus rather than evidence based [8].

**Radiography.** As per clinical practice guidelines from the American Academy of Otolaryngology and Head and Neck Surgery [8], radiographs of the sinuses are unnecessary for patients with a clinical diagnosis of ABRS. Radiographs of the paranasal sinuses in a meta-analysis of six studies [22] demonstrated a moderate sensitivity of 76% and specificity of 79% in ABRS. In addition, guidelines recommend against imaging for patients with diagnostic criteria of ARS, unless a complication or alternative diagnosis is suspected [8].

**CT.** Sinus CT imaging may be appropriate as per clinical judgment when ABRS has associated complications including headache, facial swelling, orbital proptosis, and cranial nerve palsies [8]. In these cases clinicians should distinguish presumed ABRS from viral respiratory infections and noninfectious etiologies. Clinicians should assess patients for ABRS when the signs and symptoms of ARS persist without improvement for at least 10 days beyond the onset of upper respiratory symptoms or the symptoms worsen within 10 days after initial improvement.

Because conventional sinus radiographs are inaccurate in a high percentage of patients, these are largely supplanted by CT when imaging is necessary [23]. Multiplanar CT imaging offers the advantage of both bone detail and soft-tissue imaging [9], and multiple studies demonstrated the efficacy of imaging with low-dose protocols that reduce patient radiation exposure [24-26]. Coronal CT imaging gives excellent anatomic bony detail of the paranasal sinuses, either with thin-slice axial images with reformations in both the coronal and sagittal planes or with direct coronal images, as clinically warranted. Intravenous contrast is generally not needed.

Sinus CT imaging using conventional CT may be appropriate as per clinical judgment when ABRS has associated complications, including headache, facial swelling, orbital proptosis, and cranial nerve palsies [8]. In these cases clinicians should distinguish presumed ABRS from viral respiratory infections and noninfectious etiologies. Clinicians should assess patients for ABRS when the signs and symptoms of ARS persist without improvement for at least 10 days beyond the onset of upper respiratory symptoms or the symptoms worsen within 10 days after initial improvement.

**CBCT.** CBCT became commercially available in 2001 for dentomaxillofacial imaging [27,28] and has since expanded to in-office use for sinonasal evaluation.

Current published estimates note a predicted exposure of approximately 0.1 to 0.2 mSv [29]. However, precise measurements of radiation dose exposure from CBCT are difficult to quantify because of the absence of accepted dose metrics. The main disadvantage of CBCT is the lack of adequate soft-tissue resolution.

**MRI.** MRI is not currently used in the workup of patients with uncomplicated rhinosinusitis.

### **Variant 2: Possible surgical candidate. Recurrent acute rhinosinusitis, chronic rhinosinusitis, sinonasal polyposis, or noninvasive fungal sinusitis**

This variant encompasses different scenarios where sinus surgery may be considered, rather than a uniform underlying etiology. RARS is clinically diagnosed when there are four or greater episodes of ABRS annually, without signs or symptoms between the episodes [30]. Because of the greater disease burden, different diagnostic approaches, and alterations in treatment (including increased antibiotic usage), it is important to clinically distinguish RARS from one-time cases of ABRS.

Chronic recurrent rhinosinusitis is defined when signs and symptoms of rhinosinusitis occur for 12 weeks or longer and include mucopurulent drainage, nasal obstruction and congestion, facial pain, pressure and fullness, or a decreased or absent sense of smell. Findings may coincide with the presence of mucosal polyps. Sinonasal inflammation is documented by either purulent mucus or edema in the middle meatus or ethmoid regions, polyps in the nasal cavity or middle meatus, or radiographic imaging demonstrating inflammation in the paranasal sinuses [7]. Chronic rhinosinusitis without polyposis also occurs in approximately 12% of adults, with deficient antibody production in response to vaccinations or hypogammaglobulinemia. These patients may present with a pattern of recurrent episodes of purulent sinus infections and otitis media with associated pulmonary infections. In addition, systemic illnesses such as granulomatosis with polyangiitis (Wegener granulomatosis) or Churg-Strauss vasculitis may also present with recurrent chronic rhinosinusitis [31].

Noninvasive fungal sinus disease may manifest as a fungus ball (mycetoma) or allergic fungal sinusitis. Fungus balls are a collection of fungal hyphae without allergic mucin, often occurring in maxillary and sphenoid sinuses, with etiologies postulated to occur from poor mucociliary clearance. Noninvasive fungal sinusitis may also present

as an allergic fungal sinusitis in warm, humid climates, possibly from hypersensitivity to fungal organisms, with a reactive inflammatory process usually seen in immunocompetent patients, and may be associated with allergic rhinitis, nasal polyps, and asthma [32,33].

**Radiography.** Because conventional sinus radiographs are inaccurate in a high percentage of patients, these are largely supplanted by CT when imaging is necessary [23]. Radiographic imaging may be useful in unilateral chronic recurrent rhinosinusitis to exclude anatomic variants or a foreign body.

**CT.** Because sinus radiographs are inaccurate in a high percentage of patients, these are largely supplanted by CT when imaging is necessary [23]. Noncontrast sinus CT is indicated for evaluation of RARS before surgical intervention or objective confirmation in cases of chronic recurrent rhinosinusitis. The documentation of sinonasal inflammation may also be accomplished with anterior rhinoscopy or nasal endoscopy [5,6,8,34-38]. CT scanning provides the best preoperative information for endoscopic surgery, with excellent delineation of the complex ethmoidal anatomy, ostiomeatal unit, and anatomic variations, including the presence of sphenoidal (Onodi) air cells, which increase the risk of injury to the optic nerves or carotid arteries [9,39].

CT imaging can also be imported into computer navigation systems for image-based guidance surgery during endoscopic sinus surgery. The advantages of image-based guidance surgery include a reduction of surgical risks by providing real-time information of instrument location relative to critical structures. The two major systems for image-based guidance surgery are the electromagnetic and optical guidance systems. In both systems, a registration process is imperative that creates a one-to-one relationship between points in the operative field and the imaging data set, with an accuracy within 2 mm [21].

**CBCT.** CBCT became commercially available in 2001 for dentomaxillofacial imaging [27,28] and has since expanded to in-office use for sinonasal evaluation. Current published estimates note a predicted exposure of approximately 0.1 to 0.2 mSv [29]. However, precise measurements of radiation dose exposure from CBCT are difficult to quantify because of absence of accepted dose metrics. CBCT imaging may be utilized for the assessment of sinus anatomy and pathology in uncomplicated cases of sinusitis, although it has limitations in assessing soft-tissue structures, and it may

aid in the diagnosis of odontogenic sinusitis, which may occur when periapical infections spread from the molar teeth into the floor of the maxillary sinus and may be the etiology of maxillary sinusitis in about 10% to 12% of patients [40,41]. Appropriateness for patient selection may be made either clinically or by endoscopy [42].

**MRI.** MRI is not considered the first-line study for routine sinus imaging because of lack of bone detail and length of imaging time. However, newly developed sequences and techniques are allowing for improved visualization of bony detail with decreased imaging times, although many of these are not readily commercially available at this time. In addition, inspissated secretions may appear dark on T2 sequences, mimicking air [43].

One study suggests that MRI-based Lund-Mackay scores did not show a statistically significant difference compared with CT-based scores in the same patients [44]. Rarely, in selected cases, evaluation with MRI or contrast-enhanced sinus CT may be needed to help differentiate polypoid mucosal hypertrophy from superimposed sinus fluid and also help to exclude a true underlying soft-tissue mass causing sinus obstruction.

**Single-Photon Emission CT.** The use of single-photon emission CT is limited in the evaluation of chronic rhinosinusitis. Even though positive single-photon emission CT in patients with chronic rhinosinusitis correlates with poor subjective response to medical treatment, this technique is generally not used in clinical practice [45].

**Other Clinical Tests.** In addition, these patients should be clinically assessed for findings that may modify treatment, including allergen testing, sinus cultures, and assessment for immunodeficiency, cystic fibrosis, or ciliary dysfunction. In addition, asthma and gastroesophageal reflux may be associated comorbidities [32].

### **Variant 3: Acute rhinosinusitis. Suspected orbital or intracranial complication**

If there is clinical concern for orbital or intracranial complications, both CT and MRI may be necessary to better define the soft-tissue structures, orbital contents, and brain to guide appropriate treatment, with radiation exposure as low as reasonably achievable [46]. Infection from the ethmoid sinus can spread through the perforations of the lamina papyracea and cribriform plate; through the valveless veins, which extend to the cavernous sinus; and via direct extension in osteomyelitis. The periorbita and periosteum may act as a barrier to early spread of sinusitis and become

elevated in a subperiosteal abscess. Correlation with the treatment team is essential before imaging to ensure that any protocols necessary for image-guided intervention are obtained.

**CT.** CT scanning provides the best delineation of bone integrity or erosion. A contrast-enhanced CT may be an alternative in the setting of MRI contraindications to evaluate for intraorbital or intracranial complications [46]. Dual-phase imaging (without and with contrast) is not necessary.

**MRI.** MRI may better depict intraorbital and intracranial complications in cases of aggressive sinus infection as well as differentiating soft-tissue masses from adjacent T2-hyperintense inflammatory mucosal disease [9,46].

Postcontrast T1-weighted fat-saturation sequences should be included if there is concern for abscess formation or extrasinus extension. Contrast-enhanced MRI with coverage through the cavernous sinuses is the test of choice for suspected cavernous sinus thrombosis and suspected orbital complications including both the maxillofacial and intracranial structures.

**CBCT.** CBCT is not used in the workup of patients with ARS with suspected orbital or intracranial complications due to limitations in assessing soft-tissue structures [29,47].

#### Variant 4: Sinonasal obstruction. Suspected mass

In patients with a suspected sinonasal mass and with persistent symptoms of pain, nasal obstruction, or epistaxis, complete evaluation of the extent of disease usually requires both CT and MRI sinus evaluation without contrast and, in certain cases, with contrast.

**CT.** Noncontrast sinus CT best defines bone erosion or destruction and any formation of cartilaginous or bone matrix. CT with contrast can be used in cases when a patient is unable or unwilling to have an MRI.

**MRI.** MRI of the face or sinuses without and with contrast will best differentiate a soft-tissue mass from postobstructive secretions, as well as orbital, skull base, or intracranial extension [48-50]. Brain MRI with and without contrast may be complementary to help characterize any intracranial spread of tumor.

**PET/CT.** PET/CT may be indicated if malignancy is suspected; however, this is beyond the scope of this guideline and appropriateness should be considered in the setting of tumor stage [51].

**CTA, MRA, Cerebral Arteriography.** Craniofacial catheter angiography, CT angiography (CTA), or MR angiography (MRA) may be indicated for preoperative planning, for preoperative embolization of a vascular mass such as a juvenile angiofibroma, or to treat severe epistaxis [48,52-54]. Correlation with the treatment team is essential before imaging to ensure that any protocols necessary for image-guided intervention are obtained. Dual-phase imaging (without and with contrast) is not necessary.

**CBCT.** CBCT is not used in the workup of patients with a suspected sinonasal mass.

#### Variant 5: Suspected invasive fungal sinusitis

Invasive fungal sinusitis occurs when fungal hyphae involve the paranasal sinus mucosa, submucosa, blood vessels, or bones and may be further subdivided into acute fulminant invasive fungal sinusitis (AFIFS), chronic invasive fungal sinusitis, and chronic granulomatous sinusitis [32,33]. AFIFS is rarely seen in immunocompetent patients, is more commonly associated with immunocompromised patients, and may present similarly to ABRs.

AFIFS is rapidly progressive, with a time course of <4 weeks, and is associated with a high morbidity and mortality of 50% to 80% [33]. Because of this high morbidity and mortality in patients who are immunosuppressed or leukemic, have poorly controlled diabetes, or are transplant patients on high-dose steroid treatment, a high index of suspicion should be maintained when these patients present with a fever and symptoms of sinonasal inflammation [33]. In aggressive cases of AFIFS there may be intracranial and intraorbital extension with cavernous sinus thrombosis or carotid invasion with pseudo-aneurysm formation, infarcts, and hemorrhage [33,55].

Chronic invasive fungal sinusitis is progression of fungal deposition over months to years, with invasion of the paranasal sinus mucosa, submucosa, vessels, and bones, and may also result in significant mortality and morbidity [33].

Chronic granulomatous invasive fungal sinusitis is rare in the United States, although it is seen in Africa and Southeast Asia in immunocompetent patients with non-caseating granulomas and may progress through the paranasal sinuses with intraorbital and intracranial extension [33,55].

Both CT and MRI of the sinuses, including evaluation of the adjacent brain and orbits, may be needed to

fully define the extent of disease and orbital or intracranial extension.

**CT.** A noncontrast CT may be utilized at first and may aid in surgical planning [33,55].

CT may reveal low-attenuation mucosal thickening or soft tissue unilaterally in the ethmoid or sphenoid sinuses [33]. A careful assessment of adjacent soft-tissue and fat planes should be made as invasion into adjacent structures can occur without bone erosion. Careful assessment for subtle bone erosion must be made as well. Additionally, imaging protocols should be aligned with any image-guided procedure requirements to eliminate redundant imaging for surgical guidance.

CT with contrast may be used to help define orbital and intracranial complications and can be used in cases when a patient is unable or unwilling to have an MRI [32,48,49,55,56]. Dual-phase imaging (without and with contrast) is not necessary.

**MRI.** MRI of the face or sinuses without and with contrast provides a more accurate evaluation of complex sinus secretions and extension of disease into adjacent soft tissues [32,48,49,56]. Brain MRI with and without contrast may be complementary to help characterize any intracranial spread beyond the field of view of the sinus examination. Contrast-enhanced MRI with coverage through the cavernous sinuses is the test of choice for suspected cavernous sinus thrombosis and suspected orbital complications including both the maxillofacial and intracranial structures.

**CTA, MRA, Cerebral Arteriography.** Because fungal sinusitis in the sphenoid can result in cavernous sinus invasion and involvement of the cavernous carotid artery, additional imaging via CTA, MRA, or catheter angiography may be needed if there is concern for pseudoaneurysm formation; however, they are not first-line examinations.

**CBCT.** CBCT is not used in the workup of patients with suspected invasive fungal sinusitis [29,47].

and delineation of bony anatomy and variants that increase the operative risk of injury to the optic nerve or carotid arteries. Cone-beam CT may be useful for the assessment of paranasal anatomy and pathology in uncomplicated sinusitis, although it is limited in evaluating the adjacent soft tissues.

- If there is clinical concern for orbital or intracranial complications, CT and MRI may both be necessary to delineate soft-tissue structures, orbital contents, brain, cavernous sinus, and bony dehiscence.
- MRI of the face and sinuses with inclusion of adjacent brain and orbits best differentiates a soft-tissue mass from postobstructive secretions and best delineates orbital, skull base, or intracranial involvement. CT may provide complementary improved delineation of bony destruction and dehiscence or the formation of cartilaginous or bony matrix. CT with contrast may be utilized if an MRI cannot be obtained.
- In cases of suspected invasive fungal sinusitis, MRI of the face and sinuses, including orbit and brain, is the study of choice. CT may be a complementary study and useful for surgical planning.

## SUMMARY OF RECOMMENDATIONS

- Acute uncomplicated rhinosinusitis in most cases does not require any imaging.
- Noncontrast CT of the paranasal sinuses without intravenous contrast may be utilized for evaluation of RARS prior to surgical intervention or to confirm chronic recurrent sinusitis, and it provides the best preoperative information for endoscopic surgery

## SUMMARY OF EVIDENCE

Of the 57 references cited in the ACR Appropriateness Criteria<sup>®</sup> Sinonasal Disease document, 5 are categorized as therapeutic references. Additionally, 52 references are categorized as diagnostic references including 1 well-designed study, 2 good-quality studies, and 16 quality studies that may have design limitations. There are 38 references that may not be useful as primary evidence.

The 57 references cited in the ACR Appropriateness Criteria<sup>®</sup> Sinonasal Disease document were published from 1990 to 2017.

Although there are references that report on studies with design limitations, 3 well-designed or good-quality studies provide good evidence.

## 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 1). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria<sup>®</sup> Radiation Dose Assessment Introduction document [57].

## SUPPORTING DOCUMENTS

For additional information on the Appropriateness Criteria methodology and other supporting documents go to [www.acr.org/ac](http://www.acr.org/ac).

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