

**American College of Radiology
ACR Appropriateness Criteria®
Sinonasal Disease**

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		O
MRI maxillofacial without and with IV contrast	1		O
X-ray paranasal sinuses	1		⊕

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*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		O
MRI maxillofacial without and with IV contrast	4		O
CT paranasal sinuses without and with IV contrast	1		⊕⊕⊕
X-ray paranasal sinuses	1		⊕
Tc-99m SPECT paranasal sinuses	1		⊕⊕⊕

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level

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.	O
MRI head without and with IV contrast	8	This procedure is complementary to MRI maxillofacial without and with contrast.	O
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		O
MRI head without IV contrast	6		O
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		⊕⊕

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*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.	O
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		O
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.	O
MRA head without IV contrast	4	Consultation with radiologist is recommended to ensure adequate coverage.	O
MRA neck with IV contrast	4	Consultation with radiologist is recommended to ensure adequate coverage.	O
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.	O
CT cone beam paranasal sinuses without contrast	2		⊕⊕
CT paranasal sinuses without and with IV contrast	2		⊕⊕⊕

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*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.	O
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		O
MRA head without IV contrast	5		O
CTA head with IV contrast	4		⊕⊕⊕
MRA head with IV contrast	4		O
Arteriography craniofacial	3		⊕⊕⊕
CT paranasal sinuses without and with IV contrast	2		⊕⊕⊕
CT cone beam paranasal sinuses without contrast	1		⊕⊕
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

SINONASAL DISEASE

Expert Panel on Neurologic Imaging: Claudia F. E. Kirsch, MD^a; Julie Bykowski, MD^b; Joseph M. Aulino, MD^c; Kevin L. Berger, MD^d; Asim F. Choudhri, MD^e; David B. Conley, MD^f; Michael D. Luttrull, MD^g; Diego Nunez Jr, MD, MPH^h; Lubdha M. Shah, MDⁱ; Aseem Sharma, MD^j; Vilaas S. Shetty, MD^k; Rathan M. Subramaniam, MD, PhD, MPH^l; Sophia C. Symko, MD^m; Rebecca S. Cornelius, MD.ⁿ

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 computed tomography (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

^aPrincipal Author and Panel Vice-Chair, North Shore-Long Island Jewish Hospital, Hofstra Medical School, Hempstead, New York. ^bPanel Chair, UC San Diego Health, San Diego, California. ^cVanderbilt University Medical Center, Nashville, Tennessee. ^dChesapeake Medical Imaging, Annapolis, Maryland. ^eLe Bonheur Children's Hospital, University of Tennessee Health Science Center, Memphis, Tennessee. ^fNorthwestern Medical Faculty Foundation, Chicago, Illinois; American Academy of Otolaryngology-Head and Neck Surgery. ^gThe Ohio State University Wexner Medical Center, Columbus, Ohio. ^hBrigham & Women's Hospital & Harvard Medical School, Boston, Massachusetts. ⁱUniversity of Utah, Salt Lake City, Utah. ^jMallinckrodt Institute of Radiology, Saint Louis, Missouri. ^kSaint Louis University Hospital, Saint Louis, Missouri. ^lUT Southwestern Medical Center, Dallas, Texas. ^mColorado Permanente Medical Group, Denver, Colorado. ⁿSpecialty Chair, University of Cincinnati Medical Center, Cincinnati, Ohio.

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.

Reprint requests to: publications@acr.org

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

Magnetic resonance imaging (MRI) is not currently used in the workup of patients with uncomplicated rhinosinusitis.

Variant 2: Possible surgical candidate. Recurrent acute rhinosinusitis, chronic rhinosinusitis, sinonasal polypsis, 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 sphenoethmoidal (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.

SPECT

The use of single-photon emission computed tomography (SPECT) is limited in the evaluation of chronic rhinosinusitis. Even though positive SPECT 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/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

Positron emission tomography (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 magnetic resonance 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 prior to

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 pseudoaneurysm 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 noncaseating 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].

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 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 Evidence

Of the 57 references cited in the *ACR Appropriateness Criteria® 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® 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 below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document [57].

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 (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.

References

- Blackwell DL, Lucas JW, Clarke TC. Summary health statistics for U.S. adults: national health interview survey, 2012. *Vital Health Stat 10*. 2014;(260):1-161.
- Smith KA, Orlandi RR, Rudmik L. Cost of adult chronic rhinosinusitis: A systematic review. *Laryngoscope*. 2015;125(7):1547-1556.
- Anzai Y, Weymuller EA, Jr., Yueh B, Maronian N, Jarvik JG. The impact of sinus computed tomography on treatment decisions for chronic sinusitis. *Arch Otolaryngol Head Neck Surg*. 2004;130(4):423-428.
- Batra PS. Radiologic imaging in rhinosinusitis. *Cleve Clin J Med*. 2004;71(11):886-888.
- Anand VK. Epidemiology and economic impact of rhinosinusitis. *Ann Otol Rhinol Laryngol Suppl*. 2004;193:3-5.
- Anzai Y, Yueh B. Imaging evaluation of sinusitis: diagnostic performance and impact on health outcome. *Neuroimaging Clin N Am*. 2003;13(2):251-263, xi.
- Rosenfeld RM. Clinical practice guideline on adult sinusitis. *Otolaryngol Head Neck Surg*. 2007;137(3):365-377.
- Rosenfeld RM, Piccirillo JF, Chandrasekhar SS, et al. Clinical practice guideline (update): adult sinusitis. *Otolaryngol Head Neck Surg*. 2015;152(2 Suppl):S1-S39.
- Mafee MF, Tran BH, Chapa AR. Imaging of rhinosinusitis and its complications: plain film, CT, and MRI. *Clin Rev Allergy Immunol*. 2006;30(3):165-186.
- Basu S, Georgalas C, Kumar BN, Desai S. Correlation between symptoms and radiological findings in patients with chronic rhinosinusitis: an evaluation study using the Sinonasal Assessment Questionnaire and Lund-Mackay grading system. *Eur Arch Otorhinolaryngol*. 2005;262(9):751-754.
- Bhattacharyya N. A comparison of symptom scores and radiographic staging systems in chronic rhinosinusitis. *Am J Rhinol*. 2005;19(2):175-179.
- Bhattacharyya T, Piccirillo J, Wippold FJ, 2nd. Relationship between patient-based descriptions of sinusitis and paranasal sinus computed tomographic findings. *Arch Otolaryngol Head Neck Surg*. 1997;123(11):1189-1192.
- Cousin JN, Har-El G, Li J. Is there a correlation between radiographic and histologic findings in chronic sinusitis? *J Otolaryngol*. 2000;29(3):170-173.
- Devaiah AK. Adult chronic rhinosinusitis: diagnosis and dilemmas. *Otolaryngol Clin North Am*. 2004;37(2):243-252, v.
- Hwang PH, Irwin SB, Griest SE, Caro JE, Nesbit GM. Radiologic correlates of symptom-based diagnostic criteria for chronic rhinosinusitis. *Otolaryngol Head Neck Surg*. 2003;128(4):489-496.

16. Kenny TJ, Duncavage J, Bracikowski J, Yildirim A, Murray JJ, Tanner SB. Prospective analysis of sinus symptoms and correlation with paranasal computed tomography scan. *Otolaryngol Head Neck Surg.* 2001;125(1):40-43.
17. Wabnitz DA, Nair S, Wormald PJ. Correlation between preoperative symptom scores, quality-of-life questionnaires, and staging with computed tomography in patients with chronic rhinosinusitis. *Am J Rhinol.* 2005;19(1):91-96.
18. Gwaltney JM, Jr., Phillips CD, Miller RD, Riker DK. Computed tomographic study of the common cold. *N Engl J Med.* 1994;330(1):25-30.
19. Holbrook EH, Brown CL, Lyden ER, Leopold DA. Lack of significant correlation between rhinosinusitis symptoms and specific regions of sinus computer tomography scans. *Am J Rhinol.* 2005;19(4):382-387.
20. Wittkopf ML, Beddow PA, Russell PT, Duncavage JA, Becker SS. Revisiting the interpretation of positive sinus CT findings: a radiological and symptom-based review. *Otolaryngol Head Neck Surg.* 2009;140(3):306-311.
21. Huang BY, Senior BA, Castillo M. Current Trends in Sinonasal Imaging. *Neuroimaging Clin N Am.* 2015;25(4):507-525.
22. Lau J, Zucker D, Engels EA, Balk E, et al. *Diagnosis and treatment of acute bacterial rhinosinusitis. Evidence Report/Technology Assessment No. 9 (Contract 290-97-0019 to the New England Medical Center).* Rockville, MD: Agency for Health Care Policy and Research; March 1999.
23. Aalokken TM, Hagtvedt T, Dalen I, Kolbenstvedt A. Conventional sinus radiography compared with CT in the diagnosis of acute sinusitis. *Dentomaxillofac Radiol.* 2003;32(1):60-62.
24. Campbell PD, Jr., Zinreich SJ, Aygun N. Imaging of the paranasal sinuses and in-office CT. *Otolaryngol Clin North Am.* 2009;42(5):753-764, vii.
25. Levin DC, Rao VM. Turf wars in radiology: the overutilization of imaging resulting from self-referral. *J Am Coll Radiol.* 2004;1(3):169-172.
26. Levin DC, Rao VM, Parker L, Frangos AJ, Sunshine JH. Ownership or leasing of CT scanners by nonradiologist physicians: a rapidly growing trend that raises concern about self-referral. *J Am Coll Radiol.* 2008;5(12):1206-1209.
27. Miracle AC, Mukherji SK. Conebeam CT of the head and neck, part 1: physical principles. *AJNR Am J Neuroradiol.* 2009;30(6):1088-1095.
28. Miracle AC, Mukherji SK. Conebeam CT of the head and neck, part 2: clinical applications. *AJNR Am J Neuroradiol.* 2009;30(7):1285-1292.
29. Fakhran S, Alhilali L, Sreedher G, et al. Comparison of simulated cone beam computed tomography to conventional helical computed tomography for imaging of rhinosinusitis. *Laryngoscope.* 2014;124(9):2002-2006.
30. Kaszuba SM, Stewart MG. Medical management and diagnosis of chronic rhinosinusitis: A survey of treatment patterns by United States otolaryngologists. *Am J Rhinol.* 2006;20(2):186-190.
31. Dykewicz MS, Hamilos DL. Rhinitis and sinusitis. *J Allergy Clin Immunol.* 2010;125(2 Suppl 2):S103-115.
32. Peters AT, Spector S, Hsu J, et al. Diagnosis and management of rhinosinusitis: a practice parameter update. *Ann Allergy Asthma Immunol.* 2014;113(4):347-385.
33. Aribandi M, McCoy VA, Bazan C, 3rd. Imaging features of invasive and noninvasive fungal sinusitis: a review. *Radiographics.* 2007;27(5):1283-1296.
34. Bhattacharyya N. Clinical and symptom criteria for the accurate diagnosis of chronic rhinosinusitis. *Laryngoscope.* 2006;116(7 Pt 2 Suppl 110):1-22.
35. Bhattacharyya N, Fried MP. The accuracy of computed tomography in the diagnosis of chronic rhinosinusitis. *Laryngoscope.* 2003;113(1):125-129.
36. Rosenfeld RM, Andes D, Bhattacharyya N, et al. Clinical practice guideline: adult sinusitis. *Otolaryngol Head Neck Surg.* 2007;137(3 Suppl):S1-31.
37. Tahamiler R, Canakcioglu S, Ogreden S, Acioglu E. The accuracy of symptom-based definition of chronic rhinosinusitis. *Allergy.* 2007;62(9):1029-1032.
38. Zinreich SJ. Imaging for staging of rhinosinusitis. *Ann Otol Rhinol Laryngol Suppl.* 2004;193:19-23.
39. Shpilberg KA, Daniel SC, Doshi AH, Lawson W, Som PM. CT of Anatomic Variants of the Paranasal Sinuses and Nasal Cavity: Poor Correlation With Radiologically Significant Rhinosinusitis but Importance in Surgical Planning. *AJR Am J Roentgenol.* 2015;204(6):1255-1260.

40. Leiva-Salinas C, Flors L, Gras P, et al. Dental flat panel conebeam CT in the evaluation of patients with inflammatory sinonasal disease: Diagnostic efficacy and radiation dose savings. *AJNR Am J Neuroradiol*. 2014;35(11):2052-2057.
41. Nunes CA, Guedes OA, Alencar AH, Peters OA, Estrela CR, Estrela C. Evaluation of Periapical Lesions and Their Association with Maxillary Sinus Abnormalities on Cone-beam Computed Tomographic Images. *J Endod*. 2016;42(1):42-46.
42. Fraczek M, Guzinski M, Morawska-Kochman M, Nelke KH, Krecicki T. Nasal endoscopy: an adjunct to patient selection for preoperative low-dose CT examination in chronic rhinosinusitis. *Dentomaxillofac Radiol*. 2016;45(8):20160173.
43. Dillon WP, Som PM, Fullerton GD. Hypointense MR signal in chronically inspissated sinonasal secretions. *Radiology*. 1990;174(1):73-78.
44. Lin HW, Bhattacharyya N. Diagnostic and staging accuracy of magnetic resonance imaging for the assessment of sinonasal disease. *Am J Rhinol Allergy*. 2009;23(1):36-39.
45. Saylam G, Gorgulu O, Korkmaz H, Dursun E, Ortapamuk H, Eryilmaz A. Do single-photon emission computerized tomography findings predict severity of chronic rhinosinusitis: a pilot study. *Am J Rhinol Allergy*. 2009;23(2):172-176.
46. Dankbaar JW, van Bemmel AJ, Pameijer FA. Imaging findings of the orbital and intracranial complications of acute bacterial rhinosinusitis. *Insights Imaging*. 2015;6(5):509-518.
47. Al Abduwani J, ZilinSkiene L, Colley S, Ahmed S. Cone beam CT paranasal sinuses versus standard multidetector and low dose multidetector CT studies. *Am J Otolaryngol*. 2016;37(1):59-64.
48. Momeni AK, Roberts CC, Chew FS. Imaging of chronic and exotic sinonasal disease: review. *AJR Am J Roentgenol*. 2007;189(6 Suppl):S35-45.
49. Rao VM, el-Noueam KI. Sinonasal imaging. Anatomy and pathology. *Radiol Clin North Am*. 1998;36(5):921-939, vi.
50. Yousem DM. Imaging of sinonasal inflammatory disease. *Radiology*. 1993;188(2):303-314.
51. NCCN Clinical Practice Guidelines in Oncology. Head and Neck Cancers. Version 2.2016. 2016; Available at: https://www.nccn.org/professionals/physician_gls/pdf/head-and-neck.pdf. Accessed March 1, 2017.
52. Lai V, Wong YC, Lam WY, Tsui WC, Luk SH. Inflammatory myofibroblastic tumor of the nasal cavity. *AJNR Am J Neuroradiol*. 2007;28(1):135-137.
53. Palacios E, Restrepo S, Mastrogiovanni L, Lorusso GD, Rojas R. Sinonasal hemangiopericytomas: clinicopathologic and imaging findings. *Ear Nose Throat J*. 2005;84(2):99-102.
54. Serrano E, Coste A, Percodani J, Herve S, Brugel L. Endoscopic sinus surgery for sinonasal haemangiopericytomas. *J Laryngol Otol*. 2002;116(11):951-954.
55. Adelson RT, Marple BF. Fungal rhinosinusitis: state-of-the-art diagnosis and treatment. *J Otolaryngol*. 2005;34 Suppl 1:S18-23.
56. Younis RT, Anand VK, Davidson B. The role of computed tomography and magnetic resonance imaging in patients with sinusitis with complications. *Laryngoscope*. 2002;112(2):224-229.
57. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: <http://www.acr.org/~media/ACR/Documents/AppCriteria/RadiationDoseAssessmentIntro.pdf>. Accessed March 1, 2017.

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.