American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Sinusitis — Child**

Variant 1: **Children with uncomplicated acute sinusitis.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray paranasal sinuses	1	One to four projections. See text.	☢
CT paranasal sinuses without contrast	1		☢☢☢
CT paranasal sinuses with contrast	1		☢☢☢
CT paranasal sinuses without and with contrast	1		☢☢☢☢
MRI paranasal sinuses without contrast	1		O
MRI paranasal sinuses without and with contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 2: **Children with persistent (acute sinusitis that does not respond to treatment), recurrent, or chronic sinusitis.**

Radiologic Procedure	Rating	Comments	RRL*
CT paranasal sinuses without contrast	9		☢☢☢
CT paranasal sinuses with contrast	3		☢☢☢
MRI paranasal sinuses without contrast	3		O
MRI paranasal sinuses without and with contrast	3		O
CT paranasal sinuses without and with contrast	2	High-density area in noncontrast CT may be helpful in diagnosis of sinusitis due to aspergillosis.	☢☢☢☢
X-ray paranasal sinuses	1	One to four projections. See text.	☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Clinical Condition: **Sinusitis — Child**

Variant 3: **Children with sinusitis with orbital or intracranial complications.**

Radiologic Procedure	Rating	Comments	RRL*
CT paranasal sinuses with contrast	9		☢☢☢
CT head with contrast	9	Should be done selectively when signs suggest intracranial complication.	☢☢☢
MRI paranasal sinuses without and with contrast	7	See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI head without and with contrast	7	Should be performed when signs suggest intracranial complications that are not demonstrated by initial CT scan. See statement regarding contrast in text under "Anticipated Exceptions."	O
MRI paranasal sinuses without contrast	3		O
MRI head without contrast	3	Should be performed when signs suggest intracranial complications that are not demonstrated by initial CT scan.	O
CT paranasal sinuses without and with contrast	2	High-density area in noncontrast CT may be helpful in diagnosis of sinusitis due to aspergillosis.	☢☢☢☢
CT head without and with contrast	2	Should be done selectively when signs suggest intracranial complication.	☢☢☢☢
CT paranasal sinuses without contrast	1		☢☢☢
CT head without contrast	1	Should be done selectively when signs suggest intracranial complication.	☢☢☢
X-ray paranasal sinuses	1	One to four projections. See text.	☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

SINUSITIS — CHILD

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Summary of Literature Review

Sinusitis is defined as inflammation of the paranasal sinuses. It is common in the pediatric population and often causes morbidity but rarely results in serious complications [1-8]. The most common predisposing factor for acute bacterial sinusitis is viral upper respiratory infection that involves the nose and paranasal sinuses. It is estimated that bacterial sinusitis develops in 5%-13% of viral upper respiratory infections in young children [1]. The second most important predisposing factor for bacterial sinusitis is allergic rhinitis [1-4]. Other underlying factors that may lead to sinusitis in children include nasal airway obstruction, immunodeficiencies, ciliary dysfunction, and cystic fibrosis [1-11]. The growing number of children in day care centers has led to an increase in upper respiratory infections, which usually precede acute sinusitis [2,10].

The gold standard for diagnosis of bacterial sinusitis is recovery of high-density bacteria ($\geq 10^4$ colony-forming units/mL) from sinus aspirate. However, this method is not feasible for the primary care practitioner and is invasive, time-consuming, and potentially painful [1]. Therefore, the diagnosis of bacterial sinusitis is most commonly based on clinical criteria [1].

Acute Sinusitis

The American Academy of Pediatrics (AAP) defines acute bacterial sinusitis as bacterial sinusitis that lasts <30 days and whose symptoms resolve completely [1]. A common symptom of acute sinusitis is upper respiratory infection with purulent nasal drainage [1-5]. Severe acute bacterial sinusitis is associated with high fever and headache that is typically above or behind the eyes [1]. The differentiation between viral and bacterial sinusitis and the decision about whether to treat with antibiotics may be difficult [1]. Adjuvant treatment may include saline nasal irrigation, antihistamines, decongestants, mucolytic agents, and topical intranasal steroids [1-5].

Routine imaging of the paranasal sinuses in children with acute bacterial sinusitis without complications is not recommended. It is not useful for differentiating between viral and bacterial sinusitis and usually does not change management in uncomplicated acute sinusitis. A high incidence of soft-tissue findings is noted on radiographs, computed tomography (CT), and magnetic resonance imaging (MRI) in patients who have no clinical evidence of sinus disease but have undergone these examinations for other reasons. Incidences of 33%-50% have been reported [12-21]. In most adults, the common cold acutely produces mucosal abnormalities in sinuses, including the ostiomeatal area and nasal passageways [22]. This incidence is even higher in infants and children and was 97% in a study involving infants who had a cold in the 2 weeks preceding cranial CT done for other reasons [15]. MRI studies have also shown that soft-tissue changes in sinuses can last months following an acute infection [23]. Clinical correlation is critical for evaluating the significance of the imaging findings. In addition, most children with clinical diagnosis of acute sinusitis will also have radiographic abnormalities correlating with sinusitis and, therefore their management will not change [1-5].

Persistent, Recurrent, or Chronic Sinusitis

The AAP defines subacute bacterial sinusitis as bacterial sinusitis that lasts between 30 and 90 days and whose symptoms resolve completely. Recurrent acute bacterial sinusitis is defined by episodes lasting less than 30 days

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each and separated by intervals of at least 10 asymptomatic days. Chronic sinusitis lasts more than 90 days, and patients have persistent residual respiratory symptoms such as cough, rhinorrhea, or nasal obstruction [1]. In patients with recurrent or chronic sinusitis, one must consider the possibility that they are associated with or secondary to asthma, gastroesophageal reflux, cystic fibrosis, or allergic rhinitis [1-11]. Common symptoms of chronic sinusitis are protracted nasal secretions that may be purulent or mucoid. Drainage tends to be from the posterior nasopharynx, causing frequent cough and urge to clear the throat. Other symptoms may include chronic headache and intermittent fever. Young children may have malodorous breath. The most serious complication of chronic sinusitis is extension of infection into the cranium [2,24]. Chronic or recurrent sinusitis is mainly treated medically; however, in cases that do not respond to treatment, surgery may be required [7,8,24,25]. Fungal sinusitis is unusual in children and has variable clinical and imaging findings. This condition is beyond the scope of this guideline [26,27].

Orbital and Intracranial Complications of Sinusitis

Orbital and intracranial complications of sinusitis are uncommon but may cause significant morbidity and mortality [28-34]. The orbit is prone to spread of infection through the lamina papyracea, a thin bone that separates the medial orbital wall from the ethmoid sinuses [30]. Medial wall periosteal abscess is the most common complication. Periorbital cellulitis and ocular findings (abnormal visual examination, opthalmoplegia, or proptosis) are common at presentation [28-30].

Intracranial complications most commonly result from extension of frontal sinusitis [28,29,31-34]. Intracranial spread of infection is likely through progression of septic thrombi or transmission of septic emboli through valveless diploic veins of the skull base that penetrate the dura. A less common route is through direct extension of osteomyelitis [28]. Symptoms at presentation that suggest intracranial complications include Pott's puffy tumor, altered consciousness, seizures, hemiparesis, and cranial nerve palsy [28,29,31-33]. Complications include meningitis, encephalitis, epidural and subdural suppuration, orbital abscess, and, less commonly, brain abscess and dural sinus thrombophlebitis [28,29,31-33].

Treatment includes intravenous antibiotics and surgical intervention to drain the affected sinuses and orbital or intracranial abscesses [28-30,34].

Radiography

The radiograph series for evaluation of the paranasal sinuses traditionally includes up to four views (Caldwell, Waters, submentovertex, and lateral). This series of radiographs is difficult to perform in young children [35]. As compared with CT scan, radiographs of the paranasal sinuses are less costly and more widely available. However, radiographs are limited in the evaluation of the paranasal sinuses because they cannot localize the pathology well and cannot evaluate the osteomeatal complex [35]. In addition, radiographs both underdiagnose and overdiagnose soft-tissue changes in the paranasal sinuses as compared to CT scan [25,36-39]. Some have suggested using only the Waters view radiograph [40]. However, it was shown to have 32% false negative and 49.2% false positive findings using CT scan as the gold standard [41]. In addition, most of the abnormalities in the ethmoidal and sphenoidal sinus were not detected in the Waters radiograph [41].

Computed Tomography

CT scans are the gold standard study guiding management of sinusitis because they accurately depict the sinus anatomy, including soft-tissue changes, anatomic variations; the osteomeatal complex, and complications, especially those involving the orbit or intracranial structures [1,8,31-33,35-37,42-50]. With the advent of multidetector CT scan volume isometric imaging, it is possible to obtain axial images and reconstruct the coronal planes [51]. This is especially advantageous in young children who may not be able to cooperate for direct coronal CT study of the paranasal sinuses. In addition, radiation of the orbits may be avoided [51]. Low-dose CT scan of the paranasal sinuses has doses comparable to those of two radiographic views of the paranasal sinuses [52]. CT is the study of choice in children with recurrent or chronic sinusitis before functional endoscopic sinus surgery (FESS) as it provides a road map for surgery [24,47]. However, severity of preoperative CT findings does not correlate with severity of symptoms, and CT does not predict symptomatic relief after FESS [36].

If suspicion exists for complications of sinusitis — such as preseptal or postseptal cellulitis, subperiosteal abscess, orbital cellulitis or abscess, cavernous sinus thrombosis, osteomyelitis of the frontal bone, subdural empyema, epidural or brain abscess, meningitis, brain infarction, or myotic aneurysm — then intravenous contrast CT, including the brain and sinuses, is indicated [27,33].

Magnetic Resonance Imaging

MRI of the paranasal sinuses has several potential advantages: it can well identify mucosal thickening and differentiate mucosal thickening from sinus secretions [23,53], and it is not associated with ionizing radiation. MRI is valuable in diagnosing complications of sinusitis that extend to the cranium or orbits [34] and is more sensitive than contrast CT in detecting intracranial complications such as meningeal enhancement and fluid collections [28,34]. In a study involving adult and pediatric patients, MRI was found to be more accurate than CT (97% vs 87%) and clinical findings (82%) in diagnosing meningitis [34]. Other studies in children showed that MRI was more sensitive than contrast CT (93% vs 63%) in detecting cranial complications [28]. However, it does not demonstrate bony detail of the osteomeatal complex well and is less sensitive for bony erosions. In addition, it has limited availability and higher costs compared to CT and frequently requires sedation in infants and children [38]. Therefore, MRI of the sinuses should not be the primary imaging for evaluation of sinusitis in children.

Summary

- The diagnosis of sinusitis should be made clinically, not on the basis of imaging findings alone.
- No imaging studies are indicated for uncomplicated acute sinusitis.
- CT of the paranasal sinuses is the imaging modality of choice in patients with persistent, recurrent, or chronic sinusitis.
- Cranial/orbit CT with contrast, to include the sinuses, is indicated for suspected orbital or intracranial complications of sinusitis.
- MRI, while not as good as CT for depicting bone details, is more sensitive for evaluating intracranial complications that are not demonstrated on an initial CT scan.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, <30 mL/min/1.73m^2), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m^2. For more information, please see the ACR *Manual on Contrast Media* [54].

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.

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

- ACR Appropriateness Criteria® Overview
- Procedure Information
- Evidence Table

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