American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Sinusitis—Child**

Variant 1: **Nasal discharge and fever <10 days duration.**

Radiologic Procedure	Rating	Comments	RRL*
MRI paranasal sinuses multiple views with contrast	2		None
CT head including sinuses and orbits with contrast	2		High
CT paranasal sinus coronal	2		High
X-ray paranasal sinuses	2	One to four projections. See literature review.	Med
US paranasal sinuses	1	A or B mode or real time.	None
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 2: **Purulent nasal discharge and fever >10 days duration.**

Radiologic Procedure	Rating	Comments	RRL*
CT paranasal sinus coronal	8		High
X-ray paranasal sinuses	3	One to four projections.	Med
MRI paranasal sinuses multiple views with contrast	2		None
CT head including sinuses and orbits with contrast	2		High
US paranasal sinuses	1	A or B mode or real time.	None
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 3: **Headache, no nasal discharge.**

Radiologic Procedure	Rating	Comments	RRL*
US paranasal sinuses	2	A or B mode or real time.	None
CT head including sinuses and orbits with contrast	2		High
X-ray paranasal sinuses	2	One to four projections.	Med
CT paranasal sinus coronal	2		High
MRI paranasal sinuses multiple views with contrast	2		None
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: **Sinusitis—Child**

Variant 4: **Recurrent or persistent clinical sinusitis.**

Radiologic Procedure	Rating	Comments	RRL*
CT paranasal sinus coronal	8		High
CT head including sinuses and orbits with contrast	2		High
MRI paranasal sinuses multiple views with contrast	2		None
X-ray paranasal sinuses	2	One to four projections.	Med
US paranasal sinuses	1	A or B mode or real time.	None
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 5: **Poorly responding asthma or history of atopia with persistent nasal discharge.**

Radiologic Procedure	Rating	Comments	RRL*
CT paranasal sinus coronal	6		High
MRI paranasal sinuses multiple views with contrast	2		None
CT head including sinuses and orbits with contrast	2		High
X-ray paranasal sinuses	2		Med
US paranasal sinuses	1	A or B mode or real time.	None
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 6: **Preoperative evaluation for functional endoscopic sinus surgery.**

Radiologic Procedure	Rating	Comments	RRL*
CT paranasal sinus coronal	9		High
CT head including sinuses and orbits with contrast	2		High
X-ray paranasal sinuses	2	One to four projections.	Med
MRI paranasal sinuses multiple views with contrast	2		None
US paranasal sinuses	1	A or B mode or real time.	None
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Clinical Condition: **Sinusitis—Child**

Variant 7: **Suspected complication of sinusitis (eg, orbital cellulitis).**

Radiologic Procedure	Rating	Comments	RRL*
CT head including sinuses and orbits with contrast	9		High
CT paranasal sinus coronal	4	Use IV contrast material.	High
MRI paranasal sinuses multiple views with contrast	2	For problem solving and suspected intracranial disease involvement.	None
X-ray paranasal sinuses	2	One to four projections.	Med
US paranasal sinuses	1	A or B mode or real time.	None
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Variant 8: **Complex sinus disease; rule out fungal sinusitis.**

Radiologic Procedure	Rating	Comments	RRL*
CT head including sinuses and orbits with contrast	9		High
MRI paranasal sinuses multiple views with contrast	9		None
CT paranasal sinus coronal	4	Use IV contrast material.	High
X-ray paranasal sinuses	2	One to four projections.	Med
US paranasal sinuses	1	A or B mode or real time.	None
Rating Scale: 1=Least appropriate, 9=Most appropriate			***Relative Radiation Level**

Expert Panel on Pediatric Imaging: William H. McAlister, MD[1]; John D. Strain, MD[2]; Harris L. Cohen, MD[3]; Lynn Fordham, MD[4]; Michael J. Gelfand, MD[5]; Richard Gunderman, MD, PhD[6]; Thomas L. Slovis, MD[7]; Wilbur L. Smith, MD[8]; William Rodriguez, MD.[9]

Summary of Literature Review

Sinusitis is a common problem in the pediatric population. The underlying factors that may lead to sinusitis in children include nasal airway obstruction, immunodeficiencies, alterations in the mucosa of the sinuses and nasal passageways, ciliary dysfunction, and underlying conditions such as cystic fibrosis, allergic rhinitis, and immotile cilia syndrome [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]. Recognition of the importance of sinus disease in children has been stimulated by the realization that sinus disease can have a negative impact on chronic pulmonary disease and is often a major complication of primary and acquired immunodeficiencies [12], the incidence and recognition of which are increasing. Not to be overlooked is the social and economic importance of sinusitis—parents often missing work to care for their children.

Although physicians vary in their understanding and ability to diagnose sinusitis clinically, a number of publications have detailed the signs and symptoms of acute, recurrent, and chronic sinusitis [1,3,8-11]. The findings of sinusitis, especially chronic recurrent sinusitis, are nonspecific [8,10]. The most common signs and symptoms of acute sinusitis are upper respiratory infection with cough and purulent nasal drainage persisting beyond 10 days [1,8,10]. Infants and children with acute sinusitis almost always have purulent nasal discharge with acute sinusitis. Also considered is the patient who has severe symptoms and signs, including a temperature greater than 102° F (39° C) and a purulent nasal discharge present concurrently for at least 3 to 4 consecutive days in an ill child [1]. Acute sinusitis is a clinical diagnosis which may not require imaging [13], especially in children less than 6 years of age. In patients with chronic sinusitis or rhinosinusitis with symptoms lasting more than 90 days, one must consider the possibility that they are associated with or secondary to asthma, gastroesophageal reflux, cystic fibrosis, or allergic rhinitis. Allergic patients have a higher incidence and more severe disease seen on computed tomography (CT) examinations of the sinuses. The same is true for asthma patients. The precise role of imaging for the diagnosis and management of chronic or recurrent sinusitis, is unclear, including the CT classifications of disease staging, and will therefore not be included in the clinical condition variants [1,8,13].

Two main controversies surround imaging of sinusitis in the pediatric population. The first concerns the use of radiographs versus coronal CT scans [14-16]. Although they are less costly and more widely available, radiographs both underdiagnose and overdiagnose soft tissue changes in the paranasal sinuses [15,17,18]. In addition, the Caldwell projection does not localize ethmoid disease, and the Waters projection does not show ethmoid involvement [19]. Demonstration and localization of disease are essential for endoscopic sinus surgery; therefore, radiographs cannot be used as a guide for this procedure [19]. Lateral sinus radiographs are of little value in patients under 4 years of age [19]. Coronal sinus CT is the recommended examination for imaging persistent or chronic sinusitis in patients of any age, because it accurately depicts the sinus anatomy, including soft tissue changes, anatomic variations, the ostiomeatal complex, and complications, especially those involving the orbit or intracranial structures [16,20-26]. The fourth view, the submentovertex, does not contribute to the depiction of soft tissue changes in the paranasal sinuses [19].

An even greater controversy in imaging pediatric sinusitis is the high incidence of soft tissue findings noted on radiographs, CT, or magnetic resonance imaging (MRI) examinations found in patients who have no clinical evidence of sinus disease but who have undergone these examinations for other reasons. Incidences of 33%-50% have been reported [27-36]. The common cold acutely produces mucosal abnormalities in sinuses, including the ostiomeatal area and nasal passageways, in the majority of adults [37]. This incidence is even higher in infants and children and, indeed, was 97% in a study involving infants who had a cold in the two weeks preceding cranial CT done for other reasons [30]. Another study demonstrated an 88% incidence of soft tissue changes in sinuses associated with viral respiratory infections. However, acute viral rhinosinusitis does predispose the patient to acute bacterial sinusitis. MRI studies have also shown that soft tissue changes in sinuses can last months following an acute infection [38]. Soft tissue abnormalities on CT scans are dynamic and can change from day to day. Clinical correlation with imaging

[1]Principal Author, Washington University Medical Center, St. Louis, Mo; [2]Panel Chair, The Children's Hospital, Denver, Colo; [3]Stony Brook School of Medicine, Stony Brook, NY; [4]University of North Carolina, Chapel Hill, NC; [5]Children's Hospital Medical Center, Cincinnati, Ohio; [6]Riley Hospital for Children, Indiana University, Indianapolis, Ind; [7]Children's Hospital of Michigan, Detroit, Mich; [8]Detroit Receiving Hospital, Detroit, Mich; [9]Children's National Medical Center, Washington, DC, American Academy of Pediatrics.

Reprint requests to: Department of Quality & Safety, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191-4397.

findings is critical for accurate evaluation of these findings.

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 cranial CT including the brain and sinuses is indicated [39-41]. MRI with gadolinium is especially useful if intracranial involvement is suspected [40].

MRI of the paranasal sinuses beautifully shows mucosal thickening, differentiates mucosal thickening from sinus secretions, and is not associated with ionizing radiation, but it is not feasible as a primary imaging modality for pediatric sinusitis because of its higher costs, its limited availability, frequent need for sedation in infants and children, and the lack of bony detail of the ostiomeatal complex felt to be a major factor in sinusitis [15]. MRI of the sinuses can play a role in evaluating the complications of sinusitis, such as fungal involvement of the sinuses and intracranial extension, as well as in excluding tumor in patients with opacified sinuses [41,42]. In one study the cost of MRI was comparable to the costs of radiographs and CT, but this is not typically the case [43].

Conventional tomography of the sinuses and nuclear medicine studies are rarely indicated. Control studies using ultrasound of the sinuses have shown that this modality lacks sufficient sensitivity and specificity and is not recommended [44].

Radiographs of the sinuses may be useful for confirming soft tissue findings in patients with clinical sinusitis [25], but they have very low specificity. They can be used on patients with headaches in whom the diagnosis of sinusitis is considered to be a clinical possibility. Radiographs of the sinuses can assist in excluding sinus disease when the clinical manifestations are unclear.

Coronal CT scans are the “gold standard” for diagnosing soft tissue findings in the sinuses [1,8,16,17,21,45-50]. However, the high incidence of soft tissue abnormalities in the sinuses of infants and children with intercurrent or recent upper respiratory tract infections necessitates the correlation of clinical and imaging findings. In addition, the incidence on CT of anatomic sinus variations, Haller cells, concha bullosa, and so forth, along with the distribution of diseases within the sinuses, is similar in asymptomatic infants and children, such as those with recurrent sinusitis [45].

Coronal CT scans should be obtained before functional endoscopic sinus surgery (FESS) as they provide a road map for surgery [22]. Controversies certainly exist not only about imaging for suspected sinusitis but also regarding management of the disease—antibiotic therapy [51], duration of therapy, adjunct therapies, role of FESS, etc [1,8]. A randomized placebo controlled study of clinically diagnosed acute uncomplicated sinusitis showed no clinical benefit from antibiotic therapy [51]. There is poor concordance between clinical signs and symptoms and the imaging and clinical results of FESS [26].

Recommendations are as follows:

1. The diagnosis of acute and chronic sinusitis should be made clinically, not on the basis of imaging findings alone.
2. When acute sinusitis is diagnosed and appropriately treated, no imaging studies are indicated if full clinical resolution occurs.
3. Patients with acute sinusitis persisting after 10 days of appropriate therapy, or with chronic sinusitis, and in whom imaging evaluation is desired, should undergo coronal CT scans of the sinuses regardless of their age.
4. The use of radiographs in evaluating of sinusitis should be discouraged unless exceptional circumstances warrant it. If radiographs are performed, only Waters and Caldwell views are recommended for patients younger than 4 years of age; for older patients, a lateral view is obtained. The lateral view should be performed with cross-table technique if the Waters view cannot be obtained with the patient upright.
5. Cranial CT with contrast, to include the sinuses, is indicated for suspected complications of bacterial sinusitis.

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. 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	**Effective Dose Estimate Range**
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv

References

1. American Academy of Pediatrics. Subcommittee on Management of Sinusitis and Committee on Quality Improvement. Clinical practice guideline: management of sinusitis. *Pediatrics* 2001; 108(3):798-808.
2. De Cleyn KM, Kersschot EA, De Clerck LS, et al. Paranasal sinus pathology in allergic and non-allergic respiratory tract diseases. *Allergy* 1986; 41(5):313-318.
3. Fireman P. Diagnosis of sinusitis in children: emphasis on the history and physical examination. *J Allergy Clin Immunol* 1992; 90(3 Pt 2):433-436.
4. Gungor A, Corey JP. Pediatric sinusitis: a literature review with emphasis on the role of allergy. *Otolaryngol Head Neck Surg* 1997; 116(1):4-15.
5. Jannert M, Andreasson L, Helin I, Pettersson H. Acute sinusitis in children--symptoms, clinical findings and bacteriology related to initial radiologic appearance. *Int J Pediatr Otorhinolaryngol* 1982; 4(2):139-148.
6. Nguyen KL, Corbett ML, Garcia DP, et al. Chronic sinusitis among pediatric patients with chronic respiratory complaints. *J Allergy Clin Immunol* 1993; 92(6):824-830.
7. Parsons DS. Chronic sinusitis: a medical or surgical disease? *Otolaryngol Clin North Am* 1996; 29(1):1-9.
8. Slavin RG, Spector SL, Bernstein IL, et al. The diagnosis and management of sinusitis: a practice parameter update. *J Allergy Clin Immunol* 2005; 116(6 Suppl):S13-47.
9. Wagenmann M, Naclerio RM. Anatomic and physiologic considerations in sinusitis. *J Allergy Clin Immunol* 1992; 90(3 Pt 2):419-423.
10. Wald ER. Sinusitis in children. *N Engl J Med* 1992; 326(5):319-323.
11. Wald ER, Milmoe GJ, Bowen A, Ledesma-Medina J, Salamon N, Bluestone CD. Acute maxillary sinusitis in children. *N Engl J Med* 1981; 304(13):749-754.
12. Lusk RP, Lazar RH, Muntz HR. The diagnosis and treatment of recurrent and chronic sinusitis in children. *Pediatr Clin North Am* 1989; 36(6):1411-1421.
13. Diament MJ. The diagnosis of sinusitis in infants and children: x-ray, computed tomography, and magnetic resonance imaging. Diagnostic imaging of pediatric sinusitis. *J Allergy Clin Immunol* 1992; 90(3 Pt 2):442-444.
14. Lazar RH, Younis RT, Parvey LS. Comparison of plain radiographs, coronal CT, and intraoperative findings in children with chronic sinusitis. *Otolaryngol Head Neck Surg* 1992; 107(1):29-34.
15. McAlister WH. Imaging of sinusitis in infants and children. In: Lusk RP, ed. *Pediatric Sinusitis*. New York, NY: Raven Press; 1992:15-42.
16. Yousem DM. Imaging of sinonasal inflammatory disease. *Radiology* 1993; 188(2):303-314.
17. Laine FJ, Smoker WR. The ostiomeatal unit and endoscopic surgery: anatomy, variations, and imaging findings in inflammatory diseases. *AJR* 1992; 159(4):849-857.
18. Watt-Boolsen S, Karle A. The clinical use of radiological examination of the maxillary sinuses. *Clin Otolaryngol Allied Sci* 1977; 2(1):41-43.
19. McAlister WH, Lusk R, Muntz HR. Comparison of plain radiographs and coronal CT scans in infants and children with recurrent sinusitis. *AJR* 1989; 153(6):1259-1264.
20. Arjmand EM, Lusk RP, Muntz HR. Pediatric sinusitis and subperiosteal orbital abscess formation: diagnosis and treatment. *Otolaryngol Head Neck Surg* 1993; 109(5):886-894.
21. Aygun N, Uzuner O, Zinreich SJ. Advances in imaging of the paranasal sinuses. *Otolaryngol Clin North Am* 2005; 38(3):429-437.
22. Bradley DT, Kountakis SE. Correlation between computed tomography scores and symptomatic improvement after endoscopic sinus surgery. *Laryngoscope* 2005; 115(3):466-469.
23. Clary RA, Cunningham MJ, Eavey RD. Orbital complications of acute sinusitis: comparison of computed tomography scan and surgical findings. *Ann Otol Rhinol Laryngol* 1992; 101(7):598-600.
24. Clement PA, Bluestone CD, Gordts F, et al. Management of rhinosinusitis in children: consensus meeting, Brussels, Belgium, September 13, 1996. *Arch Otolaryngol Head Neck Surg* 1998; 124(1):31-34.
25. Friedman WH, Rosenblum BN. Paranasal sinus etiology of headaches and facial pain. *Otolaryngol Clin North Am* 1989; 22(6):1217-1228.
26. 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.
27. Arruda LK, Mimica IM, Sole D, et al. Abnormal maxillary sinus radiographs in children: do they represent bacterial infection? *Pediatrics* 1990; 85(4):553-558.
28. Diament MJ, Senac MO, Jr., Gilsanz V, Baker S, Gillespie T, Larsson S. Prevalence of incidental paranasal sinuses opacification in pediatric patients: a CT study. *J Comput Assist Tomogr* 1987; 11(3):426-431.
29. Duvoisin B, Agrifoglio A. Prevalence of ethmoid sinus abnormalities on brain CT of asymptomatic adults. *AJNR* 1989; 10(3):599-601.
30. Glasier CM, Mallory GB, Jr., Steele RW. Significance of opacification of the maxillary and ethmoid sinuses in infants. *J Pediatr* 1989; 114(1):45-50.
31. Gordts F, Clement PA, Destryker A, Desprechins B, Kaufman L. Prevalence of sinusitis signs on MRI in a non-ENT paediatric population. *Rhinology* 1997; 35(4):154-157.
32. Kovatch AL, Wald ER, Ledesma-Medina J, Chiponis DM, Bedingfield B. Maxillary sinus radiographs in children with nonrespiratory complaints. *Pediatrics* 1984; 73(3):306-308.
33. Lesserson JA, Kieserman SP, Finn DG. The radiographic incidence of chronic sinus disease in the pediatric population. *Laryngoscope* 1994; 104(2):159-166.
34. Manning SC, Biavati MJ, Phillips DL. Correlation of clinical sinusitis signs and symptoms to imaging findings in pediatric patients. *Int J Pediatr Otorhinolaryngol* 1996; 37(1):65-74.
35. Odita JC, Akamaguna AI, Ogisi FO, Amu OD, Ugbodaga CI. Pneumatisation of the maxillary sinus in normal and symptomatic children. *Pediatr Radiol* 1986; 16(5):365-367.
36. Shopfner CE, Rossi JO. Roentgen evaluation of the paranasal sinuses in children. *Am J Roentgenol Radium Ther Nucl Med* 1973; 118(1):176-186.
37. 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.
38. Leopold DA, Stafford CT, Sod EW, et al. Clinical course of acute maxillary sinusitis documented by sequential MRI scanning. *Am J Rhinol* 1994; 8:19-28.
39. Clayman GL, Adams GL, Paugh DR, Koopmann CF, Jr. Intracranial complications of paranasal sinusitis: a combined institutional review. *Laryngoscope* 1991; 101(3):234-239.
40. Oxford LE, McClay J. Complications of acute sinusitis in children. *Otolaryngol Head Neck Surg* 2005; 133(1):32-37.
41. Zinreich SJ, Kennedy DW, Malat J, et al. Fungal sinusitis: diagnosis with CT and MR imaging. *Radiology* 1988; 169(2):439-444.
42. Som PM, Shapiro MD, Biller HF, Sasaki C, Lawson W. Sinonasal tumors and inflammatory tissues: differentiation with MR imaging. *Radiology* 1988; 167(3):803-808.
43. Teresi L, Lufkin R, Hanafee W. Low cost MRI of the paranasal sinuses. *Comput Med Imaging Graph* 1988; 12(3):165-168.
44. Shapiro GG, Furukawa CT, Pierson WE, Gilbertson E, Bierman CW. Blinded comparison of maxillary sinus radiography and ultrasound for diagnosis of sinusitis. *J Allergy Clin Immunol* 1986; 77(1 Pt 1):59-64.

45. April MM, Zinreich SJ, Baroody FM, Naclerio RM. Coronal CT scan abnormalities in children with chronic sinusitis. *Laryngoscope* 1993; 103(9):985-990.
46. Babbel RW, Harnsberger HR, Sonkens J, Hunt S. Recurring patterns of inflammatory sinonasal disease demonstrated on screening sinus CT. *AJNR* 1992; 13(3):903-912.
47. Parsons DS, Phillips SE. Functional endoscopic surgery in children: a retrospective analysis of results. *Laryngoscope* 1993; 103(8):899-903.
48. Sonkens JW, Harnsberger HR, Blanch GM, Babbel RW, Hunt S. The impact of screening sinus CT on the planning of functional endoscopic sinus surgery. *Otolaryngol Head Neck Surg* 1991; 105(6):802-813.
49. van der Veken PJ, Clement PA, Buisseret T, Desprechins B, Kaufman L, Derde MP. CT-scan study of the incidence of sinus involvement and nasal anatomic variations in 196 children. *Rhinology* 1990; 28(3):177-184.
50. Wolf G, Anderhuber W, Kuhn F. Development of the paranasal sinuses in children: implications for paranasal sinus surgery. *Ann Otol Rhinol Laryngol* 1993; 102(9):705-711.
51. Garbutt JM, Goldstein M, Gellman E, Shannon W, Littenberg B. A randomized, placebo-controlled trial of antimicrobial treatment for children with clinically diagnosed acute sinusitis. *Pediatrics* 2001; 107(4):619-625.