REVIEW

Acute bacterial sinusitis in children: an updated review

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Abstract

Background: In the pediatric age group, approximately 7.5% of upper respiratory tract infections (URIs) are complicated by acute bacterial sinusitis (ABS). Despite its prevalence, ABS is often overlooked in young children. The diagnosis and management present unique challenges in primary care. This is an updated narrative review on the evaluation, diagnosis, and management of ABS.

Methods: A PubMed search was performed using the key term 'acute sinusitis'. The search strategy included clinical trials, meta-analyses, randomized controlled trials, observational studies, and reviews. The search was restricted to the English literature and children.

Results: *Haemophilus influenzae* (non-typeable), *Streptococcus pneumoniae*, and *Moraxella catarrhalis* are the major pathogens in uncomplicated ABS in otherwise healthy children. In complicated ABS, polymicrobial infections are common. The diagnosis of acute sinusitis is mainly clinical and based on stringent criteria, including persistent symptoms and signs of a URI beyond 10 days, without appreciable improvement; a URI with high fever and purulent nasal discharge at onset lasting for at least 3 consecutive days; and biphasic or worsening symptoms.

Conclusion: Data from high-quality studies on the management of ABS are limited. The present consensus is that amoxicillin-clavulanate, at a standard dose of 45 mg/kg/day orally, is the drug of choice for most cases of uncomplicated ABS in children in whom antibacterial resistance is not suspected. Alternatively, oral amoxicillin 90 mg/kg/day can be administered. For those with severe ABS or uncomplicated acute sinusitis who are at risk for severe disease or antibiotic resistance, oral high-dose amoxicillin-clavulanate (90 mg/kg/day) is the drug of choice.

Keywords: amoxicillin, amoxicillin-clavulanate, bacterial sinusitis, mucociliary dysfunction, sinus ostial obstruction.

Introduction

Sinusitis, defined as an inflammation of the mucosal lining of one or more of the paranasal sinuses, can be classified arbitrarily by the duration of clinical symptoms into acute (<30 days), subacute (30–90 days), and chronic (>90 days) disease.[1–4] Acute sinusitis can be caused by viral, bacterial, or fungal infections, environmental irritants, and allergy.[5] Acute bacterial sinusitis (ABS) usually results from secondary bacterial infection of the sinus. It has been estimated that approximately 7.5% of upper respiratory tract infections (URI) in children are complicated by ABS.[6–8] Despite its prevalence, ABS is often overlooked in young children because the clinical manifestations are often non-specific and due to the misconception that bacterial sinusitis is rare in this age group. Without adequate treatment, ABS can result in subacute or chronic sinusitis as well as in serious or life-threatening complications. Therefore, ABS may pose a diagnostic and therapeutic challenge to primary care pediatricians who are not familiar with this condition.

The purpose of this article is to provide an updated review on the evaluation, diagnosis, and management of ABS in children. A PubMed search was performed in July 2020 with Clinical Queries using the key term 'acute sinusitis'. The search strategy included clinical trials, meta-analyses,

randomized controlled trials, observational studies, and reviews published within the past 10 years. The search was restricted to the English literature and to the pediatric population. The information retrieved from the above search was used in the compilation of the present article.

Incidence

It is estimated that approximately 10% of children will have had at least one case of ABS by 3 years of age and that 7.5% of URIs are complicated by ABS.[4,9] In a prospective, longitudinal cohort study of 294 children aged between 6 and 35 months, 1295 episodes of URI were documented over a 1-year period.[10] Of these, 103 (8%) episodes occurred in 73 children and were complicated by ABS. In another prospective observational cohort study of 236 children aged between 48 and 96 months, 327 episodes of symptomatic URI were documented over a 1-year period.[11] Of the 327 episodes of symptomatic URI, 29 (8.8%) episodes of sinusitis occurred in 24 children. Children attending the daycare are two to three times more likely to develop ABS after an episode of viral URI than children who do not attend daycare.[12–14] ABS most commonly occurs in children aged between 4 and 7 years.[15]

Anatomy and development of paranasal sinuses

The paranasal (maxillary, ethmoidal, sphenoidal, and frontal) sinuses are paired structures and develop as evaginations of the mucous membranes of the nasal meatuses.[2,3] These air-filled cavities are lined by a ciliated, pseudostratified, columnar epithelium.[16,17] The maxillary and ethmoidal sinuses develop around the third to fourth month of gestation and these sinuses, though small, are usually present at birth.[4,7] The sphenoidal and frontal sinuses usually do not develop until 2–3 years of age and remain rudimentary until 5–6 years of age.[4] For the maxillary and ethmoid sinuses, complete pneumatization is usually achieved at about 12 years of age whereas the frontal and sphenoidal sinuses may not completely develop until 20 years of age.[15,18] The maxillary, frontal, and anterior ethmoidal sinuses drain to the middle meatus, whereas the sphenoidal and posterior ethmoidal sinuses drain to the superior meatus below the superior turbinate.[4,17]

Etiopathogenesis

The etiopathogenesis of sinusitis can be attributed to the poor drainage of sinus secretions as a result of an impaired function or a reduction in the number of the ciliary apparatus, obstruction of the sinus ostia, and/or an overproduction or increase in the viscosity of sinus secretions.[2,7,14,16] In this regard, a URI is the most important cause for the development of ABS.[15] With a URI, the function of the ciliated pseudostratified columnar epithelium of the nasal cavity is impaired and less able to clear the secretions and mucus from the paranasal sinuses and the nasal cavity.[6] This results in a favorable environment for the growth of bacteria trapped in the paranasal sinuses.[19] Because the ostium of the maxillary sinus is located at the most superior portion of the sinus and given the small size of the maxillary sinus ostium, the clearance of secretions from the sinus is difficult,[7] which may explain why the maxillary sinus is more susceptible to ABS.

Viral URI is the most common cause of mucosal swelling, leading to the obstruction of the sinus ostia.[2,18,19] Other causes of mucosal swelling and ostia obstruction include allergic rhinitis, cystic fibrosis, immunodeficiency, facial trauma, diving, swimming, and overuse of nasal decongestants.[2,18,20–22] Mechanical obstructions resulting from adenoidal hypertrophy, nasal polyp, nasal foreign body, deviated nasal septum, craniofacial anomaly, and choanal atresia are other causes of sinus ostial obstruction.[7,23,24] Further, the negative sinus pressure created with the obstructed sinus due to the depletion of oxygen within the sinus may draw respiratory secretions and bacteria into the obstructed sinus.[6,7] In the meantime, the production of sinus secretions continues and accumulates within the sinus, thereby creating a favorable environment for the growth of bacteria.[7]

Ciliary activity of the pseudostratified columnar epithelium is important to rid the sinus of the secretion and contaminating bacteria.[15] Factors causing the impaired function of or a reduction in the number of cilia include viral URIs, dry or cold air, air pollutants, cigarette smoking, cystic fibrosis, Kartagener syndrome, and immotile cilia syndrome.[16,18,19,23] In particular, with a viral URI, there is a progressive loss of ciliated cells in the mucosal lining of the respiratory tract.[7] In conditions associated with increased mucus production and viscosity (e.g. asthma and cystic fibrosis), the ciliary activity may be impaired, resulting in diminished ciliary clearance of the mucus and debris from the sinus.[19,22,25]

Microbiology

The microbiology of acute sinusitis is influenced by antibiotic treatment within the month of presentation, hospitalization within the 5 days prior to presentation, previous vaccinations (in particular, the *Haemophilus influenzae* type b (Hib) vaccine and the 13-valent pneumococcal conjugate vaccine), immune status of the child, and whether the sinusitis is complicated.[26,27] In general, *H. influenzae* (non-typeable), *Streptococcus pneumoniae*, and *Moraxella catarrhalis* are the major pathogens in uncomplicated ABS in otherwise healthy children.[27–29] In this regard, sinusitis caused by *H. influenzae* type B and *S. pneumoniae* has dramatically decreased since the introduction of the Hib vaccine and the 13-valent pneumococcal conjugate vaccine, respectively.[5,27,30] Other less-frequently encountered pathogens include *Staphylococcus aureus*, *Streptococcus pyogenes*, group C *Streptococcus*, *Peptostreptococcus* species, *Moraxella* species, *Eikenella corrodens*, and, rarely,

anaerobes.[5,7,31] In patients with nosocomial sinusitis, immunodeficiency (in particular, those with HIV infection and neutropenia), and cystic fibrosis, *Pseudomonas aeruginosa*, *Proteus mirabilis*, *Escherichia coli*, *Klebsiella pneumoniae*, and *Enterobacter* species are common causative organisms.[5,26] In complicated ABS, polymicrobial infections are common.[27] *Streptococcus* species (e.g. *Streptococcus anginosus*) and *Staphylococcus* species (including methicillin-resistant *S. aureus*) contribute to the majority of cases.[32,33] Less commonly, complicated ABS may be caused by anaerobes, *Fusobacterium*, *Haemophilus* species, *Moraxella* species, and *Staphylococcus intermedius*.[27,32,33]

Clinical manifestations

ABS has three characteristic presentations.[7] The most common presentation consists of persistent symptoms and signs of a URI (cough, nasal congestion/discharge) beyond 10 days, without much improvement.[22,28,34–36] Although children with an uncomplicated URI may still be symptomatic by the 10th day, the symptoms are virtually always improved.[2,3] The cough must be present in the daytime, although it often worsens at night.[2,3] The latter may be a result of irritation of the pharyngeal wall by the postnasal drip in a recumbent position.[16] A cough that occurs exclusively at night is more indicative of postnasal drip or reactive airway disease.[12,37] The cough typically becomes more prominent with time. Nasal congestion is more prominent than nasal discharge.[38] The nasal discharge is typically anterior but may also be posterior. The discharge can be thin or thick, clear, serous, mucoid, mucopurulent, or purulent.[15,22]

The second presentation is a URI that has more severe symptoms (temperature >39°C and a purulent (colored, thick, and opaque) nasal discharge lasting for at least 3 consecutive days) at onset than usual.[22,34,35] In this regard, fever is usually absent in an uncomplicated URI.[15] Fever, when present, is usually low grade, occurs early in the course of the illness, and resolves within the first 2 days.[15] There may be associated facial pain or periorbital edema.[22] The child is usually sick-looking.

The third presentation is one of biphasic or worsening symptoms, referred to as 'double sickening'.[7,15] Affected children have initial symptoms of an uncomplicated viral URI. After several days of improvement, symptoms are substantially worsened, with exacerbation of nasal congestion/discharge or daytime cough, or both.[7,15] New fever onset may be present or fever may recur if present at the onset of illness.[7,15]

ABS may present with clinical features that may or may not be specific. Generally, symptoms in younger children are often non-specific and include irritability, poor appetite, throat clearing, postnasal drip, hyposmia, hyponasal speech, halitosis, and myalgia.[2–4] Older children and adolescents have more specific symptoms such as headache and facial pressure or pain. The facial pressure or pain is often centered over the cheek in maxillary sinusitis, in the parietal and temporal areas

in posterior ethmoidal sinusitis, in the inner canthal area in anterior ethmoidal sinusitis, above the eyebrows in frontal sinusitis, and in the occipital area in sphenoidal sinusitis.[5,39] Facial pain may worsen when the child bends the head forward and the pain can radiate to the teeth.[5,17]

The nasal mucosa is typically boggy and erythematous on examination.[40] A purulent/greenish discharge in the nasal cavity or dripping posteriorly into the oropharynx may be observed.[41] A purulent secretion observed coming from the nasal meatus is sine qua non of ABS.[18] Oropharyngeal erythema may result from nasal discharge dripping posteriorly. Bad breath may be noted. Periorbital edema/swelling, discoloration of eyelids, or facial/sinus tenderness suggests ABS.[1,18] Cervical lymphadenopathy is generally absent.[6,42] In general, the objective appearance does not substantially contribute toward a diagnosis.[18,34]

If necessary, anterior rhinoscopic examination may be used to assess the status of the nasal mucosa, the presence or color of the nasal discharge, and the origin of the purulent discharge. Purulent discharge from the middle meatus suggests maxillary, frontal, or anterior ethmoidal sinusitis. Purulent discharge into the nasopharynx, observed by rigid rhinoscopy, suggests the discharge probably originates from the superior meatus, which indicates sphenoidal or posterior ethmoidal sinusitis.

Transillumination of the sinus is not of much use in children younger than 10 years of age but may be useful in adolescents or adults if light transillumination is either absent or normal.[1,22,34] Absent light transmission indicates fluid in the sinus cavity, which signifies sinusitis.[4] On the other hand, if light transillumination is normal, sinusitis is unlikely.[1] Reduced or dull transillumination is a non-specific finding and cannot confirm or refute the diagnosis of sinusitis.[1]

Diagnostic studies

The diagnostic value of plain imaging, ultrasound, computed tomography (CT) scans, and magnetic resonance imaging (MRI) in ABS in children is questionable. These studies can be useful only when results are normal as they would confirm the absence of ABS.[5,7] Abnormal radiographic findings in ABS include complete opacification of the sinus, an air-fluid level, and mucosal thickening (greater than 4 mm) of the involved sinus(es) (Figure 1).[2,3,15,40] It should be noted that abnormal radiographic studies cannot confirm the diagnosis of ABS as children with a viral URI or other causes of sinus inflammation may also have abnormal sinus radiographs.[8,39,41,43,44] As such, abnormal sinus radiographs should be interpreted in the context of clinical findings and clinicians should not obtain imaging studies to distinguish between ABS and a viral URI.[35,45]

CT scans and MRI provide better visualization of the sinus cavity and its contents than plain radiographs. In addition, CT scans and MRI allow better assessment of complications involving the intracranial spaces and the orbit.[4,36] The American Academy of

Figure 1.   Contrast CT in coronal plane showing complete opacification of the right maxillary sinus. Note the mucosal enhancement (black arrows) and tiny gas locules (white arrows) within the fluid collection of the right maxillary sinus – findings suggestive of acute bacterial sinusitis. There is also mild mucosal thickening (white arrowhead) of the left maxillary sinus on the contralateral side.
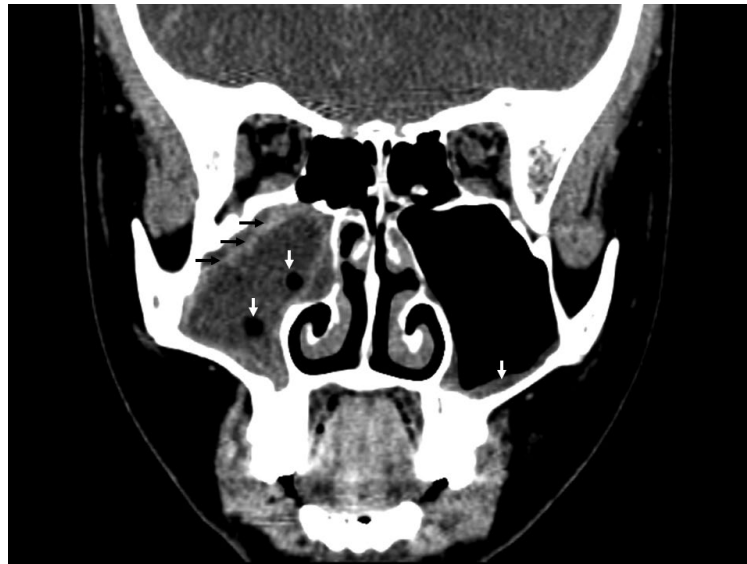
Pediatrics (AAP) and the American College of Radiology (ACR) recommend that a contrast-enhanced CT scan and/or MRI with contrast of the paranasal sinuses, orbits, and brain be performed if orbital or intracranial complications are suspected.[34,35,38,46] The ACR further suggests that both CT and MRI are complementary for the evaluation of suspected orbital or intracranial complications and that CT of the paranasal sinuses without contrast should be performed for ABS unresponsive to appropriate antimicrobial treatment, for recurrent bacterial sinusitis, or for defining sinus anatomy before functional sinus surgery is contemplated.[46] In general, a CT scan is preferred over MRI because of a lack of need for sedation, relative availability, and better visualization of the ostiomeatal complex and bony structures.[15,46,47] On the other hand, MRI is most effective in the evaluation of the extent of soft tissue inflammation and abnormalities and has an improved ability to detect intracranial complications without exposure to radiation.[5,27]

Routine cultures to identify the offending pathogens are not indicated. Cultures from nasal swabs are not recommended as they do not correlate well with cultures of sinus aspirates.[9,22] Isolating pathogen(s) in high density ($\geq 10^4$ colony forming units/ml) from sinus aspiration is the gold standard for diagnosing ABS.[4,5,22,38] However, sinus puncture with aspiration is not recommended for the routine diagnosis of ABS in children.[9,22,28] Indications for sinus aspiration include severe facial pain or headache, a toxic appearance, lack of response to conventional

antimicrobial therapy, suspected intracranial or orbital complications, and immunodeficiency.[22] Nasal, nasopharyngeal, and throat swabs are not acceptable as a surrogate.[27,48]

Diagnosis

The diagnosis of acute sinusitis is mainly clinical and based on stringent clinical criteria, including persistent clinical features of a URI beyond 10 days, without much improvement; a URI with high fever and purulent nasal discharge at onset lasting for at least three consecutive days; and biphasic or worsening symptoms (double sickening).[1,22] Laboratory investigations and radiologic studies are usually not necessary.

Differential diagnosis

ABS should be differentiated from a common URI, acute viral sinusitis, pertussis, pneumonia, bronchiolitis, a nasal foreign body, infected adenoids, rhinitis medicamentosa, allergic rhinitis, and vasomotor rhinitis (Table 1).[41,49–56]

Complications

Untreated or partially treated ABS may result in subacute or chronic bacterial sinusitis. Complications are rare if acute

Table 1.   Differential diagnosis of acute bacterial sinusitis.

Condition	Characteristics
Common upper respiratory tract infection	General well-being; usually afebrile; fever, if present, is low grade and tends to resolve within 48 hours; constitutional symptoms, such as headache and myalgias, may be present; sleep disturbance is usually absent; nasal discharge is usually clear and watery initially but may become purulent with time; the course is usually 7–10 days
Acute viral sinusitis	Clinical features are similar to those of an uncomplicated upper respiratory tract infection as acute viral sinusitis rarely occurs without concurrent rhinitis; acute viral rhinosinusitis is now the preferred term; symptoms peak in severity between the third and sixth day and then improve; facial pain and sinus tenderness may be present; fever is typically absent; the child is not sick-looking; severe headache is typically absent
Pertussis	Malaise, rhinorrhea, and conjunctival irritation in the catarrhal stage; fever is usually absent; inexorable paroxysms of cough in the paroxysmal stage; cough may be followed by an inspiratory gasp resulting in the typical whoop
Pneumonia	Fever; cough; tachypnea; positive auscultatory findings; runny nose, nasal congestion, facial pain, and sinus tenderness typically absent
Viral croup	Prodrome consists of rhinorrhea, mild cough, low-grade fever; characteristic 'brassy' or 'barking' cough; hoarseness; inspiratory stridor
Bronchiolitis	Mild cough, runny nose, and fever at the onset of illness; wheezing; prolonged expiratory phase, tachypnea, dyspnea, intercostal retraction, and hyper-resonance on chest percussion
Nasal foreign body	Foul odor from the affected nostril; serosanguineous discharge from the affected nostril; foreign body in the nostril may be seen
Infected adenoids	Halitosis; mouth breathing; snoring; downward displacement of the soft palate
Rhinitis medicamentosa	History of prolonged use of nasal alpha-adrenergic decongestants
Allergic rhinitis	Nasal congestion/stuffiness; clear and watery nasal discharge; nasal pruritus; paroxysmal sneezing; allergic salute; wrinkling of the nose (rabbit nose or facial grimace); mouth breathing; pale, bluish, boggy, and edematous nasal mucosa; 'cobblestoning' of the posterior pharynx; horizontal crease at the junction of the bulbous tip of the nose and the more rigid bridge (allergic crease); dark circles under the eyes (allergic shiners); double folds of the lower eyelids (Dennie–Morgan lines); adenoidal facies
Vasomotor rhinitis	Intermittent nasal congestion/watery discharge; exaggerated reaction to non-allergic and non-infectious triggers; cough, postnasal drip, and throat clearing are common; boggy edematous nasal mucosa with clear mucoid secretion

sinusitis is properly treated.[18] The rate of complications is higher in children of lower socioeconomic status and have poor access to medical care.[57] It is estimated that complications occur in approximately 5% of hospitalized children with ABS.[58] The frontal and ethmoidal sinuses are the most common sinuses from which complications arise.[6,7] Orbital complications are the most common complications and include preseptal or periorbital cellulitis, orbital cellulitis/abscess, orbital subperiosteal abscess, visual loss, optic neuritis, and Brown syndrome.[59–66] Intracranial complications include meningitis, cerebritis, epidural abscess, subdural abscess/empyema, cerebral abscess, subgaleal abscess, septic sagittal or cavernous sinus thrombosis, epidural hematoma, oculomotor nerve palsy, and trigeminal neuralgia.[62,66–82] Local complications include mucoceles, facial vein thrombophlebitis, premaxillary abscess, and osteomyelitis most commonly occurring with frontal sinusitis resulting in a Pott's puffy

tumor.[83–88] Systemic complications include septicemia, stroke, and pneumonia.[89]

Treatment

Treatment aims to hasten clinical improvement and cure, decrease the severity and duration of symptoms, eradicate the causative pathogens, and to prevent suppurative complications as well as chronic or recurrent sinusitis in children with ABS.[22,90] As spontaneous cure occurs in approximately 40–45% of children with ABS, some authors question the need for antimicrobial therapy.[91,92] Nevertheless, a meta-analysis of three randomized placebo-controlled trials involving 310 children with acute uncomplicated bacterial sinusitis showed that the rate of clinical improvement or cure was higher among children treated with antibiotics than with placebo (78.5% *versus* 59.7%, OR 2.52, 95% CI 1.52–4.18).[47] The AAP

recommends prompt initiation of antimicrobial therapy for ABS in children with severe onset (high fever along with purulent nasal discharge) or worsening course (double sickening).[35,45] For children with ABS who have persistent illness (cough and/or nasal discharge for at least 10 days without evidence of improvement), physicians have the option either to treat the child with antibiotics immediately or to observe for a period of 3 days.[35] In the latter case, antibiotics should be started if the child does not improve clinically after 3 days of observation or if there is a deterioration of the child's condition at any time.[35]

Antimicrobials, such as amoxicillin, amoxicillin-clavulanate, cefpodoxime, cefdinir, levofloxacin, ceftriaxone, cefpodoxime, cefuroxime, ampicillin-sulbactam, and ceftriaxone, have been claimed as effective for the treatment of ABS in children.[7,22,27,47] An antibiotic should be selected on the basis of efficacy, severity of the disease, presence of risk factors, probable causative organisms and their resistance patterns, dose convenience, safety, and cost.[2,27] The antibiotic should be given in adequate dosage and for a sufficient period of time; the present consensus is that antibiotic therapy be continued until the patient is free of symptoms and then for 7 more days, which may necessitate an antibiotic course of 10–21 days.[1,4,22,34] With appropriate antibiotic therapy, clinical improvement is expected within 72 hours.[2,5,6] The AAP recommends the use of amoxicillin or amoxicillin-clavulanate for the treatment of ABS.[35] The Infectious Diseases Society of America, on the other hand, recommends the use of amoxicillin-clavulanate in the treatment of ABS because of the increasing emergence of *H. influenzae* as a cause of ABS in children and the increasing rate of β-lactamase production by this microorganism.[47] The present consensus is that amoxicillin-clavulanate, at a standard oral dose of 45 mg/kg/day of the amoxicillin component (maximum 1.75 g/day) divided into two doses, should be used as a first-line treatment of uncomplicated ABS in children in whom antibacterial resistance is not suspected.[5,27,93] Alternatively, amoxicillin 90 mg/day (maximum 4 g/day) divided into two doses by mouth can be given.[12] For those with severe ABS or uncomplicated acute sinusitis who are at risk for severe disease or antibiotic resistance, high-dose oral amoxicillin-clavulanate (90 mg/kg/day of the amoxicillin component, divided into two doses; maximum 4 g/day) is the drug of choice.[5,27] The risk factors for bacterial resistance include age less than 2 years, residing in an area with a high endemic rate (≥10%) of ampicillin-resistant *H. influenzae* and penicillin-non-susceptible *S. pneumoniae*, antimicrobial treatment within the past month, recent hospitalization, day-care attendance, deimmunization or partial immunization with pneumococcal conjugate vaccine, and immunodeficiency.[1,5,23,27] Alternative therapies to high-dose amoxicillin-clavulanate include cefpodoxime 10 mg/kg/day (maximum 400 mg/day) orally divided into two doses, cefdinir 14 mg/kg/day (maximum 600 mg/day) orally in a single dose or divided into two doses, and levofloxacin 10–20 mg/kg/day (maximum 500 mg/day) orally in a single dose or divided into two doses.[18,27,28,34]

For children who are vomiting and cannot tolerate oral medications, ceftriaxone 50 mg/kg/day (maximum 1 g/day) intravenously or intramuscularly once a day can be given. The antibiotic should be switched to the oral route once the vomiting has resolved.[27,45]

For children who have an immediate, anaphylactic hypersensitivity reaction to penicillin, levofloxacin 10–20 mg/kg/day by mouth either in a single dose or divided into two doses should be given instead.[47,94] Systemic levofloxacin should be avoided in children if possible due to the potential risk of musculoskeletal toxicity. However, it is reasonable to use systemic levofloxacin in children when no safe and effective alternative is available. Doxycycline should be considered in older children with allergy to β-lactam. For children with a mild delayed hypersensitivity reaction to penicillin, cefpodoxime 10 mg/kg/day (maximum 400 mg/day) orally divided into two doses or cefdinir 14 mg/kg/day (maximum 600 mg/day) orally in a single dose or divided into two doses are therapeutic options.[18,27,28,34]

Children hospitalized because of severe ABS, complications, or treatment failure with outpatient therapy after a second course of oral antimicrobials should be treated with intravenous antimicrobials such as ampicillin-sulbactam (200–400 mg/kg/day every 6 hours; maximum 8 g ampicillin component/day), ceftriaxone (100 mg/kg/day every 12 hours; maximum 2 g/day), or levofloxacin 10–20 mg/kg/day (maximum 500 mg/day) divided over 12 or 24 hours.[19,22,27] Intravenous vancomycin (60 mg/kg/day; maximum 4 g/day) every 6 hours and metronidazole (30 mg/kg/day; maximum 4 g/day) every 6 hours may be added if necessary.[27]

The use of decongestants, either topical or oral, in the treatment of ABS is not recommended.[1,4,34,95] Prolonged use of topical decongestants may lead to rhinitis medicamentosa.[4,55]

Antihistamines may dry and thicken nasal secretions and may lead to blockage of the ostiomeatal complex.[5] Other adverse events include sedation, dry mouth, blurred vision, constipation, and urinary retention.[56] With possible exception in children with atopy, antihistamines are of unproven value in the treatment of ABS and are therefore not recommended.[96]

Intranasal steroids can be used as an adjunct therapy to reduce the mucous membrane inflammation that causes obstruction of the sinus ostia thereby facilitating sinus drainage.[97] Preliminary studies showed that the use of intranasal steroids can reduce the severity and hasten the resolution of symptoms of sinusitis in children.[97–99] However, studies have shown that intranasal steroids, even as an adjunct to antibiotic therapy, only have a marginal or modest effect in the treatment of ABS and therefore do not justify their routine use in the treatment of ABS.[2,3]

Some authors suggest the use of saline nose spray, saline nose drops, and/or saline nasal irrigation to prevent crust formation in the nasal cavity and thus facilitate sinus drainage.[2,3] In a randomized, prospective placebo-controlled study of 69 children with acute sinusitis, 30 children received normal saline irrigation in addition to standard treatment for acute sinusitis and 39 children received standard treatment alone.[100] The authors found that normal saline irrigation improved

symptoms, quality of life scores, and nasal peak expiratory flow rate. The same group of investigators found that normal saline irrigation is an effective adjunctive treatment of acute sinusitis in children with atopy.[101] It is hoped that future, well-designed, large-scale, randomized, double-blind, placebo-controlled trials will provide more information on the efficacy of saline nose spray, saline nose drops, and/or saline nasal irrigation in the treatment of ABS in children.

In general, children with ABS do not require surgical intervention unless they have suppurative complications, which usually require surgical drainage.[18] The indications for performing sinus aspiration in children with ABS have been previously described (vide supra).

Prevention

Preventative care includes routine childhood vaccinations (particularly, 13-valent pneumococcal conjugate vaccine and Hib vaccine) and adequate access to medical care.[102] There is no role of adenoidectomy to reduce the number of visits for ABS.[103]

Prognosis

The prognosis is good. Uncomplicated ABS typically responds to appropriate antibiotic therapy with clinical improvement within 72 hours. The condition does not cause any significant mortality by itself. Complicated ABS may lead to morbidity and, rarely, mortality.[102] Recurrence of ABS is uncommon in healthy children.[35] However, children with immunodeficiency, cystic fibrosis, nasal polyps, and immotile cilia syndrome are prone to recurrent ABS.[6]

Conclusion

As clinical features of ABS often overlap with those of acute viral URI, physicians often face the challenge of differentiating between the two conditions. Typically, ABS presents with persistent symptoms and signs of a URI beyond 10 days, without much improvement; a URI with high fever and purulent nasal discharge at onset lasting for at least 3 consecutive days; and biphasic or worsening symptoms. The diagnosis of ABS is mainly a clinical one. Imaging studies of paranasal sinuses are not recommended to diagnose ABS unless complications are suspected. The present consensus is that amoxicillin-clavulanate, at a standard dose of 45 mg/kg/day of the amoxicillin component, is the first-line therapy of uncomplicated ABS when antibacterial resistance is not suspected. For those with severe ABS and those who are at risk for severe disease or antibiotic resistance, high-dose amoxicillin-clavulanate is preferred. It is hoped that future high-quality, prospective clinical studies will provide us with more information on the diagnosis and management of ABS in children as well as to strengthen specific recommendations in dealing with this clinical condition.

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