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Rhinosinusitis in children

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Abstract. *Rhinosinusitis in children.* The definition of rhinosinusitis (RS) in children is based here on category IV reports. The diagnosis of RS is mainly made on clinical grounds helped by endoscopic investigation. Indications for additional investigation and radiological examination are outlined. Medical treatment with antibiotics is advised when bacterial infections and complications are present. There is insufficient evidence for the use of antibiotics for uncomplicated common colds in children. The strength of evidence for recommendations is mainly A-based, unless otherwise specified. There is a paucity of studies (with a rather low numbers of participants) in children. The absolute and relative indications for surgical intervention are outlined. Decisional algorithms are presented for acute and chronic rhinosinusitis in children.

I. Definition and epidemiology of rhinosinusitis in children

Rhinitis and **sinusitis** usually coexist and are concurrent in most individuals; the correct term is now ***rhinosinusitis***.[1]

Clinical definition of rhinosinusitis in children

- inflammation of the nose and the paranasal sinuses characterised by:
  - blockage/congestion
  - discharge: anterior/post-nasal drip
  - facial pain/pressure
  - impairment/loss of smell

  and either
- endoscopic signs:
  - polyp(s)
  - mucopurulent discharge from middle meatus
  - oedema/mucosal obstruction primarily in middle meatus

  and/or
- CT changes:
  - mucosal changes within ostiomeatal complex and/or sinuses

Classification in paediatric rhinosinusitis is based on the consensus meeting in Brussels.[1] To summarise:

1. **Acute rhinosinusitis** is an infection of the sinuses usually initiated by a viral infection, in which the complete resolution of symptoms (assessed on a clinical basis only) without intermittent upper respiratory tract infections may take up to twelve weeks. It can be subdivided into severe and non-severe (Table 1).
   According to the subcommittee on the management of sinusitis and the committee on quality improvement of the American Academy of Pediatricians (SMS/CQIAAB), the common predisposing event that sets the stage for acute bacterial sinusitis is a viral upper respiratory infection that results in viral sinusitis and can lead to an "acute bacterial rhinosinusitis" (ABRS). In 80% of cases, this acute bacterial rhinosinusitis is induced by an upper respiratory infection that starts a diffuse mucositis followed by bacterial superinfection. Allergy is responsible for the remaining 20% of acute bacterial sinusitis. According to the SMS-CQI-AAP guideline[2], an acute bacterial rhinosinusitis is an infection of the paranasal sinuses lasting less than 30 days in which symptoms resolve completely. According to Mucha *et al.*[3] ABRS should be considered after a viral upper respiratory infection, when the symptoms worsen after 5 days, are present for longer than 10 days or out of proportion to those seen in most viral infections. A typical evolution of this kind is more obvious in adolescent children and adults than in very young children.
   To cover the gap between acute and chronic sinusitis the SMS-CQI-AAP guideline[2] introduced, for children also, the concept of "subacute bacterial sinusitis" as an infection of the paranasal sinuses lasting between 30 and 90 days,

Table 1
Symptoms and signs of non-severe and severe sinusitis in children

Non-severe	Severe
Rhinorrhoea (of any quality) Nasal congestion Cough Facial pain and headache and Irritability (variable)	Purulent rhinorrhea (thick, coloured, opaque) Nasal congestion Facial pain and headache

in which symptoms resolve completely. The Brussels Consensus Meeting[1] did not recommend the term subacute sinusitis since the difference between acute and subacute is very arbitrary and does not imply a different therapeutic approach in children.
Recurrent acute sinusitis involves episodes of bacterial infection of the paranasal sinuses, separated by intervals during which the patient is asymptomatic. The SMS/CQI-AAP guideline[2] states that these episodes last less than 30 days and are separated by intervals of at least 10 days.

2. **Chronic rhinosinusitis** in children is defined as a non-severe sinus infection with low-grade symptoms persisting for more than twelve weeks.
Chronic rhinosinusitis with frequent exacerbations or acute bacterial sinusitis superimposed on chronic sinusitis. These are patients with residual respiratory symptoms who develop new respiratory symptoms. When treated with antimicrobials, these new symptoms resolve, but underlying residual symptoms do not.

The members of the Brussels Consensus meeting[1] noted that medical treatments such as antibiotics and nasal steroids may modify symptoms and signs of acute and chronic sinusitis and it is sometimes difficult to differentiate between infectious rhinosinusitis and allergic rhinosinusitis on clinical grounds alone in children.

II. Epidemiology

In the USA the annual incidence of viral rhinosinusitis is estimated to be 6 to 8 episodes in children and 2 to 3 episodes in the adult population.[4] Wald[5] states that colds are much more frequent in children than in adults and that the range of reported frequency for URI in young children is between 6 and 8 per year, while adults experience two or three colds a year. Between 5 and 10% of cases of viral rhinosinusitis are thought to be complicated by clinically evident acute bacterial rhinosinusitis.

Van der Veken[6] showed in a CT scan study that there was sinus involvement in 64% of children with a history of chronic purulent rhinorrhoea and a nasal obstruction. An MRI study of a non-ENT paediatric population[7] found an overall prevalence of sinusitis signs in children of 45%. This prevalence increases in the presence of a history of nasal obstruction to 50%, to 80% when bilateral mucosal swelling is present on rhinoscopy, to 81% after a recent upper respiratory tract infection (URI), and to 100% in the presence of purulent secretions. Kristo *et al.*[8] also found a similar overall percentage (50%) of abnormalities on MRI in 24 schoolchildren. They included, however, a follow-up after 6 to 7 months, and found that about half of the abnormal sinuses on MRI findings had resolved or improved without any intervention.

A very extensive prospective study was performed by Bagatsch *et al.*[9] who followed the total paediatric population (24,000 children), representing 30% of a newly developed residential area in the neighbourhood of Rostock (former DDR) with 80,000 residents, who were followed for 1 year by the only available medical centre in that area. Eighty-four percent of the children aged between 0-2 years, 74% of those between 4 and 6 years, and 80% of those over 7 years of age had one or more episodes of URI in that period. In a closer look at the 0 to 5 year old group, 72% of those children staying in day care centres and 27% of those staying at home had one or more episodes of URI. Of the 84% of children aged 0 to 3 years (n = 4.103), 32% suffered from rhinopharyngitis. The peak of this disease was located in November to February. Lind[10] and Bjuggren *et al.*[11] also found a much higher prevalence of up to 100% for maxillary sinusitis in children staying in day care centres compared with the same age group staying at home or older children in schools. Sometimes, children in day care centres also induce recurrent sinusitis in the adults watching over them (= “young child to young adult sick sinus syndrome”).[12]

All these epidemiological studies yield important information about pathophysiology and

clinical relevant factors for the prevalence of rhinosinusitis in children:

1. There is a clear-cut decrease of the prevalence of rhinosinusitis after 6 to 8 years of age. This is the natural history of the disease in children and is probably related to an immature immune system in the younger child.[6,13,14]
2. In temperate climates there is a definite increase in the occurrence of chronic rhinosinusitis in children during the autumn and in the winter, so the season seems to be another important factor.
3. The prevalence of chronic or recurrent sinusitis is much higher in younger children in day care centres than in children staying at home.

III. Pathophysiology

Although viruses are rarely recovered from sinus aspirates[15,16] most authors agree[17] that viral infections are the trigger for rhinosinusitis. Evidence supports the idea that nasal fluid containing viruses, bacteria and inflammatory mediators might be blown into the sinuses during a cold.

Although CT scan abnormality can be seen up to several weeks after the onset of a URI, one can assume that only 5 to 10% of URIs in early childhood are complicated by acute sinusitis.[18,19,20]

The factors predisposing to ostial obstruction can be divided into those that cause mucosal swelling, and those due to mechanical obstruction. Mucosal swelling is mostly induced by URI but it can be caused by systemic diseases such as cystic fibrosis, allergy, immune disorders and primary ciliary dyskinaesia. Local insult such as facial trauma, swimming and or diving can contribute to poor antral drainage and ventilation. The most common mechanical factors in children are choanal atraesia, adenoid hyperplasia, extreme anatomical variations of septum and of the lateral nasal wall, foreign bodies and tumours (juvenile angiofibroma) or pseudotumours (polyps, antrochoanal polyp, meningoencephalocoeles).

IV. Diagnostic management

1. *Clinical examination*

   – Anterior rhinoscopy: remains the first step but is inadequate on its own.
   – Endoscopy: is more useful not only for diagnosis but also for exclusion of other conditions such as polyps, foreign bodies, tumours and septal deviations. Moreover, it allows for direct sampling of the middle meatus in certain conditions.[21]

2. *Microbiology*

   Microbiological assessment is usually not necessary in children with uncomplicated acute or chronic rhinosinusitis. The indications for sinus punction are:

   1. severe illness or toxic conditions in a child;
   2. acute illness in a child that does not improve with medical therapy in 18 or 72 hours;
   3. an immunocompromised host;
   4. the presence of superative (intra-orbital, intracranial) complications (orbital cellulites excepted).

   Culture specimens obtained from the middle meatus or from the ethmoidal bulla are often more likely to show positive results than culture specimens obtained from the maxillary antrum.

3. *Imaging*

Imaging is not necessary to confirm a diagnosis of rhinosinusitis in children. Transillumination of the sinuses is difficult to perform and unreliable in children. The value of ultrasound is controversial.

– Plane sinus X-rays are insensitive and their usefulness is limited for both diagnosis and guiding surgery in children. The marginal benefits are insufficient to justify the exposure to radiation in children.[22]
– CT scanning remains the imaging methodology of choice because it can resolve both bone and soft tissue[23] and provides good visualisation of the ostiomeatal complex, the corner-stone of the diagnosis of sinusitis.[24]

Indications:

1. severe illness or toxic conditions in a child;
2. acute illness in a child that does not improve with medical therapy in 18 or 72 hours;
3. an immunocompromised host;
4. the presence of suppurative (intra-orbital, intracranial) complications (orbital cellulites excepted);
5. if surgery is being considered.

4. *Additional investigation*

Additional investigation in the presence of recalcitrant rhinosinusitis: underlying conditions such as allergy, immunodeficiency, cystic fibrosis, ciliary immotile disorders, and gastro-oesophageal reflux have to be considered. Of these, respiratory allergy is perhaps the most frequent. In children with chronic or recurrent acute rhinosinusitis with a suggestive history and/or physical examination findings, then, allergic assessment (skin-prick, nasal smear, radioallergosorbent testing, or trial of treatment) should be performed in patients who continue to have clinical difficulties, despite avoidance and simple pharmacological measures. Immunological assessment (complete blood cell count, quantitative immune globuline levels, IgG subclass levels in serum and anti-pneumococcic antibody titres) is also advised.

V. Therapeutic management

1. *Medical treatment*

a) **Common cold**

A study of the delayed use of antibiotics for symptoms and complications of respiratory infections indicates that antibiotics have no effect on the common cold. The use of antihistamines, decongestants, antitussives, expectorants, singly and in combination, are meant to provide symptom relief, but no studies are available in children and infants that have demonstrated any benefit. Their use is not recommended because of the potential of enhanced toxicity. Transmission of the common cold is best prevented by frequent hand-washing and avoiding touching one's nose and eyes.

b) **Acute rhinosinusitis**

The most common bacterial species isolated from the maxillary sinuses of patients with ABRS are *Streptococcus Pneumoniae, Haemophilus Influenzae and Moraxella catarrhalis,* the latter being more common in children.[22]
Antibiotherapy only should be considered in

– severe illness or toxic conditions in children;
– suspected or proven suppurative complications (parenteral antibiotics are preferred);
– severe acute rhinosinusitis;
– non-severe acute rhinosinusitis in a child with protracted symptoms to whom antibiotics can be given on a individualised basis (presence of asthma, chronic bronchitis, acute otitis media, immunocompromised children,...).

The duration of the antimicrobial therapy should be at least 10 to 14 days, and can be prolonged to 1 month if the symptoms have clearly improved but not resolved completely. However, if the symptoms are unchanged at 72 hours or worsen at any time, the clinician should either change antibiotics or obtain a specimen of sinus secretions for culture and make a thorough re-evaluation of the child's condition.
This recommendation is based on experience in adults. Hamory *et al*.[25] found negative cultures (n = 81) with symptoms of acute sinusitis after a 10-day course of treatment with an antibiotic to which the micro-organism was susceptible in 42 out of 44 (95%) repeated sinus aspirates. Since 1981, the percentage of β lactamase-positive strains has shown a steady increase from 6% to 17% in 1991.[26] Depending on the country and the local situation, amoxicillin can usually still be used as a good first-line antibiotic in non-severe cases. If the local prevalence of lactamase-positive strains is high, then an appropriate β lactam-resistant antibiotic such as amoxicillin-clavulanate or cefuroxime can be used for at least 10 days.

c) **Chronic rhinosinusitis**

There is no evidence – since the role of bacteria in CRS remains unclear – supporting the use of antibiotics. Van Buchem *et al*.[14] followed 169 children with a runny nose for 6 months, treating them only with decongestants or saline nose drops. They did not find a single child who developed a clinically serious disease, which proved that complications of rhinosinusitis in a child are not very common. The only long-term follow-up of the treatment of children with chronic maxillary sinusitis (n = 141), which compared oral amoxicillin combined with decongestive nose drops, drainage of the maxillary sinus (antral lavage), a combination of the two previous regimens, and placebo, was performed by Otten *et al*.[27] They found that the therapeutic effects of these four forms of treatment did not

differ significantly or have a significant curative effect. Antibiotics should not be administered in a child under the age of seven with a chronic runny nose but who is otherwise completely healthy.

d) **Chronic rhinosinusitis with frequent exacerbations**

In chronic rhinosinusitis with frequent exacerbations, an initial course of 2 weeks of oral antimicrobial treatment is advised. If there is no response within 5-7 days, the antibiotic should be changed. If there is again no response within 5-7 days a specimen of sinus secretion should be obtained for culture or a non-infectious condition should be considered. If, however, the patients respond rather slowly, a second two-week course can be prescribed. In rare cases, when there is a clear-cut improvement but symptoms still persist, a third course can be given before considering surgery. Parenteral antimicrobial therapy may be administered before considering surgery.

2. *Surgical treatment*

a) **Adenoidectomy**

One study[28] performed on 78 children showed a significant improvement ($p < 0.01$) of sinusitis signs on X-ray examination six months after surgery compared with a control group. Accordingly, in cases where chronic sinusitis is accompanied by clear-cut signs of adenoid hypertrophy resulting in nasal obstruction, snoring and speech difficulty, adenoidectomy should be performed before more extensive surgery is considered. In a retrospective study, Vandenberg *et al.*[29] showed, in 48 children after adenoidectomy or adenotonsillectomy, a clear-cut improvement in the symptoms of rhinosinusitis i.e.: rhinorrhoea, nasal congestion, mouth breathing and frequent antibiotic use. The importance of adenoidectomy is further underscored by Ungkanont *et al.*[30] in a prospective study in 37 children with chronic rhinosinusitis, showing a statistically significant reduction in episodes per year of acute rhinosinusitis and reduction in obstructive symptoms.

b) **Antral lavage**

In children with chronic rhinosinusitis, irrigation of the maxillary sinus does not lead to better results after 3 weeks compared with a control group[31] or there is no statistically significant increase in the success rate.[22]

c) **Nasal antral window in inferior meatus**

Lund[23] demonstrated that, especially in children under the age of 16 years, there is a higher rate of closure of these antral windows. She concluded that the inferior meatus in children is smaller than in adults, making it impossible to achieve an adequate antrostomy. Lusk *et al.*[22] and Muntz *et al.*[24] were therefore able to show that, in a six-month follow-up, the success rate of the nasal antral window procedure dropped to 27%. All patients remained symptomatic, and 28% needed further functional endoscopic sinus surgery.

d) **The Caldwell-Luc operation**

Is contra-indicated in children.[16,23]

e) **Functional endoscopic sinus surgery (FESS)**

Functional endoscopic sinus surgery (FESS) should be individually tailored to each case. An international consensus was reached in 1996[1] concerning the indications for FESS in children (Table 2).

Extensive sphenoidectomy is usually not necessary in children. Anterior ethmoidectomy (with removal of the uncinate process with or without maxillary antrostomy, opening of the bulla, no dissection posterior to the basal lamella) is often sufficient. It is only in children with massive polyposis due to cystic fibrosis that extensive spheno-ethmoidectomy yields better and more enduring results than limited surgery.

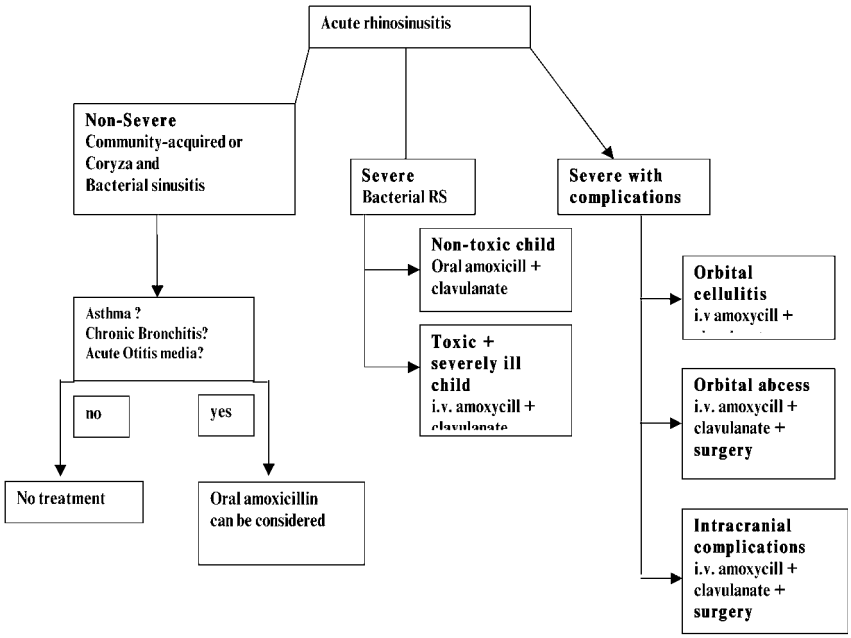
In a meta-analysis of FESS in children, Hebert *et al.*[32] (focusing on the number of patients per study, length of follow-up, prospective versus retrospective, the separation or exclusion of patients with significant underlying systemic disease) showed – in 8 published articles (832 patients) – positive outcome rates ranging from 88 to 92%. The average combined follow-up was 3.7 years. So they concluded that FESS is a safe and effective treatment for chronic sinusitis that is refractory to medical treatment.

Similar results were published in a more recent study by Jiang *et al.*[33] and Fakhri *et al.*[34] showing a postoperative improvement in 84% of cases treated with FESS

(n = 121). For this indication, Bothwell *et al*.[35] conducted a retrospective age-matched cohort outcome study using qualitative antropomorphic analysis of 12 standard facial measurements in follow-up over 13.2 years. They found no statistically significant difference in outcome in terms of facial growth between 46 children who underwent FES surgery and 21 children who did not.

VI. Decisional algorithms

Evidence-based diagram for therapy in children with acute rhinosinusitis[38]



Evidence-based diagram for therapy in children with chronic rhinosinusitis

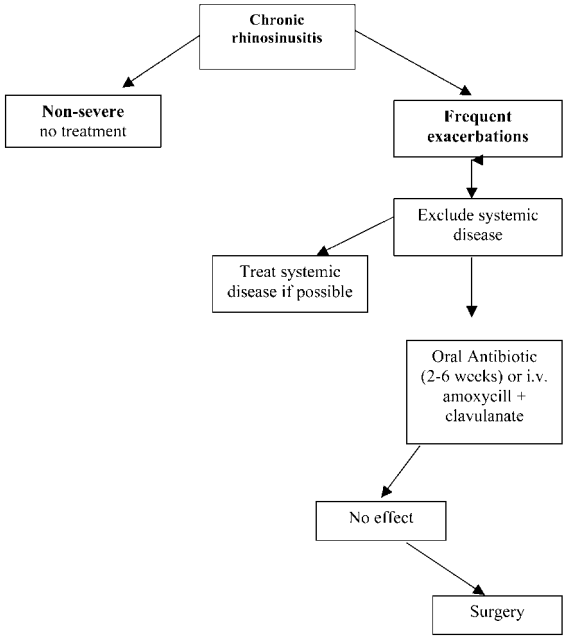


Table 2
Indications for surgery in children with rhinosinusitis

Absolute indications
1 Orbital abscess
2 Intracranial complications
3 Antrochoanal polyp
4 Mucocele or mucopyocele
5 Fungal sinusitis
6 Massive polyposis in cystic fibrosis

Possible indications
After optimal medical management and exclusion of systemic disease, persistent chronic rhinosinusitis with frequent exacerbation

Conclusion

In conclusion one can state that rhinosinusitis in children is a very common disease. Medical therapy should be restricted to well-defined conditions and surgical therapy should only considered in exceptional cases.

VII. Patient information

Rhinosinusitis is an inflammation of the mucosa of the nose and paranasal sinuses, mainly provoked by viral infections, without any need for antibiotic treatment. The development of the sinuses and hence the inflammatory changes depend on the age of the child. Factors such as bacterial superinfection, respiratory tract allergy, gastro-oesophageal reflux and immunological disorders have to be considered.

The doctor should be consulted when severe illness, fever, rhinitis, facial pain and headache are present.

The diagnosis is mainly made by clinical examination. Endoscopic inspection of the nose might

be necessary to refine the diagnosis.

In cases of severe illness or frequent exacerbation, antibiotic treatment should be considered, where appropriate based on sampling secretions for bacteriological identification.

When complications occur or symptoms worsen after 5 days or the rhinosinusitis lasts longer than 10 days with persistent acute symptoms, further evaluation is needed. Underlying conditions will be examined when frequent exacerbation or chronic rhinosinusitis persists. CT scan is the gold standard for radiological investigation.

Adenoidectomy might first be considered when persistent nasal obstruction, nasal discharge and serous otitis media seem to be linked. In exceptional cases, functional endoscopic sinus surgery (FESS) can be considered when medical treatment fails. It should be tailored to the specific indications and needs of each case, after possible underlying conditions have been ruled out or treated.

If you have further questions, please consult your medical doctor.

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Guidelines

- Sinus and Allergy Partnership: Antimicrobial treatment guidelines for acute bacterial rhinosinusitis. *Otolaryngol Head Neck Surg*. 2004;130 (1 suppl): 1-45.
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CME questions

1. The classification (acute, subacute, chronic...) in paediatric RS is based on

   A – Category of evidence I
   B – Category of evidence III
   C – Category of evidence IV
   D – None of the above
   E – Differs from country to country

2. What is correct in the following statements about acute bacterial RS?

   A – The condition is always clinically evident with the presence of purulent secretions
   B – Can only be proved by correct sampling methods for culturing
   C – Is never the result of a viral upper respiratory infection
   D – Occurs mainly in allergic patients
   E – Is obvious in the five first days of upper respiratory infection

3. What is correct in the following statements about chronic RS (CRS)?

   A – A viral inflammation persisting more than 12 weeks
   B – Severe sinusitis persisting for more than 12 weeks
   C – Low-grade symptoms in non-severe rhinosinusitis persisting for more than 12 weeks
   D – Recurrent bacterial infections with symptom-free intervals lasting more than 12 weeks
   E – All of the above

4. Look for the wrong statement

   A – The annual incidence in the USA of viral RS is estimated to be 6 to 8 episodes/year
   B – There is a clear fall in the prevalence of RS after the age of 6 to 8 years
   C – Sometimes adults induce recurrent RS in children in day care centres
   D – Young children who stay at home have much less chronic or recurrent RS
   E – In temperate climates, children are prone to chronic RS in the autumn and winter

5. After a recent upper respiratory tract infection (URI) with presence of purulent secretions

   A – MRI is likely to find signs of sinusitis in 45% of patients
   B – In more than 50% of patients
   C – In more than 64% of patients
   D – In more than 80% of patients
   E – In all patients

6. Routine investigation in children with mild uncomplicated RS requires

   A – Endoscopic nasal investigation
   B – Microbiological assessment
   C – Plane X-rays
   D – Blood-sampling for immunological work-up
   E – Simple clinical investigation without any treatment

7. Antral lavage in children with acute bacterial RS is necessary

   A – Whenever a bacterial infection is suspected
   B – When clinical signs get worse after 5 days of uri
   C – When acute symptoms of URI exceed ten days
   D – In severely ill children who do not improve with medical therapy
   E – In view of possible surgical intervention

8. CT imaging in children is necessary when

   A – You want to confirm a diagnosis of rhinosinusitis
   B – To acquire additional information to complement X-rays, which are inadequate
   C – To evaluate the approximate age of the child
   D – To prove an allergic condition
   E – None of the above reasons

9. The use of antibiotics in children with CRS should be considered

   A – When purulent nasal secretions are present, even without fever and in non-toxic cases
   B – Suspected or proven suppurative complications
   C – At the explicit request of the parents when there is a positive antibiogram
   D – In a preventive fashion for day-care purposes
   E – Persistent non-severe symptoms lasting for more than five days

10. Endoscopic sinus surgery in children

    A – Is indicated when adenoidectomy has failed
    B – Should be individually tailored
    C – Is indicated when a Caldwell-Luc operation has failed
    D – Is indicated whenever a CT scan shows signs of chronic inflammation
    E – Is indicated in all the circumstances above

Answers: 1C; 2B; 3C; 4C; 5E; 6E; 7D; 8E; 9B; 10B