Why won't this child's nose stop running?

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Recurrent rhinorrhea can present a diagnostic challenge. The authors offer tips for sorting through the differential and recommend a minimalist, individualized approach to management.

Your patient has a runny nose. Is it a simple cold? Food or seasonal allergy? Obstruction by the adenoid behind the nose? Severe gastrointestinal reflux with nasal irritation? Is it just a drippy nose? Or is it something that could lead to true chronic rhinosinusitis?

Runny noses vex pediatricians most of the year, but especially during winter months. Although clinical practice guidelines have been published to aid in diagnosis and treatment of rhinorrhea, most references are of limited practical use. Likewise, review articles on advances in research do not help the clinician differentiate among noninfectious drainage, a protracted viral infection, and rhinosinusitis. Consensus panels have toiled to arrive at helpful definitions for categories of runny nose and treatment recommendations for rhinorrhea. Yet, many clinical conditions defy clean categorization. Our goal in this article is to offer a practical framework for the diagnosis and management of the runny nose, including pearls to remember and pitfalls to avoid.

Nasal anatomy and function

The nose is divided into two chambers by the septum, which runs from the tip anteriorly to the choanae posteriorly, emptying into the nasopharynx. Inside the nose are three outgrowths on each side called turbinates. Each side of the nose also has four paired paranasal sinuses. The ethmoid and maxillary sinuses, which are present by the third or fourth month of gestation, are small at birth. The sphenoid sinuses pneumatize (become air-containing cavities) by 6 years of age. The frontal sinuses become radiographically noticeable by 7 to 8 years of age, but develop mostly between the ages of 12 and 18 years. Sometimes, a sinus does not develop (aplastic) or only partially develops (hypoplastic). In as many as 5% of adults, one or both frontal sinuses are not fully developed. The sinuses are usually asymmetrical, which often leads to misinterpretation of plain radiographs of this region.

The exact function of the paranasal sinuses is unknown. We do know that the sinuses contain ciliated respiratory lining and secrete mucus. A deeper so-called sol layer and a superficial gel layer may help the nose filter inspired bacteria and pollutants. The sinuses may aid in regulating temperature and humidification. There is good evidence for the theory that the mucociliary blanket flows within the sinus cavities toward the natural ostia into the nose. A patent sinonasal ostia, normal mucus, and functional cilia are, therefore, essential to prevent rhinosinusitis.

Of the three paired turbinates, the largest and most visible are the inferior turbinates. The nasolacrimal duct empties into the
nose just under the inferior turbinate. The maxillary, frontal, and anterior ethmoid sinuses drain by way of the middle meatus just under the middle turbinate. The posterior ethmoids and the sphenoid sinuses drain via the sphenethmoidal recess near the superior turbinate. The osteomeatal complex represents the confluence of the sinus drainage into the nose and, as such, is thought to be the key area for proper maintenance of function (Figure 1). This theory has been the prevailing notion for only the past 20 years, however, and therefore represents a relatively new concept.

The functions of the nose and sinuses are adversely altered by trauma, drying agents, chemical and particulate irritants (even passive cigarette smoke), seasonal and perennial allergens, and disruption of the normal sympathetic-parasympathetic balance. The mucosa becomes edematous with stasis of mucociliary clearance. Secretions pool and oxygen tension drops. The sinonasal ostia obstruct with onset of a closed-space infection. The figure on page 55 in the print edition ("The multifactorial nature of rhinosinusitis," adapted from Reilly JS: The Sinusitis cycle. Otolaryngol Head Neck Surg 1990;103(5, Pt 2):859), depicts this "sinusitis cycle."

(The table "Distinguishing among rhinosinusitis, allergy, and common cold," available in the print edition, is reprinted from Pediatric Rhinosinusitis with permission of the American Academy of Otolaryngology-Head and Neck Surgery Foundation, copyright © 2000)

Defining rhinosinusitis

How do you distinguish among drainage caused by allergy, a routine viral upper respiratory infection (URI), and a bout of bacterial rhinosinusitis? (The American Academy of Otolaryngology-Head and Neck Surgery prefers the term "rhinosinusitis" to "sinusitis," lest we forget the nose.) This question has been vigorously debated; for most clinicians, there is no satisfactory answer. Separation of the acute allergy component is fairly straightforward in most cases (see the table). Mucus is thin, clear, and watery. Fever, bad breath, and tooth pain are absent. Postnasal drip and, often, coughing are present, and, possibly, headache from sinonasal ostial pressure. Therefore, headache or facial pain with drainage does not necessarily indicate rhinosinusitis. It may just be mucosal swelling with ostial pressure.

The bigger diagnostic challenge is distinguishing a URI from acute rhinosinusitis. (Rhinosinusitis is defined as bacterial sinusitis to distinguish it from a viral URI.) A combined task force of the American Academy of Pediatrics (AAP) and the Centers for Disease Control and Prevention (CDC) concluded that the diagnosis of acute bacterial sinusitis in children is predicated on the following:

- prolonged nonspecific upper respiratory signs and symptoms (cough and nasal drainage) without improvement for more than 10 to 14 days, or
- more severe upper respiratory tract signs and symptoms (fever, facial swelling, facial pain).

The problem with this definition is the subjective nature of "more severe," which is open to the individual clinician's interpretation. Moreover, if symptoms deemed "more severe" recur in a patient over several months, the patient may be inappropriately labeled as having recurrent rhinosinusitis or "chronic rhinosinusitis."

Recurrent acute rhinosinusitis is analogous in certain respects to recurrent acute otitis media (AOM). In both conditions, for example, episodes last more than 30 days and are separated by asymptomatic intervals of at least 10 days. The proposed entity...
of chronic persistent rhinosinusitis, however, is an unresolved issue. Again, otitis media can serve as an analogy: Persistent middle-ear fluid with or without spikes of superimposed AOM events is called persistent otitis media with effusion (POME), sometimes referred to as persistent serous otitis media or chronic otitis media. This is, and should be, thought of as a distinct entity from recurrent AOM, where the eustachian tube eventually functions normally, allowing complete resolution of the acute process.

In POME, the eustachian tube remains blocked, either because of a single, fixable problem or multiple factors. Is there an analogous entity of persistent maxillary or ethmoid sinus effusion with intermittent pressure and pain, chronic cough, nasal discharge, and nasal obstruction? We believe there is. The patient has a URI or two, and for much of the autumn and winter months has nasal drainage, cough, intermittent headache, and poor mucociliary clearance. Multiple, sequential radiographs usually do not demonstrate complete clearance. The pathogenic process is often the result of multiple factors that are difficult to correct (see "The multifactorial nature of rhinosinusitis [http://#1]").

Narrowing the field with a history and physical

Five key elements in the history can help you home in on a diagnosis in the child who has a runny nose:

**Duration of symptoms.** When did the drainage start? Has it been present for one day, one week, or one month?

**Timing.** Has drainage occurred only since the child started day care or preschool? Do symptoms reoccur seasonally?

**Environment.** Are smokers around the child? Pets? Does the child live in an industrial area?

**Response to therapy.** What has been tried so far? What has worked and what hasn't?

**Morbidity.** Does the child seem happy running around with a drippy nose? Who is bothered by the condition more—the parent, or day-care or school personnel? Can the child breathe through the nose with the mouth closed? Are fever and facial pain or headache associated with discrete episodes? Is there a persistent or nighttime cough?

Here are some pearls to help in making the diagnosis:

If one parent has an allergy, the child has a 35% chance of having one too. If both parents have an allergy, the child has about a 70% to 80% chance of being allergic.

If the child has a significant history of atopic dermatitis, an allergy is very likely a contributor to the runny nose.

Children under 7 years old do not have developed frontal sinuses. Therefore, with rare exceptions, headache pain referred to the forehead, temples, or top of the head in this age group is not from the sinuses.

Children with Down syndrome have a narrow midface and poor mucociliary clearance and are more prone to nasal obstruction with drainage.

In performing a physical examination, consider these four key elements:

**General appearance.** Is the child happily ransacking your office during the encounter or does he seem lethargic? Does he struggle to breathe when his mouth is closed?

**Skin.** Are there rashes that appear to be atopic dermatitis?

**Nasal cavity.** Are the inferior turbinates huge, pale, and boggy? Are mucosa hyperemic? Are there true polyps (not turbinates)? Is the discharge clear? Or is it whitish, yellowish, or greenish? Is the discharge coming from the middle meatus (sinusitis) or the postnasal region (adenoiditis)?

**Oropharynx.** Is there postnasal drip?

Again, here are some pearls:

Green or yellow drainage does not necessarily mean bacterial infection. It is just as likely a viral infection.

Instead of coiling up catheters inside the nose, use a pocket mirror in front of the nose. If you see fog from each side of the nose
on the mirror, the infant or child does not have choanal atresia. Next, look in the nose. If the turbinates are small but the child has difficulty breathing through his nose, the adenoid is the likely culprit. If the turbinates are huge, the problem is likely an allergic or nonallergic irritant affecting the nasal lining.

New onset of unilateral obstruction with drainage and bad odor indicates a nasal foreign body until proved otherwise.

New onset of unilateral nasal obstruction with symptoms of eye pain and blurry or double vision lasting over 3 weeks may be caused by unremitting rhinosinusitis, but it usually represents a sinonasal tumor. This should be the presumptive diagnosis until proved otherwise.

Evaluating rhinitis

When determining the cause of an inflamed mucous membrane, keep the following information in mind:

**Nonallergic rhinitis.** Most studies linking air pollution to breathing problems focus on lower respiratory symptoms. The revised Clean Air Act of 1990 notwithstanding, air pollutants continue to exacerbate respiratory ailments in most urban centers. Passive smoke is another important contributor. Approximately 40% of children under 11 years old are exposed to second-hand smoke at home. Synthetic agents in construction materials, paints, glues, and carpets are notorious irritants.

**Allergic.** Immunoglobulin E (IgE)-mediated hypersensitivity is a major contributor to the development of chronic sinus pressure and rhinosinusitis. When an antigen binds to a specific IgE on the surface of mast cells, the release of chemical mediators (histamine, leukotrienes, and chemotactic factors) causes acute tissue edema with increased mucus production. The impairment of mucociliary clearance results in retained secretions and bacterial overgrowth. Release of late-phase mediators leads to recruitment of inflammatory cells. Allergic disease relegates the nose and sinus mucosa to an intermittent or persistent inflammatory state.

The history is the most useful tool in diagnosing an allergic disorder. Nasal smears for eosinophilia may distinguish between allergic and nonallergic rhinitis. Use of appropriate skin testing, based on the history, is a simple and safe outpatient office procedure in the hands of an experienced allergist. Initial allergy screening is helpful to ascertain the role of avoidance therapy and targeted medication for perennial or seasonal allergies. If it is positive, thorough and complete allergy testing may identify specific allergens for avoidance or treatment. Immunoglobulin screening may detect specific or general deficiencies including common variable immunodeficiency (B cells usually present) and X-linked agammaglobulinemia (B cells lacking).

**Imaging assessment**

Ultrasonography has a limited role in the diagnosis of sinonasal disease. Plain films are not useful in most circumstances they often are of variable quality and overinterpreted, and do not correlate well with findings on computed tomography (CT). For acute disease, the diagnosis is based primarily on clinical impression. For chronic disease, the imaging modality of choice is CT scan: X-ray exposure is minimal and CT can be very helpful in outlining anatomy.

Here are more pearls:

A radiograph is only a single snapshot in time. It may overrepresent or underrepresent the degree of mucosal disease.

Plain films do not distinguish well between a cloudy sinus and a hypoplastic sinus. We have seen many patients treated multiple times with antibiotics for "radiograph-proven" unremitting rhinosinusitis that was later determined to be a hypoplastic maxillary or frontal sinus on a CT scan. What was believed to be an obstructed sinus was, in reality, an absent or poorly developed sinus.

Lateral neck radiographs of the nasopharynx usually offer no new information over that which can be gleaned clinically. Endoscopy is more revealing than a radiograph if there is a diagnostic dilemma in determining whether the child has an enlarged adenoid. This may be the case in an older child (5 to 10 years old) or one who already underwent adenoidectomy and may have regrown adenoid tissue.

On CT scan, severe bowing of the medial maxillary sinus walls with effacement of the natural ostia must be considered cystic fibrosis until proved otherwise.

**Medical management of the runny nose**
Even with excellent educational forums through the AAP, the American Society of Pediatric Otolaryngology, the CDC, and the Joint Task Force on Practice Parameters in Allergy, Asthma and Immunology, clinicians still tend to diagnose a common URI as an episode of rhinosinusitis. If a child has five or six URI events in a given year but has been categorized as having recurrent acute rhinosinusitis, this may lead to unwarranted concern by the clinician or parent, overtreatment with antibiotics, excessive diagnostic CT scanning, and, perhaps, even an unwarranted recommendation for surgery.

How does the clinician avoid falling into this trap? Admittedly, there is no straightforward, cookbook answer for each patient and each encounter. Although treatment of recurrent acute rhinosinusitis may be analogous to recurrent AOM in terms of anatomy of air-containing cavities, pathophysiology, microbiology, and antibiotic choices, there are clear differences as well.

First, the clinician cannot see into the sinuses; only the swelling and discharge in the front of the nose are visible. AOM is a visual diagnosis. Acute rhinosinusitis is a gestalt diagnosis. Plain radiographs are not particularly helpful in distinguishing URI from rhinosinusitis because mucoperiosteal thickening occurs in both.

Second, if the patient does not respond to antimicrobial therapy, obtaining a sinus culture is a very different process than it is for a middle-ear culture. Whereas a middle-ear culture is an office procedure in most cases, a maxillary or ethmoid sinus culture requires general anesthesia. Nasal cultures and so-called middle meatal cultures may not reflect sinus-dwelling pathogens. Figure 2 is a photo of purulence emanating from the ethmoid sinus into the middle meatus, easily seen with an endoscope.

Third, whereas the function of the middle ear space can be tested and monitored, this is not true of the paranasal sinuses. In a patient with persistent middle ear fluid, an audiogram is essential to determine to what extent the child has conductive hearing impairment that could delay language development if left uncorrected. In sinus pathology, there is no analogous test of objective sinus dysfunction.

That said, the general principles of management of the runny nose are to:

- reduce tissue edema
- improve mucociliary function
- reestablish natural drainage and ventilation
- reduce the potential for bacterial overgrowth.

No single therapeutic modality seems to control all the symptoms of the runny nose; each patient responds differently to management strategies. We endorse a minimalist philosophy to obtain the greatest benefit with the least manipulation and use of medications, coupled with the fewest lifestyle changes for the child. With that in mind, we prefer topical agents to systemic agents to reduce potential adverse effects.

Using a stepwise approach (see Figure 3 for details), we generally begin maintenance therapy with hypertonic, buffered saline irrigation once or twice a day. This solution can be mixed at home at low cost, as outlined in the box below.

Commercial preparations are also available using both simple and sophisticated (that is, expensive) devices. For patients with significant mucosal edema, we add a topical steroid nasal spray to relieve obstruction and reduce ostial inflammation.

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Initial reports linking use of topical nasal steroids with growth suppression have not been shown to be true.\textsuperscript{18,19} In addition, there is no evidence that short-term use of topical nasal steroids induces posterior subcapsular cataracts. Long-term use (greater than three years) may pose a very small risk, but this has yet to be proved.\textsuperscript{20,21}

We try to avoid systemic decongestants and systemic steroids whenever possible. Systemic antihistamines have, traditionally, helped only the histamine-release symptoms of itchy eyes and palate but not nasal congestion. Newer formulations may, however, decrease nasal congestion more effectively. An antihistamine may be useful as part of a medical regimen for allergic rhinitis in the prevention of acute rhinosinusitis.\textsuperscript{22} Avoidance of specific allergens is more effective than treatment. When this is not practical or feasible, a targeted regimen is very efficacious. Occasionally, desensitization therapy may augment therapy to reduce mucosal edema. This is the key to minimizing sinus ostial obstruction. We avoid prophylactic antibiotic therapy except in limited populations, such as children with an immune deficiency, Down syndrome, and ciliary dyskinesia. For these patients, we use prophylactic antibiotics only during peak winter months.

Antibiotic therapy for acute rhinosinusitis is similar to that for AOM. High-dose amoxicillin remains the drug of choice as first-line therapy to cover \textit{Streptococcus pneumoniae}, \textit{Haemophilus influenzae}, and \textit{Moraxella catarrhalis}. For patients who are allergic to penicillin, trimethoprim-sulfamethoxazole had been considered a reasonable alternative. However, TMP-SMX is only variably effective against \textit{H influenzae} and \textit{S pneumoniae}. Therefore, TMP-SMX is no longer considered an appropriate alternative to amoxicillin; reasonable options include azithromycin or clarithromycin. For patients who do not respond within 72 hours or for those with recurrent infection, an agent active against penicillin-resistant pneumococci or a \beta-lactamase stable agent should be used.\textsuperscript{13,14} Duration of therapy has been debated without resolution by infectious disease experts. A case can be made for either seven to 10 days of therapy or treatment until clinical improvement.

Surgical management of chronic rhinosinusitis

Surgery is controversial.\textsuperscript{23,24} Before development of endoscopic surgical techniques, maxillary sinus lavage procedures were performed for recalcitrant disease. In addition, adenoectomy was performed to reduce nasal obstruction and congestion, remove bacterial carriage in the nasopharynx, and reestablish adequate mucociliary clearance. The relatively new theory of mucociliary flow within the paranasal sinuses toward the natural sinus ostia led to the rise of endoscopic sinus techniques in children.

With miniaturization of telescopes and instruments, surgery became feasible even in young children. In fact, the adenoid had almost become an afterthought in surgical management rather than the target for elimination in toddlers. However, the technical ability to obtain access to a cavity endoscopically does not create a mandate to use this technique and does not make it the preferred surgical technique in all cases. Furthermore, the clinician should always keep in mind the need to treat the patient not the mucoperiosteal thickening seen on radiographs.

Our philosophy is that adenoectomy should be considered as the primary treatment for many children as old as 5 years who have chronic rhinosinusitis severe enough to warrant surgery.\textsuperscript{25,26} At the time of adenoectomy, nasal endoscopy may be performed to obtain material for culture if purulence is emanating from the middle meatus. Subsequently, in children with unremitting symptoms over the ensuing three to six months, a CT scan of the sinuses should be performed. Certain selected children are good candidates for endoscopic surgery to relieve osteomeatal obstruction as an adjunct to medical treatment.\textsuperscript{27}
Rarely is surgery alone curative.

Sinus surgeons should adhere to the concept of minimalism. Only diseased mucosa should be removed. Normal tissues must remain intact. Typically, the uncinate and anterior ethmoid cells are removed. The maxillary sinus opening is examined for patency and enlarged only when obstructed by hyperplastic tissue.

In children with recurrent bronchopneumonias and rhinosinusitis with no serologic evidence of immune deficiency, biopsy should be considered to examine the ultrastructure of the patient's cilia. The best yield is obtained from the anterior tracheal wall above the carina.

**Answers still to come**

The chronic runny nose in children remains a relatively untapped area of research; many questions are yet to be answered. Among them are the effects of air pollution and chemical hypersensitivities in our environment, the role of the adenoid, and whether there really is any causal relationship between gastroesophageal reflux and the development of rhinosinusitis in children.

**REFERENCES**


The multifactorial nature of rhinosinusitis

A brief review of the physiology of healthy sinuses may help the clinician more fully understand the complexity of the rhinosinusitis cycle. Healthy paranasal sinuses are marked by normal anatomical development with no obstructive nasal defects or nasopharyngeal blockage (choanal stenosis or enlarged adenoid) that could lead to stasis of secretions and obstruction. The cilia function as they should and there is a proper mucous blanket. The immune system matures normally and on time. Healthy sinuses depend on control of certain external factors, as well. Exposure to nonallergen environmental irritants in the food supply, ambient air, and building materials is minimized. True allergens are eliminated or controlled. Viral and bacterial loads (such as encountered in day care and preschool) are kept to a minimum when feasible.

REFERENCES


7. Rantakallio P: Relationship of maternal smoking to morbidity and mortality of the child up to the age of five. *Acta Paediatr Scand* 1978;67:621


The guide on irrigating the nose with a homemade saline solution may be photocopied and distributed to families in your practice without permission of the publisher.

GUIDE FOR PATIENTS AND PARENTS

Irrigating the nose with a homemade saline solution

Benefits of hypertonic saline irrigation:

- It cleans mucus, crust, and blood clots from the nose.
- It decongests the nose. The high salt concentration in the irrigating solution pulls fluid out of the nasal membranes. This shrinks the linings, improving nasal airflow and opening up the sinus passages.
- Saltwater cleansing of the nasal membranes improves beating of the little hairs (cilia) inside the nose so that they can better clear debris, bacteria, and mucus.

Recipe for hypertonic saline (saltwater) solution:

1. Boil 1 quart of tap water and let it cool (or use distilled water, which does not need to be boiled).
2. Add 23 teaspoons of pickling salt or "sea salt." (DO NOT use regular table salt it has unwanted additives.)
3. Add 1 teaspoon of baking soda as a buffer (bicarbonate) to eliminate most of the stinging nature of the salt.

Using an infant bulb syringe, draw up the solution and irrigate through the nose over a sink. You will know that you're doing a good job if some of the irrigating solution comes out of the mouth. An alternative that some people prefer is to use a nasal attachment with an oral irrigator (such as Waterpik) to irrigate the nose. You may wish to warm up the solution before irrigation to make it more comfortable.

If you are also using a topical nasal steroid, do the saline irrigation first. Then gently blow your nose and use the topical steroid. This allows the agent to reach deeper into the nose and sinus passages and allows for maximum contact with nasal membranes.

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