Nasal irrigations: good or bad?

Christopher L. Brown and Scott M. Graham

Purpose of review

Nasal irrigations are often mentioned as adjunctive measures in treating many sinonasal conditions. Despite their widespread use, much mystique and uncertainty exist about the indications and therapeutic mechanisms of nasal irrigations. Anecdotal evidence and poorly controlled studies add to the confusion. Recent evidence challenges some of the assumptions underlying the use of nasal irrigations.

Recent findings

Studies of nasal irrigations continue to report the benefits in managing sinonasal complaints. Apart from improved patient symptomatology, prescription medication use is often decreased. When nasal irrigations are combined with other medical modalities, patients with chronic sinusitis may not require surgical intervention as often. In particular, patients using hypertonic saline nasal irrigations reported better outcomes. Different devices and techniques exist. Positive-pressure and negative-pressure methods are probably more effective than nebulizers. Furthermore, the popular belief that nasal irrigations need to be sterile is in question.

Summary

Nasal irrigations should no longer be considered merely adjunctive measures in managing sinonasal conditions. They are effective and underutilized. Some of the persisting unanswered questions will only be answered by further research.

Keywords

nasal irrigation, saline, rhinitis, sinusitis

Curr Opin Otolaryngol Head Neck Surg 12:9–13. © 2004 Lippincott Williams & Wilkins

Department of Otolaryngology–Head and Neck Surgery, University of Iowa Hospitals and Clinics, Iowa City, IA, USA

Correspondence to Scott M. Graham, MD, Department of Otolaryngology–Head and Neck Surgery, University of Iowa Hospitals and Clinics, 200 Hawkins Drive, 21201 PFP, Iowa City, Iowa 52242-1093, USA
E-mail: scott-graham@uiowa.edu

Current Opinion in Otolaryngology & Head and Neck Surgery 2004, 12:9–13

1068-9508

Introduction

Sinonasal complaints affect at least 15% of the population in the United States of America with predictable patient morbidity and financial impact [1]. Importantly, any modality that can alleviate sinonasal complaints warrants serious attention. Nasal irrigations, in the management of sinonasal complaints, are simple, inexpensive, and often effective.

Nasal irrigations may be used for a variety of conditions [2•]. Their use is included in the management of acute and chronic rhinosinusitis [3], allergic and nonallergic rhinitis, nonspecific nasal symptoms (including postnasal drip), septal perforations, and the postoperative care of surgical patients. Prescription medication use can be decreased as a result of nasal irrigations in some circumstances [4].

Nasal irrigations are often thought of as adjunctive measures. Frequently, they are mentioned only in passing in publications addressing sinonasal symptomatology. Indeed, a joint publication between the American Academy of Otolaryngology–Head and Neck Surgery and the American Academy of Allergy, Asthma, and Immunology made only a brief mention of nasal irrigations [5]. Nasal irrigations are often much more than adjunctive. They are an important component in the management of sinonasal complaints.

Unfortunately, studies of nasal irrigations are often small and poorly controlled, and unsupported conclusions are sometimes drawn. No standard uniform recommendations exist for the use of nasal irrigations. In addition, different theories exist as to how they work. Indeed, various nasal irrigation solutions are available: Different "home recipes" exist, manufactured powders or solutions can be bought, the tonicity can be varied (isotonic *vs* hypertonic saline), additives can be included, the pH can be changed, and numerous devices, including the cupped hand, can be used to administer nasal irrigations. Mystique abounds [1]!

Review

Indications for use

Numerous publications report the importance of nasal irrigations in managing the common problem of sinusitis. Hamilos [6] and Suramanian *et al.* [7•], in discussing chronic sinusitis, advocate the use of nasal irrigations. Benninger *et al.* [8] state that it is "reasonable to include them in the treatment of most patients with rhinosinusitis." For a number of years, Talbot *et al.* [9] have claimed

benefit from the use of nasal irrigations for acute and chronic sinusitis.

In a recent study, Rabago et al. [10•] performed a randomized, controlled trial looking at patients with two episodes of acute sinusitis or one episode of chronic sinusitis per year for 2 consecutive years. Fifty-two patients received hypertonic saline, whereas 24 patients did not receive any irrigations. When using hypertonic nasal irrigations, improvements in quality-of-life and overall symptom severity scores were statistically significant. Steroid nasal spray use was also decreased.

Toomoka *et al.* [11] used pulsatile hypertonic saline nasal irrigations for a range of sinonasal conditions, extending from atrophic rhinitis to the symptom of postnasal drainage. They reported that patients who used nasal irrigations for the treatment of sinonasal complaints experienced statistically significant improvements in 23 of 30 nasal symptoms.

Nasal irrigations can also be effective in rhinitis [9,12,13], including allergic and nonallergic rhinitis. Atrophic rhinitis, a difficult condition to treat, is often only effectively managed when combined with regular, diligent nasal irrigations [14].

Postoperative surgical patients are frequently managed with nasal irrigations. These are often used in conjunction with regular endoscopic nasal cleaning and suctioning. Postoperative nasal adhesions are minimized. Patients find it an effective method for helping to soften and remove the nasal crusting that is associated with surgery [9,15].

Other crust-forming conditions may also be effectively managed with nasal irrigations. Patients with septal perforations and granulomatous conditions and patients who have received radiotherapy to the nasal cavity may all report significant benefits. Even patients with the bothersome and often difficult to manage symptom of postnasal drainage may find some relief with this modality of treatment [16].

Safety

Nasal irrigations have been shown to be safe. Side effects encountered are minimal [4]. Local irritation, itching, burning [16], otalgia, and pooling in sinuses with subsequent drainage have been reported [11]. This pooling, with delayed discharge in some head positions, is most commonly seen in patients who have undergone previous sinus surgery.

Mechanism of action

The exact mechanism by which nasal irrigations work remains controversial. Various theories exist. Do nasal irrigations work predominantly in clearing mucus? Do nasal irrigations affect ciliary beat frequency? Do changes in ciliary beat frequency affect mucociliary clearance? The fact that the pathogenesis of rhinosinusitis is often enigmatic (inflammatory *vs* infectious [6], bacterial *vs* fungal [17]) only adds to the dilemma.

The mucus lining the nasal cavity constitutes one of the body's first-line defenses against potential invading organisms. It consists of a sol layer and a more superficial gel layer. Foreign material (*eg*, bacteria, fungi, allergens) become entrapped in the mucus. Cilia project from the nasal pseudostratified columnar epithelium into the mucus. The beating cilia, acting predominantly on the gel layer, sweep the mucus backward toward the nasopharynx where it is swallowed.

Nasal irrigations may enhance this movement of mucus toward the nasopharynx. This may be via a direct physical effect. Patients often report that forceful irrigations are more effective than gentle washing of the nose. Crusts associated with various conditions, may be softened and dislodged with nasal irrigations. Thick tenacious secretions may become less viscous, further enhancing the clearance of mucus.

The nasal mucus contains many inflammatory mediators, such as histamine, prostaglandins, and leukotrienes [13]. Defensins have been isolated from sinus mucus, and their concentration appears to increase with inflammation [18]. Other proteins also exist; the function of many of these is not understood [19], and nasal irrigations may work by removing these inflammatory mediators [13].

Increasing the ciliary beating frequency seems to increase mucociliary clearance [20]. If nasal irrigations increase the ciliary beating frequency and mucociliary clearance, this may help to explain how nasal irrigations may work. Unfortunately, conflicting evidence exists as to the effect of saline irrigations on ciliary beating frequency and mucociliary clearance. Talbot *et al.* [9] compared the effects of normal and hypertonic saline *in vivo*. Hypertonic saline was more effective in increasing mucociliary clearance (mean, 3.1 minutes) compared with normal saline (mean, 0.14 minutes). In contrast, two relatively recent papers by Boek *et al.* [20,21] report that both isotonic saline (0.9%) [20,21] and hypertonic saline (7% and 14%) [21] decreased ciliary activity *in vitro*. These *in vitro* studies used specimens of normal nasal mucosa.

The status of cilia in rhinosinusitis is unclear, as evidenced by conflicting reports. Evidence in humans [22] and rabbits [23] points to dysfunctional and absent cilia in sinusitis. Derangements in the epithelium and cilia are significant. However, another study reported that sinuses with purulent secretion had better ciliary beat frequencies than "empty" sinuses [24]. Extrapolating the

action of nasal irrigations from this information is again somewhat speculative.

Isotonic or hypertonic saline irrigations?

Various reports suggest that hypertonic nasal irrigations are superior to isotonic nasal irrigations.

Patients with pediatric chronic sinusitis were randomized to receive either hypertonic saline irrigations (3.5%) or normal saline irrigations for 4 weeks. Both groups had significant improvement in their post nasal drainage (PND) score, whereas patients receiving hypertonic nasal irrigations also showed improvements in cough and radiology scores [16]. In another trial looking at acute bacterial sinusitis, hypertonic nasal irrigations (3%) seemed to be somewhat more effective than isotonic nasal irrigations in improving the mucociliary clearance [25]. This difference, however, was not statistically significant.

Talbot *et al.* [9] compared hypertonic buffered saline with isotonic buffered saline in volunteers without any significant sinonasal disease. Mucociliary clearance was assessed with the saccharin clearance test. Compared with isotonic solutions, hypertonic solutions were significantly more effective in improving mucociliary clearance.

In another study, 150 patients with chronic sinusitis were assigned to three groups for 2 weeks of treatment. Group I patients used hypertonic saline irrigations with a bulb syringe, whereas patients in group II used hypertonic saline irrigations with a nasal irrigation pot. Group III patients received reflexology to established sinus contact points (tips of four fingers of both hands and all toes of both feet daily). Interestingly, each method resulted in improvement in symptoms in 70% of subjects. Medication use was decreased in approximately one-third of participants regardless of intervention [4].

Other solutions

No clear evidence exists in the literature as to which type of solution is best. The earlier paper of Boek *et al.* [21] suggested that isotonic Locke–Ringer solution is a more appropriate fluid for nasal irrigations than normal saline. Other authors assessed mucociliary clearance with irrigation after nasal septal surgery. They compared Ringer lactate solution with isotonic normal saline. Statistically significantly better mucociliary clearance times were reported with Ringer lactate solution [26].

Sterility

Most authors advocate using a sterile nasal irrigation solution. This can be achieved by a variety of methods. The solution can be purchased as sterile, or the water used can be initially boiled. However, because the nasal cavity is full of microorganisms, it is unclear how important it is to use a sterile solution.

As an interesting corollary, Valente *et al.* [27•] looked at infection rates of skin wounds in pediatric patients that were irrigated with either tap water or sterile saline. It was a prospective study with more than 500 patients enrolled. The infection rate in the saline group was 2.8% compared with 2.9% in the group receiving tap water. This difference was not statistically significant.

Buffered or nonbuffered solution?

Some authors advocate using a buffered solution (*eg*, pH 7.6) [9]. This may be achieved by the addition of baking soda (pure bicarbonate). This alkaline state may decrease mucous viscosity. Maximal ciliary beating frequency times have also been shown to occur when the pH is between 7 and 9 [28]. In contrast, other studies report that pH changes in normal subjects have been shown to have no effect on mucociliary clearance [29,30].

Additives in nasal irrigations

Various additives can be included in nasal irrigations, most often antibacterial and antifungal agents. The use of these additives is best guided by cultures.

Antibacterial agents

Different antibiotic agents usually used intravenously can be added to irrigation solutions. Gentamicin and tobramycin are most frequently used. Bactroban ointment can also be mixed as an aid to help to eradicate staphylococci infections. Evidence supporting this practice is, however, limited.

Vaughan *et al.* [32] gave culture-guided nebulized antibiotics to patients with acute sinusitis. These patients had prior sinus surgery and ongoing chronic sinusitis. They reported that patients receiving nebulized antibiotics reported a longer infection-free period (average, 17 weeks) compared with standard therapy (6 weeks). As noted by the investigators, several limitations existed in the study.

Maxillary sinus lavage with tobramycin solution in patients with cystic fibrosis has also shown promise. Statistically significant improvement in maxillary sinus aeration was documented in one study using objective serial MRI scores [33].

Antifungal agents

Ponikau *et al.* [34•] looked at intranasal antifungal treatment in 51 patients with chronic rhinosinusitis. Amphotericin B was dissolved in sterile water at 100 μg/mL. Twice-daily irrigations were performed for at least 3 months. Thirty-eight of 51 patients reported improvement in sinusitis symptoms. Most notably, there was no control population in this experiment. A different paper evaluated amphotericin B and nasal polyps [35]. Again, problems existed with a lack of appropriate control. The authors suggested that the improvement seen in their

patients could be due to the elimination of fungi and/or the direct effect of amphotericin B on nasal polyps.

In contrast, Gosepath *et al.* [36] evaluated the effect of antiseptics and antifungal agents on ciliary beat frequency. The additives studied included Betadine, hydrogen peroxide, amphotericin B, itraconazole, and clotrimazole. With the exception of clotrimazole, topical applications actually decreased mucociliary clearance.

Xylitol

Xylitol is a naturally occurring sugar that has interesting potential. Xylitol lowers the salt concentration of airway surface liquid and appears to upregulate the antimicrobial factors present [37]. Determination of the full potential of xylitol use awaits clinical studies.

"Home recipes" versus manufactured powders/solutions

Home recipes (Table 1) generally consist of boiled water, which is cooled before use, mixed with noniodized salt. Table salt is generally not recommended because it contains additives [9]. Baking soda may be used to buffer the solution. Recommendations as to the exact quantities vary from institution to institution. Indeed, there are often conflicting reports about the final tonicity of the solution [11,38]. Solutions are generally kept in the refrigerator before being discarded after several days. Manufactured solutions, powders, and sprays also exist. These may be more convenient for patients to use than home recipes. This enhanced convenience factor needs to be offset against the increased expense.

Nasal irrigation methods and devices

Delivery of the nasal solution can be by positive-pressure squeeze (bottles, bulb syringes with or without nasal adaptors), negative pressure (sniffing solution into nasal cavity), or nebulizers. A recent study by Olson *et al.* [39•], using healthy adult volunteers, analyzed these three broad categories. They found that positive-pressure and negative-pressure nasal irrigations were more effective than nebulizers in distributing solution to the ethmoidal and maxillary sinuses. Sphenoidal and frontal sinuses received limited solution with either negative- or positive-pressure nasal irrigation. The nebulizer was unable to deliver any solution to the sphenoidal or frontal sinuses.

Anecdotal concern exists over the long-term sterility of the delivery devices used. The issue of sterility is not clear. Depending on the device used, some suggest that a new device should be obtained at varying time intervals. One study, comparing the bulb syringe and the nasal irrigation pot, looked at bacterial counts after 2 weeks. Six of 82 nasal irrigation pots grew "moderate to many" bacterial colonies compared with 16 of 82 bulb syringes [4]. This difference was not statistically significant.

Practical points

Without some planning, the use of nasal irrigations can be awkward and messy. Solutions too cold or too hot are not ideal. The careful use of microwaves can be helpful. When nasal irrigations are used frequently, simplicity is far better than a complex, theoretically superior procedure. Nasal irrigations can be performed over a kitchen sink, over the bathroom basin, or, indeed, in the shower. The shower provides a ready source of nonsterile water at a chosen temperature.

In performing positive-pressure nasal irrigations, producing a "K" sound as the patient administers the solution may be beneficial. This elevates the soft palate and helps to reduce the somewhat uncomfortable problem of nasal irrigations from being transmitted to the oropharynx. Mastery of this technique requires some practice.

Our institution's guidelines

We generally recommend nasal irrigations in the majority of sinonasal conditions. Their use and frequency are tailored to the individual patient's requirements. Our "recipe" is included in Table 1 (University of Iowa Hospitals and Clinical, unpublished data, June 2003). Patients administer the solution with a bulb syringe after instruction by the nursing staff. Demonstrations and handouts are provided. At a follow-up appointment, the technique is reviewed and further questions are answered.

Table 1. Home recipes for nasal irrigation

	Liquid	Salt	Baking soda	Final tonicity
University of Iowa	4 c (1 qt) of water, boiled for 5 min	1½ level tsp of table salt	None	0.9%
Talbot *et al.* [9]	1 qt glass jar, filled with bottled water	2–3 heaping tsp of pickling or canned salt	1 rounded tsp of baking soda	3.0%
Rabago *et al.* [10•]	1 pt of tap water	1 heaping tsp of canning salt	½ tsp of baking soda	2.0%
Tomook *et al.* [11]	250 mL of lukewarm tap water	½ tsp of table salt	None	*

*See [11,38] for discussion regarding final tonicity achieved.
1 cup ≈ 240 mL, 1 pint ≈ 480 mL, 1 quart ≈ 950 mL.

Anecdotally, most patients report significant benefits using nasal irrigations.

Conclusion

Nasal irrigations are an important component in the management of most sinonasal conditions. Although there is fairly widespread agreement regarding patient benefits, a significant disparity of opinion exists about the effects of irrigations on ciliary beat frequency and mucociliary clearance. Likewise, controversy exists concerning irrigation tonicity and the use of additives to the irrigating solution.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- • Of special interest
- •• Of outstanding interest

1 Ray NF, Baraniuk JN, Thamer M, et al.: Healthcare expenditures for sinusitis in 1996: contributions of asthma, rhinitis, and other airway disorders. J Allergy Clin Immunol 1999, 103:408–414.

2 • Papsin B, McTavish A: Saline nasal irrigation: its role as an adjunct treatment. Can Fam Physician 2003, 49:168–273.
This is a good review of the indications for using nasal irrigations.

3 Lanza DC, Kennedy DW: Adult rhinosinusitis defined. Otolaryngol Head Neck Surg 1997, 117:S1–S7.

4 Heatley DG, McConnell KE, Kille TL, et al.: Nasal irrigation for the alleviation of sinonasal symptoms. Otolaryngol Head Neck Surg 2001, 125:44–48.

5 Kaliner MA, Osguthorpe JD, Fireman P, et al.: Sinusitis: bench to bedside. Current findings, future directions. Otolaryngol Head Neck Surg 1997, 116:S1–S20.

6 Hamilos DL: Chronic sinusitis. J Allergy Clin Immunol 2000, 106:213–227.

7 • Subramanian HN, Schechtman KB, Hamilos DL: A retrospective analysis of treatment outcomes and time to relapse after intensive medical treatment for chronic sinusitis. Am J Rhinol 2002, 16:303–312.
This is a good review reporting that medical management is usually effective in managing chronic sinusitis.

8 Benninger MS, Anon J, Mabry RL: The medical management of rhinosinusitis. Otolaryngol Head Neck Surg 1997, 117:S41–S9.

9 Talbot AR, Herr TM, Parsons DS: Mucociliary clearance and buffered hypertonic saline solution. Laryngoscope 1997, 107:500–503.

10 • Rabago D, Zgierska A, Mundt M, et al.: Efficacy of daily hypertonic saline nasal irrigation among patients with sinusitis: a randomized controlled trial. J Fam Pract 2002, 51:1049–1055.
This study demonstrates that hypertonic saline nasal irrigations are effective in reducing symptoms.

11 Tomooka LT, Murphy C, Davidson TM: Clinical study and literature review of nasal irrigation. Laryngoscope 2000, 110:1189–1193.

12 Primer on allergic and immunologic diseases. JAMA 1997, 278:1803–2030.

13 Georgitis JW: Nasal hyperthermia and simple irrigation for perennial rhinitis. Changes in inflammatory mediators. Chest 1994, 106:1487–1492.

14 Moore EJ, Kern EB: Atrophic rhinitis: a review of 242 cases. Am J Rhinol 2001, 15:355–361.

15 Seppey M, Schweri T, Hausler R: Comparative randomised clinical study of tolerability and efficacy of Rhinomer Force 3 versus a reference product in post-operative care of the nasal fossae after endonasal surgery. ORL J Otorhinolaryngol Relat Spec 1996, 58:87–92.

16 Shoseyov D, Bibi H, Shai P, et al.: Treatment with hypertonic saline versus normal saline nasal wash of pediatric chronic sinusitis. J Allergy Clin Immunol 1998, 101:602–605.

17 Ponikau JU, Sherris DA, Kern EB, et al.: The diagnosis and incidence of allergic fungal sinusitis. Mayo Clin Proc 1999, 74:877–884.

18 Carothers DG, Graham SM, Jia HP, et al.: Production of β-defensin antimicrobial peptides by maxillary sinus mucosa. Am J Rhinol 2001, 15:175–179.

19 Ghafouri B, Stahlbom B, Tagesson C, et al.: Newly identified proteins in human nasal lavage fluid from non-smokers and smokers using two-dimensional gel electrophoresis and peptide mass fingerprinting. Proteomics 2002, 2:112–120.

20 Boek WM, Graamans K, Natzijl H, et al.: Nasal mucociliary transport: new evidence for a key role of ciliary beat frequency. Laryngoscope 2002, 112:570–573.

21 Boek WM, Keles N, Graamans K, et al.: Physiologic and hypertonic saline solutions impair ciliary activity *in vitro*. Laryngoscope 1999, 109:396–399.

22 Toskala E, Nuutinen J, Rautiainen M: Scanning electron microscopy findings of human respiratory cilia in chronic sinusitis and in recurrent respiratory infections. J Laryngol Otol 1995, 109:509–514.

23 Bolger WE, Leonard D, Dick EJ Jr, et al.: Gram negative sinusitis: a bacteriologic and histologic study in rabbits. Am J Rhinol 1997, 11:15–25.

24 Nuutinen J, Rauch-Toskala E, Saano V, et al.: Ciliary beating frequency in chronic sinusitis. Arch Otolaryngol Head Neck Surg 1993, 119:645–647.

25 Inanli S, Oturk O, Korkmaz M, et al.: The effects of topical agents of fluticasone propionate, oxymetazoline, and 3% and 0.9% sodium chloride solutions on mucociliary clearance in the therapy of acute bacterial rhinosinusitis in vivo. Laryngoscope 2002, 112:320–325.

26 Unal M, Gorur K, Ozcan C: Ringer-lactate solution versus isotonic saline solution on mucociliary function after nasal septal surgery. J Laryngol Otol 2001, 115:796–797.

27 • Valente JH, Forti RJ, Freundlich LF, et al.: Wound irrigation in children: saline solution or tap water? Ann Emerg Med 2003, 41:609–616.
This interesting article challenges the need for sterile wound irrigations in pediatric patients, with obvious relevance to nasal irrigations.

28 Luk CK, Dulfano MJ: Effect of pH, viscosity and ionic-strength changes on ciliary beating frequency of human bronchial explants. Clin Sci (Lond) 1984, 64:449–451.

29 Homer JJ, England RJ, Wilde AD, et al.: The effect of pH of douching solutions on mucociliary clearance. Clin Otolaryngol 1999, 24:312–315.

30 England RJ, Anthony R, Homer JJ, et al.: Nasal pH and saccharin clearance are unrelated in the physiologically normal nose. Rhinology 2000, 38:66–67.

31 Deleted in proof.

32 Vaughan WC, Carvalho G: Use of nebulized antibiotics for acute infections in chronic sinusitis. Otolaryngol Head Neck Surg 2002, 127:558–568.

33 Graham SM, Launspach JL, Welsh MJ, et al.: Sequential magnetic resonance imaging analysis of the maxillary sinuses: implications for a model of gene therapy in cystic fibrosis. J Laryngol Otol 1999, 113:329–335.

34 • Ponikau JU, Sherris DA, Kita H, et al.: Intranasal antifungal treatment in 51 patients with chronic rhinosinusitis. J Allergy Clin Immunol 2002, 110:862–866.
This controversial article discusses the use of amphotericin B in chronic sinusitis. Notably, no control was used.

35 Ricchetti A, Landis BN, Maffioli A, et al.: Effect of anti-fungal nasal lavage with amphotericin B on nasal polyposis. J Laryngol Otol 2002, 116:261–263.

36 Gosepath J, Grebneva N, Mossikhin S, et al.: Topical antibiotic, antifungal, and antiseptic solutions decrease ciliary activity in nasal respiratory cells. Am J Rhinol 2002, 16:25–31.

37 Zabner J, Seiler MP, Launspach JL, et al.: The osmolyte xylitol reduces the salt concentration of airway surface liquid and may enhance bacterial killing. Proc Natl Acad Sci U S A 2000, 97:11614–11619.

38 Grossan M: Nasal irrigation. Laryngoscope 2001, 111:1867–1869.

39 • Olson DE, Rasgon BM, Hilsinger RL Jr: Radiographic comparison of three methods for nasal saline irrigation. Laryngoscope 2002, 112:1394–1398.
This is a good review of difference nasal irrigation methods and their relative effectiveness.