Nasal Saline Irrigations: Role in the Management of Upper Respiratory Tract Diseases in Children

Paola Marchisio, Elena Baggi, Sonia Bianchini, Charlotte Desantis, Miriam Fattizzo, Sara Torretta and Nicola Principi

Despite their widespread use, much uncertainty still exist about the indications and therapeutic mechanisms of nasal irrigations. Anecdotal evidence (**Figure 1**) and poorly controlled studies, especially in children, have added to the confusion.

Figure 1. Immersion

Mechanisms of action

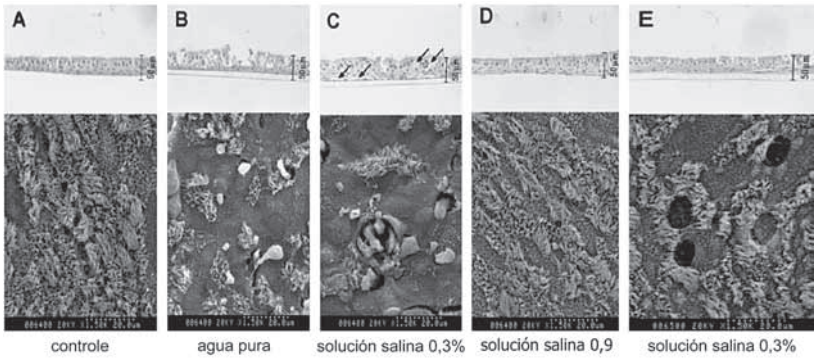
Originally part of the Yogic (Neti Lota) and Ayurvedic traditions, nasal irrigations has been used for centuries without any scientific data to determine efficacy (**Figure 2**). Traditionally, saline nasal irrigation is known to facilitate nasal drainage and clean the airway from any post nasal drainage. However, the precise mechanism by which nasal irrigations work is still controversial [1].

Figure 2. Neti Lota

The mucus lining the nasal cavity constitutes one of the first-line host defence mechanism and plays a critical role in protecting against external stimuli and infections. The beating cilia, which project from the nasal pseudostratified columnar epithelium into the mucus, sweep the mucus backward toward the nasopharynx where it is swallowed. Ciliary's beat frequency can be impaired by mucosal inflammation and by the presence of viscous and tenacious secretions, thus decreasing mucociliary clearance.

So far conflicting evidence exists as to the effect of saline irrigations on ciliary beating frequency and mucocilliary clearance. Osmolarity seem to play a major role. Min et al [2] have shown that isotonic and hypotonic solutions produced no ciliary slowing on normal turbinate mucosa, whereas cilliostasis was observed within a few minutes in 3.0% and 7.0% solution. In contrast, Talbot et al [3], have compared the effect 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). Actually, there is evidence that isotonic saline (0.9%) is the most physiologic irrigation solution in terms of mucin secretion and cellular morphology of nasal epithelial cells, whereas pure water severely damages normal human nasal epithelial cells, resulting in cell-to cell integrity destruction, and 3% saline determine a patchy exfoliation of secretory cells, without effect on cilia [4] (**Figure 3**)

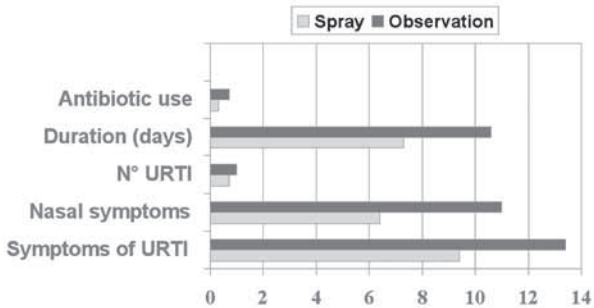
Figure 3. Effect of hypo-, iso- and hypertonic saline irrigation on morphology (scanning electron microscopic observation) of normal human nasal epithelial cells



Effect of hypo-, iso- and hypertonic saline irrigation on secretory mucins and morphology of cultured human nasal epithelial cells

Saline solution irrigation reduces the inflammatory mediators (histamine, prostaglandins D2, interleukins) in nasal secretions [1], which take part in the pathophysiology of many upper respiratory tract diseases, including upper respiratory tract infections (URTI), perennial rhinitis, asthma, acute and chronic rhinosinusitis (**Figure 4**).

Figure 4. Duration of the symptoms and almost no antibiotic use



Evidence of efficacy

Rhinosinusitis

The use of saline irrigations has been studied extensively in adults with rhinosinusitis. A Cochrane review evaluated the effectiveness and safety of topical saline in the management of chronic rhinosinusitis and suggested that saline alleviated the symptoms when used alone as treatment or as adjunct treatment. The authors [5] concluded that "saline were well tolerated and had minor adverse effects that appeared to be outweighed by benefits for most patients. Non compliance was noted, but, at this regard, Rabago [6] has demonstrated that an initial education session, particularly individual coaching on the practice of nasal irrigation, was effective in overcoming many of the barriers to the use of nasal irrigation.

Few data are available for children, even if nasal saline washes have been considered an adjunctive treatment of rhinosinusitis for the last 20 years [7,8].

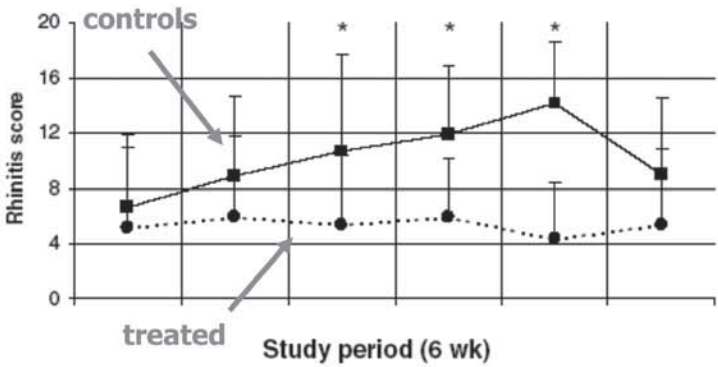
As regards acute sinusitis, the AAP 2001 clinical practice guideline[9] stated that "Neither saline nose drops nor nasal sprays have been studied in patients with acute bacterial sinusitis. However, by preventing crust formation and liquefying secretions, they may be helpful. In addition, saline also may act as a mild vasoconstrictor of nasal blood flow [10].

There is evidence that hypertonic saline irrigation (3.5%, 1ml per nostril 3 times daily) is an effective treatment of chronic rhinosinusitis, in terms of reduction of cough, postnasal drip and radiographic findings [11].

Allergic rhinitis

The Italian group of Gaini et al [12] have provided data on the efficacy of hypertonic (3%) saline irrigation in children with symptomatic seasonal allergic rhinitis. Patients given hypertonic nasal irrigation (2.5 ml/nostril, during pollen season, for six weeks), the mean rhinitis score was significantly reduced (**Figure 5**) and the consumption of oral antihistamines was decreased.

Figure 5. Effect of hypertonic nasal irrigation on rhinitis score in children with seasonal allergic rhinitis (modified from [12]).



In addition, in children with seasonal grass pollen rhino conjunctivitis, nasal rinsing with hypertonic saline for seven weeks reduced the symptoms score and the intake of oral antihistamines, without adverse effects [13].

Healthy subjects

Nasal saline irrigations is effective in otherwise healthy adults: Tano et al [14] have shown that 10 weeks of daily use of a nasal saline spray can prevent nasal symptoms of common cold and reduce the number of episodes of upper respiratory tract infections (URTI).

In healthy children with uncomplicated common cold or flu receiving irrigations with isotonic saline seawater delivered by metered spray, as an adjunctive treatment, a faster elimination of nasal symptoms during illness was observed[15] (**Figure 6**). Interestingly, in the follow-up period, the saline group had significantly fewer illness days (31% *vs* 75%), school absences (17% *vs* 35%) and complications (8% *vs* 32%) and used fewer mediations compared with control group.

Figure 6. Resolutions of nasal symptoms in children treated (T) or not treated (U) with isotonic seawater nasal wash.

		acute		*prevention*	
		V1	V2	V3	V4
Sore throat	T	1,69	1,09	1,07	1,05
	U	1,84	1,23	1,32	1,12
Dry cough	T	1,49	1,11	1,11	1,03
	U	1,60	1,14	1,40	1,04
Productive cough	T	1,36	1,23	NA	1,02
	U	1,43	1,38	NA	1,13
Nasal secretion (NS)	T	2,84	1,79	1,23	1,23
	U	2,70	2,10	1,86	1,55
Character of NS	T	2,57	1,72	NA	1,21
	U	2,56	2,06	NA	1,53
Nasal breathing	T	2,26	1,25	1,20	1,13
	U	2,16	1,58	1,64	1,39
Sneezing	T	1,51	1,04	1,06	1,06
	U	1,50	1,06	1,21	1,10
Itching	T	1,3	1,03	1,02	1,05
	U	1,27	1,06	1,08	1,11
Loss smell/taste	T	1,31	1,00	1,03	1,01
	U	1,38	1,09	1,19	1,11

Adenoidal hypertrophy

Data regarding the possible use of hypertonic saline in treating adenoidal hypertrophy have been published [16]. An 8-week treatment with intranasal hypertonic solution administered by a Rinowash device (delivering an atomized saline solution of particles of 10µl of diameter) was significantly more effective than a treatment with isotonic saline solution in reducing adenoidal hypertrophy and thus a potential decrease of surgery.

Methods

Data regarding the optimal method of nasal irrigation are scanty, often debatable and regard mainly adults.

In adults with viral rhinosinusitis, Passali et al showed that atomized nasal douche (Rinoflow Nasal Wash & Sinus System, able to create a jet of atomized saline solution with particles of 20 µl in diameter), improved significantly nasal functions, in terms of rhinomanometric resistance and nasal volumes. rhinometry, compared with nasal lavage with normal saline (using a 20 ml syringe) [17].

In adults with chronic sinusitis who had undergone functional endoscopic surgery, Wormald demonstrated that nasal douching with 5 ml of normal saline was significantly more effective in penetrating the maxillary sinus and frontal recess compared with metered nasal spray and nebulization with Rinoflow. However the position to be adopted (kneeling with the head on the floor) and maintained for two minutes seems to be quite difficult for older patients and thus this methods can be suggested only for short periods after surgery [18]. (**Figure 7**)

Figure 7. A comparative study of three methods of nasal irrigation

Douche

Nasal cavity douching was performed with the subjects kneeling on the ground, neck flexed, and forehead resting on the floor. Five milliliters of normal saline containing 25 MBq of radioactivity were then infused into the nasal cavity by way of a syringe or until the nasal cavity was filled. The subjects held this position for 2 minutes. Approximately 4 mL of saline was then recovered into a bowl on return to upright posture.

Spray

Each subject was given four puffs by way of a metered spray bottle, with the equivalent of approximately 1.5 mL of normal saline containing 15MBq of radioactivity being deposited into the designated nasal cavity.

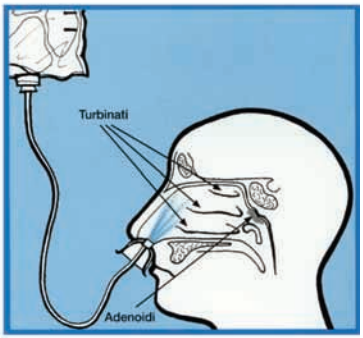
Nebulizer

Two milliliters of saline containing 20 MBq of activity were delivered into the nasal cavity using RinoFlow (Respironics, Cedar Grove, NJ), a commercially available system for generating nebulized aerosol to irrigate the nasal cavity and sinuses.

More recently, Pynnonen has shown that nasal irrigations performed with large volume and delivered with low positive pressure are more effective than saline sprays for treatment of chronic nasal and sinus symptoms in a community-based adult population [19].

Gelardi showed that nasal irrigation with a large volume of saline delivered by a recently available system (Lavonase ®, 250 ml) in adults with acute rhinosinusitis is more effective than nasal irrigation with syringe (10 ml) in reducing nasal symptoms [20] (**Figure 8**).

Figure 8. Lavonase



No comparative data are available for children. A method for performing a nasal saline flush was reported anecdotally by Schwartz [21]. A bulb - syringe is an easy and inexpensive method, provided that saline is squeezed gently into the nose, but can be frightening for some children [22]. Solutions must be warm (close to body temperature) and not too cold or too hot. Saline can be drawn from a sterile saline bottle or be prepared starting from home recipes which generally consist of boiled water, which is cooled before use, mixed with nonionixed salt (240 ml water of water boiled for five minutes, and one and a half tablespoon of table salt, reaches a final tonicity close to normal saline, i.e. 0.9%). When using nasal saline spray, it should be reminded that the frequently contained preservative benzalkonium chloride (BKC) is toxic to human neutrophils (**Figure 9**) and thus saline solutions without BKC should be preferred [23].

Figure 9. Benzalchonium chloride effect in the nasal mucosa

Wright-Giemsa staining of neutrophils exposed to 20% phosphate-buffered saline (PBS) (A) or 20% nasal saline spray (NSS) (benzalkonium chloride concentration, 0.002%) (B). The cells exposed to PBS appear normal, while the cells exposed to NSS show severe alteration of their cell membranes and intracellular structures (original magnification 1000).

Conclusion

Whatever the methods and the device, and even if not yet always included in nasal saline irrigations can be beneficial in the management of respiratory tract diseases in children. There are several open issues, to be further investigated:

(a) identification of the patients who may benefit from nasal saline irrigations (healthy children living in urban areas? children with acute upper respiratory tract infections (URTI)? only seasonal allergic rhinitis or also perennial one?);

(b) identification of the patients who may benefit from hypertonic or isotonic saline;

(c) optimal daily fractioning of nasal irrigation;

(d) best device/method at different child's age;

(e) ideal temperature for delivering saline;

(f) most effective concentration of hypertonic solution.

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