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AN OVERVIEW OF NASAL LUBRICANT FORMULATION

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ABSTRACT---*The aim of this overview is to provide information on current researches and literatures relating to nasal lubricants. Drawing upon the MEDLINE database from 1945 to 2011, in addition to other relevant sources, this overview specifically discusses and evaluates various formulations and usages of nasal lubricant, their mechanism of action, associated with nasal irrigation, as well as additives used in nasal lubricant products. It is found that although nasal irrigation or nasal lubricant basically serves the same purpose and represents a cost-effective method of alleviating symptoms of nasal diseases, the effects of additives used in their formulations have yet to be carefully studied.*

Keywords---*nasal lubricant, nasal moisturizer, nasal irrigation.*

I. Introduction

The nasal cilia are covered by a blanket of mucus containing bacteria and other irritants, and this mucus is constantly being moved to the sinus ostia and the nasopharynx. Patients with paranasal sinus diseases often have decreased mucociliary clearance (Evans, 1994; Robinson, et al. 1997). Ciliary beat frequency and a host of other factors are also responsible for the stagnation of dust, crusts, and bacteria in the area of the mucous membrane. These problems are also found among patients who have undergone radiotherapy, exposed to urbanization, industrialization, and pollution, sick building syndrome and also workers who are exposed to dust (Hellgren, Ericksson, Karlsson, & Hagberg, 2001). It is common for the vestibular secretion and trapped dust particles to form scabs. The blocking or clogging of the airway causes trauma to the nose, making it the most common cause of nose bleeds (epistaxis) (Carsons, 2001; Heatly, McConnell, Kille, & Leverson, 2001). This condition requires constant and prophylactic humidification and saline replacement using nasal lubricant.

According to a recent report, there are five most common ENT diseases found in Malaysia, i.e. rhinitis (20.2%), chronic otitis media (12.3%), nasopharyngeal carcinoma (NPC) (10.5%), tonsillitis (8.1%) and nasal polyposis (5.2%), the majority of which being allergic rhinitis, central or large subtotal perforations of eardrum, recurrent or chronic tonsillitis (mainly in children) and ethmoid polyps (Sing, 2007). Researchers have found that rhinitis and sinusitis often cause such problems as dryness, crusting, and blockage in the nose (Aurora, 2003; Hellgren, Erickson, Karlsson, & Hagberg, 2001; Bachman, Hommel, & Michel, 2000; Evans, 1994), which can cause trauma to the nose and eventually lead to nose bleeds (epistaxis) as well as secondary infection in the nose (Carsons, 2001; Heatly, McConnell, Kille, & Leverson, 2001).

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To alleviate nasal dryness, crusting, or clogging, the common treatments include chicken soup, heated humidifiers, nasal hyperthermia, hot teas, and nasal irrigation. The use of nasal irrigation has been recommended by the University of California San Diego (UCSD) Nasal Dysfunction Clinic and by numerous physicians worldwide as a secondary treatment for nasal diseases such as rhino-sinusitis, allergic rhinitis, and other sinonasal disease (Tomooka, Murphy, & Davidson, 2000).

There are currently three nasal irrigation products available locally, according to the Medical Information Management System (MIMS) Malaysia's (2011) list of products, i.e. Cleaq (produced by Hovid Sdn Bhd), Marimer® (imported and distributed by Germax Sdn Bhd) and Sterimer® (imported and distributed by Apex Pharmacy Sdn Bhd), of which only the first is locally produced.

Besides nasal irrigation, there is also nasal lubricant. Whereas nasal irrigation is usually formulated as simple solution with salt water solution (0.9% NaCl), nasal lubricant is formulated with more thickening agents such as glycol and PVA (Polyvinyl Alcohol) in order to increase its viscosity approximately to the level of the nasal mucus viscosity (Eccleston, Bakhshaee, Hudson, & Richards, 2000). Indeed, materials like glycol and PVA not only elevate viscosity but also produce lubrication effects that are much needed in the process of cleaning out nasal passages.

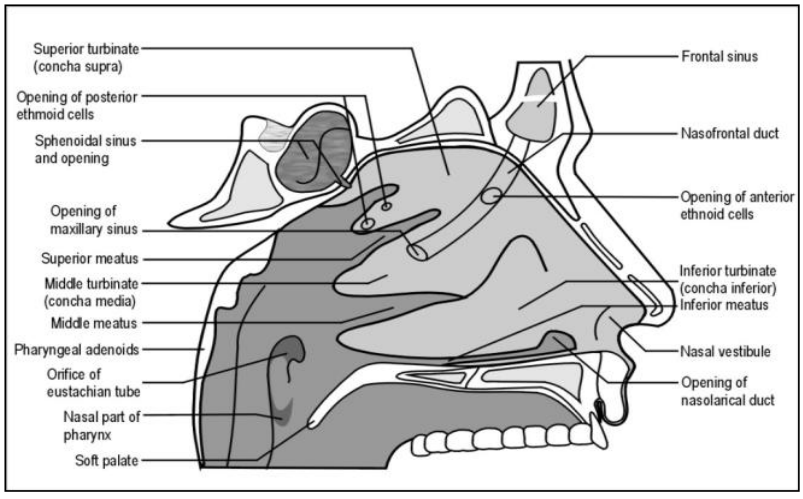
The term 'nasal lubricant' is relatively new, compared to the more familiar terms such as 'nasal irrigation' or 'nasal moisturizer' which have been widely used in medical and pharmaceutical literatures. In spite of this terminological change, significant difference in formulations have also taken place, although they all serve the same purpose and have similar function, namely, to promote improvement of nasal symptoms via: firstly, improving mucociliary function, secondly by decreasing mucosal edema, thirdly by decreasing inflammatory mediators, and lastly by mechanically clearing inspissated mucus.

Nasal lubricants are used in conditions where the nose is dry and need moisturizing while at the same time cleanses out nasal passages in order to improve mucous drainage from sinuses. These actions will help to prevent nasal crusting, bleeding, and potential blockage and should assist in reducing the risk or problems such as secondary infection in the nose.

II. Literature Review

Brief Anatomy on the Nose

Figure 1 Anatomy of the Nose



Physiology of The Nose

The original function of the nose in its evolution was olfaction, but several other duties have been added; these are warming and moistening of inspired air, removal of dust and bacteria, and assistance to the voice as a resonator.

A mucous blanket, 10-15 μm deep, covers the entire nasal cavity. It consists of a sol and gel phase, with the gel phase being closest to the air. The mucus traps particles and gases, effectively filtering and removing nearly 100% of particles larger than 4 μm in diameter. Besides filtration, the mucous layer provides water for humidification. A polypeptide backbone constitutes 10-20 % of its total structure, with the rest of the molecule containing oligosaccharide side chains. The interaction of these side chains with water, 95% of mucus by weight, produces a matrix, which gives the mucus its negative charge and its ability to lubricate and protect mucosal surfaces (Tinkelman & Naspitz 1990).

The mucus has a viscosity sufficient to allow of its being dragged by ciliary action. Viscosity must be neither too thick as to throw an excessive strain on the cilia and thus clog the mechanism, nor too thin as to lack cohesion. pH of the mucus is generally considered to be on the alkaline side of neutrality. Fabricant (1945) found that the reaction in situ lay between 5.5 and 6.5, but other investigations, some also carried out in situ, put the figure at pH 7.0 or just above, which is probably accurate. In allergic and catarrhal states the pH rises to as much as 8.3 (Thomson & Negus 1948).

Mucus and ciliated epithelial cells function together in mucociliary transport. Anderson and colleagues showed that cilia transported radio labeled particles on an average of 6 mm/min, with a range of 1 – 20 minutes. Thus, it takes about 10-20 min to clear inhaled particles from the nasal cavity. The composition of mucus affects the rate of mucociliary transport. Pharmacologic agents can likewise alter the composition of mucus and affect clearance. Guafenecin decreases the viscosity of respiratory secretions, thereby conceptually, providing more effective clearing of secretions, both by mucociliary transport and sneezing. Similarly, circulating iodide stimulates nasal glands to produce a low-viscosity, water secretion that increases the beat frequency of mucosal cilia. Anticholinergic agents increase the viscosity of secretions, thereby decreasing clearance (Tinkelman & Naspitz 1990).

Types of Nasal Lubricant Formulation

Nasal Irrigations

According to available products in the market, most of the nasal moisturizing and irrigation solutions are formulated to approximately match the body's natural salinity and electrolyte composition. Recommendations include saline of varying tonicities, physiologic saline (sodium chloride 0.9%) or hypertonic saline (NaCl 3.5%, 7% and 14.4%) with or without a variety of additives such as sodium bicarbonate, oils, glycerin and propylene glycol. Some researcher using non-buffered solution and others advocate using buffered solution. Some of the products were designed using delivery vehicles for example nasal sprayer, bulb syringe, cupped hand, and other commercially available systems.

Nasal Lubricants

A survey of the recent product formulation of nasal irrigation reveals that most of the formulators have been improving their formula with the addition of lubricant or emollient agent such as glycerin, glycols, cellulose derivatives, povidone, polyvinyl alcohol, carbowax, and aloe vera (Refer to table of nasal lubricants and their ingredients). Most of the products have also been formulated in the gel form. Since the formulations contain lubricating agents, the products are then called as nasal lubricants. When and by who this type of product was developed for the first time is still unknown, as there exists no literature or article about this kind of product. Moreover, the effect of this product improvement on CBF (ciliary's beat

frequency) has yet to be investigated. There is also no statistical evidence to support their efficacy and no record available on their adverse effects (if any). The addition of menthol, oil of eucalyptus, or similar aromatics to the formulation may add to the beneficial effect of the product.

Use of Nasal Lubricants

Nasal irrigation

Nasal irrigation used for the treatment of rhinosinusitis, allergic rhinitis, and other sinonasal diseases; use in the post operative care after rhinological operations; decreases antibiotics and nasal medication use; improves quality of live in adults subjects with a history of sinusitis (Jabarullah, 2019).

As an adjunctive treatment modality

Many researchers are often mentioned nasal irrigation as an adjunctive treatment modality in treating many sinonasal conditions. It has been use included in the management of acute and chronic rhinosinusitis, allergic and non allergic rhinitis, viral upper respiratory tract infection and other nasal symptoms. Napoli, (2007) quoted from Cochrane review concluded that, "There is evidence that (saline irrigations) relieve symptoms of chronic rhinosinusitis, help s am adjunct to treatment and are well tolerated by the majority of patients. Rabago et al., (2002) wrote, "Nasal irrigation has been suggested as adjunctive therapy for sinusitis and sinus symptoms." And Brown and Graham at 2004 stated that, "Nasal irrigation are often much more than adjunctive. They are an important component in the management of sinonasal complaints. "

Use in the post-operative care after rhinological operations

Beside as an adjunctive treatment for many nasal diseases, nasal irrigation also needed in post-operative surgical patients. Recent studies by Rabago and Zgierska (2009) quoted from Seppay et al. wrote that saline nasal irrigation has also been recommended for post-operative care of patients undergoing endoscopic sinus surgery. The authors of the study "Ringer Lactate solution versus isotonic salin solution on mucociliary function after nasal septal surgery", Ural and colleques (2001) found that there is a significant between irrigation with Ringer-Lactate solution and isotonic saline solution for the mucociliary clearance function after nasal septal surgery. Before at 1997, Talbot and colleques wrote that patients find nasal irrigation an effective method for helping to soften and remove the nasal crusting that is associated with surgery.

Nasal Lubricant Formulation

Normally, nasal lubricant is formulated in gels. There is a slight difference between nasal irrigation solution and nasal lubricant, particularly in terms of its formulation. For nasal lubricant, more thickening agents such as glycol, carboxymethyl cellulose, povidone, aloe vera and polyvinyl alcohol (PVA) are added in order to increase the viscosity to appromately the level of nasal mucus viscosity. These materials, as will be shown, not only elevate viscosity but also produce lubrication effects that are much needed in the purpose of cleaning out nasal passages and provide moisture to the nasal mucous environment. Nasal lubricants are used, for instance, in conditions where the nose is dry and needs moisturizing in the process of cleaning out nasal passages in order to improve mucous drainage from sinuses. These actions will help to prevent nasal crusting, bleeding, and potential blockage and should assist in reducing the risk of problems such as secondary infection in the nose (Wallace, D.J. & Bromet, E.J., 2005).

This product is recommended to help relieve irritated nasal membranes due to colds, allergies, low humidity or other nasal irritations. These problems are also found among patients who have undergone radiotherapy, exposed to urbanization, industrialization, and pollution, sick building syndrome and also workers who are exposed to dust. It is common for the vestibular secretion and trapped dust particles to form scabs. The blocking or clogging of the airway causes trauma to the nose, making it the most common cause of nose bleeds (epistaxis). The critical point here is constant and prophylactic humidification and saline replacement. Recently, a longer acting form of nasal lubricant is available that is glycol-based (Wallace, D.J. & Bromet, E.J., 2005).

Nasal lubricant is comfortable, easy to use and does not need any delivery systems like nasal irrigation solutions (using sprayer, bulb syringe, cupped hand, ultrasonic nebulizer and other commercially available systems) to deliver it.

Limited evidence is available suggesting that intranasal lubricant drops may reduce snoring intensity, but rigorous trials have not been performed (Meoli, Rosen, & Kristo, D., et al. 2003).

Mechanism of Action

The materials included in the nasal lubricant are categorized as water soluble polymers. This substance will keep the nasal humid due to their capability to absorb moisture. Polyvinyl alcohol or polyvinylpyrrolidone in the nasal lubricant formulation after administration both will form thin film on the surface of nostril which is capable of adsorbing moisture and dust. This could prevent nasal problem from dryness, dust allergic and itches feeling. Nasal irrigation also promotes mucociliary function (Tommoka et al. 2000).

Commercially Available Nasal Lubricant Products

Many nasal irrigation and lubricant preparations are widely used and available overseas. Examples of the preparations are listed in Table 1.

Table 1. Some of the nasal irrigation and lubricant products, their formulation types and ingredients

No.	Nasal Lubricant Trade Name	Formulation Type	Ingredients
1.	Dobell's solution®	Solution	Sodium borate, sodium bicarbonate, phenol liquefied, Glycerin water
2.	Oceant Mist®	Solution	Buffered, de-ionized saline
3.	Ponaris®	Solution	3 oils in iodized cottonseed oil
4.	Potassium permanganate solution®	Solution	0.13 gm to 1 pt water
5.	Rhinedrin®	Gel	Carbowax, Propylene glycol
6.	Rhinaris®	Gel	Carbowax, Propylene glycol

7.	Secaris®	Gel	Polyethylene-glycol, Propylene glycol
8.	Salinex Mist®	Solution	Sodium chloride 9 mg/ml, Glycerin, Benzalkonium chloride
9.	Breathe ease® Nasal Moisturizing Spray and Sinus Irrigation Solution	Spray and Solution	Buffer, Povidone, Iodine, Thiomerosal, Phenyl-carbinol
10	Pretz® solution	Solution	Glycerin, sodium chloride, yerba santa, sodium citrate, buffer
11	NutriBiotic® Nasal Spray	Spray	Glycerin, grape fruit extract, sodium ascorbate
12	Naturade® Nasal Spray	Spray	Sea salt, aloe vera, hydroxyl-propylmethyl cellulose, slippery elm bark extract, Marshmallow root extract, Fenugreek seed extract, buffer

III. Material and Methods

The MEDLINE database from 1945 to 2011 was browsed and all publications with the key words nasal, irrigation, moisturizing and nasal blockage were searched and identified. All relevant articles and related publications were reviewed. In addition, chapters in major textbooks were consulted for reference.

IV. Discussion

The use of moisturizing solution or lubricating gels will help to prevent nasal crusting, bleeding and potential blockage. Nasal lubricant can help by (i) keeping nasal and sinus passages open and draining properly, (ii) keeping nose clear and unclogged for easier breathing, and, (iii) keeping bacteria from growing and building up inside nasal passages.

Homer (1999) states that Mucociliary clearance improvised mucociliary function with patients that have nasal polysis and chronic rhirhinosinusitis. However, the exact mechanism by which hypertonic solution improves mucociliary clearance, has not been fully understood. One theory by Robinson et al. (1997) says that changes in mucociliary clearance occur as a result of changes in mucus rheology. Alternatively, hypertonic mucin gel reducing cross-linking. Another theory relates to douching solutions as an alkaline buffer which may increase the tonicity but not the pH. This is related to an unsupported notion that alkalinity reduces viscosity or that ciliary function is enhanced in alkaline environments (Talbot et al. 1997).

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V. Conclusion

Nasal irrigation and nasal lubricant serve the same purpose and have similar function, namely, to promote improvement of nasal symptoms in patients with nasal disease. Nasal irrigation or nasal lubricant will help to reduce the risk of problems such as secondary infection in the nose. They are different in formulation and both this product represents a cost-effective method of alleviating symptoms of nasal disease, although the effects of such additives in their formulations have not been reported.

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