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Sneeze reflex: facts and fiction

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Abstract: Sneezing is a protective reflex, and is sometimes a sign of various medical conditions. Sneezing has been a remarkable sign throughout the history. In Asia and Europe, superstitions regarding sneezing extend through a wide range of races and countries, and it has an ominous significance. Although sneezing is a protective reflex response, little else is known about it. A sneeze (or sternutation) is expulsion of air from the lungs through the nose and mouth, most commonly caused by the irritation of the nasal mucosa. Sneezing can further be triggered through sudden exposure to bright light, a particularly full stomach and physical stimulants of the trigeminal nerve, as a result of central nervous system pathologies such as epilepsy, posterior inferior cerebellar artery syndrome or as a symptom of psychogenic pathologies. In this first comprehensive review of the sneeze reflex in the English literature, we aim to review the pathophysiology, etiology, diagnosis, treatment and complications of sneezing.

Keywords: sneeze, sneezing, reflex, sneeze reflex, trigeminal nerve

Introduction

Sneezing is a coordinated protective respiratory reflex which occurs due to stimulation of the upper respiratory tract, particularly the nasal cavity. Despite being a common phenomenon suffered the world over, little is known about this reflex action, which is sometimes a sign associated with various medical conditions. The sneeze reflex frequently accompanies rhinitis of allergic or nonallergic origin. Sneezing can also arise due to bright light or sun (ACHOO syndrome), physical stimulants of the trigeminal nerve, psychogenic or central nervous system pathologies and even due to a full stomach (snatiation reflex) or a sexual ideation. In this first comprehensive review of the sneeze reflex in the English literature, we aim to review the pathophysiology, etiology, diagnosis, treatment and complications of sneezing.

Beliefs and myths

Sneezing has been a remarkable sign and a noteworthy occurrence throughout history. In Asia and Europe the sneezing superstition extends through a wide range of race, age, and country. Homer tells in his epic literary work, *Odysseia*, that Penelope rejoiced greatly when her son Telemachus sneezed when she expressed a wish. In another part of *Odysseia*, the Athenian General Xenophon gave a dramatic speech exhorting his

fellow soldiers to follow him to liberty or to death against the Persians. He spoke for an hour motivating his army and assuring them a safe return to Athens until a soldier underscored his conclusion with a sneeze. Thinking that this sneeze was a heavenly favorable sign from the gods, the whole army sprang to an attack. Xenophon's death after destruction of his army by the Persians can be considered as the first complication of sneezing in history. Hippocrates has mentioned that sneezing is dangerous only prior to or following a pulmonary disease. Otherwise, it is beneficial, even in patients with fatal illnesses. Celsus of Rome has suggested that sneezing is evidence of convalescence from illness. Aristo proposed that sneezing is a holy sign since it arises from lungs which are the principle and most divine parts of the body [Pioreschi, 1998; Disraeli, 1864; Aristotle, 330 BC]. The Greeks and the Romans took sneezing as a sign of wellness and expressed their good wishes to the person who sneezed using the phrase 'Live long' or 'May Jupiter bless you'. In Pagan culture, a person who sneezed was believed to get rid of the devil in his body and was congratulated passionately in every medium. It was also believed that sneezing made a person's body open to invasion by Satan and evil spirits, or even caused part of one's soul being 'thrown out of the body'. The remnant of this Pagan tradition still exists today in the expression 'live a long

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Correspondence to:

Murat Songu, MB Bchir

Department of Otorhinolaryngology, Dr Behçet Uz Children's Hospital and Department of Otorhinolaryngology, Izmir Atatürk Research and Training Hospital, Izmir, Turkey
songumurat@yahoo.com

Cemal Cingi

Department of Otorhinolaryngology, Osmangazi University Medical Faculty, Eskişehir, Turkey

life' or 'God bless you'. After the pandemics of the plague in Europe, the view of sneezing changed and it began to be assumed as a sign of a great danger. In the fourteenth century, during the great pandemic of plague, the so called *black death*, Pope Gregory VII declared the sentence 'May God bless you' as a short prayer to be said following every sneeze to protect against the plague [Ovesen, 2003]. However, the plague eliminated one-third of the European population since the Pope, or the powers that be, failed to think of taking measures in order to protect the public against the disease-causing rats or their fleas, which were the real vectors. This short prayer used in the past by the Christian population as a protection against disease is now a common everyday expression which has been passed on to modern Christian society [Knowlson, 2008].

In the Talmud, which consists of religious texts including Jewish law and history, it is considered to be a favorable omen if someone sneezes while praying. It is a sign that just as God looks favorably towards him on earth so too will he look favorably toward him in heaven. According to a common belief that still exists in the Republic of China and Japan, if a person sneezes without a reason, this means that somebody else is talking about him. It is believed that good things are told about him if he sneezes once and bad things if twice. In Naples the person who sneezes thinks that he is remembered by another person. In the Indian folkloric culture, sneezing before starting a work is believed to bring bad luck; the work is therefore started after a glass of water is drunk to avoid bad luck [Knowlson, 2008].

Pathophysiology

The sneezing reflex may be divided into two phases. The first is a nasal or sensitive phase, following stimulation of the nasal mucosa by chemical or physical irritants. Many distal branches of trigeminal nerve terminate in the facial skin transmitting tactile, pain and temperature sensations, while some branches distribute in the nasal mucosal epithelium [Nishino, 2000]. These branches are myelinated sensory fibers of small diameter, which terminate with receptor endings. Some of these receptors are triggered by chemical stimuli while others are sensitive to tactile and mechanical stimuli [Nishino, 2000]. Afferent neural stimuli are transmitted to the trigeminal ganglion via anterior ethmoidal, posterior nasal, infraorbital and ophthalmic branches of the trigeminal nerve [Wallois *et al.* 1991]. Through the trigeminal

ganglion the stimuli reach the sneezing center in the lateral medulla [Suranyi, 2001]. Upon reaching a threshold, the second phase – the efferent or respiratory phase – begins once a critical number of inspiratory and expiratory neuron has been recruited [Batsel and Lines, 1975]. This consists of eye closing, deep inspiration, and then a forced expiration with initial closing of the glottis, and increasing intrapulmonary pressure. The sudden dilatation of the glottis gives rise to an explosive exit of air through the mouth and nose, washing out mucosal debris and irritants.

The trigeminal nerve is important for the nociceptive sensory supply of the nasal mucosa in addition to the face, oral mucosa, cornea and conjunctiva. Itching and sneezing are generated by the activation of trigeminal afferent nerve terminals in the nasal mucosa [Widdicombe, 1990]. These nociceptive nerve fibers consist mainly of two types of fiber: The thin A δ -fibers that mediate acute perceptions with a quick adaptation and activation only during the actual irritation and the nonmyelinated C-fibers which adapt slowly and communicate dull burning, difficult to locate perceptions, which outlast acute pain [Torebjork and Hallin, 1973]. In allergic rhinitis, immunologically triggered inflammation results in the recruitment and activation of both types of fiber that results in itching and sneezing [Ader *et al.* 1995]. The number of particles expelled during a forceful sneeze, of which the sizes range from 0.5 to 5 μ m, is estimated to be 40,000. The estimations concerning the speed of a sneeze range between 150 km/h and 1045 km/h (nearly 85% of the velocity of sound) [Nishino, 2000].

Etiology

The factors that play role in the etiology of the sneeze reflex are listed in Box 1.

Rhinitis

Rhinitis is the inflammation of the nasal mucosa causing nasal stuffiness, rhinorrhea, nasal pruritus and sneezing [Bousquet *et al.* 2001].

Box 1. Etiology of sneeze reflex.

Rhinitis
 Photic sneeze reflex (ACHOO syndrome)
 Physical stimulations of the trigeminal nerve
 Central nervous system pathologies
 Psychogenic (intractable) sneezing
 Snatiation* reflex
 Sexual ideation or orgasm

Allergic rhinitis

Allergic rhinitis is the inflammation of the mucosa lining the nasal cavity in the form of an IgE-dependant type I hypersensitivity reaction [Bousquet *et al.* 2001]. Itching and sneezing represent two of the main bothersome symptoms, apart from nasal obstruction and rhinorrhea, in allergic rhinitis. In allergy-related nasal inflammation it can be demonstrated that the neurotransmitter substance P (SP) is released by C-fibers [Kim and Baranek, 2007; Ader *et al.* 1995]. SP is significantly increased in the nasal lavage of patients with allergic rhinitis, in contrast to healthy subjects, which is interpreted as a sustained stimulation of the sensory system [Klimek and Schäfer, 1996]. Exogenically administered SP results in a dose-dependent occurrence of nasal symptoms in asymptomatic patients with allergic rhinitis and controls, without elevation of inflammatory mediators. In addition to SP, other neuropeptides, including calcitonin gene-related peptide (CGRP) and vasoactive intestinal polypeptide (VIP), are increased in nasal lavage fluids after nasal provocation in allergic rhinitis [Mosimann *et al.* 1993]. An important feature of allergic rhinitis is hyper-responsiveness, which is influenced by products of the allergic reaction including eicosanoids, cytokines such as IL-6, IL-1 β , TNF- α and, most importantly, neurotrophins including nerve growth factor (NGF) and brain-derived neurotrophic factor (BDNF). NGF targets nociceptor fibers, leading to upregulated activity, increased SP content and dendrite sprouting [Levi-Montalcini, 1987]. The allergen-induced increased BDNF expression in the nasal mucosa is significantly correlated with the maximal increase of total nasal symptom score in allergic rhinitis [Raap *et al.* 2008].

Infectious rhinitis

In more than 50% of cases, rhinovirus is the responsible agent for common cold (nasopharyngitis), which is the most common clinical form of viral infections. Inhalation, close contact with the infected person, contact with objects contaminated with the virus such as door handles, school desks, household goods or phones, are all ways of contracting the virus. The most common prodromal manifestations include high fever, nasal irritation and sneezing. Nasal symptoms are also present in influenza (flu) caused by the influenza virus; however, they are likely to be overshadowed by malaise, fatigue, myalgia and high fever. Bacteria may infiltrate the tissue and cause infections during the course of viral rhinitis

due to impairment of mucosal integrity and ciliary function. The clinical picture of rhinitis may occur during the course of specific bacterial diseases such as diphtheria, rhinoscleroma, lepra, tuberculosis, syphilis and glanders. Opportunistic fungal infections which develop in AIDS, chemotherapy, prolonged intensive care unit stay and disorders of neutrophil number and function such as neutropenia and diabetes, may cause rhinitis.

Nonallergic noninfectious rhinitis

Not every sneezing paroxysm is caused by allergic rhinitis or the common cold. There are also many rhinitis clinical pictures of unknown etiology that may cause sneezing and are classified as 'non-allergic noninfectious rhinitis'. The commonly observed clinical pictures in this group are non-allergic rhinitis with eosinophilia syndrome (NARES) and vasomotor rhinitis and are usually confused with allergic rhinitis.

NARES. NARES is a nasal hyper-reactivity syndrome, manifested by sneezing paroxysms and watery discharge followed by nasal stuffiness and hyposmia in which the increased eosinophil count exceeds 20% of total leukocyte number in the absence of an IgE-dependant allergy [Dykewicz *et al.* 1998]. The suspected etiology is the infiltration of circulating eosinophils into the site of inflammation because of the increased level of substance P as a result of alterations within the nasal mucosa due to irritation, senility or other factors.

Idiopathic (vasomotor/nonallergic and noneosinophilic) rhinitis. This is a short-course hyper-reactive nasal mucosal disease of sudden onset manifested by nasal stuffiness, watery nasal discharge or postnasal drip, and sneezing. Eosinophilia is not found in nasal secretions and allergy tests are negative. The most important clinical feature that differentiates vasomotor rhinitis from NARES is the sudden onset of the symptoms which relieve immediately following disappearance of triggering factors. Environmental factors include cold and dry air, high amount of moisture, dyes, chlorine water, perfume, fumes, cigarette smoke, exhaust gas and other inhaled irritants may initiate the symptoms of vasomotor rhinitis. A typical example is a sudden onset of nasal stuffiness and a short-lasting but forceful sneezing paroxysm in the morning after being exposed to cold and dry air. Individual factors such as fatigue, stress and

sexual activity may develop the clinical picture as well [Fairbanks and Kaliner, 1998].

Others

Many other clinical pictures classified as nonallergic and noninfectious rhinitis are also common causes of sneezing. Occupational rhinitis is the most commonly observed among these clinical pictures and is triggered by dense cigarette smoke, cold air, air fresheners, formaldehyde and other chemical irritants in the work place [Dykewicz *et al.* 1998; Stevens, 1991]. Hormonal rhinitis may occur in cases of physiologically increased levels of estrogen such as puberty, menstrual cycle and pregnancy or in case of receiving exogenous estrogen while on oral contraceptives [Dykewicz *et al.* 1998; King and Mabry, 1993]. Inhibiting acetylcholinesterase activity, estrogen leads to edema formation in the nasal mucosa while progesterone causes congestion through vasodilatation in capacitance vessels causing sneezing [Incaudo, 2004]. As a result of sympathetic hypoactivity in hypothyroidism, parasympathetic activity relatively increases leading to vasodilation in the nasal mucosa and an increase in secretion. Drug-induced rhinitis may be manifested in two clinical patterns. In medicamentous rhinitis many drugs affect nasal mucosa through different mechanisms of action and cause sneezing. It is usually observed in treatments with antihypertensive drugs (reserpine, guanitidine, phentolamine, methyl-dopa, hydralazine and prazosine), beta blockers (propanolol, nadolol), aspirin and other NSAIDs. Rebound rhinitis, on the other hand, develops as a result of prolonged usage of vasoconstrictor drops or sprays [Dykewicz and Fairbanks, 1998; King and Mabry, 1993]. In geriatric rhinitis, there is atrophy in submucosal glands due to senility, severe irritation in sensitive nerve endings results in nasal stuffiness and sticky and thick mucus which may cause sneezing. Atrophic rhinitis is a rare pathological condition in etiology of which bacterial infections, deficiency of vitamin A or D, iron or estrogen deficiencies are suspected. In contrast to clinical conditions concerned, many different factors may cause irritant-induced rhinitis and cause sneezing [Fairbanks and Kaliner, 1998]. Some of these include dust, smoke, perfume, powder, sharp odor, ammonia, inhalation of corrosive gases or chemicals, mechanical obstruction of the nasal cavity, chymic irritation due to cauterization or silver nitrate application, capsaicin, application of airflow into the superior nasal meatus by a catheter and repetitive nasal electrical

stimulation [Kira *et al.* 1997; Kitajiri *et al.* 1993; Imamura and Kambara, 1992]. Capsaicin, the active ingredient obtained from hot chili peppers, stimulates the nasal small unmyelinated C-fiber afferent nerves to release various tachykinins. These nerves, with their somata in the trigeminal ganglion, transmit the information to the central nervous system through the trigeminal dorsal horn in the medulla and lead to sneezing and a sense of pain [Geppetti, 1988]. Although various peptides and tachykinins may be involved, it appears that the capsaicin-induced release of substance P is the most potent trigger of the sneezing response [Kitajiri *et al.* 1993; Imamura and Kambara, 1992]. Capsaicin also precipitates sneezing through a local axon reflex [Canning, 2002].

Photic sneeze reflex

It seems that *some* people really do sneeze when they look at the sun, or actually at any bright light (there is nothing special about the sun). The photic sneeze reflex is also called ACHOO (autosomal dominant compelling helio-ophthalmic outburst) syndrome [Collie *et al.* 1978]. This reflex was first described in the medical literature by Sedan [1954]. It was shown to have an autosomal dominant inheritance pattern and is assumed to affect 17–35% of the world population [Morris, 1987]. The photic sneeze reflex has been reported to be present in 23% of medical students [Everett, 1964]. In a study of 460 blood donors, photic sneezing was found in 24% [Beckman and Nordenson, 1983].

We do not know exactly why this happens, but it might reflect a 'crossing' of pathways in the brain, between the pupillary light reflex arc and the sneezing reflex arc. The reflex can be triggered only after the first exposure to light, never on repetitive stimulation and many reports cite a refractory period before the reflex can be elicited suggesting that a polysynaptic pathway is involved. The first theory concerning the pathways mentioned belongs to Eckhardt *et al.* [1943] who suggested that stimulation of the optic nerve triggers the trigeminal nerve. The afferent impulses of the pupillary light reflex are transmitted via the optic nerve while the efferent impulses are transmitted via the oculomotor nerve. According to this theory, an indirect impulse is transmitted to the ophthalmic division of the trigeminal nerve. This impulse generates the nasal stimulation that causes sneezing by affecting the maxillary division of the trigeminal

nerve as well. The second theory of crossing pathways belongs to Watson. Light falling on the retina stimulates afferent fibers to the pretectal nuclei, which then send interneurons to the Edinger-Westphal nuclei. The parasympathetic fibers from the Edinger-Westphal nuclei and the trigeminal afferent fibers from the cornea both pass through the ciliary ganglion, where they may participate in transmission [Watson, 1875]. Parasympathetic generalization may also contribute to photic sneeze. Stimuli which excite primarily one branch of the parasympathetic nervous system tend to activate other branches. Thus, the parasympathetic branches of the oculomotor nerve which are activated to generate pupillary constriction against the bright light cause secretion and congestion in the nasal mucosa by triggering the parasympathetic activation by the pterygopalatine ganglion. This process triggers sneezing [Brubaker, 1919].

What is the benefit of the photic sneeze reflex? The reflex exists in animals for which the smell sensation is vital to survive and can be used to clean the nasal cavity. Animals such as cats and dogs sneeze largely through their nose while the adults sneeze through their mouth. The reflex arc may also be useful to a limited extent in human beings when it is considered that the nasal respiration is dominant in the neonatal period. Babies have no other way to get rid of the annoying little tickle caused by normal mucus. Young children sometimes have more disgusting ways of dealing with that sensation, but babies simply sneeze, often with the help of the photic sneeze reflex. In conclusion, the photic sneeze reflex, which can lead to drivers having accidents following a sudden exposure to sunlight at the end of a long tunnel, or can cause a plane crash by inactivating the masks of jet pilots, can be considered to be an annoying 'holdover' of evolution [Breitenbach *et al.* 1993; Benbow, 1991].

Physical stimulants of the trigeminal nerve

Physical or mechanical stimulants in the innervation zone of the trigeminal nerve may trigger the sneezing reflex. Some of these stimulants include pulling hair, tearing off eyebrows or orbital injections administered frequently during ocular surgery under local anesthesia [Sekizawa, 1998; Wallois, 1997].

Central nervous system pathologies

Lateral medullary syndrome (LMS), or Wallenberg's syndrome, often results from

occlusion or dissection of the vertebral artery. Vertebral artery dissection has been blamed on many different life events, such as sneezing [Schievink, 2001]. Paroxysmal sneezing at the onset of LMS is usually interpreted as a cause, since a violent sneeze could potentially result in a vertebral artery dissection. Due to inactivation of the sneezing center in LMS, sneezing cannot occur although the sensation of sneezing is present [Bernat and Suranyi, 2000; Hersch, 2000; Martin *et al.* 1991]. Localization of the human sneeze center was described in a patient with right LMS, initially presenting with violent sneezes and followed by a brief loss of the sneeze reflex with eventual recovery [Seijo-Martinez, 2006].

Sneezing may commonly accompany temporal lobe and grand-mal epilepsy. It may be observed during the aura prior to an epileptic seizure or it may develop as an autonomic reflexive response during the seizure as well [Penfield and Jasper, 1954; Penfield and Kristiansen, 1951]. Beverwyck commented upon the analogy of the epileptic seizure with hiccups and sneezing and noted that the physiological and anatomical basis for such a hypothesis remained to be unexplained [Temkin, 1945]. In the mid-nineteenth century Jackson used the term epilepsy 'as the name for occasional, sudden, excessive, rapid and local discharges of grey matter' [Jackson, 1958]. Jackson further commented upon the healthy and yet random discharge and concluded that 'a sneeze is a sort of healthy epilepsy'.

Psychogenic (intractable) sneezing

Intractable sneezing, first described by Shilkrel in 1949, is a rare pathological condition that has been detected in more than 50 cases in literature to date [Bhatia *et al.* 2004; Shilkrel, 1949]. Kanner referred to a 13-year-old girl who had incessant sneezing for over 2 months and whose progress was followed by a daily newspaper communique [Kanner, 1957]. A diagnosis of hysteria was made and subsequent psychotherapy eliminated the sneezing. Yater referred to similar explosive repetitious episodes and considered them to be a sort of imitation of the true act of sneezing [Yater and Barton, 1942].

Psychogenic intractable sneezing occurs mainly in adolescent girls for which a cause may not be found. Patients are usually refractory to various medications and have an otherwise unremarkable extensive workup [Lin *et al.* 2003; Bergman, 1984]. Inspiratory phase is quite short and the

amount of nasal mucosal secretion expelled very low. Eyes may remain open during sneezing. It usually develops due to psychogenic factors and is refractory to medical treatment [Gopalan and Browning, 2002]. Psychogenic sneezing responds well to psychological measures such as psychotherapy, biofeedback, relaxation exercises, supportive psychotherapy (i.e. explanation of nature of illness, suggestion to overcome symptoms) and behavior therapy (reward when there is symptom reduction, aversion therapy, hypnosis and relaxation). The role of anxiolytic drugs lies in reducing underlying anxiety and making the patient more amenable to psychotherapy.

Snatiation reflex

An uncontrollable sneezing attack developing as a result of stretching of the stomach following an excessive nutrition are first described by Teebi and Al-Saleh [1989] as a reflex with an autosomal dominant inheritance pattern. The mechanism of development is unknown. Snatiation is a combination of the words 'sneeze' and 'satiation'. Snatiation also stands for 'Sneezing Noncontrollably At a Tune of Indulgence of the Appetite-a Trait Inherited and Ordained to be Named' [Hall, 1990]. This abbreviation was supposed to facilitate future cases to be evaluated in the same class. Recently, two patients have been reported, who state that several members of their family sneeze on a full stomach [Bhutta and Maxwell, 2009]. This report doubles the number of families with the snatiation reflex in the medical literature.

Sexual ideation or orgasm

An association between sexual excitement and sneezing was first described in the nineteenth century [Mackenzie, 1884; Watson, 1875] followed by a young German otolaryngologist who developed a theory of 'nasal reflex neurosis' due to the finding of erectile tissue in both nasal mucous membranes and genital areas [Young, 2002; Jones, 1974]. The first report of this phenomenon in the literature describes a 69-year-old man who complained of severe sneezing immediately following orgasm, with no associated psychiatric morbidity [Anon. 1972]. Stromberg [1975] and Korpas and Tomori [1979], described male orgasm as a precipitant for the sneeze reflex. Recently, Bhutta described a middle-aged man with uncontrollable fits of sneezing with sexual thought. The patient had no other rhinological symptoms and psychiatric morbidity [Bhutta and Maxwell, 2008]. Bhutta *et al.* performed a search of Internet 'chatrooms' and found 17 people of both sexes

reporting sneezing immediately upon sexual ideation, and three people after orgasm. Although Internet reports do not give an accurate incidence, their findings do suggest that it is much more common than is currently recognized.

Diagnosis, differential diagnosis and management of rhinitis

The evaluation of a patient with sneezing should be individualized according to the duration and severity of the symptom (Table 1). Laboratory tests are not necessary in the majority of patients, since the diagnosis is usually obvious from the history and physical examination. It should be remembered that the history of the patient is the most important and determining stage for the diagnosis [Kramer, 2006]. The patient should be asked what his/her main complaint is, the duration and frequency of the symptoms like nasal discharge, stuffiness and pruritus if present, whether the nasal discharge or stuffiness is present on one side or both, perennial or seasonal, whether he/she has allergic complaints, past trauma, past nasal surgery history, known diseases, drugs used and also how these symptoms effect the quality of life. In female patients it is also important to ask whether she is pregnant or on oral contraceptives [Incaudo, 2004]. One of the most common signs of allergic rhinitis in children is a horizontal creasing over the nasal tip. This physical examination sign develops as a result of habitual rubbing, which is also called 'allergic salute', after a duration of at least 2 years, a repeated action in order to relieve pruritus and improve respiration. This habit may turn into facial grimacing in adulthood for social reasons. 'Allergic shiner', on the other hand, is permanent pigmentation on the skin of lower eyelid which presents as dark circles at the beginning stage. It develops due to subcutaneous hemosiderin through a capillary leak during periorbital venous stasis as a result of nasal mucosal congestion. 'Dennie- Morgan folds' are short semilunar lines or folds found below the inferior eyelid. These lines develop due to venous blood retention cause by continuous spasm of Müller's muscle under the inferior eyelid. 'Silky long eyelashes' is another outstanding concomitant sign of allergy. Clinical examination including anterior rhinoscopy and nasal endoscopy provides large information about pathologies related to the septum and lateral nasal wall. Allergy is prediagnosed with medical history and physical examination. If the patient has a medical history and complaints that are compatible with allergy, *in vivo* (Prick test, SET, Scratch test) and/or

Table 1. Differential diagnosis of rhinitis in terms of history and laboratory tests.

Feature	Allergic rhinitis	Infectious rhinitis	NARES	Vasomotor rhinitis
Onset of symptoms	Seasonal/ perennial	Seasonal	Perennial	Perennial
Symptoms	Sneezing Nasal stuffiness Nasal pruritus Nasal discharge Postnasal drip	Sneezing Nasal stuffiness Nasal discharge Fever Myalgia	Sneezing Nasal stuffiness Nasal discharge	Sneezing Nasal stuffiness Nasal discharge Postnasal drip
Triggering allergen	Yes	No	No	No
Triggering irritant	Yes	No	Yes	Yes
Allergy tests	Positive	Negative	Negative	Negative
Nasal cytology	Eosinophilia	Neutrophilia	Eosinophilia	Rare eosinophilia

NARES: non-allergic rhinitis with eosinophilia syndrome.

in vitro (serum-specific IgE), allergy tests should be performed [Settipane and Klein, 1985]. The skin prick test is the most common epidermal test. A positive allergen skin test that is compatible with the medical history and findings of physical examination should be assumed to be significant [Skoner, 2001]. RAST (Radio Allergosorbent Test) ELISA (Enzyme Linked Immunosorbent Assay) tests measure the amount of allergen-specific IgE antibodies. Since there is no risk of systemic reactions during the application of these tests, they can safely be performed on pregnant women, on patients with a past history of systemic reaction, during measuring the sensitivity to antigens with a high risk of systemic reaction, on patients with skin diseases, on people who use drugs that may affect the skinprick test results, in medico-legal cases where objective data are needed and also on children. The changes that develop due to gradually increasing doses of the allergen are followed by the nasal provocation test. This test is performed when objective data are needed for occupational rhinitis. Nasal cytology is not a diagnostic method performed for routine clinical practice and considered as an evaluation that does not provide a sufficient support alone [Scadding, 2001]. The use of acoustic rhinometry and rhinomanometry, which are the most common objective nasal airway tests, are confined because they have high costs and are time-demanding in terms of application and interpretation [Galen, 1997]. Mucociliary function may be evaluated for differential diagnosis in patients with rhinitis [Shaari *et al.* 2006]. Radiological examination is not necessary in a patient pre-diagnosed with rhinitis as long as an additional pathology is not suspected.

The treatment of persistent or recurring sneezing should be directed at the cause whenever possible.

The best treatment in patients with allergic rhinitis is to avoid the allergen. Medical treatment, even immunotherapy when needed, is used in patients who do not benefit from avoidance or environmental control. Some patients may benefit from adjunctive surgical treatment. The management of common cold and influenza is symptomatic. Decongestants, antipyretics, bed rest and increased fluid intake are recommended. Systemic antibiotics are preferred in patients who develop bacterial infections secondary to a viral infection while agent-specific antibiotic treatment is applied in those who develop rhinitis secondary to specific bacteria. It is vital to diagnose the patient and initiate the treatment immediately, particularly in fulminant fungal infections.

The initial stage in the treatment of patients with NARES is avoiding irritant environmental conditions. Medical treatment is considered in case the initial stage fails to succeed. The success of steroids in early phases decreases in long-term administrations due to decreased steroid receptors on eosinophils. Oral and topical decongestants may be used as an adjunct to steroid therapy. Capsaicin, a substance isolated from chili pepper extract, has an initial stimulating effect on C receptors which turns into an inhibiting effect following repetitive application. Antihistamines are of no use and treatment of vasomotor rhinitis is palliative. Oral and topical decongestants can be applied. Topical corticosteroids are not always beneficial. Ipratropium bromide, which prevents the secretions from serous and seromucous glands inhibiting the cholinergic system, may be effective. Antihistamines are of no use.

In the treatment of gestational rhinitis, medication should definitely be avoided for the first 10 weeks

and the treatment should be applied with obstetric advice in the following period. Isotonic saline sprays may be useful for pregnant women due to their humidifying and mucosal cleaning effects. The first-line medical treatment for allergic rhinitis in pregnant women is cromolyn sodium, a mast cell stabilizer. Beclomethasone and triamcinolone are the topical steroids of choice for those who do not benefit from cromolyn sodium. The safest antihistamine during pregnancy is chlorpheniramine and the safest oral decongestant is pseudoephedrine.

In the management of rebound rhinitis, the inducing drug should be discontinued and oral or parenteral corticosteroids should be administered in order to relieve the patient's complaints. The treatment should be supported with topical nasal corticosteroids. Surgery may be necessary if irreversible changes have developed in the inferior conchae.

The purpose of treatment in geriatric rhinitis should be to provide sufficient intracellular moisture. For this purpose, it is appropriate to humidify the nasal mucosa with solutions including a combination of isotonic solution and glycerine and to add gunifenasine to treatment which stimulates the submucosal glands.

Isotonic solutions can be combined with glycerine for the initial management of atrophic rhinitis. Other solutions can be antibiotherapy, estrogen support, vitamin A and D administration, iron support or corticosteroid administration. It has also been recommended to practice surgical closure of one or both nostrils for a period of 1 year, and surgical procedures to narrow the nasal cavity have been recommended. Avoiding irritant substances should be the initial approach for the management of occupational or irritant-induced rhinitis.

Complications of the sneeze reflex

Since the symptoms of majority of upper respiratory tract infections include coughing and sneezing, numerous particles disperse into the air during the course of these diseases. The most important complication of sneezing that affects public health is spread of droplet infections, tuberculosis in particular. The incidence of tuberculosis, which was taken under control through the improvement of efficient treatments in the second half of the twentieth century, began to increase again due to certain factors including

the outburst of HIV infection, the decrease in the importance given to disease control, and poverty [Adler and Rose, 1996; Centers for Disease Control and Prevention, 1994].

Gwaltmey *et al.* [2000] have determined that the intranasal pressure increases up to 176 mmHg during sneezing with the mouth open and the nostrils closed. Complications pertaining to this high pressure have been reported in literature. These complications include acute aortic dissection, cerebral venous thrombosis, loss of hearing due to fracture footplate, abortus, orbital emphysema, pneumocephalus, acute wide-angle glaucoma, pneumatocele of the lacrimal sac, retinal hemorrhagia and costal fracture reported in a patient with osteoporosis [Birkent *et al.* 2008; Fonseca *et al.* 2007; Baydin *et al.* 2005; Gonzalez, 2005; Gonzalez and Baydin, 2005; Whitehead, 1999; Sharir *et al.* 1992; Rochels *et al.* 1989].

Conclusion

Sneezing is a phenomenon that is common to all humans and is widespread in the animal kingdom as well. It may play an important role in maintaining health in ways that we don't currently understand. Sneezing, which cannot consciously be controlled, is a protective reflex for the body during which facial, pectoral and abdominal muscles function concordantly, maintaining respiration. It is rarely a sign of serious illness or impending disaster as feared by previous generations. On the other hand, it can be remarkably annoying. A thorough knowledge of this reflex can be a valuable aid in the diagnosis of other concomitant diseases.

Conflict of interest statement

None declared.

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