S. M. Puhlyk, *M.D., Professor,*
Head of Department of Otorhinolaryngology
Odessa State Medical University

S. M. Puhlyk
M.D. Professor

Nasal and paranasal sinuses disease growth factors and methods of controlling them

Both native and foreign researches acknowledge growing spread of nasal and paranasal sinuses diseases. It is noted in ARIA 2008 (International conciliatory document on Allergic Rhinitis (AR) and its Impact on Asthma (bronchial asthma – BA)) that AR spread level has risen significantly for the last 50 years and now this disease presents a global issue. On a conservative estimate, more than 500 mln people in the world suffer from AR. Only in the USA, more than 100 mln people suffer from symptoms of chronic rhinitis (basically, every other person), and this number is rising annually.

Incidence rate is noted in the majority of countries and it does not depend on age or nationality. AR affects significantly various aspects of social life and also leads to serious economic losses.

It is noted in the European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS 2007) that AR incidence rate has increased, particularly this is true for polypous rhinosinusitis, the number of cases of which among the Earth population has increased from 2 % to 4 % for the last ten years. The following questions arise regarding this: why this happens and what should be done? Unfortunately, it is not so easy to obtain a clear answer to these questions. In this context, changes of environmental conditions with the whole complex of negative factors affecting human beings (change of air composition, worsening of living conditions, nourishment, etc) are considered to be one of the main reasons of this issue. Below we will review this issue in detail.

However, there are also other factors one of which deals with immune alterations. Otolaryngologists also have impacted the origin of the latter, namely: in 1950-1960s, ENT specialists started active fight with chronic tonsillitis by removing tonsils as an unnecessary and rudimentary organ (similar to appendix). Tonsillectomy was practiced widely (being a young specialist, I removed the tonsils in 10-15 people per surgical day), and not only from patients who suffered from frequent tonsillitis, but also from those who had frequent catarrhal diseases as well as from cadets and maritime academy students as a preventive measure. The following decade of the past century was marked by some slowdown of this process. Information about special role of tonsils in forming immunity has become available leading to a new view on surgical methods of treating chronic tonsillitis. But by that time a layer of population living without tonsils had been created globally, which, according to modern concepts, had no well-formed tissue immunity, above all having no immunity of mucous membrane of upper air passages.

In 1970s, it was noted that diseases of upper air passages, in particular nasal diseases, were growing in number.

Particular attention was paid to allergic diseases of ENT organs. This was not only because allergology became a "fashionable" science but also due to a practical need to study allergic diseases as the result of their growth. These facts stimulated researching mucous membrane inflammation of upper air passages at a deeper level – cellular and molecular. It was noticed that AR and other nasal and paranasal sinuses diseases were increasing in their number. For example, if ten years ago foreign sources stated that 2 % of the world's population suffered from chronic polypous rhinosinusitis, in 2007 prevalence rate of various forms of rhinosinusitis was already 15 %, polypous forms making up 4 %. Whereby, the spread of such pathologies as BA and chronic obstructive pulmonary disease increased. These diseases essentially result from weakening of local protective forces of mucous membrane of air passages, i.e. tissue immunity.

Thus we, otolaryngologists, have significantly contributed to weakening the immune system of some layer of population by conducting tonsillectomy and adenotomy without well-grounded indication. In no way do I encourage to stop conducting these surgeries. However, they should be carried out according to strict indication which is clearly formulated today.

Attention should be paid to the fact that a high prevalence rate of nasal and paranasal sinuses diseases results in significant economic losses. Expenses for rhinosinusitis diagnostics and treatment in the USA make up to $6 billion, whereas in our country nobody calculates such costs. There is no doubt that respiratory viruses play a leading role in primary damage of paranasal sinuses mucous membrane. They are found in the nasal cavity and in paranasal sinuses of more than 50 % of patients suffering from acute purulent sinusitis [8]. Virus infections damage a drainage function of mucociliary transport and have immunosuppressive action reducing activity of microphages and T-lymphocytes. Development of cellular immune deficiency leads to pathogen elimination disorder and contributes to bacillosis overlay. Incomplete pathogen elimination from human body is one of the essential components of activator's reactivation and probably is the basis for a lingering run of purulent sinusitis and its transformation into chronic forms. There is a physiological mechanism of mucus release from nasal cavity and tracheobronchial tree called ***mucociliary clearance (transport)***. Nasal and bronchial mucosa is covered by a plural-row ciliated epithelium which includes ciliated, scyphiform, goblet, basal, and intermediate cells.

Air passages mucosa is covered by secretion of 2 mkm (in bronchioles) to 5 mkm (in bronchi, trachea and nasal cavity) thick along its whole length (from nasal cavity to terminal bronchioles). This secretion includes two layers: lower layer which is liquid ("***colloid solution***" layer) and in which cilia are sunk; and upper layer which is more thick ("***gel***" layer or secretion as such). It is due to coordinated oscillative motion of ciliary cilia that secretion movement and elimination are possible.

Due to normal activity of mucociliary clearance the bacteria of rhinobronchial secretion can move along 10 or more cells of bronchial mucosa per second which makes the time of contact of a microbe with a cell 0.1 second and makes the microbe invasion into epithelium more difficult. Mechanical clearance efficiency also depends on flow properties of rhinobronchial secretion itself, i.e. its ability to "flow". In its turn, volume of secretion and its chemical composure are connected with impact of mechanical (dust particle size) and physical (humidity, temperature) environmental factors.

Nasal secretion is a complex mix of secretion mucous glands and goblet cells of germinal epithelium as well as tissular transudate and specialized cells waste products.

Combination of forming rhinobronchial secretion and its transport is one of the most important functions of respiratory organs. Disorder of any chain in this system may lead to disadaptation and illness.

Mucociliary apparatus is a leading factor of respiratory passage protection. The following fact may show importance of mucociliary epithelium for human body: Consistent protein (like myosin) is responsible for functional activity of cilia and spermatozoids. In case of its inefficiency, the most serious illnesses may progress: chronic pneumonia, bronchiectasia, polypous and purulent sinusitis (syndrome of Young or Sievert – Cartagener syndrome) as much as mucoviscidosis during which sick children seldom live until 10-12 years old (male patients with this pathology have immobile spermatozoids).

In addition to the abovementioned examples of the most serious congenital defect, a temporary functional immobility or decrease of activity of mucociliary apparatus may be seen very frequently developing secondary to acute or chronic inflammation in nasal cavity or paranasal sinuses as well as when vasoconstrictive nasal drops, antibiotics, non-adapted hormones, the range of antiseptics, hypertonic solution, harsh acid or alkaline agents, etc get into mucosa of respiratory passage. The same condition is observed in professional contact with dust particles of different size, gases, during sudden drops of temperature, etc.

Therefore, there is a range of reasons leading to modification of flow characteristics of mucus which makes it viscous and thick:

- drying the air indoors especially in wintertime by using heaters, radiators, air-conditioners, etc;
- inflammatory and allergic processes;
- dyspraxia of mucous glands and goblet cells during occupational exposures;
- medicated blockade, degenerative changes, surgical interference on intranasal structures.

Such combined effect both on epithelium cilia directly and on mucosa state results in disorder of mucous membrane main function, i.e. clearance, in future contributing to adhesion of microbes and viruses to mucous membrane and their deeper penetration into tissues, which is impossible under normal conditions.

Thus, there are different options of mucociliary clearance disorder related to modification of both the secretion nature and coordinated activity of epithelium cilia of nose mucous membrane. If mucociliary transport functions normally, it is impossible for bacteria to have a long enough contact with epithelium cells of nasal cavity and paranasal sinuses.

Milieu is very important for normal state of mucous membrane of upper air passages. Allergenic load on mucosa (viruses, bacteria, fungi, etc) causes its immunologic alteration and alteration of its lymphadenoid organs (above all adenoids). Increasing cellular infiltration causes tissue hypertrophy. Increasing nasal resistance results in aggravation of mucoliciary transport, mucosa retention, increases time of antigen contact with epithelium cells, which in its complex creates conditions for human body allergization or bacterial inflammation transforming into a chronic form.

Today the main allergenic agents which people contact in everyday life and which are capable of causing allergic diseases are house dust mites, microfungi (micromyces), epidermal agents, waste products of insects, animals, etc.

The mites' quantity (a species size is 10 to 40 micrometers) per one cubic meter of air makes up 100 thousand. This number may increase thousandfold in the unaired dwellings. It has been proved that domestic dust allergen exposure is a significant factor evoking onset of BA, especially in new-born and babies. Human sensitization to microfungi populating indoor environment in abundance is very important. Fungi *Aspergillus, Penicillium, Alternaria, Mucor, Candida, Aureobasidium, Cladosporium* are pointed out more frequently in samples of house dust and air of indoor environment. Species composition and the number of spores in the air are affected by the nature of indoor environment or industrial enterprise. Such spores of fungi growing indoors as, for example *Aspergillus* and *Penicillium*, are found in great concentration in the air in the autumn or in the summer. In addition to the above-mentioned agents, samples of house dust include particles of kitchen smut and tobacco smoke that are considered to be cancerogenic. Any aerosol dust including deodorants in aerosol cans is also harmful. Crumbling particles of parquet varnish are extremely harmful.

Flour dust, harmful due to its allergic reactions, may be found in the kitchen; microfungi may be found in the bathroom. In houses where there are many books and paper, paper dust is abundant producing specific allergy often affecting librarians. It is also necessary to mention that a person loses around 1 gram of skin per day and 2-3 grams during the night totaling 28 grams per week adding to composition of house dust.

It has been proved that humans breathe in about two table spoons of dust with the air per day, and the smaller it is, the deeper it penetrates into the lungs. A normal and healthy mucosa with actively functioning mucociliary transport will handle clearance of respiratory passages without any problem. But what if a person smokes? Let me remind you that a smoked cigarette stops functioning of ciliated epithelium approximately for an hour. And what if an electrical heater or an air-conditioner is powered on in the apartment? Mucosa on the surface of respiratory passages will dry up, ciliated epithelium will stop functioning and dust particles will damage alveoli walls by this damaging immune barriers and opening the way for infections and allergens.

WHO experts came to a conclusion that quality of air typical for indoor environment of various constructions and buildings is more important for human health and well-being than quality of outdoor air.

So what are we to do? How can we protect ourselves from allergens? How can we preserve (or repair) our health? How can we protect mucosa of upper air passages and actively functioning ciliated epithelium?

In my opinion, it is extremely important to clean the air inhaled in enclosed room. The first working model of a vacuum cleaner was built in 1901. The vacuum cleaner was named “Puffing Billy” and ran on petrol. It was equipped with a 5 horsepower vacuum pump and was the size of a vehicle. It was “parked” at the roadside and the carpets were taken outside to be cleaned.

In 1912 Axel Wenner-Gren, a Swedish founder of Electrolux, proposed to change an air pump in the vacuum cleaners with a fan resulting in this household appliance weight reduction down to 14 kg. However, this company was renowned worldwide after its Model V entered the market in 1921. A metal cylinder moved on wheels was connected to an air-sucking brush by a flexible hose and was equipped with replaceable nozzles. It was copied by all the household appliances manufactures practically until the end of the 20th century.

Researches have proved that traditional cleaning methods harm human health. In reality, many vacuum cleaners only make the situation worse. They simply cannot filter microparticles with the size of 1/300 of human hair diameter. “Raising” such particles from the surface of a carpet, bed, furniture (where they are relatively harmless), a vacuum cleaner blows them out into the air which we breathe. A vacuum cleaner can only gather a visible litter. Even the most expensive microfilters and dust-collecting bags do not solve the issue of retaining microdust, catching only bigger dust and dirt particles.

Unfortunately, only some people know that using a conventional vacuum cleaner presents some risk for human health.

Experts from Germany and Slovenia have solved this issue by developing a multifunctional cleaning system called ***HYLA***. HYLA is an advanced technology using a natural cleaning approach – water separation. This is more practical than internal dust-removal system. HYLA is used instead of a vacuum cleaner.

HYLA combines multiple house cleaning features and, more important, it cleans the air. Cleaning process using this system will become a pleasant procedure ultimately resulting in a clean and fresh environment.

All people know what a vacuum cleaner is and how it works, even those who are not knowledgeable in household appliances. History of how a vacuum cleaner was created and improved is long and captivating. When one starts studying these issues, he or she will understand that the most important thing about a modern vacuum cleaner is degree of filtration and dust content in the air after cleaning.

Doctor Sigrid Flade, a famous German allergologist, in his book called "Allergy: How to Combat it Naturally" recommends HYLA as an ideal cleaning system for people who suffer from allergy.

HYLA ensures air cleaning from allergens, toxic substances, radioactive dust, removes unpleasant smell, provides dry cleaning for carpets, upholstered furniture, car passenger compartment, patterned furniture, paintings, books, parquet, laminated flooring, drapes, curtains, ensures deep cleaning of mattresses and pillows as well as wet cleaning and hypoallergic dry-cleaning. HYLA does not have any removable or non-removable bags or filters! After using HYLA, the air in a room becomes clean and, more important, fresh. Independent tests showed that HYLA cleans indoor air removing more than 99.95 % of particles sized up to 3 microns and 100 % of particles with the size of more than 5 microns. It also cleans the room from fungi spores and can reduce their concentration for more than 60 % and for more than 40 % in case of bacterial spores.

It is very important that due to using HYLA in indoor environment, people's mucosa of upper air passages is moistened naturally. It suffers particularly in the winter when windows are closed and heaters are on or in the summer when air conditioner is turned on. The device cleans the air and moistens it at the same time using water as a filter and diluting dirt, dust, allergens, and gases. Unpleasant smell can be neutralized using HYLA including cigarette smoke, cooked food smell, etc. The device may be used for aromatherapy as well as for conducting cold inhalation which presents special interest for children of young age. To do so, add several drops of flavoring agent such as, for instance, eucalyptus, which has antiseptic properties, into the water.

HYLA normalizes air humidity, neutralizes and binds microparticles: allergens (tiny dust particles, pollen, etc), chemicals (cleaning agents, perfumes, etc) and gases (formaldehyde). It is also possible to neutralize bacteria using HYLA with sanitizers.

To summarize, we may say that the following causes of acute and chronic rhinosinusitis including polypous may be pointed out:

- congenital or secondary immunodeficiency (including allergy);
- increasing allergenic load on mucosa causing immunologic alteration of mucosa of upper air passages (respiratory viruses spread level is still high, polluted environment, and urbanization);
- social habits suppressing protective factors of respiratory passages mucosa (smoking, use of vasoconstrictive drops, etc);
- changes of living conditions leading to disorders of protective and adaptive mechanisms of our body.

The ways of solving the abovementioned issues are as follows:

- "sanitation" of domestic and industrial rooms (normalize humidity, clean the air, limit allergenic load on respiratory passages mucosa, etc);
- fight with social habits damaging protective and adaptive mechanisms of human body, personal hygiene, occupation physical training, and health-improving procedures;
- change of "radical" approach in treatment of chronic diseases of upper air passages in order to preserve tissue and systemic immunity;
- increase level of specialist training;
- provide population with broad and available information about the state of the issue (educative activities);
- study mucous membrane inflammation at molecular level.

References

1. Solving polyposis and rhinosinusitis issue // Materials of European Academy of Allergy and Clinical Immunology Congress. – Amsterdam, 2004.
2. B. M. Puhlyk. Notes of Allergologist. – Vinnitsa: ITI, 2008. — 95 p.
3. Diagnostics and treatment of allergic rhinitis and its impact on asthma (ARIA). Guide for doctors and nurses. – 24 p.
4. Roncoleukinum immunotherapy of acute sinusitis // Methodological recommendations. – SPb., 2003.
5. S. M. Puhlyk. Aspects of using Sinupret medication in otorhinolaryngology // ZhVNHKh. – 2003. – № 5.
6. A. S. Lopatin. Acute rhinosinusitis: is it always necessary to order antibiotics? // Meditsinskaya Kafedra. – 2002. – No. 4.
7. H. E. Tymen, O. F. Melnikov, V. M. Pysanko, L. A. Kud', A. F. Karas'. Efficiency of non-invasive tactics in treating children suffering from acute sinusitis // ZhVNHKh. – 2006. – № 5. – P. 15-20.
8. European Position Paper on Rhinosinusitis and Nasal Polyposis, Supplement (EPOS) 2007; 20.