

# Halotherapy in Controlled Salt Chamber Microclimate for Recovering Medicine

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## Summary

The review presents the method of halotherapy which models the microclimate parameters of salt speleoclinics. It gives historical data on the method development, principles and advantages of halotherapy by means of controlled microclimate. The influence of the main curing factor – the dry fine-grained sodium chloride aerosol, and pathophysiological basis of curing effect of the halotherapy method are under review in the article. The article describes the method of controlled halotherapy and its technology, that is the halocomplex equipped with a controlled halogenerator.

Data on clinical efficacy and the grounds for the method usage in the recovering treatment for bronchopulmonary and otorhinolaryngologic pathologies, skin diseases and combined cardiovascular pathology, as well as preventive measures against respiratory diseases are cited. Efficacy of halotherapy in treatment and recovery of children is under review. Foundations for perspective usage of halotherapy in all kinds of medical and recovering establishments are given.

**Key words:** halotherapy, speleotherapy, drug free method, salt room, salt cave, salt chamber, halochamber, halocomplex, halogenerator, dry sodium chloride aerosol, respiratory diseases.

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## Beginnings of halotherapy

In the last decade the usage of therapeutic air with the modeling of natural factors has become notable among physical methods used in recovering and resort medicine.

Speleotherapy (ST) is one of the methods which have given rise to further development of the whole trend in modern recovering medicine. ST («speleon»- Greek - «cave») – means usage of the underground caves microclimate for treatment. The most perspective and popular trend of ST is the treatment in the microclimate of salt caves (as a rule they are former salt mines). The overwhelming mass of all rock-salt deposit was formed in the Permian geological epoch. Ancient underground salt deposit is used for salt extraction (halite, sylvinite).

In 1843 a Polish doctor F. Bochkowski was the first

to assume, that air sated with particles of salt has a therapeutic action. In 1958 in the salt mines of Velichka, Krakow province, the first salt medical resort for patients with lung diseases was founded. Today speleotherapy has become a conventional effective non-drug method of treatment. In many countries they created speleotherapeutic clinics on the basis of natural caves — Austria (Salzebad-Salzeman), Poland (Velichka), Romania (Siget), Azerbaijan (Nakhichevan), Kirgistan (Chon-Tuz), Russia - Perm area (Berezniki), Carpatho-Ukraine (Solotvino), Ukraine (Artemovsk, Donetsk area), Byelorussia (Soligorsk). Speleotherapeutic clinics are mainly located at a depth of 200 - 300 meters. Some of them (Duz-Dag, Chon-Tuz) are situated at a height of midmontane above sea level.

The microclimate of different speleotherapeutic clinics (temperature, humidity, air composition,

presence of aeroions and others) has specific features. It is characterized by temperature and pressure constancy, gas composition of the air, low relative humidity, increased content of negative ions, absence of bacterial flora and allergens, slightly increased content of carbonic acid. The main component that determines special efficacy of treatment especially in salt caves is the presence of the finest salt particles in the air - dry salt aerosol of certain density (concentration) and particle size. The salt speleoclinics treat patients with chronic lung diseases (CLD) with the medical action of air sated with particles of rock salt.

Aerosol composition in speleoclinics depends on the structure of speleo forming rocks. The main component of aerosol in salt caves is sodium chloride. It is the main component of halite speleoclinics (Solotvino, Velichka, Chon-Tuz and others) and constitutes the major part (60-80%) of aerosol in sylvinite speleoclinics (Perm Region). Density (concentration) of salt aerosol in different speleoclinics varies within 1 to 20 mg/m<sup>3</sup>, (often from 2 to 5 mg/m<sup>3</sup>). The fact that the natural salt aerosol contains considerable amount of respirable particles (1-5 μm) which are the most effective in respiratory tract is of high significance. Moreover, it is the salt aerosol which cleans the air of underground clinics by creating nonbacterial and almost sterile atmosphere.

ST in the microclimate of salt mines has a nonspecific hyposensitizing effect, leads to reduction of infectious and inflammatory process in respiratory apparatus, and stimulates different units of local and general protective mechanisms. In the process of treatment the organism adapts to specific properties of microclimate which causes reorganization of functioning of all body systems. Research held in different speleoclinics made possible to determine the ST prescriptions and to develop differentiated complexes of its usage (1, 27, 37).

ST in salt caves has won the recognition of patients and physicians as an efficient drug-free method. However, undoubted exclusiveness of the method and related to it small number of beds, high price of treatment and necessity to move to other climatic zones have naturally restricted its spreading. ST prescription is also restricted with contra-indications which considerably constrict the circle of patients.

Tendency to use medicinal quality of salt caves microclimate for treatment of the wider circle of patients has motivated for the search for ways of reconstruction of artificial microclimate in medical establishments. ST has underlain the methods which use microclimatic factors of

salt speleoclinics in ground-based premises. The method of usage the salt caves microclimate in ground-based premises in mid 80s was given the name of «halotherapy» in St. Petersburg, Russia («hals»-Greek – «salt»). Later while using premises for treatment they started to apply other names, such as «speleoclimatotherapy», «speleotherapy» and others. In the scientific publications method halotherapy (HT) is called «haloaerosol therapy» as well.

Aggregate usage of active factors of salt caves, and namely dry sodium chloride aerosol as the main factor, certain stable comfortable room temperature and optimum air moisture have recently got the definition of «speleo impact».

### Technique of the method

While modeling the salt cave microclimate various techniques have been used. Long since the first attempts to create the microclimate it has been determined that indoors it is impossible to create the atmosphere of fine sodium chloride aerosol with the only use of such passive methods as salt coating of walls (halite or sylvinite) (23). This method turned out to be ineffective. Salt bricks which cover the walls can be used only in decorative purposes. In the premises where along with salt blocks so called filters – saturators, labyrinth partitions and ventilation systems served as presumable sources of sodium chloride aerosol, the concentration of aerosol particles has been insignificant or they were absent; that is the necessary concentration and dispersion of particles has not reproduced.

Modern theoretical ideas and accumulated practical experience on the formation means and mode of behavior of aerosols have revealed that for indoor reproduction of therapeutically significant parameters of aerosol (concentration, necessary contents of respirable particles) special aerosol equipment is needed, that is halogenerators - the generators of sodium chloride aerosol. Walls with salt coating may fulfill only auxiliary functions like mental and emotional impact on patients, some maintenance of temperature and moisture conditions and air purity (due to interaction with sodium chloride aerosol produced by the halogenerator), contribute to noise absorbing. Air saturation with moist aerosol as a result of saline solution dispersion by means of inhalers is sometimes used to create the microclimate. The essence of such method is a group inhalation of saline solutions. Besides, because of instability of moist aerosol in the indoor air it is almost impossible to measure it. Inhalations of saline solutions are more well-handled through nebuliser.

Another important function of the dry sodium chloride aerosol is to maintain hypobacterial and allergen-free air. Indoors, where there is no necessary level of dry sodium chloride aerosol, no air purification occurs, and during the treatment patients run the risk of infectious contamination concerned with accumulation of products from expired air and secretion of respiratory tract. The problem also occurs when spraying moist sodium chloride aerosol which does not possess bactericidal activity.

Analysis of the impact of sodium chloride microclimate has revealed that for optimization of the one treatment and the whole course duration, its high efficacy and safety it is necessary to measure out the level of the dry sodium chloride aerosol concentration taking into account the characteristic features of respiratory diseases as well as those of other pathologies. With regard to modern requirements for representation the microclimate of salt speleoclinics the method of controlled HT is now used (12, 29). The controlled HT provides for creation and maintenance of all the parameters of the method, differentiated dosing and controlling the level of sodium chloride aerosol in the process of treatment.

Together with studies of the method acting the equipment for its implementation has been developed and improved. The method of controlled HT is carried out with the halocomplex equipment based on the halogenerator which creates and maintains the level of natural concentration and parameters of sodium chloride aerosol with several modes of treatment by monitoring in the medical facilities like halochamber, haloroom, haloward. Some institutions with the aim of attraction of clients call the facility equipped with the halocomplex «salt room», «salt grotto», «salt cave» etc. Such names are often used for rooms with salt coating of walls but not equipped with halogenerators. The main difference is in the fact that without special aerosol equipment it is impossible to create natural environment of sodium chloride aerosol.

The halocomplex with controllable microclimate consists of two equipped rooms as a rule. The main treatment room is meant for patients sitting in comfortable armchairs. In the adjacent room, the operator's room is for the staff, the operator, who operates the halogenerator and registers patients (fig.1). The halogenerator provides for feeding of the dry fine-grained aerosol composed of prevailing respirable particles fraction (over 80%).

At present halogenerators GDA 01.17, HALOSPA-01 (UAB Halomed, Lithuania) and ASA-01.3 (JSC Aeromed, Russia) is used to equip halocomplexes. For the purpose of maintenance of prescribed

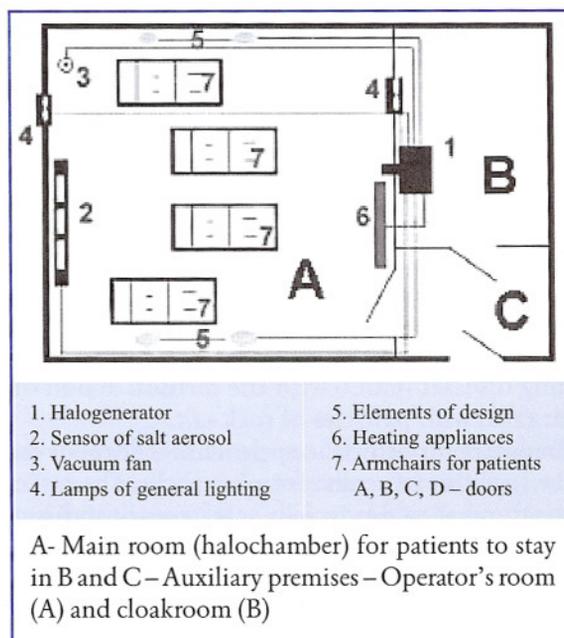


Fig. 1. Sample plan of controlled halocomplex.

treatment modes in the treatment room a sensor of continuous control of aerosol mass concentration is installed. The halogenerator's microprocessor processes sensor's signals by feed back coupling and maintains the prescribed salt aerosol parameters by means of automatic tuning to different space of the room. Microprocessor block can also provide for lightning and ventilation systems between the treatments. In the treatment room the sensors maintain the microclimate with the temperature of 20-24°C and humidity of 40-60%. As it was mentioned earlier salt coated walls are of auxiliary significance.

Halorooms where the halogenerator is located directly in the treatment room have been used for HT recently. Halorooms can also function in their full value without salt coating. Such a variant which is the most cost-effective has been widely used in pediatric practice, preschool institutions and schools where playing environment and special interior design are created.

### Main treatment factors of halotherapy in controlled microclimate

**Dry fine-grained sodium chloride aerosol of certain ranges with controllable medicinal concentrations (modes).**

The main mass of particles in aerodispersed environment (over 80%) consists of respirable fraction (1-5 μm), and it is because of that the aerosol effectively influence all sections of respiratory tract.

Due to dispersant method of dry aerosol formation by means of heavy mechanical effect on salt crystals, particles obtain high surface energy and negative electric charge. Physicochemical properties of dry aerosol determines the specific character of the HT method which characteristic feature is in multi component curing effect of extremely small doses of the substance. The concentration of fine-grained sodium chloride aerosol in treatment room is from 1 to 10 mg/m<sup>3</sup> and is maintained within certain limits (modes): the 1<sup>st</sup> mode - 1,0 mg/m<sup>3</sup>; 2<sup>nd</sup> mode - 1,0-3,0 mg/m<sup>3</sup>; 3<sup>rd</sup> mode - 3,0-5,0 mg/m<sup>3</sup>; 4<sup>th</sup> mode - 7,0-10,0 mg/m<sup>3</sup> (12).

Dosing and management of salt aerosol parameters are necessary for efficient and safe usage of the method taking into account variety of nosological forms. It makes optimization of treatment and course duration possible which becomes more and more topical for medical and sanitary institutions.

#### **Hypobacterial and allergen-free air.**

Particles of dry salt aerosol which interconnect due to electrostatic interacting forces with particles of aerial contamination quicken their settling thus purifying the air in the room.

**Aeroionization.** At decomposition of salt particles as a result of heavy mechanical effect in the halogenerator obtain high surface energy and negative electric charge. When aerosol particles interact with air molecules it causes aeroionization of air (6-10 nK/m<sup>3</sup>). Light negative ions are accessory factors of therapeutic impact on the organism and purification of indoor air.

#### **Stability of optimal microclimatic parameters.**

Curing air has stable humidity of 40-60% and constant temperature of 20-24°C which are the most favorable and comfortable for respiratory organs and stability of aerodispersion environment.

**Design of natural salt cave, aesthetic attraction.** Have positive influence on mental and emotional sphere, create comfortable conditions for carrying out treatment.

### **Action mechanisms**

According to experimental and clinical studies, among salt aerosols the dry sodium chloride aerosol (haloaerosol) is the most effective for the respiratory tract. Action mechanisms of dry sodium chloride aerosol present in underground clinics and used in the HT method are well founded in the series of studies (3, 7, 8, 17, 18). Physical characteristics of haloaerosol are of great importance. Prevalence of respirable particles in its composition guarantees the efficiency of action and penetration of all

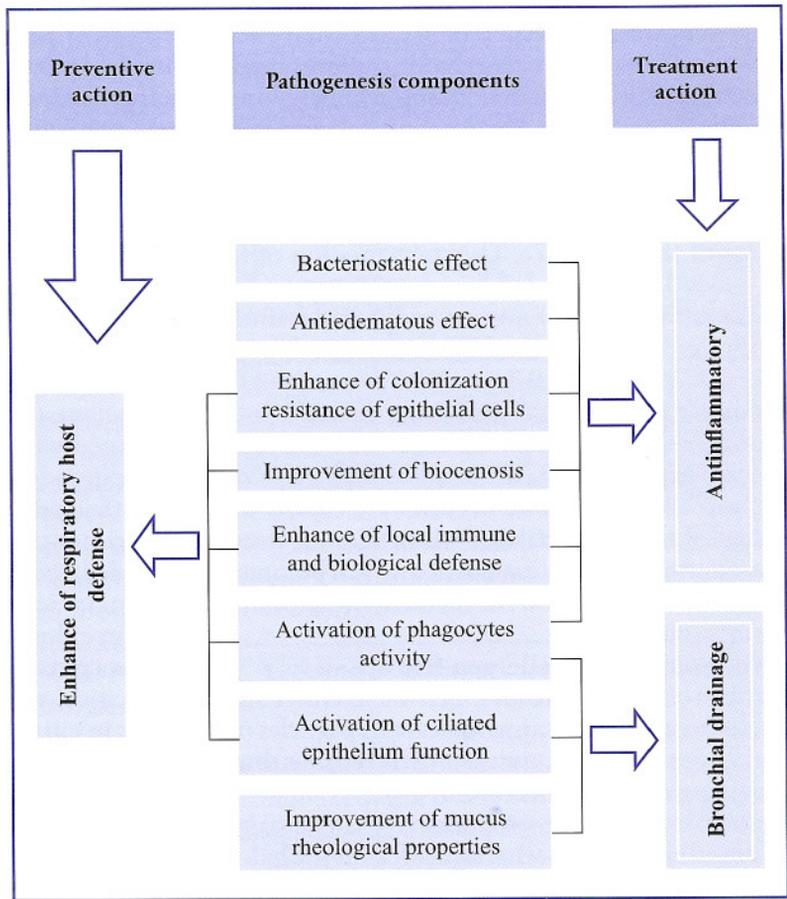
sections of respiratory tract right up to the deepest. Surface energy of dry salt aerosol produced in the halogenerator is higher if compared with aerosol produced by dispersion of liquid. Particles of negative charged aerosol possess one more important property, and namely they stimulate the work of respiratory epithelium cilia. Studies of absorption of liquid-droplet (moist) and dry aerosol of sodium chloride in respiratory organs ascertained that the extent of delay of particles with equal dispersity is higher in dry aerosol. Moist sodium chloride aerosol which is fed indoors by means of different types of nebulisers (jet, ultrasound etc.) is less effective as compared with the dry one (31, 38). Moreover, high humidity indoors can cause respiratory discomfort and other side effects.

Experimental and clinical data have allowed formulating the idea of mechanisms of HT action. The main acting factor is the dry fine-grained sodium chloride aerosol which:

- acts as a physiological osmolar stimulus, improves rheological properties of bronchial mucus and assists in ciliated epithelium function;
- causes fluid outflow from vessels to bronchus gap thus assisting in decrease of edema in bronchus walls and stagnation in their vessels;
- stimulates elimination of opportunistic microflora (*S. neumoniae*, *H. influenzae* and etc.);
- has a bacteriostatic effect;
- increases the number of phagocytes of respiratory tract and intensify phagocytic activity (increase in macrophages activity);
- positively influences local immune and metabolic processes (increase in SIgA and lactoferrin in pharyngeal and bronchial wash-outs, normalization of serotonin secretion; decrease in initially heightened level of catecholamines, serotonin, and histamine in bronchoalveolar lavage;
- enhances electrophysiological cell activity of mucosa epithelium;
- increases colonization resistance of epithelium cells regarding to opportunistic microflora;
- assists in restoring of biocenosis in respiratory tract;
- improves condition of systemic immunity.

Thus, the dry fine-grained sodium chloride aerosol has mucolytic, bronchodrainage, antiinflammatory and immune-response modulating effect on respiratory tract. It has airway «cleansing» (enhance host defense) effect and indirectly improves general host defense (fig. 2). Haloaerosol has an antiphlogistic and sanitating influence on airway surface liquid at its affection caused by infection and inflammation as well as by irritation due to pollutants. Improvement of drainage function and decrease in inflammation of respiratory tract contribute to abatement of

hyperreactivity and decrease of bronchospastic obstruction component (9). Light negative aeroions that are present in halochamber activate metabolism and local defense of biological tissues, stabilize processes of vegetative regulation, have favourable effect on cardio-vascular system, endocrine system, gastrointestinal tract, mucosa of respiratory apparatus and have adaptogenic effect on central and peripheral stress-limiting systems of the organism. Staying in the halochamber breaks the contact with external unfavourable effects as allergens and pollutants, stabilizes vegetative nervous system and has a positive psycho-emotional effect. Taking into consideration all curing factors it was ascertained that the microclimate created by halocomplex influences the respiratory tract, immune and cardio-vascular system, cutaneous covering, vegetative nervous system and psycho-emotional sphere.



**Fig. 2.** Action of dry fine-grained sodium chloride aerosol on respiratory tract (Chervinskaya A.V., 1998).

### Description of the method

During HT procedure patients (as a rule 4-6 persons) sit in comfortable armchairs in the treatment room (halochamber, haloroom). HT treatment usually is accompanied by tranquil music and/or psycho-suggestological programs; for children tales and calm musical entertainment programs are broadcasted. During the day several HT sessions (4-5 on average) are held. Between the sessions rooms have an airing for half an hour.

HT course consists of 10-20 daily treatment sessions of 30 minutes for children and 40-60 minutes for adults. HT courses with rehabilitation and preventive purposes are advisable to get 1-2 times a year. HT courses are expedient in work collectives during unfavorable weather seasons with the aim of prevention of acute respiratory viral infections and exacerbations of respiratory diseases. Preventive HT is also advisable for pollen allergy. It is appropriate to start treatment shortly before or with the appearance of its first symptoms. In that case HT contributes to interruption of

contact and elimination of pollen allergens out of respiratory tract.

Controlled HT provides for differentiated application of certain concentration (modes) of dry fine-grained sodium chloride aerosol according to clinical features of the disease and characteristics of the external respiration function (12, 16).

### Areas of application

Possibility of choosing parameters of aerosol speleoimpact which is brought about when using controlled HT ensures the method adaptation to conditions of various fields of medicine and hygiene.

HT is described for all the most widespread respiratory diseases. As a rehabilitation method HT is prescribed to patients with acute bronchitis, prolonged pneumonia, chronic obstructive pulmonary diseases (COPD), asthma of different stages and different clinical and pathogenetic variants of their course including hormone dependent

forms, bronchiectasia, cystic fibrosis. Dosing of treatment taking into account concentration of salt aerosol allows applying the method at heavy forms of diseases with considerable obstructive dysfunction. Controlled randomized placebo studies showed (3, 7, 9, 10, 25) that method inclusion in the complex of recovering treatment and rehabilitation of patients with chronic bronchopulmonary pathology (asthma, COPD) allows achieving maximum clinical effect at 82 - 96% of patients at the most optimal doses of medicament therapy and contributes to raising efficiency of treatment and prolongation of remission.

In pediatric practice HT is most frequently used in treatment and rehabilitation of children with asthma in post-attack period and in between attacks (efficiency of 75-85%). High efficacy was achieved in treatment of children with recurrent bronchitis especially in obstructive forms. Scope of HT therapeutic effect allows considerably decrease prescription of antibacterial medicine which prevents dysbacteriosis and allergic reactions in children (22, 26, 30). Preventive courses for frequently sick children diminish the risk of recurring diseases and contribute to speeding up of recovery (24). Long-term clinical application of HT method in various fields of medicine (pulmonology, allergology, paediatrics, otolaryngology, dermatology and others) as well as studies of its mechanisms has brought to understanding that the method has pronounced recovering effect. In Russia halocomplexes are used in hundreds of health centers. Recently halocomplexes have been used in SPA-industry. Method usage in the recovering complex in health and preventive centers in patients with lung diseases and with risk factors (those working in adverse conditions) makes possible to achieve respiratory sickness rate of 1,5-2 times less and prevents exacerbation of main disease (13). HT is used in a complex treatment of patients with occupational lung diseases (25). Application of HT is effective in 82% of patients with pollen allergy (2). Preventive HT treatment for smokers and patients with exogenous risk factors allows recovering of mucociliary clearance, liquidates first manifestations of obstruction and restores respiratory tract defense (5, 6). With the help of preventive usage of 2 times weekly HT treatment during three months decrease in sickness rate of acute respiratory viral infections was attained in patients with chronic pulmonary diseases as well as conditionally healthy but threatened with COPD development (15).

Application of special modes of salt aerosol concentration makes it possible to use HT not only for respiratory diseases but also in the fields

of otolaryngology and dermatocosmetology. Dry aerosol of sodium chloride has an antiphlogistic and antiedematous effect on nasal and pharyngeal mucosa as well as that of accessory sinuses of nose in chronic pharyngitis, rhinitis and sinusitis. Immune-modeling effect of haloaerosol has been proved in otolaryngological pathologies (35). HT usage as a method of conservative treatment of nasal pathology allows attaining positive results in 72% - 87% of cases with the largest effectiveness in vasomotor and allergic rhinitis (4). Dry aerosol of sodium chloride has a favorable effect on mucosa of nose and accessory sinuses in chronic sinusitis (21). In 90% of patients with acute sinusitis 2-3 inhalations of aerosol of dry sodium chloride aerosol prescribed after initial puncture have sanifying effect (28, 31).

Controlled HT is successful for treatment of skin diseases (diffusive neurodermatitis, allergic dermatitis, eczema, psoriasis and others) (32, 36). Staying in halo-chamber has a positive cleansing effect and restores biocenosis of skin covering, and improves microcirculation, all of which is used in cosmetological programs (19).

Long-term usage of HT has shown the safety of the method as for side effects on cardio-vascular system which allows using it in patients with COPD having associated cardio-vascular pathology, old age group included. HT usage in patients with asthma and COPD with associated cardio-vascular pathology (ischemia, hypertension and discirculatory encephalopathy) at the old age allowed attaining positive clinical effect in the absence of any negative reactions (11, 34). Positive results of HT usage have been achieved in patients in postoperative period after coronary artery bypass grafting (14). In such patients rehabilitation complexes including therapeutic physical training, thorax massage, balneotherapy and local treatment of magnet therapy, ultrasound and aeroion therapy along with HT are advisable.

Research and clinical experience of controlled microclimate application with the ability to choose appropriate mode of curing concentration of dry sodium chloride aerosol on the whole have demonstrated positive effect of HT on the state of cardio-vascular system. At present controlled HT is included cardio-vascular pathology in the cardio-vascular pathology programs of rehabilitation of patients with cardio-vascular pathology (20, 33).

### Practical application of halotherapy

HT can be successfully combined with other physiotherapeutic and drug-free methods. HT efficacy increases in conjunction with drainage gymnastics, ►

vacuum thorax massage and kinesiotherapy. HT usage together with aeroionotherapy, aromatherapy, phytotherapy, magnetotherapy, laser therapy, ultrasound, low-frequency electromagnetic field, and normobarometric hypoxithery has made a god showing.

In Russian Federation HT has been officially authorized for medical usage by the Ministry of Public Health. At present controlled halocomplexes have been installed in more than 1000 medical and sanitary institutions.

The analysis of HT application during the last 7 years (2000 - 2006) has shown that the method is being used by various medical, preventive and sanitary institutions. In the most demand HT is in sanatoria and health resorts (43%). During the last years the method has been introduced in sanitary programs in SPA facilities. Halocomplexes (halochambers and halorooms) are widely used in out-patient department, physiotherapeutic, therapeutic, pulmonological, rehabilitation and ENT- department in hospitals, medical units of industrial enterprises (34%). In out-patient department and hospitals the most reasonable organizational form for HT application is a daily clinic. Practical experience has shown that HT usage is advisable for children and adolescent practice in children pre-school facilities and schools (23%). Because of wide possibilities of preventive effect this segment continues growing.

## Conclusion

Thus the ST method has been further developed into a new medical technique – the controlled HT. The achievement of the method is in the principle of controlling the parameters which ensures dosing and control of employed natural factor – dry sodium chloride aerosol. Scientific grounds for action mechanism, proven clinical efficiency verified by research on standards of evidence-based medicine and practical application in various fields of public health determine broad prospect of the method in rehabilitation, sanatoria and health resorts and preventive medicine. Numerous research and wide experience of practical application confirm the efficacy and broad opportunities of HT usage as rehabilitation and preventive medicine in all kinds of medical and recovering establishments.

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