

Halotherapy in Treatment of Consequences of Pulmonary Pathology (Thoracic Pathology): Effectiveness, Optimal Use in Modern Conditions

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Abstract. The healthcare sector is faced with the need to find new innovative and multidisciplinary approaches for the prevention and treatment of Covid, post-Covid, long-Covid, chronic, comorbid disorders. The results of 30 years of experience in the use of halotherapy in the treatment of pulmonary pathology indicate that the authors of the article have established the optimal level of use of halotherapy in pathological pulmonary processes. At the same time, clinical experience provides evidence for the optimal method of using the halotherapy method in pulmonary nosologies. The method of using salt therapy in exudative pleurisy, in fibrinous pleurisy, in fibrotic processes in the lungs has been theoretically substantiated, developed, and implemented in clinical practice. It has been proven that halotherapy is an effective treatment method for bronchial asthma, chronic obstructive pulmonary diseases, acute respiratory

viral infections, fibrinous and exudative pleurisy. The therapeutic effect of this method is observed only when using halogenerators with the ability to grind salt in the range of 1-5 microns. Halotherapy sessions in patients with bronchial asthma with mild and moderate severity lead to the development of nonspecific hyposensitization, which in turn provides long-term remission of attacks and reduces the need for glucocorticosteroid drugs. Halotherapy has a confirmed immunomodulatory effect and activates local and T-cell immunity. It requires further study of the experience of halotherapy, conducting marketing, pharmacoeconomic and comparative analysis.

Keywords: halotherapy, pulmonary pathologies, thoracic pathology, bronchial asthma, fibrinous pleurisy, post-covid syndrome, patient.

Introduction. In modern conditions, the healthcare sector is faced with the need to find new innovative and multidisciplinary approaches. In order to eliminate the risks of patient disability and restore working capacity, quality and longevity of life of all segments of the population, it is necessary to prevent and treat the consequences of the seasonal epidemic spread of influenza, Covid, post-Covid, long-Covid, comorbid, infectious, non-infectious disorders, the spread of thoracic pathologies, wounds resulting from hostilities, road accidents, accidents in accordance with ICD-11 [1-30].

Studies show that one of the known approaches to treating patients with the above pathologies is salt therapy, aerosol therapy, halotherapy. It uses sodium chloride in various forms. It remains relevant to improve the methods of using and applying equipment for halotherapy, study marketing and pharmacoeconomic indicators for implementation in healthcare institutions [31-47].

Historically, the use of halotherapy in medical practice dates to the 19th century, when it was practiced as a therapeutic agent in old salt mines of Central and Eastern Europe [48].

That is, salt therapy, salt therapy - treatment and recovery with salt. As an auxiliary method, it has a positive effect on the treatment of respiratory diseases and dermatological diseases. Types of treatment with dry salt.

- ✓ Halotherapy – as a method of recovery and treatment has been used since ancient times, when:
 - the positive effect of a person's stay in salt mines was noticed;
 - workers who worked in these mines suffered from lung diseases much less often;
 - a direct interdependence was established between people's stay in a salt environment and the absence of lung pathologies in them;
 - halotherapy is based on the healing properties of salt, which artificially recreates a microclimate like underground salt caves, mines, shafts, and rooms [49];

- the mechanisms of action of halotherapy are manifold: mucolytic, antibacterial, anti-inflammatory, immunomodulating, hyposensitizing [46];
- halotherapy has an inherent immunomodulatory effect; literature indicates that salt therapy contributes to the normalization of CD4 and CD8 levels, and an increase in the level of B lymphocytes is also noted [47];
- indications for the use of halotherapy are mild and moderate bronchial asthma; hay fever; chronic inflammatory processes of the lungs; allergic rhinosinusitis; chronic bronchitis; fibrotic processes of the lungs after COVID-19, migraine [50-52].
- ✓ Speleotherapy (Greek speleon – cave, therapia – treatment) – treatment and recovery with salt (salt therapy), a non-drug method of treatment, which is due to [46, 50-53]:
 - long-term stay in a peculiar microenvironment of caves, grottoes, salt mines, mines;
 - appropriately equipped wards (offices) in a health care facility or resort town;
 - salt room – a technique that artificially recreates a microclimate like underground salt caves, mines, mines;
 - salt therapy – a method based on the healing properties of salt;
 - the salt therapy method is successfully used in the treatment of several bronchopulmonary, larynx, otos, rhinos, allergic pathologies.

In Ukraine, the therapeutic method of salt therapy was widely used in the Solotvyn mines. At a depth of 300 meters in the salt galleries, a department (250 beds) was equipped for the stay of patients (bronchial asthma, preasthma, allergic rhinitis, rhinosinusopathy, polynomas, etc.) for a certain time [54, 55].

The purpose of the study for to consider the evidence of the effectiveness of the use of halotherapy in the treatment of pulmonary disorders - thoracic pathology. To present the results of 30 years of experience in the use of halotherapy in the treatment of pulmonary pathology. To establish the optimal use of halotherapy for pathological pulmonary processes. Based on clinical experience, to present the most optimal methods of using this method in pulmonary nosologies. To develop and implement in clinical practice the use of salt therapy for exudative pleurisy, for fibrinous pleurisy, for fibrotic processes in the lungs.

Materials and methods. The authors analyzed the use of halotherapy in the treatment of patients with bronchial asthma, chronic obstructive pulmonary disease (COPD), acute respiratory viral diseases (ARVD), fibrinous pleurisy, exudative pleurisy, fibrinous pulmonary processes.

Patients were treated in health care institutions, namely:

- Central Transport Hospital (2018), modern name - State Institution Clinical Hospital "Lviv Railway";
- Municipal Non-Profit Enterprise of the Lviv Regional Council "Lviv Regional Phthisiopulmonological Clinical Treatment Center";
- Lviv Military Medical Clinical Center of the State Border Guard Service of Ukraine
- Municipal Non-Profit Enterprise "5th City Clinical Hospital of Lviv";
- Sanatorium "Geneva" of the city Truskavets Drohobych district, Lviv region [56];
- sanatorium "Trembita" village Velyatino, Zakarpattia region [57].

Among the patients were: 95 patients with bronchial asthma, 137 patients with chronic obstructive pulmonary diseases, patients with acute respiratory viral diseases, 55 patients with fibrinous pleurisy, 89 patients with exudative pleurisy, 49 patients with fibrinous processes in the lungs.

Halotherapy was performed in a salt chamber. The ceiling (by spraying method), floor, walls (salt blocks) were covered with salt. Non-allergenic materials were used to attach the salt to the surfaces. The salt concentration in the halo chamber was maintained at 14-16 mg/cubic meter.

Fig. 1, 2 show the halo chambers used by the authors.



Fig. 1. Halo chamber No. 1.



Fig. 1. Halo chamber No. 2.

More than fifty legislative, regulatory, and legal acts, instructional and methodical documents were developed for the research. The methods of documentary, graphic, clinical, pharmacological, pharmaceutical, normative and legal, retrospective, comparative, system analysis are applied.

The study of the article is a fragment of research works of Private Scientific Institution "Scientific and Research University of Medical and Pharmaceutical Law" and Danylo Halytsky Lviv National Medical University on the topic "Diagnosis, treatment, pharmacotherapy of inflammatory, traumatic and onco-thoracic pathology using instrumental methods" (state registration number 0125U000071, implementation period 2025-2031) and "Multidisciplinary research of post-traumatic stress disorders during war among patients (primarily combatants)" (state registration number 0124U002540, implementation period 2024-2029); Lviv Medical Institute on the topic of "Improving the system of circulation of drugs during pharmacotherapy on the basis of evidentiary and forensic pharmacy, organization, technology, biopharmacy and pharmaceutical law" (state registration number 0120U105348, implementation period 2021-2026).

Results and discussion. Specialists of the Ministry of Health of Ukraine, thanks to constant monitoring, note that [58]:

- in 5 regions, due to the increase in the incidence of acute respiratory viral infections, COVID-19 and influenza among all segments of the population, the epidemic threshold was exceeded – Zakarpattia, Ivano-Frankivsk, Rivne, Khmelnytskyi and Chernivtsi regions;
- in total, over the last week (as of February 12, 2025), 171,068 citizens fell ill in the country, of which 104,843 were children, which is 13% more than a week earlier;
- this number of patients is typical for the middle of the epidemic season and does not exceed the epidemic threshold calculated for Ukraine for 2024/2025;
- over the last week (as of 02/12/2025), only 3% of those infected with complications of acute respiratory viral infections required hospitalization: 4,687 patients, of which 2,912 were children who received all the necessary medical and pharmaceutical care;
- the increase in the incidence of acute respiratory viral infections is observed due to the circulation of influenza viruses in 22 regions of the country;
- it is predicted that by April 2025 the influenza virus will prevail over the coronavirus infection;
- since the beginning of the circulation of influenza viruses in the country (since January), 15 deaths have been registered due to complications of the disease;
- according to doctors, the deceased did not have preventive vaccinations against influenza;
- in total, from the beginning of the epidemic season from September 30, 2024 to September 02, 2025, 2,262,760 people fell ill with acute respiratory viral infections, influenza and COVID-19 in the country (this is 22.8% less than the same period of the epidemic season in 2023-2024)
- during this time, 17,380 cases of COVID-19 were diagnosed, of which 78 patients died.

At the same time, specialists from the virological laboratory of the State Institution "Lviv Regional Center for Disease Control and Prevention of the Ministry of Health of Ukraine" established that [59]:

- ❖ from January 27 to February 2, 2025 the incidence of influenza and acute respiratory viral infections increased (compared to the previous week), 715 more people fell ill than in the previous week, of which:
 - 5,716 (52.7%) – children of different age groups;
 - the epidemic threshold was exceeded by 1.6%;
- ❖ a total of 10,846 residents of the region sought medical help, that is, among:
 - children, the category 5-14 years old is most affected by diseases (29% of patients);
 - adults 30-64 years old – 26.9%;
- ❖ when examining the material from patients (as of February 02, 2025), influenza A, influenza B, adenovirus, rhinovirus was detected;

- ❖ 134 patients were hospitalized (in the previous week – 96 patients), of which – 80 children, (last week – 55 children);
- ❖ in the intensive care unit of the Municipal Non-profit Enterprise of the Lviv Regional Council "Lviv Regional Infectious Clinical Hospital" (as of January 31, 2025) there are 409 patients, half of them are children [60];
- ❖ by age group the distribution among age groups of patients (out of 10 thousand patients 5716 are children of different age groups) is as follows (Fig. 3):
 - preschool children 0-4 years old – 1,553 patients (14.3%);
 - children 5-14 years old – 3142 (29%);
 - adolescents 15-17 years old – 1,021 (9.4%);
 - youth 18-29 years old make up 13.2% or cases;
 - adults 30-64 years old – 1431 (26.9%);
 - pensioners aged 65 and older – 777 (7.2%).

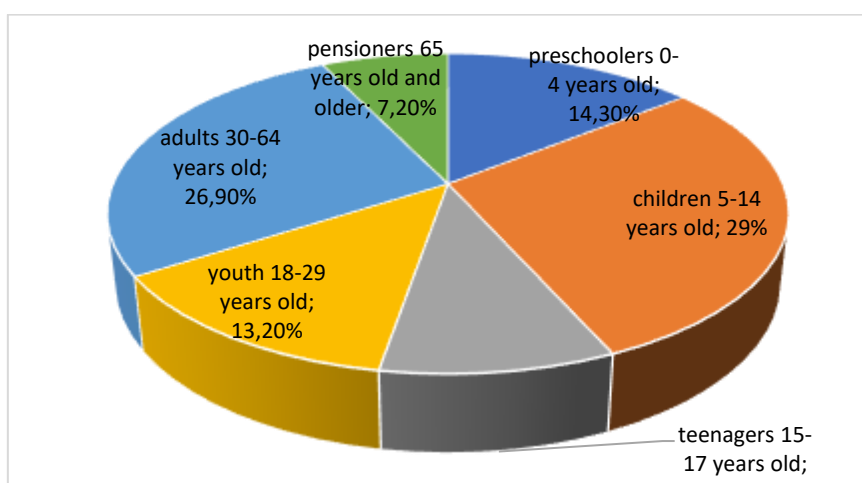


Fig. 3. Distribution of patients among age groups of patients.

It is typical for the Lviv region that salt rooms are created in healthcare institutions for patients with pulmonary diseases. Thus, among the 405 patients who underwent a course of halotherapy in the period from 2021 to 2024, which was carried out in a salt chamber, the nosological groups were divided as follows (Fig. 4):

- 95 patients with bronchial asthma (22.35%);
- 137 patients with chronic obstructive pulmonary diseases, patients with acute respiratory viral diseases (ARVD), influenza, post-covid syndrome (32.24%);
- 55 patients with fibrinous pleurisy (12.94%);
- 89 patients with exudative pleurisy (20.94%);
- 49 patients with fibrinous processes in the lungs (12.94%).

It is important to note that a new stage in the development of the halotherapy method was the organization and adjustment of work in 1988, in Lviv, Ukraine, by the co-author of the article Anatolii Nevzghoda. The first halochamber with a halogenerator was proposed. An innovative method of halotherapy was introduced for the prevention and means of additional supportive therapy of pulmonary diseases.

The discovery of a halochamber with a halogenerator significantly expanded the possibilities of using the halotherapy method. Thus, treatment was carried out for patients with concomitant cardiovascular pathology. After all, several contraindications for concomitant cardiovascular pathology in patients for salt speleotherapy are known. In addition, there is the possibility of intensive observation and intensive therapy in a halochamber. The halochamber was in a hospital room. It was possible to provide complex therapy to lung patients. To maintain a given constant salt concentration in the working room, a halogenerator was used. On this device, Solotvyno salt was crushed to a given size and fed into the halo chamber by a pump through a tube.

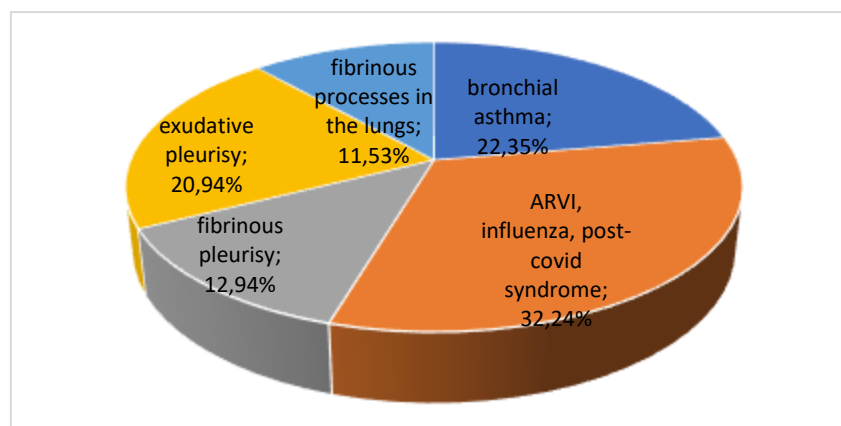


Fig. 4. Percentage ratio of nosological groups of patients who underwent a course of halotherapy, which was carried out in a salt chamber.

The direct mechanism of therapeutic action when using halotherapy is the antibacterial effect. We know that salt itself has pronounced antimicrobial properties. The saline environment also has a positive antibacterial effect. An important factor is the anti-inflammatory effect. We remember the main signs of inflammation: tumor, rubor, dolor, color, and function lease. In this case, the edematous component of the inflammatory process is removed.

The medical use of halo chambers was theoretically substantiated and introduced into practical activity in the Western region of Ukraine based on the Central Transport Hospital.

The salt room was equipped based on the 100-bed pulmonology department of the hospital.

- ✓ The walls, ceiling and floor in this room were lined with salt blocks from the Solotvyno mine, and the climatic conditions in the salt room were as follows:
 - ✓ temperature 22-24°C;
 - ✓ relative humidity 35-50%;
 - ✓ average concentration: light electronegative aeroions – $33 \cdot 10^3/\text{cm}^3$;
 - ✓ aerosol dispersion – 0.5 μm -10 μm ;
 - ✓ salt aerosol concentration – 5 mg/m³;
 - ✓ absence of allergens and pathogenic microorganisms;
 - ✓ To maintain the specified salt concentration and optimal air humidity in the working room, a halogen generator was used.
 - ✓ On the device, Solotvyno salt was crushed to the specified size and fed into the working room through a pump through a tube.
 - ✓ Crushed salt was fed into the working room to maintain a constant salt concentration.
 - ✓ As is known, there are currently 2 types of halogenerators. The first is devices on which salt is crushed (like a coffee grinder); then the crushed salt particles are fed into the halochamber.
 - ✓ The principle is that the size of the crushed salt particles should not exceed 10 microns.
 - ✓ Optimal parameters of crushed salt: 1-5 microns.
 - ✓ Larger crushed particles are perceived by the body as foreign bodies, can cause inflammatory reactions on the endotracheal wall, can cause not positive effects, but pathological reactions.
 - ✓ The second type of devices is ionizers. Considering that the therapeutic effect of crushed salt particles of strictly regulated parameters, the use of ionizers is more subjectively of a recreational nature.

The authors of the article used a halogenerator of their own production. The principle for this device is that the grinding of salt clearly corresponds to the treatment parameters. When microscopically examining samples of ground salt on this device, the sizes were 1-5 microns, respectively.

Fig. 5 shows samples of ground salt on a halogenerator of the author's production. When examining samples of ground salt, it was microscopically established that 95% of the ground salt has a size from 1 to 5 microns.

The discovery by the authors of the article of a halochamber with a halogenerator significantly expanded the possibilities of using the halotherapy method. The treatment was carried out on patients with concomitant cardiovascular pathology. After all, there are several contraindications for concomitant cardiovascular pathology in patients for salt speleotherapy. In addition, there is the possibility of intensive observation and intensive therapy in a halochamber. The halochamber was in a hospital room, which facilitated the possibility of providing complex therapy to patients suffering from pulmonary health disorders. The direct mechanism of therapeutic action when using halotherapy is the antibacterial effect, because salt has pronounced antimicrobial properties and anti-inflammatory effects (the main signs of inflammation: tumor, rubor, dolor, color, and function lease), which helps to remove the edematous component of the inflammatory process.



Fig. 5. Samples of crushed salt on the author's halogenerator. Microscopic examination.

Patients with bronchial asthma underwent:

- immunogram with determination of levels of low- and high-molecular circulating immune complexes;
- determination of complement activity;
- determination of serum IgA, IgM, IgG, IgE contents;
- determination of CD3, CD4, CD8, CD 19 levels.

Immunological examination methods are necessary and decisive in the diagnosis of bronchial asthma [61, 62].

Duration of halotherapy sessions – from 30 min to 45 min. Up to 10 halotherapy sessions were performed per course of treatment.

For the diagnosis of fibrinous processes in fibrinous and exudative pleurisy, an ultrasound method was used [63].

In the complex treatment of 95 patients with bronchial asthma of moderate and mild stages, the authors used the halotherapy method. The salt concentration in the halochamber was maintained at 14-16 mg/cubic meter using a halogenerator. It was very important to maintain the optimal size of the salt, namely 1-5 microns.

To confirm the data obtained, the authors analyzed the results of using a halogenerator in one of the recreational facilities. The size of the crushed salt particles on this halogenerator was over 70 microns. When using this halogenerator, no positive therapeutic effects were observed in patients. The use of this halogenerator was indifferent in terms of effectiveness in acute respiratory viral infections. It did not affect the duration of remission in bronchial asthma.

The use of the halogenerator of the authors of the article with a particle size of 1-5 microns had a pronounced positive therapeutic effect. Halotherapy had a clearly expressed immunomodulatory and hyposensitizing effect. The level of complement activity after a course of halotherapy decreased from 123 ± 1.1 to 74 ± 2 . After a course of salt therapy, the level of IgA, IgG, IgM in patients significantly decreased. The immunogram results are presented in Table. 1.

Table 1. Results of a complex immunogram before and after halotherapy sessions in patients with bronchial asthma (N=65).

Study title	Result	Units of measurement	Reference values	
Complement activity (CH50)	$123 \pm 1.1 / 74 \pm 1.2$	g/l	56 - 91	$p < 0,05$
Serum immunoglobulin A content	$8 \pm 1.1 / 2.41 \pm 0.9$	g/l	0,7 - 4	$p < 0,05$
Serum immunoglobulin M content	$3,3 \pm 1,3 / 1.29 \pm 1,1$	g/l	0,4 - 2,3	$p < 0,05$
Serum immunoglobulin G content	$21 \pm 1,2 / 12.0 \pm 1,1$	g/l	6,5 - 16	$p < 0,05$
Serum immunoglobulin E content	$189 \pm 0,9 / 95.5 \pm 1,1$	g/l	1,5 - 158	$p < 0,05$

According to the results of halotherapy regarding the level of large-molecular and low-molecular circulating immune complexes (Table 2), a clearly expressed positive effect is observed. Accordingly, the level of large-molecular immune complexes decreased from 75 ± 1.1 to 15 ± 1.1 . The level of circulating low-molecular immune complexes decreased from 145 ± 1.1 to 44 ± 1.1 . The listed factors: a decrease in the level of circulating immune complexes, a decrease in the level of IgA as a component of circulating immune complexes, affect the development of nonspecific hyposensitization processes after a course of halotherapy for bronchial asthma.

Table 2. Results of the study of circulating immune complexes before and after halotherapy sessions in patients with bronchial asthma (N=65).

Study title	Result	Units of measurement	Reference values
Circulating Immune	$75 \pm 1,1 / 15 \pm 1,1$	Optical density units	< 55

Complexes, Large Molecular Weight			
Circulating Immune Complexes, Low Molecular Weight	145±1,1/44±1,1	Optical density units	< 115

Halotherapy affects the level of cellular and humoral immunity in bronchial asthma. After a course of salt therapy, the following is observed (Table 3):

- increase in the level of T-helpers from 0.3±1.1 to 1.4±1.1;
- decrease in the level of T-suppressor lymphocytes (CD8+) from 0.2±1.1 to 0.60±1.1;
- decrease in the level of B-lymphocytes (CD 19+) from 21.2±1.1 to 10.3±1.1

Table 3. The level of cellular and humoral immunity before and after halotherapy sessions in patients with bronchial asthma (N=65).

Study title	Result	Units of measurement	Reference values
T-lymphocytes (CD3+)	2,6±1,1/2.0±1,1	x10*9/l	0.8 - 2.2
T-helper (CD4+)	0.3±1,1/1,4±1,1	x10*9/l	0.5 - 1.4
T-suppressor lymphocytes (CD8+)	0,2 ±1,1/0.60±1,1	x10*9/l	0,3 - 0.9
B-lymphocytes (CD19+)	21±1,1/10.3±1,1	x10*9/l	7 - 19

Exposure of patients diagnosed with chronic inflammatory lung diseases to a salt cave impacted on normalization of CD4 and CD8 levels, increase of B lymphocytes and immunoglobulins [47]. Similarly to effects of the salt therapy in asthma, it improves lung functions, spirometric parameters, oxygen saturation in arterial blood. It liquefies the airway secretions, which facilitates the expectoration of secretions. There are evidences based on the randomized controlled trial that the speleotherapy cause increase in lymphocytes level, neutrophil phagocytosis activity. The halotherapy decreased bronchial obstruction and medication use in patients diagnosed with chronic inflammatory lung diseases. It improves life quality by decreasing exacerbations, reducing hospitalization, improving effort tolerance [47].

The main immunological mechanisms of halotherapy are shown in Fig. 6.

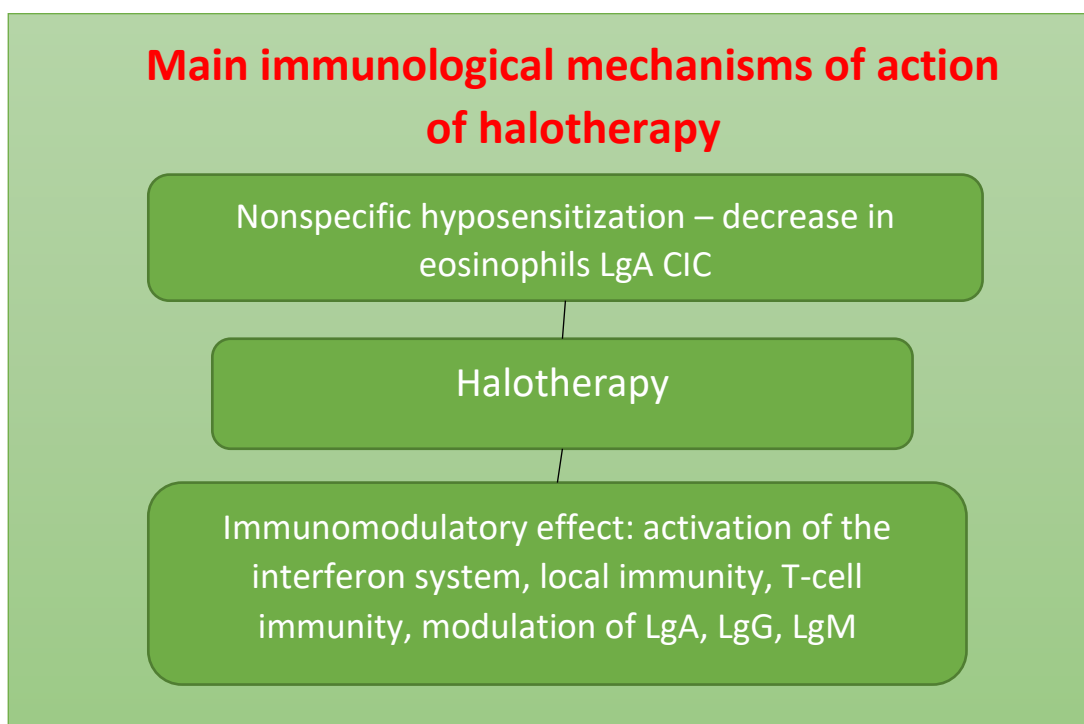


Fig. 6. The main immunological mechanisms of halotherapy.

Halotherapy in patients with chronic obstructive pulmonary diseases led to a significant improvement in the general condition of patients, long-term remission of the disease.

The use of halotherapy in acute respiratory viral infections in the initial stages of the disease (on the first day) led to regression of the pathological process and the cure of patients.

The authors of the article first used halotherapy in exudative pleurisy. A pronounced positive effect was established both in terms of anti-inflammatory action and in the prevention of adhesion formation and the development of fibrinous pleural complications.

Conclusions. The healthcare sector is faced with the need to find new innovative and multidisciplinary approaches for the prevention and treatment of Covid, post-Covid, long-Covid, chronic, comorbid disorders. It has been established that halotherapy is an effective method of treatment and rehabilitation for bronchial asthma, chronic obstructive pulmonary diseases, acute respiratory viral infections, fibrinous and exudative pleurisy. The therapeutic effect of this method is observed only when using halogenerators with the ability to grind salt in the range of 0-5 microns. Halotherapy sessions in patients with bronchial asthma with mild and moderate severity lead to the development of nonspecific hyposensitization, which in turn provides long-term remission of attacks and reduces the need for glucocorticosteroid drugs. Halotherapy has a confirmed immunomodulatory effect and activates local and T-cell immunity. The priority experience of the authors of the article in the use of halotherapy for fibrinous and exudative pleurisy indicates the high effectiveness of this method. Requires further study of the experience of halotherapy, conducting marketing, pharmacoeconomic and comparative analysis of one patient and the corresponding price of stay for 1 session (course session in halo chambers (rooms) of medical departments of healthcare institutions and sanatoriums.

Declaration of conflict interest. The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article. The authors confirm that they are the authors of this work and have approved it for publication. The authors also certify that the obtained clinical data and research were conducted in compliance with the requirements of moral and ethical principles based on medical and pharmaceutical law, and in the absence of any commercial or financial relationships that could be interpreted as potential conflict of interest.

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Ethical approval. Ethical clearance was obtained from the administration of the Danylo Halytsky Lviv National Medical University. Permission statement for conducting the experiments was received from the administration of the Danylo Halytsky Lviv National Medical University. Before any data collection, the main purpose of the study was clearly explained to each department (concerned personnel) in accordance with the Law of Ukraine "On the Protection of Personal Data", which regulates legal relations related to the protection and processing of personal data, and is aimed at protecting the fundamental rights and freedoms of a person and a citizen, in particular the right to non-interference in personal life, in connection with processing of personal data. This Law applies to the processing of personal data, which is carried out in whole or in part using automated means, as well as to the processing of personal data contained in the card file or intended to be entered in the card file, using non-automated means.

Data availability statement. The datasets analyzed during the current study are available from the corresponding author on reasonable request.

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