Krystyna OBTUŁOWICZ

Jagiellonian University Medical Faculty
Department of Clinical and Environmental
Allergology in Cracow

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Mechanisms of Therapeutic Effects of Subterraneotherapy in the Chambers of the Salt Mine in Wieliczka, Poland

Mechanizmy zdrowotnego działania subterraneoterapii w komorach Kopalni Soli w Wieliczce

Streszczenie: Subterraneoterapia czyli leczenie mikroklimatem podziemnych komór solnych nieczynnych wyrobisk kopalni soli stosowane jest w leczeniu nieinfekcyjnych chorób dróg oddechowych, takich jak: astma oskrzelowa, przewlekle zapalenie oskrzeli w wielu miejscach Europy.
Historia tego leczenia w wyrobiskach solnych Kopalni w Wieliczce sięga XIX wieku
i była wprowadzona przez dr Boczkowskiego – lekarza salinarnego. Regularne leczenie subterraneoterapią w komorach solnych Kopalni w Wieliczce powiązane z badaniami naukowymi wprowadził w połowie XX wieku prof. Krakowskiej Akademii Medycznej – Mieczysław Skulimowski. Wyniki własnych badań nad skutecznością tego leczenia ogłosił w Przeglądzie Lekarskim w 1964 r. i utworzył Szpital Uzdrowiskowy Kinga w Wieliczce. W latach 70-90 tych XX wieku lecznictwem sanatoryjnym związanym z subterraneoterapią kierowała dr Izabella Wróblewska, a nadzór naukowy powierzono Krakowskiej Akademii Medycznej. Obserwacje lekarskie z tego okresu potwierdziły poprawę zdrowia u 60% chorych z astmą oskrzelową. Zwróciły uwagę na zmniejszanie skłonności do infekcji dróg oddechowych u tych chorych, na drożność nosa i poprawę węchu u chorych z alergicznym n. nosa i zatok, na ustępowanie objawów alergii pyłkowej podczas przebywania chorych w komorach solnych. Ponadto zaobserwowano leczniczy wpływ samego przebywania w komorach na świąd skóry oraz na wyprysk alergiczny towarzyszący alergii dróg oddechowych leczonych chorych.
Dotychczasowe obserwacje i badania nad mechanizmem zdrowotnego działania subterraneoterapii na organizm ludzki w komorach solnych Kopalni Soli w Wieliczce, a zwłaszcza na drogi oddechowe i skórę wskazują, że są to procesy złożone. Należą do nich przede wszystkim:

1. **czystość powietrza, izolująca chorych od czynników drażniących i alergizujących obecnych w powietrzu na powierzchni ziemi, wysoka wilgotność i podwyższone stężenie CO2.**
2. **hyperosmia spowodowana wysokim stężeniem NaCL,**
3. **silnie bodźcowy charakter codziennych zjazdów i wjazdów na głębokość 110-130 m wymuszających adaptacje ustroju dwa razy dziennie do zmiennych warunków środowiska w tym ciśnienia powietrza, temperatury, wilgotności, aerosolu powietrznego.**

Wszystko to czyni subterraneoterapię w komorach solnych szczególną i silnie bodźcową metodę leczenia całego ustroju i ma bezpośredni wpływ na błony śluzowe dróg oddechowych oraz skóry zwłaszcza takich środowiskowych schorzeń jakimi są alergiczne choroby dróg oddechowych i skóry.

Abstract: Subterraneotherapy or the treatment with the microclimate of the subterranean salt chambers of closed salt mine excavations is used in the treatment of noninfectious respiratory tract diseases such as bronchial asthma or chronic bronchitis in various regions of Europe.

Adres do korespondencji:
Prof. zw. dr hab. med. Krystyna Obtułowicz
Zakład Alergologii Klinicznej i Środowiskowej
UJCM
Kraków, ul. Śniadeckich 10
tel/fax:48 12 423 11 22
e-mail: mmobtulo@cyf-kr.edu.pl, po80@wp.pll

The history of the treatment in excavations of the Salt Mine in Wieliczka dates back to the 19th century and was introduced by dr Boczkowski, a salinary physician. The regular treatment with the use of subterraneotherapy in the Wieliczka Salt Mine chambers and the scientific research were conducted by the professor of the Krakow Medical Academy, Mieczyslaw Skulimowski, in the middle of the 20th century. Results of his examinations, concerning the effectiveness of the treatment, were included in the Przeglad Lekarski (The Review of Medicine) in 1964 and Kinga Spa Hospital was created in Wieliczka.

In the 70s – 90s of the 20th century dr Izabella Wroblewska was conducting the sanatorium treatment which used subterraneotherapy under the supervision of the Medical Academy in Krakow. Current medical observations confirmed health improvement in 60% of patients with bronchial asthma. It revealed a decrease of predisposition to respiratory tract infections in these patients as well as the nasal patency and improved sense of smell in patients with allergic rhinitis and sinusitis and also a decrease of symptoms of allergy to pollens during their stay in the salt chambers. Morover, the therapeutic effect of the salt chambers on skin itching and allergic eczema, which accompanied the allergy of airways of affected patients, was shown.

These observations as well as studies on the mechanism of therapeutic effects of subterraneotherapy on the body in the salt chambers in Wieliczka, especially on the respiratory tract and the skin, show that these processes are complex. They include:

1. **purity of the air isolating patients from irritating and allergizing factors present in the air on the surface, high humidity and an increased concentration of carbon dioxide.**
2. **Hyperosmia caused by high concentration of NACL.**
3. **High stimulogenic character of daily going down and entering the depth of 110 – 130 meters, which makes the body adapt itself to changing conditions of the environment including the atmospheric pressure, temperature, humidity and aerosol air twice a day.**

Thus, salt mine subterraneotherapy is a specific and highly stimulogenic method of treatment of the body which directly affects mucous membranes of airways and the skin, specially such environmental disorders as allergic diseases of airways and the skin.

Subterraneotherapy or the treatment with microclimate of subterranean salt chambers of closed excavations is used in the treatment of noninfectious diseases of airways such as bronchial asthma and chronic bronchitis in various European regions [1 – 10].

The history of the treatment in Wieliczka Salt Mine excavations dates back to the 19th cewntury and was introduced by dr Boczkowski, a salinary physician. The regular treatment with the use of subterraneotherapy in the salt chambers of the Salt Mine in Wieliczka in conjunction with the scientific studies was instituted by Krakow Medical Academy professor, Mieczyslaw Skulimowski, in the middle of the 20th century. He introduced the term subterraneotherapy to the medical vocabulary and together with results of his own examinations, concerning the effectiveness of the treatment of patients undergoing the therapy on the level 110 -130 meters under the ground for 5 – 6 hours daily for 3 months, uncluded them in the Przeglad Lekarski (The Review of Medicine) in 1964 and also created Kinga Spa Hospital in Wieliczka [3, 6].

In the 70s – 90s of the 20th century the sanatorial treatment which used subrerraneotherapy was conducted by dr Izabella Wroblewska under the supervision of the Medical Academy in Krakow. Current medical observations confirmed the health improvement in 60 % of patients with bronchial asthma [11, 12].They focused the attention on a decrease of predisposition to infections of airways in these patients, nasal patency and improved sense of smell in individuals with allergic rhinitis and sinusitis as well as a relief of symptoms of allergy to pollens while staying in the salt chambers. Moreover, a relief of skin itching and skin lesions having the character of eczema, which accompanied the allergy of airways of patients treated in the salt chambers, was observed [16].

Observations and studies of the mechanism of therapeutic effects of subterraneotherapy on the body, especially on airways and the skin indicate that these complex mechanisms act simultaneously on the whole human body [19, 20]. They comprise (Tab.1):

1. biological and environmental purity of the air [19, 20], isolating patients from irritating and allergizing factors suspended in the aerosol air on the surface, exceptionally pure microbiologically (< 500 bacterial cells and volume of fungal spores /m3).
2. Hyperosmia (high NaCl -30,3mg/m3) due to the high concentration of sodium chlorine cristallizing into very fine forms (approximately 1um in diameter), with the

Tab. 1. Physicochemical parameter values of the air in the salt chambers of the Wieliczka Salt Mine and on the surface.

Własności parametrów fizyko-chemicznych powietrza komór solnych Kopalni w Wieliczce i na powierzchni

	ground surface:	salt chamber:
02 concentration	normal	normal
CO2concetration	0.03%	0.1-0.2%
atmospheric pressure	950-1000 hPa >>>>	average higher by 23 hPa
humidity	40-60 % >>>>	60- 80% (max in autum)
temperature	+:- 30 degrees.C >>>>	12-14 degrees.C
value of the cooling air	5-8.7 mcal-cm3.s-1	>>>>>..... 8.7 mcal-cm3.s-1
indicator of thermal comfort	2.5-5.5 Cm-2, s-1	1.6 mcal-cm3.s-1
air movement	-------	<0.1 m/s (weak)
radiation	-------	low

addition of Ca, Mg and Mn salts and small amounts of calcium sulphate [20].

In the aerosol air there are trace quantities of CaSO4. 2H20 gypsum crystallites (hydrated sulfate Ca), NaCl-halite (30,3mg/m3), SiO2-quartz, CaCO2-calcium carbonate [20].

3. * slightly elevated but within normal limits (1%) concentration of CO2 (0.1-0.2%), average 3-4 times as compared to the concentration of CO2 in the air on the surface, which forces hyperventilation.
   * normal concentration of O2
   * microbiologically pure aerosol air with the purity corresponding standards of treatment rooms (single colonies of non-pathogenic bacteria, fungal spores)
   * aerosol air is free of aeroallergens (pollen grains, fungal spores, animal epidermis, mites).
   * high but normal air humudity (60-80%)
   * stable, low temperature ca 13 – 14 degrees centigrade
4. stimulogenic –going down to the depth of 110 – 130 m twice a day caused a severe stimulus forcing the body to adapt itself to the new environment within several minutes.

All that makes subterraneotherapy in Wieliczka Salt Mine chambers the method isolating patients from allergizing and irritating environmental substances on the surface and due to hyperosmia and increased humidity also makes it a method moisturizing mucous membranes and the skin as well as markedly stimulating the body, affecting the endocrine system and the immune system of patients [21].

Clinical observations of patients with bronchial asthma , chronic allergic rhinitis and sinusitis as well as allergy to pollens, who underwent an inpatient treatment for 3 weeks (24 days), with the use of subterraneotherapy in the salt chambers for 6-8 hours a day, 4-5 times a week under the ground revealed that:

1. Symptoms of allergy to pollens vanish after the patients` entering the salt chamber due to the direct action of aerosol air which is free of allergizing aeroplankton. A repeated treatment in the consecutive 3 seasons of pollen allergy enhances the effect [13, 15, 23, 25].
2. In 50% of patients symptoms of chronic, allergic inflammation of the mucous membrane of the nose and sinuses due to allergy to mites, epidermis and moulds significantly improve in the 3rd week of the treatment. It manifests itself by the improvement of the nasal patency and the sense of smell [13, 15, 23, 25, 26].
3. Symptoms of bronchial asthma (both atopic and nonatopic), are weakened in the 2nd - 3rd week of the treatment in over 60% of patients. Both aggravation and frequency of attacks of dyspnoea are reduced [3, 5, 6, 7, 11, 14, 22]. The use of rescue medication is decreased and in some patients the dose or the number of drugs used in the chronic treatment can be reduced prior to subterraneotherapy.

These observations show few cases of disease exacerbation during subterraneotherapy, estimated as 3% of patients, and they are connected with the infection diagnosed during the treatment or with diagnosed exercise-induced insufficiency due to the effort to reach the salt chambers or leave them and get to the shaft (2x about 1000 m).

Another finding is the therapeutic effect of subterraneotherapy on allergic eczema, pruritus and rough skin in patients treated due to allergy of airways [16, 26]. Therapeutic effects of subterraneotherapy on bronchial hyperactivity [27], allergic inflammation of the mucous membrane of airways documented by the reduced release of NO in the patients` expired air [28], and also antifungal activity of high-salt aerosol air of the salt chambers require similar confirmations, which is suggested by some authors.

Patients repeatedly treated with subterraneotherapy reported, during their consecutive treatment stays, that after the treatment they didn`t develop infections of airways for 6 months [26].

Thus, clinical observations indicate that subterraneotherapy in the salt chambers can also have the therapeutic effect on allergic skin lesions and on mechanisms of body immunity, which needs clinical investigations based on objective clinical and laboratory parameters which will enable to create mechanisms of action of the method of treatment of particular disorders, especially environmental ones.

In other European countries subterraneotherapy and speleotherapy are used in noninfectious disorders of airways i.e., in Germany (Schonebeck, Klutetthohle), Austria (Salcema), Bulgaria (Magura), Hungary (Joszafe), Ukraine (Solotwinowo) [1, 15, 16]. Assessment of the effectiveness of the treatment requires follow-up examinations with the use of placebo [27, 29, 32], and constant aerobiological monitoring of the treatment chambers [33].

Because of the strong stimulogenic effect of going down and entering the chamber, patients with contraindications for treatment stimulus should not be referred to the treatment with subterraneotherapy. The patient referred to this treatment requires the high capability of the respiratory and circulatory systems.

Predisposition to infections of airways, especially in the first days of the stay (adaptation period, exposition to cold current of air), requires individual protection and education concerning conditions of subterraneotherapy.

Therapeutic effects of subterraneotherapy can`t be compared to the treatment with speleotherapy in which the treatment stimulus is slight or is not present [31]. Results of subterraneotherapy and speleotherapy should be assessed with great caution, especially if there is no constant aerobiological monitoring of the salt chambers.

Conclusions:

1. Therapeutic effects of subterraneotherapy in the Salt Mine chambers in Wieliczka are complex and mostly concern chronic, noninfectious disorders of airways and the skin. Essential factors in this activity are:
   a. purity of aerosol air isolating patients from irritating and allergizing factors present in the air on the surface,high humidity within the normal limits and elevated concentration of CO2.
   b. hyperosmia caused by the high concentration of NaCl, with

moisturizing activity (moisturizing mucous membrane), and antifungal activity.

c. stimulogenic effect of daily going down to the depth of 110 – 130 m and entering the chamber, forcing the body to adapt itself to new environmental conditions twice a day.

2. Disorders with contraindications of treatment stimulus are not recommended for the treatment with subterraneotherapy in the Wieliczka Salt Mine chambers.

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