Research Article

Halotherapy as Adjuvant Therapy for Respiratory Diseases: A Literature Review

Rhea Veda Nugraha[1]*, Daffa Muhammad Rhamdan[2], and Ria Ardia Kartika Sari[2]

[1]Department of Pharmacology, Faculty of Medicine, Universitas Jenderal Achmad Yani, Cimahi, Indonesia
[2]Faculty of Medicine, Universitas Jenderal Achmad Yani, Cimahi, Indonesia

ORCID
Rhea Veda Nugraha: https://orcid.org/0000-0002-6266-4107

Abstract.
Halotherapy (HT) is part of salt therapy derived from speleotherapy/speleoclimate, which comes from using a micro size of dry salt in aerosol form (such as sodium, potassium, magnesium, calcium, and sodium chloride) with stable air temperature (18–24°C) and moderate to high humidity (40–60%) for inhalation inside a cave/imitation cave since the nineteenth century. The benefits of HT as an adjuvant may help patients with many medical conditions, especially respiratory and dermatology diseases. This therapy is believed to alleviate inflammation and the immune response and improve respiratory function, etc. The clinical benefits of HT are advocated, but the mechanisms still need to be explicitly elucidated. This study's main objective is to critically review and evaluate the evidence from existing literature of HT efficacy as an adjuvant therapy for respiratory disease in a narrative review. This review used a systematic approach and narrative synthesis. PubMed, Google Scholar, and Cochrane Central Register of Controlled Trials (CENTRAL) were searched. Based on preset selection criteria, two reviewers separately looked over abstracts and chose relevant papers. HT improves mucociliary elimination, diminishes airway inflammation, and improves pulmonary function. This adjuvant therapy is safe and does not cause serious adverse events. Therefore, this therapy should be considered an adjuvant therapy for respiratory diseases because of its potential effects. However, scientific evidence of the effectiveness of HT is limited. High-quality further research is required to ascertain the effectiveness of this treatment for respiratory conditions.

Keywords: adjuvant, halotherapy, respiratory diseases, salt therapy, therapy

Corresponding Author: Rhea Veda Nugraha; email: dr.rheaveda@gmail.com

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1. Introduction

Prolonged exposure to indoor air dampness microbiota could result in problems with the vocal cords, irritation of the mucosa, chronic rhinitis, cough, wheezing, dyspnea, recurrent infections of the upper and lower respiratory tract, exacerbation of existing asthma, and the commencement of a new asthmatic attack [1]. Numerous undiagnosed

respiratory symptoms may represent undiagnosed allergic alveolitis or panbronchoalveolitis. Notably, the components of moist microbiota may inhibit the function of epithelial cilia cells, the first line of defense in innate immunity [2].

Halotherapy (HT) comes from speleotherapy/speleoclimate, which comes from using a micro size of dry salt (such as sodium, potassium, magnesium, calcium, and sodium chloride) for inhalation inside a cave/imitation cave [3]. The benefits of HT may help patients with many medical conditions, especially respiratory and dermatology diseases. This therapy is believed to alleviate inflammation and the immune response, improve respiratory function, and many more [4]. The clinical benefits of HT are advocated, but the mechanisms still need to be explicitly elucidated. The main objectives of this study are critically review and evaluate the evidence from existing literature of HT efficacy as adjuvant therapy for respiratory disease in a narrative review. HT may be adjuvant therapy for preventing severe exacerbations, thus reducing the need for frequent pharmacological set-up interventions, especially in the pediatric population [5].

Salt therapy in respiratory medicine began in the 19th century due to the many practical benefits of salt treatment to respiratory patients. This discovery established the groundwork for speleotherapy (aerosols therapy offered in naturally occurring salt environments, such as salt caves) and HT (aerosols therapy in any salt-enriched environment, such as home devices or surface halo chambers). In treating and preventing asthma, HT has been shown to have various beneficial effects [5]. HT could also diagnose asthma through a bronchial challenge analogous to physical activity. An opposing process accomplishes this. In addition, it has a bacteriostatic impact and a beneficial effect on the immune response of the immediate area. Even though it is ecological and kind to the environment, as well as the fact that there is new and recent evidence, including ongoing studies (NCT03556683) [5], no scientific study covering the topic of the benefits of HT in asthma has been published in the past two decades. In addition, the most recent guidelines for asthma sometimes reference HT, but solely as a bronchial challenge agent used to identify asthma. We aim to review all studies evaluating the effect of HT as adjuvant therapy for respiratory diseases.

2. Method

The Cochrane Central Register of PubMed, EAACI, MDPI, Liebert Pub, and Google Scholar were some sources used for study. Keywords associated with halotherapy/speleotherapy were employed in the search method: adjuvant, halotherapy, respiratory diseases, salt therapy, randomized controlled trials, both prospective and retrospective, comparing halotherapy or speleotherapy to a control group were taken into consideration. Full-text papers, and abstracts in languages other than English were not included. Subsequently, full-text papers satisfying the inclusion criteria were acquired.

3. Results

3.1. Dose and duration of halotherapy

In this investigation, six publications examined the effect of HT on respiratory disorders. Two of the six journals examined in this study did not include the dosages used in their research, while the other four listed the doses. Diepeveen's research [6] and Rabbani et al. research [7] determined that the same dose of HT was administered to all intervention groups, regardless of the type of disease they were suffering from. In contrast, in the studies conducted by Chervinskaya and Zilber [8] and Sandell et al. [9], distinct concentrations of HT were administered based on the type of respiratory disease experienced [8] and the level of treatment dose.

All six journals reviewed for this study included the duration of HT treatment for patients with respiratory disorders. The duration of HT in the studies examined ranged from 1 to 8 weeks, with two studies providing HT in less than 2 weeks and four other studies providing HT for longer than 2 weeks.

3.2. Outcome of halotherapy management in patients with respiratory diseases

Most of the journals reviewed for this study demonstrated that HT treatment, when administered to patients suffering from respiratory disorders, had a beneficial influence (benefits) on their ability to overcome their conditions. Even at the cellular level, the treatment appeared to benefit patients who suffered from respiratory diseases. It was

shown that administering HT treatment to rats with COPD led to a reduction in the amount of glandular hypertrophy, an improvement in lumen stenosis, and a reduction in the infiltration of surrounding inflammatory cells. It was discovered that HT might boost lung function indices while simultaneously decreasing antioxidant levels in rats [10]. It was also shown that rats with asthma who received HT had improved cell morphological characteristics compared to those who did not.

It was discovered that HT had a positive impact and was beneficial to individuals who suffered from bronchial blockage. This research looked at a total of two previous studies. It concluded that HT compounds' antibacterial and antibacterial-suppressing properties could influence the microbiota in the respiratory system. As a result, these chemicals could help reduce inflammation and boost phagocytosis. It has also been discovered that HT could enhance the quality of life of people with respiratory disorders. However, this research includes two publications that suggest that HT does not substantially influence the management of individuals with respiratory disorders.

4. Discussion

4.1. Halotherapy

Halotherapy (HT; "halos" is the Greek word for salt) looks to be a potential alternative therapy that aims to introduce salt particles into the upper and lower airways. Pavel Gorbenko used the term "halotherapy" in 1985 to characterize methods of using halite in the form of dried aerosols above ground [11]. The most rational is using dried aerosols of rock salt (haloaerosols) with specific concentration and dispersion characteristics. Summary of the benefits of halotherapy for respiratory diseases can be seen in Table 1.

People have visited natural salt caverns for centuries, particularly in Eastern Europe, for the medicinal properties of the air. The microclimate within the caves is distinguished by its stable air temperature, moderate to high humidity, fine aerosol elements (sodium, potassium, magnesium, and calcium), and absence of airborne contaminants and pollens [13].

Halos contain regulated environments in which tiny salt particles are inhaled [14]. The chamber's architecture aims to replicate the natural salt cave's environment. By distributing salt particles inside a regulated airspace, HT mimics the environment of a natural salt cave. While comparable in concept to hypertonic saline, HT delivers dry aerosol microparticles of salt (1-5m) instead of a moist solution. In most cases, a person

Table 1: Summary of the benefits of halotherapy for respiratory diseases.

Study	Dose and Duration	Another drug-induced in the regimen	Outcome
Zhang et al. [10]	Dose: N/A Duration: 1 month	Terbutaline, Caspase-1 inhibitor	The coat color gradually returned to normal after 1 month, the degree of glandular hypertrophy in COPD rats was reduced, lumen stenosis was improved, and the infiltration of surrounding inflammatory cells were reduced; the rats' TV, EV, EE, and pulmonary function were improved, and COPD rats in the HT group showed decreased NO levels.
Chervinskaya & Zilber [8]	Dose: Bronchial asthma: 0,5-2 mg/m3 Chronic obstructive bronchitis: 0,5-1 mg/m3 Chronic non-obstructive bronchitis: 3-5 mg/m3 Bronchiectasis FEV<60%: 1-2 mg/m3 Bronchiectasis FEV>60%: 7-9-mg/m3 Cystic fibrosis: 3-5 mg/m3 Duration: Bronchial asthma (allergic): 12-14 days Bronchial asthma (infection-dependent), chronic, and non-chronic obstructive bronchitis: 18-21 days Bronchiectasis and cystic fibrosis: 21- 25 days	Beta- agonist, theophyllin e, cromoglyca te nitric, corticostero id	HT significantly improved bronchial patency, started on the 7th day, persisted until the course's end, and gradually positively influenced bronchial obstruction. Sodium chloride aerosol causes bactericidal and bacteriostatic effects on the respiratory airway microflora and prevents the development of inflammatory processes.
Sandell et al. [9]	Dose: Placebo: 0,3 mg/m3 Low salt: 6,6 mg/m3 High salt: 10,8 mg/m3 Duration: 2 weeks	N/A	The treatment did not affect lung function and eosinophilic markers.
Simionca & Mirescu [12]	Dose: N/A Duration: 7 days	HAM-F12, Penicillin, streptomyci n, neomycin, fetal calf serum	The culture of the 7 days skin cells acquired from rats with injuries and burns of Calcica and Dej's study showed a microscopically visible improvement of morphologic parameters, lung fibroblast in the 7 days culture acquired from ovalbumin- sensitized rats showed an improvement of morphologic parameters of cells.
Diepeveen [6]	Dose: 0,5 – 10,8 mg/m3 Duration: 2– 8 weeks	N/A	Two studies showed increased quality of life; Lazarescu et al. found that HT increases phagocytosis processes and non-specific anti-inflammatory resistance. The high salt group showed a decrease in the ECP values directly after treatment, and it continued until four weeks after treatment.
Rabbani et al. [7]	Dose: 70- gram crystal salt Duration: 2 months	N/A	No statistically significant difference was detected in spirometry results and the 6-minute walk test, and it caused no change in any of the patients' SF- 36 quality of life questionnaire scales.

spends 30 to 60 minutes reading or doing other calming activities at a facility that provides HT services. Nasal and oral respiration allow medical practitioners to target the upper and lower airways [15].

Asthma, cystic fibrosis, chronic obstructive pulmonary disease (COPD), eczema, and dermatitis have been associated with HT treatment [13]. Many clinical investigations have assessed the effectiveness of HT, despite it being regarded as a spa therapy. 139 individuals with respiratory conditions, five of whom had cystic fibrosis, were examined for HT. After 10 to 20 sessions, plethysmography indicated lower bronchial resistance and improved flow volume loop parameters [15]. CF patients were reported to respond similarly to the treatment. Six patients with cystic fibrosis demonstrated an improvement in respiratory function and sputum secretion after only five sessions of HT [6].

A recent study of patients with bronchiectasis found that HT was of limited advantage. Vital Signs on Cable Network News and other TV networks including the British Broadcasting Corporation have also covered HT extensively. In Australia, HT has been covered by Channel 9's A Current Affair and Channel 7's Today Tonight.

4.2. Mechanism action of halotherapy

HT is an aerosol therapy procedure instead of speleotherapy, which relies on complex natural factors for its therapeutic effect [16]. medium spread by air that has been saturated with dry sodium chloride aerosol at mass concentrations between 5.5 and 10.3 mg/m3 and particle sizes between 1 and 5 mkm provide therapeutic action; these specifications were taken from several physiotherapy establishments. The major negative charge of haloaerosol particles is 6–10 nK/m3 [11]. The temperature and relative humidity of the air are both comfortably high (18–24 degrees Celsius and 40–60 percent). Normal bronchial ciliated epithelium functioning requires sodium chloride, in contrast, bronchial secretions from individuals suffering from chronic pulmonary disease had a lower salt chloride level. In addition to producing anti-inflammatory effects, aerosolized sodium chloride exerts bactericidal and bacteriostatic effects on respiratory tract microflora and increases alveolar macrophage responsiveness by promoting the growth of phagocytic elements and their phagocytic activity [17]. Haloaerosol particles have a significant negative charge (6-10 nK/m^3). Furthermore useful for therapy, a large negative charge also makes the aerosol more stable. The physical characteristics of sodium chloride aerosol are just as important to the HT technique as its biological features. All parts of the respiratory system, including the deepest ones, can be reached by haloaerosol [18].

The method's fundamental characteristic is the administration of dried sodium chloride aerosol [14]. The basis of haloaerosol influence is a hyperosmolar stimulus, primarily manifested by enhancing the rheological properties of sputum and stimulating the ciliated epithelium, resulting in enhanced mucociliary clearance and bronchial discharge function. When equal dispersion was studied, the respiratory tract's ability to absorb dry and droplet sodium chloride aerosols showed that the dry aerosol caused the greatest amount of particle delay [11]. This meant that lesser dosages may be given and negative side effects might be avoided by applying a dry, widely diffused aerosol.

At the level of the pulmonary membranes and the mucociliary system, the action mechanisms of the dried NaCl nanoparticles are direct and inverse osmosis and an ionic change process, with a revitalizing and detoxifying effect. Dried aerosol optimizes the camera's temperature and humidity parameters [8]. This makes it possible to prevent the bronchial spasm and mucosal edema in the respiratory tract, which are common responses in individuals exposed to wet aerosols. The additional effects of HT could be explained by the patient's exposure to hypoallergenic, antimicrobial, noiseless, and psychologically comfortable air.

HT is an all-natural, risk-free therapy with no serious adverse effects [14]. This method is extremely beneficial for an individual's overall health because it strengthens respiratory system function, gets rid of harmful elements, and promotes promotes immunity, eases stress, and improves the look and function of the epidermis [19].

4.3. Benefit of halotherapy

The effectiveness of HT is primarily attributable to three factors. First, salt has antibacterial, antimycotic, and anti- inflammatory properties. Chervinskaya and Zilber (1995) also found that HT acts on the pulmonary airway microbiota, bactericidally and bacteriostatically, to prevent the development of inflammatory processes [8]. Salt rooms are three times more hygienic than the best operating room, according to research [14].

Second, salt naturally emits negative ions, which neutralize a positive charge. The salt particles have a considerable negative charge (6-10 nK/m^3), and the surface of the airways has a slight positive electric charge; as a result, the salt could enter the respiratory system and "bind" to the airway epithelium. This contributes to the increase in the organism's resistance to respiratory infections and has desensitizing effects on allergens [12]. Third, dried salt has an incredible absorption capacity. The salt itself is

inherently absorbent, and according to one theory, it may collect and dehydrate any infectious droplets before they become airborne [20].

Most respiratory ailments, including tonsillitis [21], pharyngitis [16], sinusitis [15], rhinitis [21], asthma [5], allergies [18], and chronic bronchitis [18], as well as respiratory tract infections [8], recurring colds [5], and pneumonia following an acute phase [16], can be treated with HT. It has been demonstrated that this is a highly effective method of positively influencing a variety of respiratory diseases with a rapid resolution of symptoms, enhancement of pulmonary ventilation and tolerance of physical exertion, and an increase in the body's immunity and resistance [14].

Salt therapy is a complementary treatment for a few pediatric conditions [22]. It is risk-free, noninvasive, and without adverse effects or potential health hazards. Clinical studies have demonstrated that adolescents react more rapidly and vigorously than adults (Larson). Data suggests that HT is very effective as a preventative measure in children who are sick often [14], additionally to the prospect of using it to treat acute respiratory illnesses in kids who suffer from long-term ENT, respiratory, and skin conditions. This therapy is readily applicable to minors. Toys and work equipment are placed in dedicated salt rooms, which helps kids feel comfortable and calm [23].

4.4. Future prospective of halotherapy as adjuvant therapy

Although HT has been utilized for centuries in various cultures, its modern application as a complementary therapy for respiratory diseases has attracted considerable attention. Several studies have demonstrated its efficacy to be promising. In asthma and COPD patients, HT has been demonstrated to enhance lung function, reduce respiratory symptoms, and lessen the need for conventional medications, according to clinical trials [1]. In addition, it has been reported that HT improves the quality of life and general health of individuals with respiratory conditions [24].

As interest in HT increases, scientific studies will likely examine its mechanisms of action, effectiveness, and safety. Future research may focus on determining how salt particles specifically interact with the respiratory system and how they modulate inflammatory responses. Additionally, research efforts may be focused on optimizing HT protocols, such as determining the optimal treatment duration and frequency for various respiratory conditions.

As interest in HT grows, scientific studies examining its mechanisms of action, efficacy, and safety will likely increase. Future research may investigate how salt particles interact specifically with the respiratory system and how they modulate inflammatory responses. Additionally, research may concentrate on optimizing HT protocols, such as determining the optimal treatment duration and frequency for different respiratory conditions.

Future expansion of telemedicine and remote healthcare services could include HT. Patients may benefit from HT without physically visiting salt chambers if virtual or at-home HT options become available. Incorporating HT into telemedicine platforms may increase accessibility and convenience for patients, especially those with limited mobility or who reside in remote areas.

As HT grows in popularity as a complementary treatment for respiratory diseases, it may contribute to a closer working relationship between halotherapists and respiratory specialists. This approach could facilitate knowledge sharing, research collaboration, and the development of evidence-based guidelines for incorporating HT into managing respiratory diseases. HT may have applications in preventive care and its prospective function in treating respiratory diseases. Regular HT sessions may aid in maintaining respiratory health, bolstering the immune system, and decreasing the risk of respiratory infections and exacerbations in susceptible individuals.

5. Conclusion

Future research will likely unearth additional therapeutic advantages and refine the clinical application of HT as an adjunctive treatment for respiratory diseases. HT could enhance the quality of life for people with respiratory conditions by reducing inflammation, enhancing mucous clearance, and alleviating respiratory symptoms. As medical technology advances, HT may become integral to holistic treatment plans, complementing conventional therapies to offer patients a more comprehensive and individualized approach to respiratory disease management. However, rigorous research must continue to establish its efficacy, safety, and optimal implementation in clinical practice.

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