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Review Article

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Synergistic Effects of Combined Thermal and Halotherapy Interventions on Respiratory Mucosa and Bronchial Function: A Narrative Review

Amalia Tri Utami*, Aasiyah Muzaahim, Al Haarits Harrats and Maryam Aali Imroon

Maryam and Isa Health Center, Indonesia

***Corresponding author**
Amalia Tri Utami, Maryam and Isa Health Center, Indonesia.

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ABSTRACT
Chronic respiratory disorders and the growing impact of air pollution have highlighted the need for effective non-pharmacological rehabilitation strategies. This narrative review evaluates the therapeutic potential of thermal salt sauna therapy (thermal halotherapy), a modality that integrates inhalation of dry sodium chloride microparticles within a high-temperature environment. The review examines the physicochemical characteristics of different salt types, the biological mechanisms underlying mucociliary clearance, and the critical physiological rationale for the use of hyperthermic conditions. Evidence from the literature indicates that heat acts as a catalytic factor, enhancing salt aerosol penetration through pulmonary vasodilation and bronchial dilation, thereby significantly improving mucus clearance compared with halotherapy conducted at room temperature. This integrated approach represents a promising adjunctive strategy for respiratory health management.

Keywords: Halotherapy, Thermal therapy, Respiratory rehabilitation, Mucociliary clearance, Sodium chloride aerosol.

Introduction

Global respiratory health challenges—ranging from chronic obstructive pulmonary disease (COPD) to pollution-induced allergic rhinitis—have encouraged the incorporation of complementary therapeutic modalities into modern rehabilitation protocols. One intervention that has gained increasing clinical attention, particularly within integrative health practices in East Asia, is the combination of thermotherapy (sauna exposure) and halotherapy (salt therapy). This approach extends beyond conventional thermal relaxation by incorporating targeted inhalation of dry salt aerosols aimed at improving bronchial hygiene.

Although the health benefits of salt have been recognized for centuries, its application within a controlled hyperthermic environment introduces a novel paradigm in respiratory biophysics. This review synthesizes current evidence on the mechanisms underlying this combined modality, with particular emphasis on how thermal conditions potentiate the therapeutic effects of salt particles within the lower respiratory tract [1].

Characteristics of Therapeutic Agents

The effectiveness of thermal halotherapy is strongly influenced by the physicochemical properties of the salt employed. In practice, a clear distinction exists between the use of natural mineral salts and highly purified pharmaceutical-grade salts, each serving distinct functions within the sauna environment.

Natural rock salts, such as Himalayan salt commonly used in sauna wall construction, are valued for their trace mineral content—including magnesium, potassium, and calcium—and for their capacity to release negative ions when heated, thereby contributing to ambient air quality. In contrast, active inhalation therapy targeting deep respiratory pathology relies on pharmaceutical-grade sodium chloride (NaCl) with a purity exceeding 99.5%.

This purified salt is processed using a halogenerator, which mechanically reduces salt crystals into dry aerosol particles of microscopic size. Studies demonstrate that only particles with an aerodynamic diameter between 1 and 5 micrometers are capable of bypassing the upper airways and depositing effectively within the bronchioles and alveoli. This size range constitutes the respirable fraction essential for therapeutic efficacy [2].

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Biophysiological Mechanisms of Action on Respiratory Mucosa

The primary therapeutic action of dry salt aerosols in the respiratory system is attributed to the hygroscopic nature of sodium chloride and its effect on mucus rheology. In individuals with chronic respiratory conditions, pathological changes often include excessive production of thick, dehydrated mucus that impairs mucociliary function.

When dry salt microparticles deposit on the airway mucosa, a high osmotic gradient is created. Sodium chloride draws water from surrounding interstitial tissues into the airway lumen, effectively rehydrating the periciliary liquid layer and reducing mucus viscosity. This osmotic rehydration facilitates mechanical clearance of secretions through coughing and enhances ciliary activity.

Beyond its mucolytic effects, chloride ions exhibit bactericidal and bacteriostatic properties by disrupting bacterial cell membrane integrity, while sodium ions contribute to the reduction of bronchial mucosal edema through tissue fluid regulation. Collectively, these effects alleviate airway obstruction and reduce inflammatory burden [3].

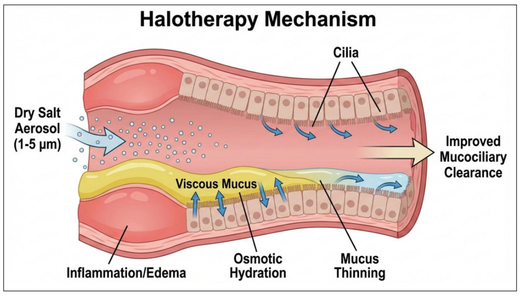

Figure 1: Mechanism of Action in the Airways

The illustration depicts dry salt aerosols (1–5 μm) entering an inflamed bronchial lumen. Salt particles induce osmotic hydration by attracting water into thickened mucus, leading to mucus dilution. Combined with reduced inflammatory edema of the airway wall, this process enhances ciliary movement and promotes effective mucociliary clearance.

Discussion: The Synergistic Role of the Hyperthermic Environment

A key question in evaluating this modality concerns the physiological justification for administering halotherapy within a hyperthermic (sauna) environment rather than at ambient temperature. The literature indicates that heat is not merely an adjunctive relaxation element but a critical synergistic factor that fundamentally alters aerosol deposition dynamics.

From a physiological perspective, whole-body heat exposure triggers thermoregulatory responses including systemic vasodilation and increased pulmonary perfusion. Concurrently, mild heat stress induces an increase in minute ventilation through elevated respiratory rate and tidal volume. This controlled hyperventilation facilitates deeper inhalation of salt-laden air into the tracheobronchial tree, increasing the likelihood that therapeutic particles reach peripheral airways—sites commonly affected in chronic obstructive diseases [4].

A second synergistic mechanism relates to physical and anatomical factors. The high temperature of dry saunas, typically accompanied by low relative humidity, is crucial for maintaining salt aerosol stability. In humid environments, microscopic salt particles rapidly absorb moisture, aggregate, and increase in size prior to inhalation, leading to premature deposition in the oropharynx rather than the lower lungs. Heat preserves particle dryness and maintains the optimal respirable size range (1–5 μm).

Furthermore, heat directly relaxes bronchial smooth muscle, resulting in transient bronchodilation. This airway widening mechanically enhances access prior to aerosol deposition, enabling more uniform and deeper distribution of the mucolytic agent across the mucosal surface. Such thermal "priming" effects are not achievable with halotherapy conducted at normal room temperature [5].

Conclusion

The current body of evidence supports the conclusion that the integration of thermotherapy and halotherapy represents a biologically rational and effective approach to respiratory rehabilitation. The dual mechanism—whereby salt provides osmotic mucolytic and anti-inflammatory actions while heat optimizes aerosol delivery through bronchodilation and enhanced ventilation—produces therapeutic effects greater than either intervention alone.

This modality demonstrates considerable potential as a non-invasive adjunct therapy for improving airway clearance and vital capacity, particularly in the management of chronic obstructive respiratory diseases. Future large-scale randomized controlled trials are warranted to standardize optimal temperature parameters and treatment duration.

Acknowledgment

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