Review Article

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MODERNIZING THE TRADITION OF DHUMAPANA BY NEBULIZATION IN RESPIRATORY DISORDERS: A REVIEW ARTICLE

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ABSTRACT

Respiratory diseases are major global health concern and it is expected to rise due to increasing urbanization and air pollution. This conditions significantly impair quality of life, as the patient has ongoing stress and fear of exacerbations. Modern medicine has made substantial advances in treatment of respiratory ailments, particularly through inhalation therapies like nebulization. Despite the efficacy of contemporary inhalation treatments, the use of inhaled corticosteroids (ICS) is associated with localized side effects, including viral gastroenteritis and oral candidiasis. Ayurvedic physicians were managing the respiratory ailments since time unknown and its contribution to worldwide development of inhalation therapy as Dhumapana (therapeutic smoke inhalation) cannot be unseen. But Dhumapana had not got extensive development in terms of technological advancement. Therefore, integrating traditional Ayurvedic formulations such as Arka Kalpana (ayurvedic distillates), the Dhumapana procedure, and modern technologies like nebulizers and pressurized metered-dose inhalers (pMDI) presents a promising therapeutic approach for the management of respiratory disorders.

Keywords: Nebulization, respiratory disorders, Dhumapana, Swasa, Arka Kalpana.

INTRODUCTION

Ayurveda, one of the ancient systems of medicine, has long utilized inhalation therapy in the treatment of respiratory disorders as Dhumapana. "Dhumapana" is a Sanskrit term where, "Dhuma" refers to smoke or vapours[1], and "Paana" means intake. Therefore, Dhumapana refers to the therapeutic practice of inhaling the smoke of medicinal herbs and mineral following specific guidelines[2]. Dhumapana was not only used for respiratory disorders but also formed an integral part of Ayurvedic Dinacharya (daily regimen)[3], treatment of Unmada (psychiatric)[4], Apasmara (epilepsy) etc. It primarily aims to prevent and treat disorders related to Vata and Kapha (bodily humor) that affect the head and neck region. Dhumapana involves the use of a medicated wick, which is ignited, and the resulting smoke is directed through a Dhumanetra (a conical-shaped apparatus) to the nostrils or mouth. Acharyas also outlines various guidelines and regulations for smoking. Dhumapana (therapeutic smoke inhalation) was traditionally intended to be inhaled through the nose and exhaled through the mouth, though variations exist depending on the type of Dhumapana[5]. Even though it being used in ayurveda clinical practices to treat respiratory ailments this approach did not gain widespread recognition and, as a result, did not undergo extensive development.

The breakthrough in treatment of respiratory disorders evolved with discovering the inhalation therapy in the modern world. The pMDI was developed in 1956, marking a major milestone in modern respiratory care[6]. It has proven to greatly enhance the quality of life for individuals suffering from respiratory conditions. This method of treatment has gained importance in recent decades due to its rapid action and convenience. One the other hand Inhaled corticosteroid is reported to associate with several adverse effects such, oropharyngeal candidiasis[7]. These ancient wisdom with modern technology together could lead to a more effective approach to respiratory care. Ayurveda, with its vast repository of medicinal herbs, holds considerable potential in offering effective medicine for inhalation therapy. In this article, major contributions to inhalation therapy worldwide, the benefits of inhalation therapy its mode of action and scope of integration are discussed.

World-wide developmental history of inhalation therapy

Inhalation therapy has been a time-tested approach for treating respiratory disorders, with various methods employed across different regions, highlighting the therapeutic benefits of this treatment modality. Details are provided in Table 1.[5,6,8–10]

From Table 1 we may analyse that India gave major contributions to the inhalation therapy as a treatment. In last part of 1700 medicated vapor (by passing bubble through the medicated solution or by boiling the saturated solution) was used. In 1849 first atomizer was developed by Dr. Auphon in France and the portable one was developed in 1858[11]. In 20th century invention of rubber helped in making rubber pump for inhalers. In 1955 first MDI was introduced and in 1987 DPI devices which can store the capsule got wide spread recognition. Nebulizer system got developed later as open vent air jet nebulizer, breath enhanced nebulizer and vibrating mesh nebulizer. Later from 1990s to the present, extensive researches are done on discovering effect of new medication for osteoporosis[12], liver disorders by aerosol therapy[13].

Table 1

1554 BC- Egypt	Inhale the vapour formed when *Hyoscyamus niger* by placing it on hot brick, covering it with jar with hole and inhale the fume through stalk of reed.
1300-1100 BC- China	Use of opium for recreational purpose, analgesia and cough
150-200 BC- India Acharya Charaka	Preparation of herbal compounds that can be used for relieving asthmatic symptoms.
600 and 1000 BCE- India Acharya Sushrutha	Details about ingredients for fomentation, cigars smoking its perfect instruction about procedures, instruments and doses are mentioned. Sushrutha Samhita includes exclusive chapter for Dhumapana. This therapy can date back to 2000 BC with early traditional ayurvedic medicine
1025 AD- Persia- Avicenna	Described Toxicity of opium inhalation
2nd century AD- Greece- Galen of Pergmon	Inhalation of powdered drug (myrrh and nutgall for chest troubles.
4th – 5th century AD- Rome, Caelius Aurelians	Inhalation of steam and sea air treat asthma episode
6th to 7th century AD- India, Acharya Vagbhata	Equal quantity of Manashila (realgar) and tender sprouts of vata (*Ficus benghalensis*) made in to wicks, smeared with ghee and smoked. Beneficial in Swasa, Kasa, Yakshma (respiratory disorders). Exclusive chapters for Dhumapana mentioned.
7th century AD -Greece- Paulus Aegineta	Inhalation of complex herbs in coal for respiratory troubles
12th century AD -India – Sharangadara	Exclusive chapter for Dhumapana (inhalation of medicated fumes) comprising the types, indication and contraindication, management of complication, apparatus and herbs to be used etc.
12th century (1137) AD- Maimonides	wrote the first known book on asthma (A Treatise on Asthma) in 1190. management of asthma included inhaling herbs burned on a fire.

Need of Integration of Dhumapana with Modern Inhalation Technology

Dhumapana was traditionally intended to be inhaled through the nose and exhaled through the mouth, though variations exist depending on the type of Dhumapana. This practice may have been prescribed to reduce the deposition of carbon particles within the lungs. Failure to follow the prescribed guidelines can result in adverse reactions. A notable example of this is asthma cigarettes. Smoke therapy using *Datura stramonium* for respiratory issues was practiced in India and introduced to Great Britain in 1802 by General Gent. Initially administered under medical supervision and gave huge relief to the users. By the 20th century, it was commercialized as "asthma cigarettes[14] " These cigarettes were sold without medical oversight. Advertisements encouraged users to inhale deeply, holding the smoke for several seconds before exhale through nose or mouth. By the early 21st century, reports highlighted the health risks of these products, including exposure to carbon, tar, and other substances, similar to conventional cigarettes. This underscores the importance of medical supervision and following established guidelines for Dhumapana.

Burning a cigar is an organic combustion such combustion typically produces therapeutic particles around 1-10 µm in diameter[15], whereas lipophilic medicated compounds with a particle size between 0.5–5 µm are required to effectively reach the lungs and exert a therapeutic effect. Therefore, by integrating modern technological advancements with traditional practices of Dhumapana and medicines in form of *Arka* (distillate), the active principles of drug can be separately delivered to the lungs without subjecting it to first pass metabolism and it will be more convenient for the users. The treatment can be created to reduce its limitations and enhance its therapeutic efficacy. A significant development in aerosol therapy happened with the invention of atomizers and nebulizers, which enabled the dispersion of liquids into ultrafine particles, facilitating their delivery to the deepest parts of the lungs. Ayurveda, with its huge repository of medicinal plants, offers remedies that, when combined with modern technology, can further refine and improve therapeutic outcomes.

Inhalation therapy over other methods of drug administration

In the past decade, inhalation therapy has proven to be more effective than other methods of drug administration, particularly in the treatment of respiratory disorders, due to several key factors. The pharmacokinetics of inhalation have been shown to be superior to those of oral or intravenous (IV) administration. Lung is very tolerant to foreign substances, and more permeable than gastro intestinal tract. When a drug is administered orally, it must undergo first-pass metabolism before reaching the target organ, which compromises its bioavailability. In contrast, intravenous (IV) administration involves the direct infusion or injection of drug molecules into the bloodstream, thereby bypassing the gastrointestinal absorption process and the hepatic first-pass metabolism. Following IV administration, the drug must undergo systemic distribution to reach the target site, such as the lungs in the treatment of respiratory disorders. Given the absence of significant drug transporters or notable barriers between the blood and pulmonary tissue, the pulmonary drug concentration generally does not exceed that in the plasma. Therefore, selective pharmacokinetics in the lungs cannot be achieved through systemic routes of administration. In inhalation therapy, especially with nebulizers or pressurized metered-dose inhalers (pMDIs), when executed effectively, the desired therapeutic effect is achieved in just 1 to 2 minutes where full effect seen in 15 to 20 minutes[16]. The optimal pharmacokinetics involve six key steps[17],

Deposition of drug particles or droplets in the airways.
Dissolution of the drug in lung fluids.
Mucociliary clearance in the conducting airways and macrophage clearance in the alveolar space.
Absorption of the dissolved drug into the lung tissue.
Retention of the drug in the pulmonary tissue and potential pulmonary metabolism.
Absorptive drug clearance, with transport from lung tissue to systemic circulation.

Pulmonary Drug Deposition and distribution

Following inhalation, a portion of the drug particles or droplets is deposited in the inhaler device, while the remaining fraction is delivered to the respiratory system. As the particles travel through the airways, deposition occurs in the mouth-throat region, conducting airways, and the alveolar space. The total fraction deposited in the lungs is referred to as the "lung dose," and deposition patterns are described as central (larger airways) or peripheral (smaller airways and alveolar space). The lung dose and deposition patterns depend on factors such as aerodynamic particle size, inhalation flow, device characteristics, and disease-related factors but are generally independent of the drug's physicochemical properties. Particles that do not reach the lung are either swallowed if deposited in the mouth-throat region, or exhaled if they fail to deposit in the lungs.

The aerodynamic particle diameter is an important factor in determining where the drug is deposited in the respiratory system. Particles with an aerodynamic diameter of 0.5–5 µm are most likely to reach the lungs, with smaller particles depositing more peripherally (e.g., alveolar space) and larger particles depositing centrally (e.g., conducting airways). Particles larger than 5 µm tend to deposit in the mouth-throat region, reducing the lung dose. Larger particles deposit in the central airways due to inertial impaction, while smaller particles are primarily deposited via sedimentation in the peripheral airways, with Brownian motion contributing to deposition in the alveolar space. Modern inhalation devices are designed to emit small particles (1–5 µm), which maximize lung dose and target specific sites. The most effective inhalation device design combines slow-moving aerosol with small drug particles for optimal lung deposition and distal airway penetration.

Pulmonary Drug Dissolution

For drug particles deposited in the lungs to be absorbed, they must dissolve in the pulmonary fluids. This process is influenced by drug formulation, physicochemical properties, and the characteristics of the pulmonary environment. The conducting airways are lined with mucus layer, while alveoli are coated with alveolar lining fluid and surfactants. The thickness of the pulmonary lining fluid and its composition can affect dissolution. Inhaled drugs with slower dissolution rates, offer prolonged lung retention, while faster-dissolving drugs provide rapid therapeutic effects.

Mucociliary and Macrophage Clearance

The bioavailability of deposited drug particles is influenced by mucociliary clearance and macrophage clearance. Mucociliary clearance, a protective mechanism, moves drug particles from the conducting airways to the pharynx, where they are swallowed. This process is faster in larger airways and may be reduced in patients with thick mucus or impaired ciliary function. Macrophage clearance is slower and occurs in the alveolar space, where particles are phagocytosed and transported to lymph nodes.

Absorption into Lung Tissue

Drug absorption in the lungs occurs via passive transcellular diffusion or paracellular diffusion, depending on the drug's lipophilicity and size. Absorption rates are higher in the alveolar space due to its larger surface area and high perfusion, while absorption in the conducting airways is slower due to lower perfusion and surface area.

Pulmonary Tissue Retention and Metabolism

Pulmonary retention of drugs is influenced by their physicochemical properties and the patient's airway characteristics. Some drugs tend to have longer retention times due to their interaction with lung tissues and slower receptor dissociation. The lung also contains drug-metabolizing enzymes, although their capacity is lower compared to the liver and gastrointestinal tract.

Absorptive drug clearance, and systemic circulation

The final process, absorptive clearance, involves the transfer of the drug from lung tissue to the bloodstream and is highly dependent on lung perfusion. The lungs receive the highest blood flow in the body, with the alveolar region having the highest perfusion, promoting rapid drug absorption due to its large surface area, thin epithelium, and efficient pulmonary circulation. In contrast, the conducting airways, with lower perfusion and smaller surface area, rely on systemic circulation, leading to slower absorption. High perfusion in the alveoli allows for rapid equilibration with the systemic circulation, reducing airway selectivity. In the tracheobronchial region, slower perfusion and higher tissue retention lead to a longer equilibration time and greater local airway selectivity.

Therefore, Inhaled drugs are most effective, with optimal drug formulations and well-designed inhalation devices maximizing the difference between pulmonary and systemic drug concentrations.

The scope of inhalation therapy by integrating with wisdom of Arka Kalpana

The concept and preparation of Arka (distillate) in the field of Ayurveda is quite unique in nature. Arka (distillate) is known for its palatability, especially when compared to other preparations like Kashaya (decoctions). It has the unique ability to extract the active principles. This method of preparation retains all the volatile active substances in the final product, making Arka superior to other forms such as Kalka (paste), Churna (powder), Rasa (juice), and Taila(oil). Other benefits include its long shelf life, easy digestibility, and its ability to be quickly distributed and absorbed in the body[18]. It is more sterile compared to other preparation. It has the unique ability to extract the active principles of a drug or volatile oils which are lost on boiling.

Arka was first introduced into Ayurveda during the Samhita period. The text Arka Prakasha, authored by Lankapati Ravana, is an exclusive treatise on Arka Kalpana. In modern terms, Arka can be called as a "distillate." The text outlines the general method of Arka preparation as follows: The required quantity of water is added to the drugs for soaking and left overnight. The following morning, the mixture is poured into an Arka Yantra (distillation apparatus), and the remaining water is added and boiled. The vapours are then condensed and collected in a receiver. The liquid collected during this process contain the active ingredients and are mixed together to ensure uniformity. These general principles may vary based on the hardness and moisture content of the drug. The distillate is stored in coloured, airtight glass bottles, as exposure to air can cause the evaporation of the medically important volatile oils[19]. Acharya has mentioned the Arka Kalpana for various drugs such as Shunti *(Zingiber officinale),* Marica *(Piper nigrum),* Pippali *(Piper longum),* Yavani *(Trachyspermum ammi),* Dhanyaka *(Coriandrum sativum),* Pushkaramula *(Inula racemosa),* Bharangi *(Clerodendrum serratum),* and Katphala *(Myrica esculenta*), which are indicated for conditions like cough and breathing difficulties[18].

As discussed earlier, oral administration of such preparations may have limited bioavailability compared to nasal administration. Therefore, alternative methods of delivering the active compounds directly to the target site should be considered. This is where integrating modern technologies with ancient wisdom becomes crucial. Technologies such as pMDI or nebulizers can be used to convert the Arka (distillate) into an aerosol and deliver it directly to the lungs. Since the preparation is lipophilic and the technology can reduce particle size, the therapeutic effects will be enhanced. This mode of action of Dhumapana closely resembles to this. Acharya Charaka prescribes Dhumapana (therapeutic smoke inhalation) when Doshas (bodily humors) are in Leena Avastha (adhered to deeper channels), it interrupts with the respiration, then the Shamana (pacification) of these Doshas can be facilitated through Dhumapana. Dhumapana with its Theekshna (dry) Ushna (hot) property does the Vilayana of Kapha (mucous liquefaction) and corrects the Pranavaha Shrotas, (channels of respiration) thus facilitating the ease of respiration. Same way The Arka on reaching the deeper part of lung tissue, it does the mucolysis thus ease the mucous clearance. Therefore, it may give immediate relief. So, nebulization using an Arka Kalpana (distillate) is beneficial in management of acute respiratory conditions.

CONCLUSION

This paper has been prepared to elaborate the influence of ayurveda to inhalation therapy worldwide. It proposes the preparations of ayurvedic nebulisation using herbal drugs and *Arka* which can be converted in form of aerosol using a nebulizer or pMDI. It discussed the importance of inhalation therapy over oral and intravenous drug administration. Yet, more researches have to be done in this field to maximise the effect of inhalation therapy by discovering the mode of action of different drugs mentioned in classics, and document it.

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