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Bronchial Cleaning in Older Adults with Copd

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ABSTRACT
Chronic obstructive pulmonary disease (COPD) is a prevalent condition in older adults, characterized by persistent airflow obstruction, leading to respiratory distress and secretion accumulation. This study aims to analyze the benefits of bronchial cleansing in older adults with COPD, using a qualitative methodology based on a review of scientific literature and a critical analysis of physiotherapeutic interventions. The results highlight that bronchial cleansing techniques, such as respiratory physiotherapy, postural drainage, chest percussion, and assisted breathing exercises, significantly improve the removal of secretions, reduce dyspnea, and optimize quality of life in this population. In addition, additional benefits were identified, such as decreased risk of exacerbations and improved oxygenation. It is concluded that bronchial cleansing is a key intervention for the comprehensive management of COPD in older adults, especially when combined with pulmonary rehabilitation programs. This approach helps reduce complications, improve lung function and promote autonomy in this vulnerable population.

Keywords: *Chronic obstructive pulmonary disease, older adults, bronchial clearance, quality of life.*

1. INTRODUCTION

Chronic obstructive pulmonary disease (COPD) represents one of the leading causes of morbidity and mortality worldwide, mainly affecting older adults due to age-related physiological changes and prolonged exposure to risk factors, such as smoking and environmental pollution. This pathology is characterized by a chronic and progressive limitation of airflow, which generates debilitating symptoms such as dyspnea, persistent cough and excessive mucus production, which considerably affects the quality of life of patients (1).

Within the management of COPD, bronchial cleansing plays a critical role in removing excess respiratory secretions that contribute to airflow obstruction. In older adults, this process is hindered by a decrease in the effectiveness of respiratory defense mechanisms, such as the cough reflex and ciliary mobility, which increases the risk of recurrent respiratory infections, as well as hospitalizations. Hence the importance of implementing bronchial cleansing strategies adapted to this vulnerable population.

These techniques aim to improve mucociliary clearance and reduce secretion buildup, which in turn improves oxygenation and reduces the frequency of exacerbations. However, in older adults with COPD, the implementation of these interventions should be carefully evaluated, due to the presence of comorbidities and physical frailty that may limit the ability to perform certain procedures.

Aging brings with it a series of structural and functional changes in the respiratory system. Respiratory muscles tend to weaken, and lung elasticity decreases, compromising patients' ability to mobilize air effectively. In addition, mucus production tends to increase, aggravating the difficulty in eliminating secretions naturally (2). These factors further complicate the management of COPD in older adults, so bronchial cleansing should be approached holistically, taking into account both the individual characteristics of the patient and the severity of the disease.

One of the most important challenges in bronchial cleansing of older adults with COPD is adherence to treatment. The use of techniques such as respiratory physiotherapy requires the active participation of the patient,

which can be a challenge in those with cognitive impairment or physical limitations (3). Education of the patient and their caregivers on the importance of bronchial hygiene, as well as continuous supervision, are essential to ensure the success of treatment. In this sense, family support and the intervention of physiotherapy professionals play a key role in promoting adequate respiratory hygiene.

In recent years, progress has been made in the development of respiratory support devices that facilitate bronchial cleansing in patients with COPD. These include positive expiratory pressure devices and high-frequency oscillation vests, which help mobilize secretions through mechanical vibrations. These devices have been shown to be effective in improving mucociliary clearance, but their implementation in older adults requires careful evaluation due to possible adverse effects related to physical frailty and the presence of other pathologies. However, the contribution made through physiotherapy will always be of better quality and according to the specific needs of each patient.

Despite advances in COPD management and bronchial cleansing techniques, there is still a significant gap in the care of older adults with this disease. Current research highlights the need to develop personalized approaches that consider both physical limitations and comorbidities associated with old age. In addition, it is crucial to further investigate the long-term impact of different bronchial cleansing interventions on the quality of life and survival of COPD patients (4).

Bronchial cleansing in older adults with COPD contributes positively to improving lung ventilation, reducing the risk of respiratory infections and preventing exacerbations. Positive expiratory pressure techniques facilitate the elimination of mucous secretions that obstruct the airways, thus generating an improvement in patients who have this pathology.

That is why, within the present research, bronchial cleansing is analyzed as an essential intervention in the management of COPD, particularly in older adults, who represent a vulnerable population due to physiological changes related to age and comorbidities. This research strengthens the thesis that bronchial hygiene techniques should be adapted to the individual characteristics of each patient, and continuous supervision and education should be guaranteed to maximize their effectiveness. As the prevalence of COPD continues to rise, especially in countries with aging populations, research and development of new strategies to improve the management of respiratory secretions in older adults are priority areas that require further attention.

2. MATERIALS AND METHODS

For this research, a qualitative approach will be used, aimed at exploring and understanding the processes and factors involved in the application of bronchial cleansing techniques in this specific population (5). The deductive method will guide the study, allowing to start from general theories on respiratory physiotherapy and chronic obstructive pulmonary diseases, to analyze how these techniques are adapted and applied to older adults. The observation technique will be essential to collect data on the implementation and results of bronchial hygiene interventions, focusing on documenting practices, reactions and possible benefits in the patients observed. This research will have a bibliographic and documentary modality, based on current and relevant scientific sources, such as articles, reviews and clinical guidelines, which will address both the theoretical and practical aspects of bronchial cleansing in elderly people with COPD (6).

3. RESULTS

Pathophysiology of COPD in older adults

Chronic obstructive pulmonary disease (COPD) is a prevalent respiratory pathology among older adults, characterized by persistent and progressive airflow obstruction. Aging, a natural biological process, introduces a series of physiological changes that contribute to the progression and exacerbation of COPD. This analysis examines how these changes aggravate the disease, focusing on structural, functional, and immunological alterations associated with age.

With aging, the respiratory system undergoes significant structural modifications that negatively impact lung function. One of the most obvious alterations is the decrease in lung elasticity due to the progressive degradation of elastin fibers in the lungs. This phenomenon causes an increase in lung compliance, resulting in a reduced ability of lung tissue to retract and hinders full exhalation of air. In addition, aging leads to a deterioration of the alveolar architecture, with a process known as "aging of the lung parenchyma". This deterioration is characterized by coalescence of the alveoli, which decreases the surface area available for gas exchange. The combination of lower elasticity and a reduced alveolar surface area contributes to less efficient alveolar ventilation (7).

Another important change occurs in the rib cage. Over time, the costal cartilages calcify, reducing thoracic mobility. This, added to the progressive weakness of the respiratory muscles, affects the ability to generate adequate inspiratory and expiratory pressures. In the context of COPD, these structural alterations exacerbate pulmonary hyperinflation and aggravate symptoms of dyspnea. Aging also involves functional changes that affect respiratory dynamics. Among the most relevant aspects is the decrease in forced expiratory volume in one second (FEV1), a key parameter to assess lung function. It is estimated that FEV1 decreases by approximately 30 mL per year after the age of 30 years in healthy individuals, and this loss is accelerated in the presence of factors such as smoking or exposure to pollutants (7).

On the other hand, aging affects the ventilation/perfusion (V/Q) ratio, a critical indicator of gas exchange efficiency. The redistribution of blood flow in the lungs, combined with alterations in ventilation, leads to an increase in physiological dead space. This implies that a higher proportion of inhaled air is not involved in the exchange of oxygen and carbon dioxide, contributing to hypoxemia. The reduction in ventilatory responsiveness is also remarkable. Peripheral and central chemoreceptors, responsible for detecting changes in oxygen and carbon dioxide levels in the blood, show lower sensitivity with age. This decrease in chemoreceptor response limits the body's ability to adapt to states of hypoxia or hypercapnia, common conditions in COPD patients (8).

The immune system also undergoes significant modifications with aging, a process known as immunosenescence. This phenomenon implies a decrease in the effectiveness of the innate and adaptive immune response. In patients with COPD, immunosenescence exacerbates susceptibility to respiratory infections, one of the main causes of acute exacerbations. In the context of innate immunity, a decrease in the activity of alveolar macrophages, essential cells for the phagocytosis of pathogens and the elimination of cellular detritus, is observed. In addition, aging affects the production of cytokines and chemokines, which alters inflammatory signaling and contributes to a chronic pro-inflammatory state known as *inflammaging* (8).

In terms of adaptive immunity, there is a decrease in the production of naïve T cells, which reduces the body's ability to generate specific immune responses to new pathogens. An accumulation of dysfunctional memory T cells is also observed, limiting the effectiveness of ongoing immune responses. These changes not only increase the risk of infections, but also perpetuate the chronic inflammation that characterizes COPD.

Aging also influences the cardiovascular system, which has direct repercussions on the progression of COPD. Arterial stiffness, a result of loss of elasticity in the arteries, increases with age and contributes to pulmonary hypertension, a common comorbidity in COPD patients. This condition increases the hemodynamic load in the right heart, which can lead to the development of right heart failure or *cor pulmonale* (9). The decrease in oxygen transport capacity, derived from lower cardiovascular efficiency and reduced hemoglobin content, also aggravates hypoxemia in patients with COPD. These factors, combined with lower lung capacity, generate a vicious circle that affects both quality of life and prognosis in older adults with this disease

In addition to the intrinsic changes related to aging, external factors such as prolonged exposure to environmental pollutants and smoking aggravate the physiological effects on the respiratory system. These factors contribute to additional damage to lung tissue and exacerbate inflammation12. Likewise, common comorbidities in older adults, such as diabetes, obesity and osteoporosis, complicate the management of COPD and increase the symptom burden.

Bronchial cleansing techniques: principles and applications

Respiratory therapy is an essential component in the management of various lung diseases, particularly in conditions such as chronic obstructive pulmonary disease (COPD) and other pathologies that involve an excessive accumulation of secretions. Breathing techniques and exercises are key interventions used by physiotherapists to improve ventilation, facilitate the clearance of secretions and optimise lung function in patients with breathing difficulties. This text offers a detailed description of these techniques and their application in clinical practice, subdividing them into two stages, the first being the first.

ELTGOL (Total Slow Expiration with Open Glotis in Lateral Decubitus)

It is a respiratory physiotherapy technique designed to facilitate the drainage of lung secretions, especially in patients with chronic obstructive conditions or diseases that hinder the mobilization of mucus in the airways. This technique is characterized by a slow and controlled expiration with the glottis open, performed in lateral decubitus to take advantage of gravity and lung biomechanics, favoring the displacement of secretions from the peripheral regions to the central regions of the bronchial tree.

The fundamental principle of ELTGOL lies in the use of low lung volumes to generate a laminar expiratory flow, which minimizes the risk of bronchial collapse in susceptible areas. In patients with diseases such as bronchiectasis or cystic fibrosis, where secretions tend to accumulate in the most distal areas of the lung, ELTGOL is particularly effective. The application of this technique requires a detailed understanding of lung anatomy and physiology, as well as a thorough evaluation of the patient to identify the most affected areas (9).

During ELTGOL, the patient is positioned in lateral decubitus position, with the affected side facing up, which allows gravity to facilitate drainage into the main airway. Slow, controlled expiration is performed with the mouth open to keep the glottis relaxed, thus avoiding an unnecessary increase in intrathoracic pressure that could compromise airflow or cause a collapse of the small airways. This maneuver also promotes better air distribution, which contributes to a more efficient mobilization of secretions.

One of the highlights of the ELTGOL is its ability to generate a pressure gradient that favors the movement of secretions from the small airways to the larger ones. This gradient is achieved by combining the force of gravity, expiratory flow

control, and patient position. In contrast to other respiratory physiotherapy techniques, ELTGOL focuses on a progressive and non-invasive action that respects the lung structure, being especially useful in patients who do not tolerate more aggressive manoeuvres such as chest percussion or vibration.

The effectiveness of ELTGOL is also increased when combined with other complementary interventions, such as adequate hydration to reduce mucus viscosity or the use of positive expiratory pressure (PEP) devices. In addition, training the patient to perform the technique autonomously can improve treatment adherence and long-term clinical outcomes. This is particularly relevant in chronic diseases, where continuous management of secretions is essential to prevent complications such as recurrent respiratory infections (21).

From a biomechanical point of view, ELTGOL takes advantage of lung elasticity and airway resistance to generate a laminar flow that mobilizes secretions without damaging lung tissue. This approach is especially beneficial in patients with emphysema or chronic bronchitis, where lung structures are weakened and susceptible to injury induced by more aggressive drainage techniques. The controlled and gentle nature of the ELTGOL also makes it a safe choice for vulnerable populations, such as the elderly or children (9).

In the clinical setting, physiotherapists often use ELTGOL as part of a comprehensive respiratory rehabilitation programme. This approach includes periodic assessment of lung function, patient education, and implementation of personalized strategies for secretion management. Patient-reported benefits include a reduction in the sensation of dyspnea, less frequent exacerbations, and an improvement in quality of life. In addition, regular application of ELTGOL can reduce the need for hospitalizations and pharmacological treatments, which represents a relief for both the health system and the patients themselves.

Another important aspect to consider is the training of health personnel for the proper application of ELTGOL. Although it is a relatively simple technique in its execution, it requires in-depth knowledge of respiratory physiology and the particularities of each patient to ensure its efficacy and safety. Ongoing training in respiratory physiotherapy is essential so that practitioners can tailor the technique to individual needs and monitor its effectiveness over time.

On the other hand, ELTGOL also has some limitations that must be considered. For example, its effectiveness may be reduced in patients with extremely viscous secretions or in those with severe obstructions that prevent the passage of air even at low volumes. In these cases, it may be necessary to complement ELTGOL with other therapeutic approaches, such as the administration of bronchodilators or the use of more advanced instrumental techniques (21).

Scientific research on ELTGOL has proven effective in a variety of clinical contexts, although there are still areas that require further exploration. Future studies could focus on comparing its effectiveness with other drainage techniques, as well as evaluating its long-term impact on different population groups. In addition, the incorporation of advanced technologies, such as real-time monitoring of respiratory flows, could improve the accuracy and results of this technique (21).

Thus, ELTGOL is a valuable tool in respiratory physiotherapy, designed to clear the airways from the bottom up efficiently and safely. Its approach based on the use of low volumes, expiratory flow control and body position make it an ideal choice for patients with chronic respiratory diseases or conditions that make it difficult to manage secretions. Although it has some limitations, its benefits far outweigh its disadvantages, especially when combined with other therapeutic interventions. With proper implementation and continuous monitoring, ELTGOL can significantly improve patients' quality of life and reduce the burden on healthcare systems.

Prolonged Slow Breathing (LPR)

The Prolonged Slow Breathing (LPR) technique is a therapeutic approach used in respiratory physiotherapy with the aim of facilitating the management of lung secretions and optimising ventilation in patients with chronic respiratory diseases or airway obstructions. This technique is based on the control of respiratory flow during expiration, allowing secretions to be effectively mobilized from the peripheral regions to the central airways of the lung, where they can be eliminated more easily.

LPR is based on biomechanical and physiological principles that seek to optimize the relationship between lung volume and airway resistance. During its execution, the patient performs a slow, prolonged and controlled expiration, using a low lung volume, which helps to generate a laminar expiratory flow. This gentle flow minimizes the risk of collapse of the small airways, a critical factor in patients with pathologies such as cystic fibrosis, COPD or bronchiectasis.

One of the distinctive aspects of LPR is its personalized application, adapted to the needs and abilities of each patient. To maximize its effectiveness, the therapist must first evaluate the specific characteristics of the patient's lung function, identifying the areas with the greatest accumulation of secretions. This makes it possible to determine the most appropriate body position and the ideal breathing rhythm to facilitate drainage (22).

During the session, the patient is instructed to inhale naturally and then perform a long, controlled exhalation with the mouth open. The glottis should remain relaxed, avoiding any obstruction to airflow. This careful control of expiration allows the airflow to maintain sufficient pressure to mobilize secretions without inducing a collapse of the airway. In addition, the

controlled nature of this technique reduces respiratory fatigue, making it suitable even for patients with lower functional capacity.

LPR also leverages the patient's body position as a key tool to optimize drainage. By placing the patient in positions that favor the action of gravity on the secretions, it is easier for them to move towards the main airways. For example, in lateral decubitus or sitting with a slight forward leaning, gravity helps to mobilize secretions from the affected areas (22).

From a clinical point of view, LPR is particularly useful in the management of chronic pathologies of the respiratory system. Patients with conditions such as COPD, bronchial asthma, cystic fibrosis, or recurrent respiratory infections can benefit significantly from this technique, as it contributes to improved lung function by reducing obstruction caused by excess mucus. It has also been observed that LPR helps to reduce the sensation of dyspnea and improves general respiratory comfort, positively impacting the quality of life of patients.

An additional benefit of LPR is its low cost and accessibility, as it does not require sophisticated equipment for its implementation. With proper training, patients can learn to perform this technique autonomously at home, which favors treatment continuity and reduces dependence on frequent medical interventions. However, it is essential that the initial instruction is provided by an experienced physiotherapist to ensure that the technique is executed correctly and potential complications are avoided.

Despite its many benefits, LPR also has some limitations. For example, its effectiveness may be compromised in patients with extremely viscous secretions or severe obstructions that prevent the passage of air even during controlled expiration. In these cases, LPR may need to be supplemented with other treatments, such as the administration of mucolytic medications or the use of respiratory assist devices. In addition, in patients with cognitive impairment or severe physical limitations, performing the technique may be difficult without the assistance of a professional or caregiver.

Scientific evidence supports the efficacy of LPR in a variety of clinical settings, although there are still areas where further research is required. Future studies could focus on comparing its effectiveness with other respiratory physiotherapy techniques and exploring its application in specific populations, such as children, the elderly or post-surgical patients. In addition, the incorporation of technological tools, such as sensors to monitor respiratory flows in real time, could improve the accuracy and results of this technique.

Prolonged Slow Breathing is an effective and accessible technique that plays a key role in the management of lung secretions and in the optimization of respiratory function. Its non-invasive approach, combined with its ability to adapt to individual patient needs, makes it a valuable tool in respiratory physiotherapy. Although it has certain limitations, its proper implementation can significantly improve the quality of life of patients and contribute to the comprehensive management of chronic respiratory diseases.

Acapella

The Acapella technique is a therapeutic modality widely used in respiratory physiotherapy to facilitate bronchial cleansing and improve lung function in patients with chronic or obstructive respiratory diseases. This device combines the principles of positive expiratory pressure (PEP) and oscillatory vibrations, offering an effective and accessible solution to mobilize lung secretions and prevent complications associated with their accumulation.

This technique is a portable and easy-to-use device that consists of an adjustable resistance system and an internal mechanism that generates vibrations during expiration. Its design allows patients to use it in various positions, such as sitting, standing or even lying down, which increases its versatility and facilitates its integration into the patient's daily routine (23).

The operation of the Acapella is based on two fundamental principles: positive expiratory pressure (PEP) and high-frequency oscillations. During expiration through the device, the patient must overcome a resistance, which generates positive pressure in the airways. This helps keep them open, preventing the collapse of the small airways and allowing for more even airflow to the peripheral areas of the lung. In addition, the internal mechanism of the Acapella produces vibrations during expiration, which are transmitted to the respiratory tract. These oscillations help to reduce the viscosity of mucus and facilitate its detachment from the bronchial walls, promoting its mobilization to the central airways for subsequent elimination by coughing or assisted drainage (23).

The Acapella technique is indicated for a wide range of respiratory conditions, including bronchiectasis, cystic fibrosis, chronic obstructive pulmonary disease (COPD), asthma with hypersecretion, recurrent respiratory infections, and post-surgical conditions requiring prevention of atelectasis. The use of Acapella offers several benefits for patients. The combination of PEP and vibration helps to mobilise and remove secretions more efficiently than traditional respiratory physiotherapy techniques. By clearing the airways of secretions, ventilation and gas exchange are optimized, reducing hypoxemia and improving oxygen saturation. In addition, regular mucus clearance reduces the risk of infections and acute exacerbations in chronic diseases, improving the clinical stability of the patient. Its intuitive design allows patients to use it autonomously at home, which favors adherence to treatment. Unlike other devices, the Acapella can be used in different body positions, adapting to the patient's individual needs.

To use Acapella correctly, several steps must be followed. It is important to ensure that the device is clean and ready for use, adjusting the resistance as directed by the physiotherapist or healthcare professional. The patient may be sitting, standing, or lying down, depending on their comfort and fitness. It is essential to maintain a posture that favors thoracic expansion. The patient inhales deeply and then exhales through the device in a slow and controlled manner, repeating this process several times according to the indicated protocol. After several exhalations, the patient is instructed to perform controlled coughing maneuvers to remove the mobilized mucus. After each session, the device should be properly cleaned to prevent the accumulation of bacteria and ensure optimal operation (23).

Although the Acapella is an effective tool, it has some limitations that need to be considered. In patients with severe obstructions or extremely viscous secretions, its efficacy may be lower without the combination of other therapies. It requires initial learning for its correct use, which can be a challenge in patients with cognitive impairment or lack of family support. It does not replace other respiratory management strategies, such as the use of bronchodilators, but must be integrated into a complete therapeutic plan.

The aforementioned technique continues to be researched to optimize its efficacy and expand its clinical applications. Future innovations could include devices with real-time feedback to monitor the quality of expiratory flow and pressure generated, as well as the development of specific models for different patient groups. Acapella is a highly effective and versatile tool in respiratory physiotherapy, designed to improve bronchial cleansing and reduce complications associated with secretion retention. Its ease of use, combined with its therapeutic benefits, makes it an ideal choice for patients with chronic or acute respiratory diseases. Properly integrated into a treatment plan, Acapella can significantly contribute to improving patients' quality of life and optimizing clinical outcomes.

However, within the second stage, some techniques can be considered, such as those detailed below.

Breathing exercises

Breathing exercises are interventions designed to strengthen the respiratory muscles, improve lung ventilation, and increase the efficiency of gas exchange. These exercises can be tailored to the specific needs of each patient, and their effectiveness depends on consistency and proper supervision during practice.

Diaphragmatic breathing exercise

This type of exercise focuses on optimizing the use of the diaphragm, the main muscle of breathing. To perform it, the patient must be in a comfortable position, usually sitting or lying down. He is instructed to place one hand on the abdomen and the other on the chest to identify breathing movements (11). When breathing in, the patient should focus on expanding the abdomen while keeping the chest as still as possible. During exhalation, the patient is encouraged to gently contract the abdomen to expel air efficiently. This exercise improves ventilation of the lung bases, reduces work of breathing, and promotes relaxation, which is useful in patients with dyspnea-related anxiety. In addition, it can be beneficial in preventing post-surgical complications such as atelectasis.

Pursed-lip breathing

Puckered lip breathing is a simple technique that helps prolong exhalation and reduce air entrapment in the lungs. To perform it, the patient inhales slowly through the nose and then exhales gently through pursed lips, as if blowing out a candle. This exercise can be performed at any time and is particularly useful during episodes of acute dyspnea. Benefits include improved oxygenation, decreased feelings of shortness of breath, and better respiratory rate control. In addition, this technique helps patients to remain calm during episodes of exacerbation of chronic lung diseases (11).

Thoracic expansion exercises

These exercises focus on improving rib cage mobility and increasing lung capacity. Patients should take a deep breath while expanding the chest as much as possible, holding the inspiration for a few seconds before exhaling in a controlled manner (12). This type of exercise can be performed several times a day, with repetitions adjusted according to the patient's tolerance. Regular practice of these exercises helps prevent chest stiffness, improves ventilation in previously underutilized lung regions, and promotes the elimination of retained secretions. In addition, they can be combined with feedback devices to monitor the patient's progress.

Inspiratory Muscle Training

Strengthening of inspiratory muscles can be achieved through the use of resistance devices. These devices allow the patient to breathe in against controlled resistance, which strengthens the diaphragm and other respiratory muscles. This type of training is especially effective in improving endurance and reducing fatigue in patients with chronic respiratory diseases (12).

Benefits of bronchial cleansing in the management of COPD

Chronic obstructive pulmonary disease (COPD) is a chronic respiratory condition characterized by progressive airflow

obstruction and an abnormal inflammatory response in the airways. This disease, which includes conditions such as chronic bronchitis and pulmonary emphysema, generates an excessive accumulation of secretions, which contributes to the deterioration of lung function and the decrease in patients' quality of life (13). Bronchial cleansing is a key therapeutic intervention in the management of COPD, as it facilitates the elimination of secretions, improves ventilation and reduces respiratory symptoms. This analysis explores the benefits of bronchial cleansing and its impact on the comprehensive management of this disease.

One of the main benefits of bronchial cleansing is improved lung function. Excessive secretions in the airways are common in patients with COPD and can obstruct airflow, reduce gas exchange, and contribute to air entrapment in the lungs. Through techniques such as mechanical aspiration, Acapella or some of those mentioned, it is possible to mobilize and eliminate these secretions, which allows a better passage of air and greater respiratory efficiency. Removing secretions also reduces resistance to airflow in the airways, which decreases the effort required to breathe. This not only relieves dyspnea, but also reduces the load on the respiratory muscles, allowing the patient to conserve energy for other activities. In addition, bronchial cleansing improves oxygenation by facilitating more even ventilation in the lungs, resulting in more efficient gas exchange (13).

The accumulation of secretions in the respiratory tract creates an environment conducive to the growth of pathogenic microorganisms, which increases the risk of respiratory infections. These infections, such as pneumonia, are a common cause of exacerbations in COPD patients and contribute to the rapid deterioration of lung function. Bronchial cleansing plays a crucial role in preventing these infections by removing secretions where pathogens can proliferate. Through regular bronchial cleansing techniques, the bacterial load in the respiratory tract is reduced, which decreases the incidence of infections and their associated complications. In addition, by keeping the airways clear, the ability of the local immune system to respond to potential threats is improved, strengthening the body's natural defense.

Exacerbations are acute episodes of worsening respiratory symptoms in patients with COPD, and their management represents a significant clinical challenge. These exacerbations are frequently triggered by the accumulation of secretions, respiratory infections or excessive inflammation in the airways. Bronchial cleansing contributes significantly to reducing the frequency and severity of these exacerbations (14). By keeping the airways free of secretions, triggers that can precipitate an exacerbation are minimized. This, in turn, reduces the need for hospitalizations and the use of rescue medications, improving overall disease control. In addition, a lower frequency of exacerbations is associated with slower progression of COPD, which prolongs survival and improves the patient's quality of life.

The buildup of secretions in the airways contributes to the onset of debilitating symptoms such as chronic cough, dyspnea, and a feeling of chest tightness. These symptoms not only affect lung function, but also have a negative impact on the patient's quality of life and ability to perform daily activities. Bronchial cleansing provides immediate and effective relief from these symptoms by clearing the airways and improving airflow. Reducing chronic cough and dyspnea allows patients to feel more comfortable and relaxed, which improves their overall well-being. In addition, by relieving the feeling of chest tightness, more natural and efficient breathing is promoted.

COPD has a significant impact on patients' quality of life, limiting their ability to perform daily activities, enjoy hobbies, and maintain social relationships (15). Bronchial cleansing, by relieving respiratory symptoms and improving lung function, directly contributes to improving the quality of life of these patients. With less dyspnea and greater exercise tolerance, patients can participate more actively in their daily activities and maintain a more independent lifestyle. In addition, by reducing the incidence of exacerbations and hospitalizations, bronchial cleansing decreases the stress associated with the disease and improves the emotional well-being of patients. This comprehensive benefit is critical to promoting a fuller and more fulfilling life.

Bronchial cleansing also promotes patients' autonomy in the management of their disease. By learning techniques such as assisted coughing, controlled breathing, and the use of secretion removal devices, patients gain tools to manage their symptoms effectively at home. This autonomy not only reduces dependence on medical services, but also increases the patient's confidence in their ability to control the disease (16). Empowering patients through education and regular practice of bronchial cleansing also improves adherence to treatments and promotes better long-term outcomes. This patient-centred approach is key to ensuring successful management of COPD and to promoting greater satisfaction with the care received.

COPD is an expensive disease to manage due to frequent hospitalizations, drug treatments, and recurrent exacerbations. Bronchial cleansing, by reducing the frequency of these exacerbations and preventing respiratory complications, contributes significantly to reducing the costs associated with the disease. By maintaining better symptom control and improving lung function, patients require fewer hospital visits and fewer emergency interventions. This not only benefits patients, but also eases the economic burden on health systems, allowing for a more efficient allocation of available resources.

Role of the physiotherapist in bronchial cleansing and patient education

In the context of health care, individualised assessment and the design of personalised programmes are fundamental pillars to guarantee an effective intervention adapted to the specific needs of each patient. This approach, focused on the uniqueness

of each individual, is especially relevant in the management of chronic conditions, rehabilitation and disease prevention, where variations in clinical, functional and personal characteristics significantly influence therapeutic outcomes.

Individualized assessment involves an exhaustive and detailed analysis of the patient's state of health, considering both physical and psychological, social and environmental aspects. This process allows us to identify not only immediate clinical needs, but also factors that may influence disease progression, adherence to treatment, and quality of life.

Each patient has a unique combination of risk factors that can impact their health. Individualized assessment allows the identification of these factors, such as comorbidities, lifestyle habits, level of physical activity, nutritional status, and family history. This knowledge is essential for establishing therapeutic priorities and designing preventive strategies (17). For example, in a patient with chronic obstructive pulmonary disease (COPD), the assessment may include pulmonary function tests, arterial gas analysis, and assessment of daily activity level. These data help to personalize treatment, adjusting pharmacological management and designing interventions such as pulmonary rehabilitation programs.

In addition to addressing clinical aspects, the individualized assessment also focuses on the patient's functionality. This includes assessing the ability to perform daily activities, mobility, and cognitive status. The information obtained allows for the design of interventions that not only improve physical health, but also promote the patient's independence and emotional well-being.

Once the individualized assessment has been carried out, the design of personalized programs is the next step. These programs seek to maximize therapeutic benefits by tailoring interventions to each patient's unique characteristics, ensuring they are practical, effective, and sustainable. In the area of rehabilitation, personalized programs are essential to address functional limitations and promote recovery. These programs include specific exercises designed to improve strength, flexibility, balance, and endurance, adjusting to each patient's level of physical ability (18).

Nutrition is another area where personalization plays a crucial role. Nutritional programs designed specifically for each patient consider factors such as metabolic status, food preferences, dietary restrictions, and energy needs. This is particularly important in patients with chronic diseases, where proper nutrition can significantly influence disease control and the prevention of complications. Emotional well-being is an integral component of health. Personalized programs also include psychological interventions tailored to patients' emotional and social needs. Therapies such as cognitive behavioral psychotherapy, meditation, and stress management techniques can be adjusted to address specific issues such as anxiety, depression, or coping with chronic illnesses.

Tailoring interventions to individual needs significantly improves clinical outcomes. Patients who participate in personalized programs tend to show higher adherence rates, fewer complications, and faster recovery compared to those who receive standardized treatments. Personalization also has economic implications. By focusing on specific interventions and avoiding unnecessary or ineffective treatments, the use of healthcare resources is optimized and the economic burden on both health systems and patients is reduced.

Patients value interventions that consider their personal needs and preferences positively. Not only does this improve the patient experience, but it also strengthens the therapeutic relationship and encourages greater active participation in their health care. Despite the obvious benefits, the implementation of individualized assessments and personalized programs faces several challenges. These include the need for specialized training, the time required to conduct detailed assessments, and limited access to resources in some clinical settings (18).

The use of technology can facilitate the implementation of customized programs. Tools such as mobile apps, wearable monitoring devices, and digital platforms for remote tracking allow for continuous evaluation and dynamic adjustment of interventions, improving efficiency and accessibility. Collaboration between professionals from different disciplines is essential to comprehensively address the needs of the patient. Multidisciplinary teams that include physicians, physical therapists, nutritionists, psychologists, and social workers can develop more comprehensive and effective programs.

The main educational strategies to promote adherence to respiratory interventions focus on activities that help promote adherence to respiratory interventions requires a comprehensive approach that combines personalized educational strategies, the use of technological tools and the active participation of the patient and their environment. Personalized education is essential, as it allows the patient to be instructed about their respiratory disease, clearly explaining how it affects their body and the importance of treatment. It is crucial to demonstrate in a practical way the correct use of devices such as inhalers, nebulizers or positive pressure equipment, making sure that the patient understands and can replicate these techniques. In addition, it is necessary to answer all the doubts that the patient may have, eliminating any knowledge barrier that hinders adherence (19).

Another key element is to set realistic and achievable goals, designing specific objectives that the patient can meet progressively. These goals should be built together with the patient, fostering their sense of responsibility and active participation in the treatment. To complement, educational materials such as brochures, videos or infographics that explain in a simple way the techniques and benefits of respiratory interventions should be provided. These materials must be adapted to the patient's educational and cultural level, ensuring their understanding.

The use of technology can be a powerful tool for monitoring and reinforcement. Mobile applications, digital reminders and telemedicine platforms help the patient to maintain a constant routine, also allowing them to monitor their progress and provide feedback in real time. At the same time, the inclusion of the family or caregivers in the educational process is essential. It is important to instruct them on respiratory techniques and their role in patient support, creating a collaborative environment that favors adherence (19).

Positive reinforcement also plays an important role in patient motivation. Recognizing and praising their efforts, as well as showing concrete progress, helps to reinforce their commitment. It is equally important to educate the patient about the short- and long-term benefits of respiratory interventions, highlighting immediate improvements such as the ability to breathe better, and long-term benefits such as the prevention of exacerbations and the improvement of quality of life. In addition, identifying potential barriers, such as lack of time, forgetfulness or discomfort, and working together to overcome them, can make all the difference in adherence. For example, adjusting interventions to be less invasive or more manageable can facilitate compliance.

At each visit, the patient's progress should be reviewed and the importance of continuing with respiratory interventions should be reinforced. This constant feedback helps maintain patient engagement and allows for customized adjustments as needed. Finally, group sessions and educational workshops can be valuable tools to strengthen adherence, by providing a space where patients share experiences, learn together, and find motivation in the community. With these strategies, it is possible to ensure a sustained commitment to respiratory interventions, optimizing outcomes and improving patients' quality of life.

4. DISCUSSION

The discussion of the results obtained in this study on bronchial cleansing in older adults with chronic obstructive pulmonary disease (COPD) highlights the importance of implementing personalized and evidence-based strategies to optimize the management of this pathology. From the analysis carried out, several key aspects emerge that underscore the effectiveness of targeted interventions and the relevance of addressing the specific needs of this vulnerable population.

First, the physiological changes associated with aging significantly aggravate the course of COPD, reinforcing the need for individualized assessment. Progressive decrease in lung elasticity, reduction in respiratory muscle strength, and deterioration of mucociliary clearance contribute to increased secretion retention and difficulty in maintaining adequate ventilation. In this sense, bronchial cleansing techniques and breathing exercises prove to be effective tools to improve the elimination of secretions and reduce the risk of exacerbations. The results indicate that these interventions not only facilitate bronchial hygiene, but also contribute to improving functional parameters, such as oxygen saturation and lung capacity.

The analysis also highlights the benefits of bronchial cleansing in the comprehensive management of COPD. These interventions not only relieve respiratory symptoms, such as dyspnea and productive cough, but also improve quality of life by reducing fatigue and increasing exercise tolerance. In addition, the implementation of personalised programmes allows techniques to be adapted to the individual characteristics of each patient, guaranteeing greater efficiency and safety. In patients with physical limitations or comorbidities, the design of adapted programs is essential to avoid complications and maximize therapeutic benefits.

Another relevant aspect identified in the results is the importance of education and adherence to respiratory interventions. Educational strategies play a crucial role in patient motivation and improving long-term adherence. Educational programs that include hands-on demonstrations, informational materials, and follow-up sessions help empower the patient, encouraging their active participation in disease management. In addition, the involvement of caregivers and the family in the educational process reinforces social support, creating a more favorable environment for the application of the techniques.

Despite the benefits observed, some challenges and limitations were also identified. The variability in response to bronchial cleansing techniques highlights the need for constant monitoring and adjustments in interventions. Some patients, especially those with advanced COPD, may require combinations of techniques or the use of complementary devices to achieve optimal results. In addition, factors such as age, level of disease severity, and the presence of comorbidities can influence the effectiveness of interventions, underscoring the importance of a multidisciplinary approach in COPD management.

From an economic and access to services perspective, barriers to the implementation of these interventions must also be considered. The cost of some devices or the unavailability of resources in certain settings can limit patient access to these techniques. Therefore, it is crucial to develop strategies that promote equity in care, such as training health workers in remote communities and implementing public health programs that include these interventions.

The use of technology also emerges as a valuable tool to improve adherence and tracking. Mobile apps, remote monitoring devices, and digital platforms can facilitate patient education and ongoing monitoring of their health status. These tools allow interventions to be adjusted in real time, improving the efficiency and effectiveness of treatment. However, it is important to consider the digital divide and ensure that these solutions are accessible to all patients, regardless of their socioeconomic status or technological experience.

Finally, the results highlight the importance of promoting future research that deepens the evaluation of bronchial cleansing techniques and their long-term impact on the progression of COPD. Larger-scale controlled studies will validate the findings obtained and establish more robust clinical guidelines for the management of this disease. In addition, exploring new techniques and combinations of interventions could pave the way for more effective strategies adapted to the changing needs of patients.

Aging introduces a series of physiological changes that aggravate the progression of COPD in older adults. Structural and functional alterations of the respiratory system, together with immunological and cardiovascular modifications, contribute to the severity of symptoms and limit the ability to respond to treatment. Recognizing these interactions is essential to develop more effective and personalized therapeutic strategies that improve the quality of life of this vulnerable population (20).

The techniques analyzed in this article represent valuable tools in the comprehensive management of patients with respiratory difficulties. Its application must be personalized, taking into account the individual needs, contraindications and tolerance capacity of each patient. In addition, supervision by a trained physiotherapist is essential to ensure the safety and effectiveness of these interventions (20).

When implemented properly, these techniques not only contribute to improved lung function, but also increase patients' quality of life by reducing dyspnea, facilitating the elimination of secretions, and optimizing functional capacity. The integration of these strategies into pulmonary rehabilitation programs can also enhance therapeutic outcomes and promote greater autonomy in the management of chronic respiratory diseases.

Conclusion

Bronchial cleansing is an essential therapeutic intervention in the management of COPD, with clear benefits in improving lung function, preventing infections, reducing exacerbations, and relieving respiratory symptoms. In addition, this technique promotes a better quality of life, encourages patient autonomy and contributes to the reduction of costs associated with the disease. Its regular and proper implementation, under the supervision of health professionals, is essential to ensure successful management of this complex chronic disease.

Individualized assessment and personalized program design represent a fundamental approach in modern healthcare. By considering the unique characteristics of each patient, these strategies not only optimize clinical outcomes, but also improve the patient experience and contribute to a more efficient and sustainable healthcare system. Implementing this approach requires commitment, innovation, and a collaborative approach, but the potential benefits amply justify the effort.

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