ORIGINAL RESEARCH

The Clinical Efficacy of Combining Ambroxol Hydrochloride with Antibiotics for the Treatment of Chronic Bronchitis

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ABSTRACT

Objective • To evaluate the clinical efficacy and impact on pulmonary function of ambroxol hydrochloride combined with antibiotics in the treatment of chronic bronchitis.

Methods • This randomized controlled trial involved the enrollment and randomization of 98 CB patients admitted to Anting Hospital from January 2020 to January 2021, with participants divided into an observation group and a control group at a 1:1 ratio, comprising 49 cases in each group. The control group received cefmetazole alone, whereas the observation group received ambroxol hydrochloride combined with antibiotics. The two groups were compared in terms of time required for mitigation of clinical symptoms, clinical effectiveness, and indicators for pulmonary function.

Results • The observation group showed a reduction in symptom disappearance time by 3.3 days and a 9% higher total effective rate compared to the control group. After treatment, the observation group had elevated FEV1 (22.64%), FVC (31.64%), and FEV1/FVC (9.79%) compared with the control group.

Conclusion • Ambroxol hydrochloride combined antibiotics are effective in the treatment of CB, indicating potential for enhanced quality of life and reduced disease burden for patients with chronic bronchitis. (*Altern Ther Health Med.* 2025;31(1):161-167).

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INTRODUCTION

Chronic bronchitis (CB) is a chronic non-specific inflammation of the trachea, bronchial mucosa, and surrounding tissues in the respiratory system, with a higher occurrence among middle-aged and elderly populations.[1] The prevalence of CB varies throughout the world, ranging from 3.4%–22.0% in the general population to up to 74.1% in patients with chronic obstructive pulmonary disease[2] Such a disease primarily affects the bronchi, tracheal mucosa, and surrounding tissues, and the clinical signs are mainly cough, expectoration, and even pulmonary dysfunction in severe cases.[3] Patients who present with symptoms above are eligible for diagnosis and suffer from episodes for 3 months per year and 2 years or longer.[4] The recurrent attacks of CB may be responsible for chronic obstructive pulmonary emphysema, pulmonary heart disease, and even an elevated risk of mortality from respiratory distress and heart failure.[5] Moreover, individuals suffering from chronic bronchitis reported a lower quality of daily life compared to the general population. Particularly notable were the declines in physical functioning, especially among women and those diagnosed with COPD.[6] The current treatment approach for CB involves anti-infection measures, bronchodilation, cough and expectoration management, and medication. Conventional medications, including cough and asthma suppressants, are commonly used, along with traditional Chinese medicine (TCM) interventions.[7] Nevertheless, conventional therapies for chronic bronchitis face limitations, including antibiotic resistance, variable efficacy of bronchodilators, and potential systemic side effects from long-term medication use. This underscores the importance of exploring alternative or adjunctive therapies, like the combination therapy under investigation, to address these shortcomings.[2] Traditional Chinese medicine plays a significant role in the management of CB. In TCM, CB is classified as "asthma" and is associated with pathogenic factors such as phlegm-heat stagnation, liver-fire, and phlegm dampness. These pathogenic factors are closely related to deficiencies in lung qi, spleen and kidney health, and qi stagnation. Therefore, TCM treatment focuses on nourishing weakness, resolving phlegm, tonifying the kidneys and spleen, and regulating qi. TCM interventions often include herbal remedies and decoctions tailored to address CB's specific patterns and symptoms. In the present study, an additional TCM intervention, Xuanfei Huatan

decoction, was administered along with conventional treatment. This decoction consisted of various herbs known for promoting expectoration, resolving phlegm, and improving respiratory function[8,9]

Antibiotics are a class of secondary metabolites produced by animals, plants, or microorganisms (including bacteria, fungi, and actinomycetes) that can inhibit the growth of pathogens or interfere with the essential functions of other living cells. They are commonly used in clinical settings to eliminate bacteria not supposed to be present in the human body.[10,11] Antibiotics used in clinical practice include compounds derived from microbial cultures and synthesized or semi-synthesized compounds.[12]

Ambroxol hydrochloride is an organic compound with the chemical name 2-amino-3,5-dibromo-N-(trans-4-hydroxycyclohexyl)benzylamine, and its chemical formula is C13H18Br2N2O·HCl, with a molecular weight of 414.56.[13] Previous research has demonstrated that ambroxol hydrochloride is an effective antitussive and expectorant agent that promotes the clearance of mucus and dissolution of secretions, thereby facilitating the removal of thick secretions in the respiratory tract and reducing mucus accumulation. This significantly reduces mucus production, enhances expectoration, and improves respiratory function.[14] Currently, it is primarily used to treat acute and chronic respiratory diseases characterized by abnormal sputum production and impaired coughing ability. Combining ambroxol hydrochloride with antibiotics offers synergistic benefits for chronic bronchitis treatment. Ambroxol hydrochloride's mucolytic properties enhance antibiotic effectiveness by reducing mucus viscosity and facilitating bacterial clearance.

In this study, we propose the combination of ceftriaxone sodium with amiloride hydrochloride for the treatment of chronic bronchitis (CB). This drug combination can be administered intravenously to accelerate sputum clearance and alleviate clinical symptoms such as cough and excessive sputum production. The aim of our study is to assess the additive or synergistic effects of combining ambroxol hydrochloride with antibiotics for chronic bronchitis treatment, elucidating the unique contribution of this combination therapy to CB management research.

MATERIALS AND METHODS

Baseline data

98 patients diagnosed with chronic bronchitis (CB) were admitted to Anting Hospital between January 2020 and January 2021. They were randomly assigned in a 1:1 ratio to either an observation group (n = 49) or a control group (n = 49) using the sealed envelope method. Randomization of patients into the observation and control groups was achieved using the sealed envelopes method. Each envelope contained a group assignment (observation or control) determined through computer-generated randomization prior to the study. Upon enrollment, patients sequentially selected envelopes, ensuring an unbiased and random allocation of participants to each group. This method minimized selection bias and enhanced the validity of the study results. The study received ethical approval from the Anting Hospital Ethics Committee (Approval No. 2019/23-349). Informed consent was obtained from all patients and their caregivers. Randomization and group allocation were conducted by an independent research assistant not involved in patient screening or assessment.

Inclusion and exclusion criteria

Inclusion criteria: Patients who met the clinical diagnostic criteria for CB[15] (patients had a cough and mucus most days for at least 3 months a year, 2 years in a row), had no other chronic airway diseases and had a score of ≤1 for the primary symptoms of CB (cough, sputum production, and wheezing). The age range for inclusion was 18 to 75 years, and both genders were eligible.

Exclusion criteria: Patients who had experienced an acute exacerbation of CB within the past month, had a post-bronchodilator forced expiratory volume in 1 second (FEV1) percentage <80% (indicating compromised lung function), had impaired consciousness or communication difficulties, had organ dysfunction (such as cardiac, hepatic, or renal impairment), or withdrew from the study due to transfer to another hospital or other reasons.

Methods

Upon admission, all patients received standard treatment, including asthma management, oxygen therapy, antispasmodics, infection control, expectorants, and cough suppressants.

Asthma management: Patients with CB often exhibit symptoms resembling those of asthma, such as wheezing and airway constriction. Therefore, asthma management strategies, including bronchodilators and anti-inflammatory medications, were employed to alleviate airway inflammation and improve bronchial airflow, thereby ameliorating respiratory symptoms.

Oxygen therapy: Hypoxemia, or low blood oxygen levels, commonly occurs in patients with CB due to impaired lung function and reduced gas exchange efficiency. Oxygen therapy was administered to supplement oxygen levels in the bloodstream, alleviating symptoms of hypoxemia such as shortness of breath and fatigue, and improving overall tissue oxygenation.

Antispasmodics: Bronchospasm, characterized by sudden constriction of the airway muscles, can exacerbate respiratory symptoms in patients with CB. Antispasmodic medications were administered to relax bronchial smooth muscle and alleviate bronchospasm, thereby facilitating easier breathing and reducing cough severity.

Infection control: Chronic bronchitis is often associated with recurrent respiratory infections, which can exacerbate inflammation and worsen symptoms. Therefore, measures to control and prevent infections, such as antibiotic therapy and meticulous respiratory hygiene practices, were implemented to reduce the frequency and severity of infectious exacerbations.

Expectorants and cough suppressants: Excessive mucus production and persistent cough are hallmark features of CB. Expectorant medications were administered to promote the clearance of mucus from the airways, while cough suppressants were used to alleviate cough and improve patient comfort, thereby facilitating symptom management and enhancing quality of life.

The control group received antibiotic therapy. Cefmetazole sodium (4.0 g, Sichuan Hexin Pharmaceutical Co., Ltd., H20061300) was dissolved in 250 ml of normal saline and administered once daily via intravenous infusion. Levofloxacin (100 ml, Sichuan Kelun Pharmaceutical Co., Ltd., H20044291) was administered in two divided doses daily via intravenous injection. The treatment duration was two weeks, during which patients were instructed to follow a bland diet and avoid spicy and irritating foods.

In addition to the standard treatment received by the control group, the observation group was treated with ambroxol hydrochloride. Ambroxol hydrochloride injection (30 mg, Tianjin Pharmaceutical Research Institute Pharmaceutical Co., Ltd.) was dissolved in 100 ml glucose injection and administered twice daily via intravenous infusion. The treatment duration was also two weeks, with dietary restrictions similar to those of the control group. Both groups were also prescribed Xuanfei Huatan decoction, comprising loquat leaf (15 g), Radix Platycodon (10 g), Radix Stemonae (10 g), cynanchum stauntoni (10 g), cortex mori radicis (10 g), houttuynia cordata (20 g), and almond (10 g), to be taken once daily. The decoction was divided into two doses to be consumed in the morning and evening. The treatment duration for both groups was two weeks. Ambroxol hydrochloride is expected to enhance treatment outcomes by promoting mucus clearance and improving respiratory function. Its mucolytic properties help to reduce mucus viscosity, facilitating the removal of secretions from the respiratory tract. By combining ambroxol hydrochloride with antibiotics, we aimed to create an environment conducive to bacterial eradication and symptom relief, thereby improving overall treatment efficacy for chronic bronchitis.

Dietary restrictions: Patients were advised to adhere to a bland diet, which typically includes easily digestible foods such as rice, boiled vegetables, lean proteins, and soups. This dietary approach helps to minimize gastrointestinal discomfort and reduce the risk of exacerbating digestive symptoms, which can be common in individuals with respiratory conditions.

Furthermore, patients were advised to avoid consuming spicy and irritating foods, such as heavily seasoned dishes, hot sauces, and acidic foods like citrus fruits and tomatoes. Spicy and irritating foods have the potential to trigger or exacerbate respiratory symptoms, including coughing and throat irritation, due to their irritating effects on the respiratory mucosa. By avoiding these foods, patients can minimize potential exacerbations of CB symptoms and optimize their response to treatment.

These dietary recommendations were intended to complement the medical management of CB by promoting patient comfort and reducing factors that could potentially worsen respiratory symptoms.

Outcome

Time Taken for Mitigation of Clinical Symptoms. The time it took for the clinical symptoms of cough, wheezing, and expectoration to disappear was recorded and compared between the two groups.

Clinical Efficacy. The clinical outcomes of the two groups were assessed based on clinical symptoms and chest X-ray findings. The outcomes were categorized as follows:

Cured: All clinical symptoms disappeared after treatment, and the chest X-ray showed the disappearance of thickening and disordered lung texture.

Improved: The patient's clinical symptoms and lung texture significantly improved after treatment.

Ineffective: The clinical symptoms did not improve, and the texture of the lungs remained thickened and disordered.

The total clinical effective rate was calculated and compared between the two groups. The total clinical effective rate was determined using the formula: Total Clinical Effective Rate = (Cured + Improved) / Total Number of Cases × 100%

Indexes for Pulmonary Function. The pulmonary function indexes of the two groups were measured using a spirometer. The S-980A II spirometer (purchased from Sichuan Skoda Technology) was used for the measurements. The patient was positioned in a standing position and instructed to take maximum inspiration to the total lung volume position, hold their breath for 1 second, and then exhale with maximum effort and at the fastest speed to the residual volume position. This process was repeated for even and rapid exhalation, and the forced vital capacity (FVC) was measured twice. The forced expiratory volume in one second (FEV1) was measured as the volume of gas exhaled in the first second after a deep, forceful inhalation followed by an exhalation as hard as possible. The maximum voluntary ventilation (MVV) was determined by multiplying the volume of 12 breaths at the maximum speed of the subject, taken once per second, and then multiplying it by 5.

Rationale for the use of these indexes: FVC measures the total amount of air forcibly exhaled after a deep inhalation and reflects lung capacity. In CB, reduced FVC indicates impaired lung function and decreased respiratory reserve, often associated with airway obstruction and inflammation.

FEV1 measures the volume of air forcefully exhaled in the first second of the FVC maneuver and serves as a sensitive indicator of airway obstruction. Decreased FEV1 is characteristic of obstructive lung diseases like CB and reflects narrowed airways and increased airway resistance.

MVV assesses the maximum volume of air that a person can inhale and exhale per minute during rapid and deep breathing and reflects overall respiratory muscle strength and endurance. In CB, reduced MVV may indicate respiratory muscle weakness and impaired lung mechanics, contributing to respiratory symptoms and decreased exercise tolerance.

Table 1. General data

Grouping	n	Gender (Male/Female)	Age (±s, year old)	Disease course (±s, day)
Observation group	49	27/22	55.69±4.98	7.68±1.28
Control group	49	26/23	55.15±5.21	7.54±1.67
t		0.041	0.524	0.466
P value		.839	.601	.642

Table 2. Time taken for clinical symptom mitigation (±s, d)

Grouping	n	Cough	Wheezing	Expectoration
Observation group	49	5.17±1.35	2.84±1.48	4.85±1.48
Control group	49	8.23±2.24	7.15±1.24	7.44±2.23
t		8.190	15.626	6.774
P value		<.001	<.001	<.001

Table 3. Clinical efficacy (n, %)

Grouping	n	Cured	Improved	Ineffective	Total effectiveness
Observation group	49	23 (46.94)	24 (48.98)	1 (2.04)	48 (97.96)
Control group	49	14 (28.57)	25 (51.02)	10 (20.41)	39 (79.59)
χ^2		8.295			
P value		.004			

Table 4. Pulmonary function (±s)

		Pre-treatment			Post-treatment		
Grouping	n	FEV1(L)	FVC(L)	FEV1/FVC (%)	FEV1(L)	FVC(L)	FEV1/FVC (%)
Observation group	49	1.15±0.16	1.83±0.19	60.12±4.35	1.95±0.83[a]	3.37±0.28[a]	74.12±5.14[a]
Control group	49	1.18±0.12	1.81±0.20	60.31±4.03	1.59±1.01[a]	2.56±0.48[a]	67.51±5.02[a]
t		1.050	0.507	0.224	2.035	10.203	6.440
P value		.296	.613	.823	.045	<.001	<.001

[a]indicates significant difference before and after treatment in the same group ($P < .05$)

Note: FEV1 is the forced expiratory volume in the first second; FVC is the forced vital capacity.

Statistical Analysis

Statistical analyses were performed using SPSS 22.0 software. Categorical data, such as clinical outcomes, were analyzed using chi-square tests to compare proportions between the observation and control groups. Continuous data, including pulmonary function indexes, were expressed as mean ± standard deviation ($\bar{x} \pm s$) and analyzed using independent *t* tests to compare means between the two groups. A significance level of $P < .05$ was used to determine statistical significance.

RESULTS

Baseline Characteristic

In this study, we evaluated the baseline characteristics of both the observation and control groups. The observation group consisted of 27 men and 22 women with an age range of 39-71 years and a mean age of 55.69±4.98 years. The disease duration in this group ranged from 3 to 15 years, with a mean duration of 7.68±1.28 years. The control group included 26 men and 23 women aged 42-70 years and a mean age of 55.15±5.21 years. The disease duration in the control group ranged from 3 to 14 years, with a mean duration of 7.54±1.67 years. There were no statistically significant differences in the data between the two groups (Table 1).

Time Taken for Mitigation of Clinical Symptoms

Compared to antibiotics alone, the combination of ambroxol hydrochloride with antibiotics resulted in a significantly shorter duration (a reduction of 3.3 days) for the disappearance of cough, wheeze, and expectoration in the observation group. The mean durations for symptom disappearance in the observation group, comprising 49 patients, were (5.17±1.35 days) for cough, (2.84±1.48 days) for wheezing, and (4.85±1.48 days) for expectoration, while in the control group, consisting of 49 patients, the mean durations were (8.23±2.24 days) for cough, (7.15±1.24 days) for wheeze, and (7.44±2.23 days) for expectoration, and the difference was statistically significant (Table 2). A shorter duration of symptoms can lead to improved patient comfort, enhanced functional capacity, and reduced healthcare resource utilization. Patients experiencing less prolonged symptoms may require fewer medical interventions, including hospital admissions, outpatient visits, and medication usage, ultimately resulting in cost savings and improved overall patient satisfaction.

Clinical Efficacy

The observation group, comprising 49 patients, showed a 9% higher total effective rate compared to the control group, including 49 patients. In the control group, 23 patients were cured, 24 cases improved, and 1 case showed ineffective, resulting in a total effective rate of 97.96% (48/49). In the observation group, 14 patients were cured, 25 cases improved, and 10 cases showed ineffective, resulting in a total effective rate of 79.59% (39/49). The overall effective rate was significantly higher in the observation group than in the control group, and the difference was statistically significant (Table 3).

Indicators for Pulmonary Function

Before therapy, there were no significant differences between the two groups in FEV1, FVC, or FEV1/FVC values ($P > .05$). After therapy, combining ambroxol hydrochloride with antibiotics resulted in higher FEV1 (22.64%), FVC (31.64%), and FEV1/FVC (9.79%) values compared to antibiotics alone. The mean values in the observation group, comprising 49 patients, were (1.95±0.83 L) for FEV1, (3.37±0.28 L) for FVC, and (74.12±5.14%) for FEV1/FVC, while in the control group, consisting of 49 patients, the mean values were (1.59±1.01 L) for FEV1, (2.56±0.48 L) for FVC, and (67.51±5.02%) for FEV1/FVC, and the difference was statistically significant (Table 4).

FEV1, reflecting airway obstruction, increased, indicating improved airflow. FVC, representing lung capacity, also increased, suggesting enhanced respiratory function. Additionally, the FEV1/FVC ratio, an indicator of airway obstruction, improved, highlighting better lung function. These improvements signify enhanced respiratory mechanics, reduced airway resistance, and improved overall respiratory health in patients with chronic bronchitis.

These improvements in pulmonary function parameters not only signify the effectiveness of the combined therapy with ambroxol hydrochloride and antibiotics but also have important clinical implications. Enhanced pulmonary function translates to improved respiratory mechanics,

increased exercise tolerance, and better overall respiratory health for patients with chronic bronchitis. These improvements can lead to reduced respiratory symptoms, such as dyspnea and fatigue, allowing patients to engage in daily activities more comfortably and effectively.

DISCUSSION

Chronic bronchitis (CB) is characterized by chronic inflammation in the respiratory system, primarily affecting the bronchi, tracheal mucosa, and adjacent tissues. The disease's impact can vary, with some patients able to manage it without significant disruptions to daily life. In contrast, others may experience complications such as obstructive lung disease or pulmonary heart disease, leading to a poor prognosis and increased risk of respiratory distress and heart failure.[16] Therefore, monitoring changes in lung function in CB is crucial for timely treatment selection and disease control.

The pathogenesis of chronic bronchitis is not fully understood, but research suggests that it is associated with various factors. Chronic exposure to harmful gases or particles, such as cigarette smoke, dust, or irritating gases, and viral, bacterial, and mycoplasma infections, are considered essential causes of CB. Other factors, such as the body's immune response, age, and climate in the patient's location, are also implicated in the development of the disease.[17]

Antibiotics are commonly used in clinical treatment and have significant bacteriostatic and bactericidal effects. Commonly used antibiotics include those derived from microbial culture fluids and chemically synthesized or semi-synthetic compounds, such as cefmetazole sodium and levofloxacin hydrochloride.[18] Previous studies have shown that the combination of antibiotics can effectively relieve symptoms in a short time without adverse reactions.[19] Ambroxol hydrochloride acts by stimulating the production and secretion of respiratory mucus, aiding in its clearance from the airways. It also enhances the movement of cilia on the respiratory epithelium, facilitating the removal of mucus. Additionally, ambroxol has protective effects on the respiratory mucosa, reducing inflammation and promoting tissue repair. These mechanisms collectively alleviate symptoms and improve lung function in chronic bronchitis patients, making it a valuable adjunct to antibiotic therapy.[20] It has demonstrated good efficacy and safety profiles even at high doses.[21] Moreover, studies have suggested that the combination of ambroxol hydrochloride and antibiotics can have a synergistic effect and enhance the overall therapeutic outcome.[22]

In traditional Chinese medicine, chronic bronchitis is classified as "internal cough," "phlegm," and "asthma" based on its symptoms and signs. According to ancient texts like the Emperor's Classic of Internal Medicine, chronic bronchitis is believed to primarily affect the lungs due to the imbalance of Qi. The basic pathogenesis involves the presence of internal cold in the lungs and external evil from the skin and hair.[23] This imbalance leads to asthma and cough. Chronic bronchitis often persists, resulting in deficiencies in the spleen and kidneys, the internal accumulation of phlegm and dampness, and the failure to return Qi to its roots. The lung channels become obstructed by phlegm and stasis, leading to damage in the lungs, spleen, and kidneys. Acute attacks are often triggered by repeated respiratory tract infections, and symptoms such as cough, sputum production, asthma, and inflammation become prominent. Therefore, treatment should focus on addressing the underlying sputum production. The self-made Xuanfei Huatan decoction, which includes ingredients such as loquat leaves, Radix Platycodon grandiflorus, Radix Stemonae, cynanchum stauntoni, Cortex Mori Radicis, Houttuynia cordata, and Almond, aims to clear the lungs, resolve phlegm, and relieve cough.[24,25]

This study showed that the disappearance time of cough, wheezing, and expectoration in the observation group was shorter than in the control group, and the total effective rate of treatment was significantly higher in the observation group than in the control group. These results were consistent with previous research.[26] The conjecture may be attributed to both groups being treated with antibiotics. Cefmetazole sodium is a semi-synthetic drug that can strongly act on Gram-negative bacteria. Sodium azole can effectively impede some Enterobacteriaceae, 90% of Serratia and Influenza bacillus, so both groups exhibited effective outcomes in mitigating clinical symptoms. On this premise, the observation group was also given ambroxol hydrochloride. Ambroxol hydrochloride is a novel family of medications that aids in the removal of phlegm and the lubrication of the respiratory system, which can also effectively block the synthesis of acid mucopolysaccharide in glands, lyse acid mucopolysaccharide in sputum and facilitate the secretion of pulmonary surfactant and respiratory fluid secretion, thereby contributing to the restoration of normal pH, the reduction of sticky phlegm, and the promotion of smooth sputum.[27] Therefore, the joint use of both eradicates some drug-resistant bacteria and improves clinical symptoms by acting synergistically, similar to the findings of Bai et al. Moreover, the present study also showed that the levels of FEV1, FVC, and FEV1/FVC were higher than those of the control group after treatment. It might be attributed to the fact that ambroxol hydrochloride allows the patient's mucus secretion to return to normal, reduces the amount of cough and phlegm, and further realizes the normal protective function of the surface active substances on the respiratory mucosa, thereby significantly enhancing the lung function and minimizing the recurrence of the disease.[28] Ambroxol Hydrochloride is an expectorant drug, mainly used in acute and chronic bronchitis to dissolve mucus and lubricate the respiratory tract, promote the secretion of superficial active substances in the patient's lungs, and inhibit the abnormal secretion of plasma and mucus secretions in the respiratory tract. In addition, it can increase the secretion of neutral mucopolysaccharides and effectively reduce the synthesis of acidic mucopolysaccharides to promote the metabolism of mucus in the respiratory tract. Meanwhile, it can enhance the movement of bronchial cilia, facilitate the expulsion of sputum from the body, reduce the retention of mucus in the patient's respiratory tract, enable the surface layer of the respiratory

mucosa to play its protective role effectively, and ultimately improve the patient's breathing condition. Cefmetazole is a broad-spectrum antibacterial agent with strong antibacterial activity against a wide range of gram-negative and gram-positive bacteria and is highly effective in treating respiratory tract infections. Therefore, the combination of amiloride hydrochloride and antibiotics can fully play the good pharmacological properties of multiple drugs and facilitate the consolidation of the therapeutic effect.

The discussion of clinical implications highlights the significant benefits of combination therapy involving ambroxol hydrochloride and antibiotics for chronic bronchitis management. By elucidating how this approach can expedite symptom relief and potentially decrease disease recurrence, clinicians gain insight into its potential advantages. Incorporating ambroxol hydrochloride with antibiotics into treatment protocols holds promise for enhancing patient outcomes and reducing the burden of chronic bronchitis. This section provides valuable guidance to clinicians, encouraging consideration of this combination therapy as an effective strategy for managing the condition.

The study has several limitations that should be acknowledged. Firstly, the relatively small sample size may restrict the generalizability of the findings. Conducting larger-scale studies involving diverse patient populations would be beneficial to validate the results and assess the treatment's effectiveness across different demographics. Additionally, the study's duration was relatively short, highlighting the need for longer-term follow-up studies to evaluate the sustained benefits and potential long-term effects of the combination therapy. Addressing these limitations through future research endeavors will provide a more comprehensive understanding of chronic bronchitis management and optimize treatment strategies.

Future research should explore several avenues to further advance the understanding and treatment of CB. Firstly, investigating the optimal dosage and duration of ambroxol hydrochloride combined with antibiotics would provide valuable insights into the most effective treatment regimen. Additionally, comparing the combination therapy with other treatment approaches, such as TCM interventions or different combinations of medications, would help identify the most suitable and personalized treatment options for CB patients. Moreover, assessing the safety profile and potential adverse effects of the combination therapy is crucial. While this study suggests a favorable safety profile, further research, including larger patient cohorts and long-term follow-up, is needed to ensure the treatment's safety and minimize potential risks. Furthermore, considering the potential impact of lifestyle factors, such as smoking cessation, exercise, and dietary interventions, in conjunction with combination therapy may offer a comprehensive approach to CB management. Exploring the synergistic effects of these interventions could provide valuable insights into optimizing patient outcomes.

The recommendation to integrate lifestyle interventions alongside pharmacological treatments reflects the evolving paradigm of holistic and personalized medicine. This approach acknowledges the interconnectedness of various factors influencing health and encourages exploring how lifestyle modifications can complement pharmacological interventions to achieve optimal patient outcomes. By considering the broader context of patients' lives and tailoring treatments accordingly, clinicians can enhance the effectiveness of therapeutic strategies and promote holistic well-being. Embracing this perspective fosters a more comprehensive approach to healthcare delivery, emphasizing the importance of addressing individual needs and preferences in chronic bronchitis management.

In conclusion, the findings of this study suggest that ambroxol hydrochloride combined with antibiotics has the potential to provide faster symptom relief and improve pulmonary function in CB patients. However, further research with larger sample sizes, longer follow-up periods, and comparisons with other treatment approaches is needed to confirm these findings and optimize treatment strategies. Additionally, investigating the safety profile, exploring lifestyle interventions, and personalizing treatment options are important areas for future research to enhance CB management.

CONFLICT OF INTEREST

All authors declared that they have no financial conflict of interest.

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CONSENT FOR PUBLICATION

All authors have read and approved this manuscript to be considered for publication.

DATA AVAILABILITY STATEMENT

The datasets used during the present study are available from the corresponding author upon reasonable request.

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