Journal of Clinical and Nursing Research, 2025, Volume 9, Issue 8
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

A Study of the Effect of Supervised Pulmonary Rehabilitation Training on Patients with Bronchiectasis in a Home-based Rehabilitation Model

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Abstract: Bronchiectasis is a chronic inflammatory airway disease, and patients often suffer from recurrent airway infections leading to decreased lung function and impaired quality of life. In this study, the effects of supervised pulmonary rehabilitation training on pulmonary function, training compliance, and quality of life in patients with bronchiectasis under home rehabilitation mode are investigated. Ninety stable patients were selected, and the observation group adopted the home-supervised mode of pulmonary rehabilitation training. The results showed that the observation group's pulmonary function indexes, quality of life, and training adherence were better than those of the control group. The differences were statistically significant ($P < 0.05$). The supervised pulmonary rehabilitation training in home rehabilitation mode can effectively improve patients' pulmonary function and quality of life, and improve training compliance, which has good clinical application value.

Keywords: Bronchiectasis; Pulmonary rehabilitation training; Home rehabilitation; Supervisory model

Online publication: September 4, 2025

1. Introduction

Bronchiectasis is a common chronic inflammatory disease of the airways, and patients often present with symptoms such as cough, sputum, and shortness of breath, and the condition may gradually worsen without timely intervention, affecting the quality of life or even endangering life [1]. Pulmonary rehabilitation training, as an effective non-pharmacological intervention, can improve patients' lung function and prognosis, but its long-term compliance is poor, which restricts the efficacy of the treatment. Home-based rehabilitation provides a convenient rehabilitation environment for patients, while supervised pulmonary rehabilitation improves the standardization and continuity of training through professional supervision [2]. The combination of the two is expected to enhance

patient compliance and improve the effectiveness of rehabilitation. From April 2024 to April 2025, this study enrolled patients with stable bronchiectasis from two respiratory wards of a tertiary hospital in a prefecture-level city. A supervised pulmonary rehabilitation program was implemented within a home-based model to improve training adherence, aiming at exploring a more scientific and feasible rehabilitation pathway.

2. Objects

2.1. Study objects

The study population consisted of patients hospitalized in two wards of the Department of Respiratory Medicine in a tertiary care hospital in a prefecture-level city from April 2024 to April 2025 during the stable phase of bronchiectasis. The block random grouping method was used, in which patients were assigned to the intervention and control groups on a 1:1 basis by a randomized grouper using the Blockrand package in the R language, with the stratification factors being the first and second wards of the Department of Respiratory Medicine, and a mixed block group of 4 and 6, and 6 and 4, respectively, for the two wards. The generated grouping sequences were written in cards of uniform size and thickness, placed in separate sealed opaque envelopes of the same shape, and opened and placed according to ward. Groups were determined by opening the envelopes sequentially according to the order of discharge of patients from each ward (sequence A for the intervention group and sequence B for the control group). Randomization groupers were not allowed to disclose the patient grouping to any study-related personnel. The persons measuring the indicators before and after the intervention were blinded, but the patients, their families and the care implementers were not blinded.

In the control group, there were 22 males and 23 females, with ages ranging from 22 to 65 years, with a mean age of (43.70 ± 10.46) years; the duration of the disease ranged from 1 to 10 years, with a mean of (5.81 ± 2.06) years; of these subjects, 9 had an education level of less than 9 years, 21 had an education level of between 9 and 12 years, and 15 had an education level of more than 12 years. In the observation group, there were 24 males and 21 females, aged between 23 and 65 years, with a mean age of (44.23 ± 10.22) years; the duration of the disease ranged from 1 to 12 years, with a mean of (6.60 ± 2.44) years; of these, 10 subjects had an education level of less than 9 years, 19 had an education level of between 9 and 12 years, and 16 had an education level of more than 12 years. There was no statistically significant difference between the two groups in terms of general information ($P > 0.05$) and they were comparable.

2.2. Inclusion and exclusion criteria

2.2.1. Inclusion criteria

(1) Meet the diagnostic criteria of the Expert Consensus on the Diagnosis and Treatment of Bronchiectasis in Adults, and are diagnosed with bronchiectasis by the S Hospital [3].

(2) Have completed inpatient treatment, are in stable condition, and have the conditions to carry out home-based rehabilitation training.

(3) Have signed an informed consent form and voluntarily participate in the home-based rehabilitation interventions.

(4) Have normal communication skills and are able to understand and cooperate with the rehabilitation guidance.

(5) Aged between 20 and 65 years old [4].

2.2.2. Exclusion criteria

(1) The presence of severe hepatic and renal insufficiency.

(2) Accompanied by obvious neurological disorders.

(3) The presence of physical dysfunction, unable to complete the rehabilitation training.

(4) The combination of other serious organic diseases, such as serious cardiovascular disease, malignant tumours, etc.

(5) The combination of other lung diseases, such as chronic bronchitis, pneumonia, tuberculosis, etc., which affect the effect of the research intervention [5].

3. Methods

3.1. Control group

The control group implemented routine discharge guidance and follow-up care. Before the patients are discharged from the hospital, the responsible nurse carries out health education, including knowledge about bronchiectasis, medication guidance, reasonable diet, lifestyle adjustment (such as quitting smoking and alcohol, preventing colds), condition monitoring, and identification of acute exacerbation and coping methods. After discharge, patients were advised to perform aerobic exercise (e.g., jogging, walking, or jumping rope) for about 2 hours daily for 3 months [6]. Nursing staff followed up the patients every fortnight by telephone to understand the execution of exercise and provide necessary rehabilitation guidance.

3.2. Observation group

The observation group implemented supervised pulmonary rehabilitation training under the home rehabilitation model on the basis of the control group.

For the pre-discharge intervention preparation, the nursing team organized the patients and their family members to participate in a supervised mobilization meeting for pulmonary rehabilitation training, which was conducted by the head nurse or nurse-in-charge and assisted by the rest of the nurses, and lasted 40 minutes. The content of the mobilization included: (1) Explaining the importance of pulmonary rehabilitation training and the expected results; (2) Showing standard training movements through video, and the nurse led the patient and family members to practice together on the spot; (3) Clarifying the supervisory responsibilities of family members in the process of family rehabilitation, supervising the patient's training every day, providing timely feedback on the rehabilitation situation and giving emotional support and encouragement; (4) Establishing a WeChat follow-up group, which the patient and the family members designated by the patient swept the code to join, and the nurse sent training video materials on a regular basis, the patient sent training video materials every morning. The nurse regularly sends training video materials, the patient trains once a day in the morning and once in the evening, and the family members record and upload the video of each training session to the group, the nurse in charge records and evaluates once a week and reminds those who do not follow the training requirements by phone [7].

The pulmonary rehabilitation training content included:

(1) Breathing training: (a) Lip-contraction breathing method: deep inhalation through the nose, slow exhalation with puckered lips, exhalation time of 46 seconds, 6 times a day, 15 minutes each time; (b) Active circular breathing techniques, including breath control (abdominal relaxation perception), chest expansion (deep inhalation and then hold the breath), forceful exhalation training (long and deep huffing),

each repeated 5 times [8].

(2) Expectorant training: (a) percussion expectoration: family members to bowl palm percussion back to assist expectoration; (b) Postural drainage: adjust the position according to the orientation of the lesion 12 hours after the meal to promote the drainage of secretions [9].

(3) Cough training: The patient sits in a forward-leaning position, hands on the abdomen, three consecutive huffs to perceive the abdominal pressure, and then deep inhalation after the practice of the sound of 'k' and cough for two consecutive times [10].

(4) Aerobic exercise: Jogging in the family (30 minutes/time), walking (1 hour/time) or jumping rope (1 hour/time). Aerobic exercise: choose one of jogging (30 minutes/times), walking (1 hour/times), or jumping rope (2,000 times/times) at home, and do it once a day [11].

The training lasted for 3 months, during which time the family was supervised daily and nursing staff regularly tracked, assessed, and provided individualized guidance via WeChat video and telephone.

3.3. Observation indicators and evaluation criteria

(1) Lung function-related indexes: Before and after training, the first-second forceful expiratory volume (FEV1), forceful lung capacity (FVC), and FEV1/FVC ratio of the two groups of patients were measured by using a lung function detector to evaluate the changes in lung function [12].

(2) Dyspnoea assessment: The modified version of the British Medical Research Council respiratory questionnaire (mMRC) was used to assess the severity of dyspnoea before and after the training of the patients, which was divided into grades 0–4, with higher grades indicating more severe symptoms, and grades ≥ 2 suggesting more severe dyspnoea [13].

(3) Training adherence: After the training, the patient's family members and the nurse in charge jointly assessed the patient's training adherence, covering 4 indicators of training attitude, participation, movement accuracy and autonomy, with a score of 1 to 4 points for each item and a total score of 4 to 16 points, with 4 to 8 points as low adherence, 9 to 12 points as fair adherence, and 13 to 16 points as high adherence. The training adherence rate was calculated as the percentage of the number of patients with high and fair adherence to the total number of patients.

(4) Quality of life: The St George's Respiratory Questionnaire (SGRQ) was used to assess the quality of life of patients before and after training, covering three items, namely symptoms, activities and life impact, with a total of 50 items and a total score of 0–100, with higher scores indicating poorer quality of life [14].

4. Results

4.1. Comparison of lung function-related indexes between the two groups

Before training, the differences between the FEV1, FVC, and FEV1/FVC values of the two groups of patients were not statistically significant ($P > 0.05$) and were comparable. After the supervised pulmonary rehabilitation training in the home rehabilitation mode, the pulmonary function indexes of both groups improved compared with the pre-training period, and the degree of improvement of the observation group was significantly better than that of the control group ($P < 0.05$). The results are shown in **Table 1**.

Table 1. Comparison of lung function-related indexes between the two groups

Group	Sample size	FEV1(L)		FVC(L)		FEV1/FVC(%)	
		Before training	After training	Before training	After training	Before training	After training
Observation group	45	1.52 ± 0.13	1.78 ± 0.20(1)	1.93 ± 0.15	2.18 ± 0.08(1)	78.76 ± 2.42	81.65 ± 3.87(1)
Control group	45	1.54 ± 0.14	1.69 ± 0.17(1)	1.95 ± 0.17	2.11 ± 0.13(1)	78.97 ± 2.59	80.09 ± 3.12(1)
t		0.702	2.300	0.592	3.076	0.397	2.105
P		0.484	0.024	0.556	0.003	0.692	0.038

Note: (1)$P < 0.05$ compared with the same group before training

4.2. Comparison of the degree of dyspnoea between the two groups

Before the training, the difference in the degree of dyspnoea between the two groups of patients was not statistically significant ($P > 0.05$), and was similar at baseline. After the supervised pulmonary rehabilitation training in home rehabilitation mode, the degree of dyspnoea in both groups improved significantly compared with that before training, and the degree of dyspnoea in the observation group was significantly lower than that in the control group ($P < 0.05$). The details are shown in **Table 2**.

Table 2. Comparison of dyspnea between the two groups [Example (%)]

Time	Group	Sample size	Level 0	Level 1	Level 2	Level 3	Level 4	u	*P*
Before training	Observation group	45	0(0.00)	5(11.11)	22(48.89)	10(22.22)	8(17.78)	1.160	0.246
	Control group	45	0(0.00)	7(15.56)	20(44.44)	11(24.44)	7(15.56)		
After training	Observation group	45	10(22.22)	34(75.56)	1(2.22)	0(0.00)	0(0.00)	4.245	< 0.001
	Control group	45	2(4.44)	25(55.56)	13(28.89)	5(11.11)	0(0.00)		

Note: Control group post-training vs. pre-training u = 4. 394 , $P < 0.001$; Observation group post-training vs. pre-training u = 7 . 396 , $p < 0.001$

4.3. Comparison of training adherence between the two groups

Under the supervision of the family rehabilitation model, the training adherence rate of the observation group was 95.56%, which was significantly higher than that of the control group, which was 75.56% ($P < 0.05$), as shown in **Table 3**.

Table 3. Comparison of training adherence between the two groups [cases (%)]

Group	Sample Size	Low compliance	Fairly good compliance	High compliance	Training compliance rate
Observation group	45	2(4.44)	13(28.89)	30(66.67)	43(95.56)
Control group	45	11(24.44)	19(42.22)	15(33.33)	34(75.56)
χ^2					7.283
P					0.007

4.4. Comparison of the quality of life between the two groups

Before training, the difference between the St George's Respiratory Questionnaire (SGRQ) scores of the two groups of patients was not statistically significant ($P > 0.05$) and was comparable. After the supervised pulmonary

rehabilitation training in the home rehabilitation mode, the quality of life of patients in both groups improved, as evidenced by a significant decrease in SGRQ scores compared with the pre-training period, and the scores of the observation group were significantly lower than those of the control group ($P < 0.05$), as shown in **Table 4**.

Table 4. Comparison of quality of life between the two groups (points)

Group	Sample Size	Before training	After training
Observation group	45	81.67 ± 6.38	70.19 ± 5.36(1)
Control group	45	80.52 ± 5.95	73.04 ± 6.82(1)
t		0.884	2.204
P		0.379	0.030

Note: (1) Comparison with the same group before training $P < 0.05$

5. Discussion

Bronchiectasis is a chronic inflammatory disease of the airways, and repeated infections lead to the destruction of airway structures and a continuous decline in lung function, which seriously affects the quality of life of patients. Pulmonary rehabilitation training, as an important part of non-pharmacological treatment, has been widely used in the rehabilitation of respiratory diseases. Pulmonary rehabilitation training in the traditional hospital setting is effective, but it is often difficult to achieve ideal results due to poor patient compliance and restricted training environment. In recent years, the home rehabilitation model has gradually gained attention because of its convenience and continuity [15]. Supervised pulmonary rehabilitation training, as a key part of home rehabilitation, significantly improves patient compliance through the dual supervision of family members and caregivers.

The results of this study showed that the patients in the observation group who received supervised pulmonary rehabilitation training under the home rehabilitation model had significantly better lung function indexes FEV1, FVC, and FEV1/FVC than those in the control group, indicating that the model had a positive effect on improving the patients' lung function. The improvement of dyspnoea degree was equally obvious, and the patients' subjective symptoms were relieved, and their quality of life was improved. In terms of adherence, the observation group reached 95.56%, which was significantly higher than the 75.56% of the control group, reflecting that home supervision can effectively promote patients' adherence to the training, and overcome the problems of insufficient motivation and non-standardized operation that existed in traditional training.

The training content includes lip-contraction breathing, active cyclic breathing, sputum expectoration training and aerobic exercise, all of which are suitable for carrying out in the home environment, simple and easy to learn, and convenient for patients to persist in the long term. Lip-contraction breathing helps relieve dyspnoea by lengthening expiratory time, reducing airway resistance, and improving alveolar ventilation; active circular breathing strengthens respiratory muscles and improves lung capacity; sputum expectoration training effectively removes airway secretions and prevents the recurrence of infections; and aerobic exercise strengthens cardiorespiratory endurance and promotes overall health. The supervision mechanism ensures the standardization and continuity of the training and improves the training effect through the continuous accompaniment of family members and the professional guidance of responsible nurses, using a combination of online and offline methods.

The family rehabilitation mode facilitates patients to integrate pulmonary rehabilitation training in their daily life, reduces the economic and time burden of frequent medical visits, and enhances patient satisfaction

and motivation. In terms of quality of life, the St George's Breathing Questionnaire scores of patients in the observation group decreased significantly, indicating that the training not only improved physiological function, but also promoted the recovery of mental health and social function. Relevant literature also supports that home-supervised pulmonary rehabilitation training is effective for patients with chronic respiratory diseases.

In conclusion, supervised pulmonary rehabilitation training in the home rehabilitation mode effectively improves the pulmonary function and quality of life of patients with bronchiectasis by enhancing adherence and training quality, which is worthy of clinical promotion and application. In the future, the construction of resources related to home rehabilitation should be strengthened, and the means of supervision should be optimized to promote more patients to benefit.

6. Conclusion

Supervised pulmonary rehabilitation training in the home rehabilitation mode can not only significantly improve lung function and dyspnoea in patients with bronchiectasis, but also effectively enhance patients' training compliance and quality of life. When pulmonary rehabilitation training is carried out alone without systematic family supervision, patient compliance is difficult to guarantee, and the rehabilitation effect is often unsatisfactory. Clinics should actively advocate and guide patients' family members to participate in the supervision process of rehabilitation training, through the continuous supervision and support of family members, which not only promotes patients' adherence to training, but also helps family members to deeply understand the content and importance of pulmonary rehabilitation care, thus enhancing the overall effect of rehabilitation. The present study has a limited sample size and geographical limitations, so the study can be expanded in the future to further validate the clinical effectiveness and promotion value of supervised pulmonary rehabilitation training under the family rehabilitation model.

Disclosure statement

The authors declare no conflict of interest.

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