International Journal of Nursing Sciences xxx (2017) 1–7

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Contents lists available at ScienceDirect

International Journal of Nursing Sciences

journal homepage: http://www.elsevier.com/journals/international-journal-of-nursing-sciences/2352-0132

Effects of modified pulmonary rehabilitation on patients with moderate to severe chronic obstructive pulmonary disease: A randomized controlled trail

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ARTICLE INFO

Article history:
Received 16 February 2017
Received in revised form
19 June 2017
Accepted 26 June 2017
Available online xxx

Keywords:
Chronic obstructive pulmonary disease
Moderate to severe
Nursing
Pulmonary rehabilitation
Relaxation exercises
Lower extremity muscle training
Upper extremity muscle training

ABSTRACT

Objectives: This study aimed to assess the effects of modified pulmonary rehabilitation (PR) on patients with moderate to severe chronic obstructive pulmonary disease (COPD).
Methods: A total of 125 patients (63 in the PR group and 62 in the control group) were recruited in this study. The patients in the PR group received 12 weeks of conventional treatment, nursing, and modified pulmonary rehabilitation, while the patients in the control group underwent 12 weeks of conventional treatment, nursing, pursed-lip breathing training, and abdominal breathing training. Baseline characteristics, St. George's Respiratory Questionnaire (SGRQ), the six-minute walk test (6MWT), modified medical research council (MMRC) dyspnea scale, and lung function were compared between the two groups.
Results: A total of 112 patients (58 patients in the PR group and 54 patients in the control group) completed the 12-week monitoring and follow-up. The SGRQ scores, symptoms (54.933 ± 11.900), activity (52.644 ± 14.334), impact (55.400 ± 9.905), and total score (54.655 ± 10.681) of the PR group did not significantly differ in pre- and post-treatments ($P < 0.05$). No significant change was also observed in the control group ($P > 0.05$). 6MWT [(372.089 ± 67.149) m] was significantly improved in the PR group ($P < 0.05$) but was not significantly different in the control group ($P > 0.05$). MMRC (actual rank sum 1719, rank sum 2047.5) was significantly reduced in the PR group ($P < 0.05$) but not in the control group ($P > 0.05$). The lung function (FVC, FEV1, FEV1/FVC, FEV1% and PEF) of the patients in both groups did not significantly change ($P > 0.05$).
Conclusion: Modified PR reduces the symptoms of dyspnea, increases exercise capacity, and improves the quality of life of patients with moderate to severe COPD.

1. Introduction

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) defined chronic obstructive pulmonary disease (COPD) as the limitation of a partially reversible airflow usually progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases [1]. COPD is a major cause of mortality and morbidity worldwide [2]. This disease causes symptoms of breathlessness, which limits daily activities and consequently reduces quality of life (QoL) [3]. A decreased QoL is indicated as an exacerbated emotional status and is related to fatigue [4]. COPD management aims to improve pulmonary function, prevent deterioration, and enhance QoL [5].

Few guidelines are related specifically to the physiotherapeutic management of COPD. Pulmonary rehabilitation (PR) is defined as a "supervised therapeutic process of restoring a patient's function" [6]. PR is an essential treatment for Patients with COPD [7]. A few statements and guidelines have recommended PR as a first-line management strategy for patients with COPD [8–11]. In China, PR incorporates ventilatory muscle and breathing exercises.

PR usually includes physical exercise, education, psychosocial therapy, and self-management [8,9]. The effectiveness of PR in

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Peer review under responsibility of Chinese Nursing Association.

http://dx.doi.org/10.1016/j.ijnss.2017.06.011

Please cite this article in press as: Xu J, et al., Effects of modified pulmonary rehabilitation on patients with moderate to severe chronic obstructive pulmonary disease: A randomized controlled trail, International Journal of Nursing Sciences (2017), http://dx.doi.org/10.1016/j.ijnss.2017.06.011

exercise capacity, symptoms, and QoL of patients with COPD have also been investigated [12,13].

Studies have yet to bridge the gaps between PR guidelines and clinical implementation in China. Most of the publications on PR have mostly focused on medications, education, oxygen therapy, breathing exercises, and traditional Chinese exercise [14–16].

This study aimed to incorporate relaxation exercises and extremity muscle training to a conventional PR program and to assess the effects of these exercises on QoL, dyspnea degree, exercise tolerance, and pulmonary function of patients with COPD.

2. Methods

2.1. Study design

This study employed a prospective, randomized, and controlled trial. Participants were recruited from patients in the Department of Respiratory Disease discharged between September 2014 and December 2015 and assigned either to the conventional care group or to the PR group. These were then assessed upon enrollment in the study and after a 12-week intervention.

2.2. Participants

The participants were recruited from the patients admitted in the Department of Respiratory Disease and were discharged by the study's principal investigator. The following inclusion criteria were considered: age >50 years, diagnosed with moderate to severe COPD [moderate, forced expiratory volume in one second (FEV1)/forced vital capacity (FVC) < 70%, 50% ≤ the percentage of FEV1 in FVC (FEV1%) < 80%; severe, FEV1/FVC < 70%, 30% ≤ FEV1% < 50%], presence of a stable condition without infection or exacerbation for more than 4 weeks after hospital discharge, and could walk independently and complete a questionnaire. The following exclusion criteria were determined: severe and unstable cardiac disease, pulmonary bulla, pneumothorax, orthopedic disease, malignant tumor, or mental disorder. The following withdrawal criteria during the 12-week observation were set: inability to complete exercises and acute exacerbation, which was defined as the presentation of productive cough or purulent sputum and worsened shortness of breath or refusal to undergo follow-up visits [17].

2.3. Intervention

The patients in the control and PR groups received conventional drug treatment and nursing care. All of the patients were given an inhaled corticosteroid and an inhaled β-agonist or an anticholinergic agent according to the physicians' prescriptions. Health education included information about COPD, acute exacerbation of symptoms, and benefits of various habits, including smoking cessation, healthy diet, and medication compliance.

2.4. Control group

The control group was given conventional treatment and nursing care combined with breathing exercises incorporating pursed lip breathing and diaphragmatic breathing. Pursed lip breathing involves patients relaxing the muscles in the neck and shoulders, breathing (inhaling) slowly through the nose with no deep breaths, and keeping their mouths closed. During inhalation, the patients puckered or “pursed” their lips as they counted to two. As they exhaled, the patients breathe out through their pursed lips as they counted to four. Diaphragmatic breathing involves slow inhalation through the nose, usually to a count of 10, followed by an exhalation to the same count. Inefficient ventilation during exercise is a key pathophysiological feature of COPD [18]. Respiratory muscle training is an established effective method to increase inspiratory muscle strength [19–21]. These two exercises were repeated by participants five to 10 times, several times a day [22]. A follow-up through telephone was conducted once a week and lasted 12 weeks.

2.5. PR group

Relaxation exercises and extremity muscle training were incorporated in the PR group. Relaxation exercises can increase the SpO_2 of patients with COPD [23]. Extremity muscle training can enhance muscle force and tolerance to hypoxia [24]. The patients in the PR group received conventional treatment and nursing care combined with a 12-week outpatient PR program, including the same pursed lip breathing and diaphragmatic breathing as in the control group. Relaxation exercises are performed in supine position, with slow music, tensing muscles while inhaling and then relaxing muscles while exhaling, starting at the toes and working all the way up to the scalp. These exercises are performed for approximately five minutes, twice a day, before getting out of bed and before falling asleep. Upper extremity muscle training involves slowly lifting the arms while inhaling and lowering the arms while exhaling, 10 repetitions per set for three sets per day. For this exercise, the elbows are then flexed, with fists clenched, and punched obliquely forward alternating fists, inhaling while stretching and exhaling while drawing back, 10 repetitions per set, three sets per day. Finally, lower extremity muscle training involves standing and bending alternating knees to 90°, 10 repetitions per set, three sets per day. Follow-up by telephone was conducted once a week for 12 weeks.

2.6. Quality control

Our study team, supervised by a chest physician, consisted of respiratory nurses, occupational therapists, physiotherapists, a dietician, a psychologist, and social workers. All team members were trained for two weeks and qualified after inspection. The training contents included the screening of study subjects, communication skills with subjects, conventional treatment methods and nursing, methods of PR, collection of data, and methods of follow-up. Patients were instructed to practice the program daily and were supervised by a respiratory therapist in the hospital.

2.7. Measurements and outcomes

General characteristics of patients, such as sex, age, severity, duration, and Barthel index were recorded during the baseline assessment. Four outcome measures are as follows: QoL, level of dyspnea, exercise tolerance, and pulmonary function. Related data were assessed at baseline and again after 12-week intervention. Questionnaires were independently completed by patients.

QoL was assessed using the St. George's Respiratory Questionnaire (SGRQ), a 76-item self-administered disease specific questionnaire for patients with COPD [25]. The translated Chinese language version was used for this study. Scores were calculated for the three domains of symptoms, activity, and impacts (Psycho-social) and for a total score. Scores ranged from 0 to 100, with higher scores indicating poorer health.

The level of dyspnea was assessed through modified medical research council (MMRC) dyspnea scale. The scores of MMRC were determined as: 0 (patients breathless with strenuous exercise), 1 (patients short of breath when hurrying on level ground or walking up a slight hill), 2 (patients walk slower on level ground than people

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