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Application of a Cross-Theoretical Model-Based Frailty Management Program in Elderly Patients with COPD Comorbidities

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Abstract: *Objective*: To investigate the effectiveness of a frailty management program based on a trans-theoretical model in elderly patients with chronic obstructive pulmonary disease (COPD) and comorbidities. *Methods*: From January to September 2025, 80 elderly COPD patients with comorbidities admitted to the Department of Respiratory and Critical Care Medicine were randomly assigned to an observation group (n=40) and a control group (n=40) using a random number table. The control group received routine nursing care, while the observation group underwent a frailty management program based on a cross-theoretical model. Pre- and post-operation compliance with frailty management, activities of daily living (ADL), pulmonary function indicators (FEV1, FEV1/FVC), and frailty (EFS) occurrence were compared between groups. *Results*: Post-intervention, the observation group demonstrated superior scores in frailty management adherence, ADL, and pulmonary function indicators compared to the control group (P<0.05), with a lower incidence of frailty (P<0.05). *Conclusion*: A frailty management program based on a cross-theoretical model effectively enhances frailty management adherence, improves pulmonary function and ADL, and reduces frailty incidence in elderly COPD patients with comorbidities, demonstrating clinical applicability.

Keywords: Trans-theoretical model; Frailty management; Chronic obstructive pulmonary disease; Comorbidity; Geriatric care

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1. Introduction

Chronic obstructive pulmonary disease (COPD) is a chronic respiratory disorder characterized by persistent airflow limitation, predominantly affecting the elderly population. It frequently coexists with multiple comorbidities such as cardiovascular disease, diabetes, and osteoporosis, significantly impairing patients' quality of life and prognosis [1]. Frailty is an age-related clinical syndrome involving diminished physiological reserves and multisystem

functional impairment, manifested as increased vulnerability to stressors. It is closely associated with high COPD prevalence and poor outcomes. Studies indicate that COPD patients have significantly higher frailty rates than non-COPD individuals, and frailty further exacerbates COPD severity, increasing acute exacerbation risk, readmission rates, and mortality [2]. Current interventions for COPD with frailty primarily focus on rehabilitation exercises and nutritional support, but issues such as poor patient compliance and fragmented interventions remain prominent. The Transtheoretical Model (TTM) is a behavioral change theory emphasizing the stage-specific nature of individual behavioral change. By identifying the stage of behavioral change a patient is in and implementing targeted interventions, it helps improve compliance and sustainability of health behaviors [3-4]. This study aims to develop a TTM-based frailty management program and evaluate its efficacy in elderly patients with COPD and frailty, thereby providing clinicians with a scientific, systematic, and actionable frailty management strategy.

2. Subjects and methods

2.1. Study population

Eighty elderly patients with COPD and comorbidities admitted to the Department of Respiratory and Critical Care Medicine at our hospital between January 2025 and September 2025 were selected. Inclusion criteria: (1) Diagnosis meeting the criteria of the "Guidelines for the Diagnosis and Treatment of Chronic Obstructive Pulmonary Disease (2021 Revised Edition)"; (2) Age ≥ 60 years; (3) Presence of at least one comorbidity (e.g., hypertension, diabetes, coronary heart disease); (4) Being conscious and able to cooperate with the study; (5) Signing an informed consent form. Exclusion criteria: (1) Concurrent malignant tumors or severe hepatic/renal insufficiency; (2) Presence of psychiatric disorders or cognitive impairment; (3) Recent history of acute myocardial infarction or stroke. Patients were randomly assigned using a random number table to an observation group and a control group (40 patients each). There were no statistically significant differences in general characteristics between the two groups ($P > 0.05$), ensuring comparability.

2.2. Research methods

2.2.1. Control group

Received routine nursing care, including: comprehensive assessment of patient condition; close monitoring of respiratory status and comorbid indicators with vigilance for acute exacerbations; strict implementation of oxygen therapy, standardized medication administration, and coordination of comorbid treatment; health education to guide patients in mastering respiratory exercises, smoking cessation, nutrition, and self-monitoring; discharge instructions and regular telephone follow-ups to enhance overall disease management capacity and improve quality of life.

2.2.2. Observation group

Implement a frailty management protocol based on the TTM model, building upon the control group approach. Specific measures include:

Establish a multidisciplinary management team comprising: 1 Associate Chief Physician from Respiratory and Critical Care Medicine, 1 Associate Chief Physician from Geriatric Medicine, 1 Head Nurse from Respiratory and Critical Care Medicine, 5 Specialist Nurses, 1 Rehabilitation Therapist, 1 Psychologist, 1 Nutritionist. The associate chief physicians from Respiratory and Critical Care Medicine and Geriatrics were responsible

for developing respiratory specialty and related comorbidity treatment plans. The head nurse and specialized nurses were responsible for constructing the frailty management plan, training nursing staff, implementing the management plan, and collecting and analyzing data. The rehabilitation therapist was responsible for assisting patients with respiratory rehabilitation therapy, including designing and executing rehabilitation plans, monitoring patient rehabilitation progress, and providing rehabilitation consultation and education. The psychological counselor provides psychological support and counseling to help patients cope with psychological stress and emotional issues, offering psychological adjustment and psychotherapy services. The nutritionist assesses patients' nutritional status and provides nutritional guidance and intervention.

Literature Search Based on the evidence-based 6S model, a systematic search was conducted across Chinese and English databases, including PubMed, Web of Science, CNKI, and Wanfang Data. Evidence retrieval employed a combination of subject headings and free-text terms, using "Chronic Obstructive Pulmonary Disease; COPD; chronic obstructive emphysema", "elderly; frailty; sarcopenia", and "identification; intervention; management" as English keywords. The search period spanned from database inception to December 2024. Literature inclusion criteria: (1) Study subjects: age ≥60 years; (2) Research content involving nursing, management, intervention, rehabilitation, etc., for frail patients; (3) Document types: guidelines, expert consensus statements, systematic reviews, evidence summaries, and relevant original research; (4) Languages: Chinese or English. Exclusion criteria: (1) Directly translated guidelines or duplicated guidelines; (2) Documents without full-text availability; (3) Low-quality documents; (4) News articles, evaluations, abstracts, or interpretations related to clinical practice guidelines. A preliminary draft management plan was developed based on relevant domestic and international evidence-based evidence.

Delphi Expert Consultation and Pilot Study: Develop an expert consultation questionnaire and select 12 qualified experts for two rounds of consultation. After the second round, the research team refines the plan based on expert feedback. Prior to formal implementation, conduct a pilot study involving 20 eligible patients to test the preliminary management plan. Optimize the plan based on pilot results to finalize the frailty management implementation protocol.

The Program Training and Assessment Team members provided standardized training to all participating nursing staff. Only those who passed the post-training assessment were authorized to implement the clinical program.

Implementation of the TTM-Based Frailty Management Protocol in Elderly COPD Patients with Comorbidities: (1) Pre-Intention Phase (Within 24 Hours of Admission): The core of the management protocol focuses on risk identification and establishing initial awareness. This involves conducting a comprehensive patient assessment and providing acute treatment for stable COPD and comorbidities. Through non-confrontational communication, understand patients' perceptions of their frailty status. Explain the close relationship between COPD, multiple comorbidities, and frailty, and convey the key message that "frailty is preventable and treatable." (2) Intentional Phase (Approximately 1 week after admission): Focus shifts to stimulating patients' motivation for active change. This phase requires assessing patients' activities of daily living (ADL) capabilities, fall risk, and polypharmacy safety. Provide targeted health education: Guide patients in practicing diaphragmatic breathing and pursed-lip breathing using a breathing trainer to alleviate shortness of breath. Conduct strength training using resistance bands and sandbags. Advise on balanced nutrition, emphasizing increased protein intake and vitamin D supplementation. Deliver medication guidance through multiple formats to minimize adverse drug reactions. Educate patients on specific fall prevention techniques. (3) Preparation Phase (3 days prior to discharge): Conduct

a comprehensive pre-discharge assessment, including reconfirmation of home oxygen therapy indications. Collaborate with patients and families to develop a detailed, actionable post-discharge plan encompassing medication lists, home oxygen therapy safety training, personalized home exercise regimens, high-protein dietary plans, scheduled follow-up appointments, and defined family support roles. (4) Action Phase (Within 1 month of discharge): Monitor implementation of plans via phone or outpatient follow-ups, assess challenges and experiences with exercise/nutrition programs, and provide timely support and guidance. (5) Maintenance Phase (within 2–3 months post-discharge): Assess the patient's current home management status, encourage enhanced self-care, consistent functional exercise, improved nutrition, and proper medication adherence. Provide encouragement and affirmation to boost confidence and compliance, reinforcing health awareness and behavioral habits.

2.3. Observation indicators

2.3.1. Frailty management adherence

The Frailty Management Adherence Questionnaire, developed by Jin et al., is used to evaluate compliance across seven domains: participation in frailty screening, frailty awareness, dietary and nutritional management, exercise management, emotional and psychological regulation, comorbidity medication management, and follow-up management [4]. Scores range from 1 to 5, with a total possible score of 0–35. Higher scores indicate better frailty management compliance. The Cronbach's α coefficient for the scale was 0.862, and the validity coefficient was 0.883.

2.3.2. Activities of daily living (ADL)

The Barthel Index was used to assess ADL, comprising 10 items including dressing, bathing, grooming, eating, and toileting. The total score ranges from 0 to 100, with higher scores indicating better ADL.

2.3.3. Frailty

Frailty was assessed using the Edmonton Frailty Scale (EFS), with a total score ranging from 0 to 17. A total score >6 indicated frailty. Frailty incidence rate = number of frail cases / total number of cases × 100% [5].

2.3.4. Pulmonary function indicators

A spirometer was used to monitor patients' forced expiratory volume in one second (FEV1), peak expiratory flow (PEF), and the ratio of FEV1 to forced vital capacity (FEV1/FVC).

2.4. Statistical methods

Statistical analysis was performed using SPSS 26.0 software. Quantitative data were expressed as the mean ± standard deviation (Mean ± SD), and t-tests were applied. Comparisons between groups were conducted using independent samples t-tests, while categorical data were analyzed using chi-square (x^2) tests. The significance level was set at $\alpha=0.05$, with $P<0.05$ indicating statistically significant differences.

3. Results

3.1. Comparison of frailty management adherence between groups

After intervention, frailty management adherence scores improved in both groups compared to pre-intervention

levels. The observation group demonstrated significantly higher scores than the control group ($P < 0.05$), as shown in **Table 1**.

Table 1. Comparison of frailty management adherence scores between groups [(Mean ± SD), points]

Group	Number of Cases (n)	Frailty Management Adherence Score		*t*	*P*
		Pre-intervention	Post-intervention		
Control Group	40	18.23±4.12	24.56±5.31	6.872	<0.001
Observation group	40	18.47±4.05	31.29±5.67	12.134	<0.001
t-value		0.265	5.432		
P-value		0.792	<0.001		

3.2. Comparison of activities of daily living (ADL) scores between groups

After intervention, both groups showed improved ADL scores compared to pre-intervention levels. The observation group achieved significantly higher scores than the control group, with statistically significant differences ($P < 0.05$), as shown in **Table 2**.

Table 2. Comparison of activities of daily living (ADL) scores between groups [(Mean ± SD), points]

Group	Number of Cases (n)	ADL Score		*t*	*P*
		Pre-intervention	After Intervention		
Control group	40	41.51±3.55	66.39±6.71	20.546	<0.001
Observation Group	40	42.16±3.49	77.56±6.91	27.312	<0.001
t-value		0.835	7.335		
P-value		0.406	<0.001		

3.3. Comparison of the incidence of exhaustion (EFS) between the two groups

After intervention, the incidence of exhaustion (EFS) in the observation group was significantly lower than that in the control group, with a statistically significant difference ($P < 0.05$), as shown in **Table 3**.

Table 3. Comparison of the incidence of fatigue (EFS) between the two groups (%)

Group	Number of Cases (n)	Incidence of Fatigue
Control Group	40	9 (22.5)
Observation group	40	1 (2.5)
x^2		5.6
P		<0.01

3.4. Comparison of pulmonary function levels between groups

After intervention, the observed group demonstrated significantly higher pulmonary function scores than the

control group, with statistically significant differences ($P < 0.05$), as shown in **Table 4**.

Table 4. Comparison of pulmonary function levels between groups after intervention (Mean ± SD)

Group	Number of Cases (n)	PEF	FEV1	FEV1/FVC
Control Group	40	3.11 ± 1.25	2.23±0.41	65.38±3.02
Observation Group	40	4.95±1.49	2.46±0.43	74.57 ± 3.25
t-value		5.98	2.52	13.31
P value		<0.001	0.014	<0.001

4. Discussion

Elderly patients with chronic obstructive pulmonary disease (COPD) often present with multiple comorbidities and frailty, which interact to form a vicious cycle leading to poor outcomes [1]. This study developed a multidisciplinary, phased frailty management protocol based on the TTM model and applied it to elderly COPD patients with comorbidities. Results demonstrated that this protocol significantly outperformed routine care in enhancing patient adherence to frailty management, improving activities of daily living and pulmonary function, and reducing frailty incidence. This provides new insights and evidence-based guidance for the clinical management of such complex patients.

4.1. The TTM-based management program effectively promoted the formation and maintenance of healthy behaviors

Behavioral change represents both the core and the challenge in chronic disease management. This study's protocol delivers tailored intervention strategies according to patients' behavioral change stages during different phases from hospitalization to home care. For instance, the precontemplation stage emphasizes non-confrontational risk communication and cognitive arousal rather than demanding immediate change. During the contemplation stage, personalized and feasible discharge plans are jointly developed with patients and caregivers, enhancing patient engagement and sense of control. This stage-specific teaching approach aligns better with patients' psychological development patterns, effectively stimulating and sustaining their intrinsic motivation for change. Research indicates that TTM-based interventions significantly improve long-term adherence to dietary and exercise regimens among chronic disease patients [6]. The findings further validate TTM's efficacy in enhancing adherence to comprehensive frailty management programs among elderly COPD patients with comorbidities.

4.2. Comprehensive intervention strategy synergistically improves patient physiological function

Patients in the observation group demonstrated more pronounced improvements in activities of daily living (ADL) and pulmonary function indicators (FEV1, FEV1/FVC). The pathophysiology of COPD coexisting with frailty involves multiple mechanisms, including systemic inflammation, skeletal muscle wasting, and energy metabolism abnormalities [7]. Single-dimensional interventions often yield limited effects. This protocol integrates multidisciplinary strategies, including respiratory rehabilitation, nutritional support, strength training, and optimization of comorbid medications, forming a synergistic whole. The combination of respiratory rehabilitation and targeted strength training helps improve respiratory muscle function, enhance limb muscle strength, and exercise endurance, thereby enhancing patients' ability to perform activities of daily living and improving

cognitive decline [8–9]. Individualized nutritional interventions counteract malnutrition and muscle protein breakdown commonly observed in COPD and frail patients [10]. More importantly, the TTM framework ensures these integrated measures are progressively adopted and practiced by patients at the appropriate time and in an acceptable manner, thereby enabling physiological improvements. This suggests that for elderly COPD patients with comorbid frailty, a theory-guided, integrated rather than fragmented intervention model is an effective approach to improving physical function.

4.3. Multidimensional management aids in reversing or delaying the frailty process

Frailty fundamentally involves diminished physiological reserves and multisystem dysfunction. This study addresses not only patients' physical function and disease management but also incorporates emotional counseling by psychologists. The management team further focuses on medication safety and social support. Psychological stress, social isolation, and polypharmacy represent key modifiable factors contributing to or exacerbating frailty [11]. Through TTM-based interventions, patients experience concurrent improvements in physical function, emotional regulation capacity, self-management knowledge, and social engagement. This multidimensional reduction of physical and psychological burdens helps break the vicious cycle of frailty, effectively delaying or partially reversing its progression.

5. Summary

The frailty management program based on the TTM model effectively enhances frailty management adherence among elderly COPD patients with comorbidities, improves exercise endurance, lung function, and activities of daily living, and reduces frailty incidence. This program demonstrates strong scientific validity and practical applicability, making it suitable for clinical implementation.

Disclosure statement

The authors declare no conflict of interest.

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