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ORIGINAL RESEARCH

# Effect of Orem Self-Care Model Combined with Early Rehabilitation Training on Mechanically Ventilated Patients in ICU: A Retrospective Cohort Study

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**Objective:** To evaluate the effectiveness of integrating Orem self-care mode with early rehabilitation training in mechanically ventilated ICU patients.

**Methods:** This retrospective cohort study included 142 patients who underwent mechanical ventilation at the Department of Intensive Care Medicine from January to December 2023. Patients were divided into two groups based on documented nursing interventions: the control group (n=62) received standard care, while the experimental group (n=62) received Orem-based nursing combined with structured early rehabilitation training. Respiratory function, psychological status, and adverse event incidence were compared between groups.

**Results:** The experimental group showed significantly improved respiratory parameters including respiratory rate, partial pressure of oxygen ($PaO_2$), partial pressure of carbon dioxide ($PaCO_2$), and $PaO_2/FiO_2$ ratio ($P < 0.05$). Mechanical ventilation duration and ICU length of stay were significantly shorter in the experimental group ($P < 0.001$). Psychological assessments revealed significantly lower scores for delirium, anxiety (HAMA), and depression (HAMD) in the experimental group post-intervention ($P < 0.001$). Additionally, the incidence of adverse events such as pressure ulcers and delirium was markedly reduced ($P < 0.001$).

**Conclusion:** Integrating Orem self-care model with early rehabilitation training demonstrates significant benefits in improving respiratory outcomes, mental health, and clinical safety for mechanically ventilated ICU patients, offering a promising approach for critical care nursing.

**Keywords:** Orem self-care model, early rehabilitation, ICU acquired weakness, delirium prevention, patient-centered care

## Introduction

With the continuous progress of medical science, Intensive Care Units (ICU) play an increasingly vital role in critical care.[1] While mechanical ventilation serves as essential life support, prolonged use leads to complications including ventilator-associated pneumonia, muscle atrophy, and Post-Intensive Care Syndrome (PICS) - a constellation of physical, cognitive, and mental health impairments affecting up to 50% of survivors.[2,3] Particularly relevant to this population is ICU-Acquired Weakness (ICUAW), occurring in 25–50% of mechanically ventilated patients, which substantially prolongs rehabilitation and diminishes quality of life.[4]

Traditional ICU rehabilitation strategies primarily focus on physical function recovery through therapist-led interventions.[5] However, emerging evidence suggests that integrating psychological empowerment with physical rehabilitation may yield superior outcomes. The Orem self-care model addresses this gap by enhancing patients' active participation in care - a critical factor often overlooked in conventional approaches. Recent studies demonstrate the Orem model's effectiveness in chronic disease management, with a randomized trial by Fan et al showing 30% greater self-efficacy scores in intervention groups.[6] In critical care settings, early rehabilitation protocols reduce mechanical



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ventilation duration by 1.5 days (95% CI 0.8–2.1) and decrease ICU stay by 2.3 days compared to standard care.[7] Nevertheless, current literature lacks integration of psychological empowerment models with structured rehabilitation, particularly during the vulnerable transition from passive care recipient to active participant.[8,9]

Therefore, this study aims to evaluate the impact of implementing the Orem self-care model combined with early rehabilitation training on clinical outcomes in mechanically ventilated ICU patients. By analyzing existing medical records, we assess changes in physiological parameters, psychological status, and the incidence of adverse events. The findings provide evidence for integrating psychological empowerment with structured physical rehabilitation in critical care settings, offering insights into optimizing nursing strategies for mechanically ventilated patients in ICU.

# Data and Methods

## Study Design

This retrospective cohort study included 142 patients who underwent mechanical ventilation at the Department of Intensive Care Medicine from January to December 2023 to evaluate the impact of different nursing interventions. The patient selection process is illustrated in Figure 1. A priori power analysis using historical data ($\alpha$=0.05, $\beta$=0.2) indicated 58/group needed to detect 2-day ventilation difference. Patients were divided into two groups based on

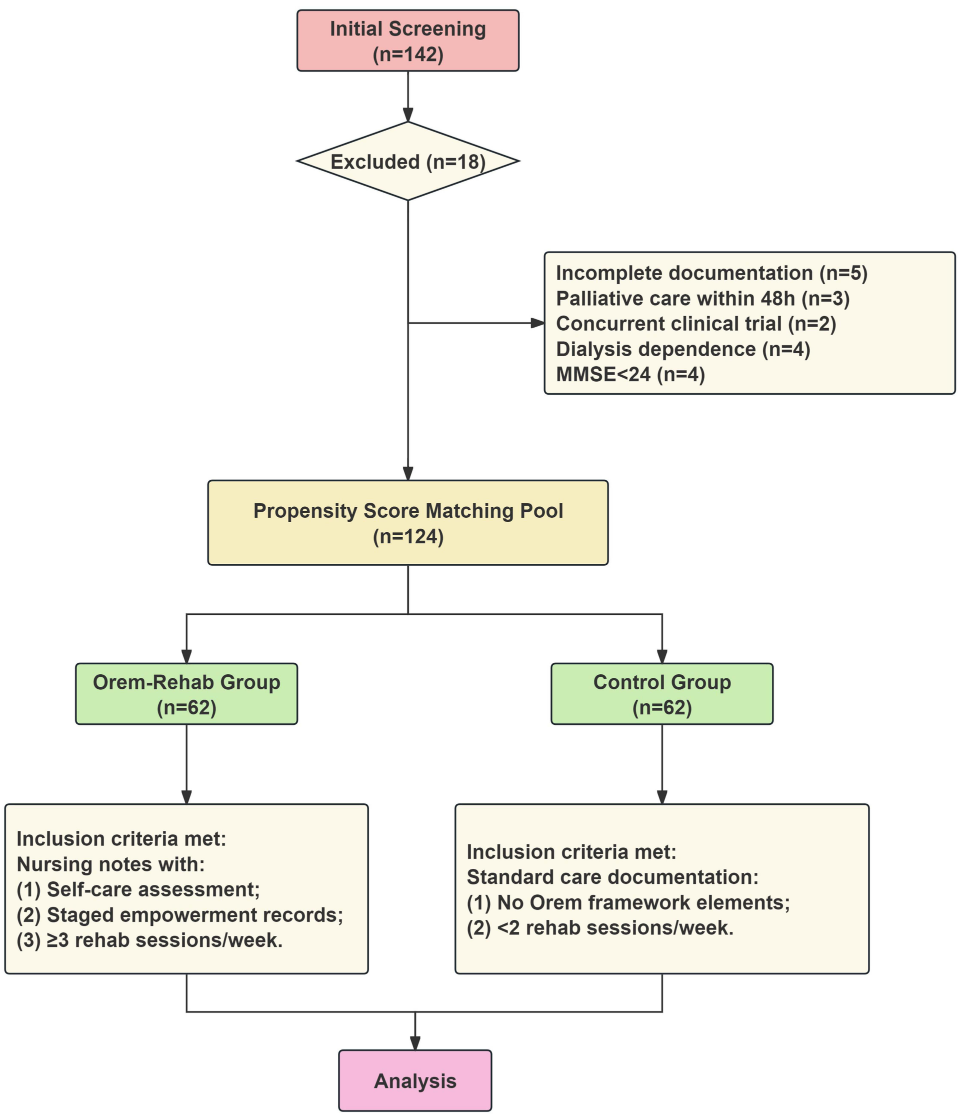


**Figure 1** The patient selection process.

documented nursing protocols. The Orem-Rehab Group (n=62) received Orem self-care interventions combined with early rehabilitation training, as evidenced by nursing notes containing at least three key elements: a self-care needs assessment, staged empowerment documentation, and records of rehabilitation participation. The Control Group (n=62) received standard care, characterized by the absence of documentation based on the Orem framework and fewer than two recorded rehabilitation sessions per week. This retrospective cohort study was approved by the Ethics Committee of Heilongjiang Provincial Hospital (Approval No: H2023-012). The study was conducted in accordance with the Declaration of Helsinki. Given the retrospective nature of the study and the use of anonymized data, the requirement for informed consent was waived by the ethics committee.

Inclusion criteria: (1) Adults (>18 years) requiring mechanical ventilation >72 hours; (2) Hemodynamic stability (defined as norepinephrine dose <0.1 μg/kg/min for ≥24 hours); (3) Complete nursing documentation covering ≥80% of ICU stay.

Exclusion criteria: Patients were excluded if they met any of the following conditions: (1) pregnancy or breastfeeding; (2) severe pre-existing liver disease, including clinically significant portal hypertension, Child-Pugh grade C cirrhosis, or acute liver failure; (3) renal insufficiency requiring acute or chronic dialysis; (4) history of alcohol or drug abuse; (5) cognitive dysfunction, defined as a documented MMSE score <24 at admission or other conditions interfering with cognitive assessment (eg, speech or sensory disorders, dyslexia, or organic mental disorders); (6) terminal illness, indicated by palliative care orders within 48 hours of ICU admission; (7) missing documentation for more than 30% of rehabilitation sessions during ICU stay; and (8) participation in other interventional clinical trials within 6 months prior to screening.

## Nursing Interventions

The enrolled patients were retrospectively divided into two groups based on the nursing mode documented in their medical records, with 62 patients in each group.

### Control Group

Patients received standard ICU nursing care throughout their hospitalization. This included continuous ECG and blood pressure monitoring, ventilator-assisted breathing management, and pharmacological treatment adjusted according to individual patient condition. Nurses performed limb massage every 4 hours to prevent muscle atrophy, and turned patients and performed back tapping every 2 hours to promote sputum clearance and reduce the risk of pulmonary complications. No structured rehabilitation program was implemented in this group, and all interventions were carried out as clinically indicated.

### Experimental Group

In addition to standard ICU nursing care, patients in the experimental group received nursing interventions based on the Orem Self-Care Deficit Nursing Theory. These interventions were systematically tailored to each patient's self-care ability and needs, and implemented in three progressive stages:

### Response: We Have Added a Breakdown of the Phases

#### Full Compensation System (First 2–3 Days)

For patients under deep sedation or analgesia who could not actively cooperate, nurses met all basic self-care needs, including positioning, airway management, feeding, hygiene, and safety measures. Passive limb exercises targeting shoulder abduction (50°), internal rotation (50°), elbow flexion (40–50°), and hip/knee/ankle joint movements were conducted every 8 hours to maintain joint mobility and prevent contractures. Patients were also turned every 2 hours, and back tapping with assisted coughing was performed to prevent respiratory complications. This phase lasted from ICU admission until the patient regained sufficient consciousness and cooperation ability.

#### Partial Compensation System (Days 4–7)

Initiated when the patient's condition stabilized, sedation decreased, and responsiveness improved. Nurses encouraged patients to participate in bed mobility activities such as bridging (Babath handshake), rolling over, sitting up with assistance, and active-assisted limb movements. Each session lasted approximately 20–30 minutes and was conducted twice daily. The nurse guided and confirmed completion of each movement to enhance the patient's sense of accomplishment, facilitating the transition from passive to active participation.

### Supportive-Educative System (After Day 7 or Extubation)

Introduced once patients demonstrated improved motor function (eg, MRC grade ≥3). Nurses provided education and guidance on self-directed rehabilitation, including upper and lower limb strengthening exercises such as arm flexion/extension/lifting and knee flexion/extension. Training intensity and duration were gradually increased based on patient tolerance. Patients were encouraged to sit up and perform leg swinging exercises when hemodynamically stable Sessions were held three times weekly, lasting 30–45 minutes each, and continued until discharge or no further functional improvement was observed.

All interventions in the experimental group were documented daily in nursing records and performed by trained ICU nurses.

### Pain and Sedation Management

For mechanically ventilated patients in both groups, sedation and analgesia were administered according to institutional guidelines to ensure patient comfort and optimal ventilator synchrony. Sedation was maintained using midazolam or propofol infusion, titrated to achieve a target Richmond Agitation-Sedation Scale (RASS) score of –2 to 0. Fentanyl or morphine was administered as needed for pain control. Daily sedation interruption was performed whenever clinically feasible to assess neurological status and evaluate readiness for weaning. Importantly, there was no difference in sedation or analgesia protocols between the control and experimental groups.

## Observation Indicators

The main outcome measures in this retrospective study included respiratory function, clinical outcomes, psychological status, and adverse events. In terms of respiratory function, tidal volume, respiratory rate, partial pressure of oxygen and partial pressure of carbon dioxide were recorded before and after treatment. In terms of clinical outcome comparison, mechanical ventilation time, ICU stay time and 28d mortality of the two groups were counted. In terms of mental state, delirium scores, Hamilton Anxiety Scale (HAMA) scores and Hamilton Depression Scale (HAMD) scores of the two groups before and after treatment were analyzed. All patients were recorded for any adverse medical events that occurred during treatment, not necessarily causally related to treatment, including: accidental extubation, bed fall, skin pressure sores, and delirium.

## Statistical Analysis

SPSS 18.0 was selected for data statistics. The measurement data were expressed as mean ± standard deviation, and *T*-test was used for comparison between groups. The use cases and percentage of counting data were represented by Chi-square test. $P < 0.05$ meant that the difference was statistically significant.

# Results

## Comparison of Baseline Characteristics

The baseline characteristics of the two groups were comparable in terms of age, gender, weight, and height (all $P > 0.05$). No significant differences were found in primary ICU admission diagnoses, including respiratory diseases, neurological disorders, trauma-related conditions, or other systemic illnesses. Disease severity, assessed by APACHE II and ISS scores, was also similar between groups. Additionally, there were no significant differences in the prevalence of pre-existing respiratory conditions such as COPD, asthma, chronic bronchitis, or pneumonia at admission (all $P > 0.05$). These results indicate that the two groups were well-balanced in baseline demographics, clinical presentation, and disease severity (Table 1).

## Comparison of Improvement of Respiratory Function Indexes

The results of respiratory function indicators showed that, after intervention, the experimental group exhibited significant improvements in respiratory rate, partial pressure of oxygen ($PaO_2$), and reduced partial pressure of carbon dioxide

**Table 1** Comparison of Baseline Characteristics

| | Control Group (n=62) | Experimental Group (n=62) | $t/\chi^2$ | P |
|---|---|---|---|---|
| Age (years) | 55.23 ± 12.45 | 54.76 ± 11.89 | 0.213 | 0.832 |
| Gender (male/female) [n(%)] | 40 (64.5%) / 22 (35.5%) | 38 (61.3%) / 24 (38.7%) | 0.362 | 0.547 |
| Weight (kg) | 70.15 ± 10.56 | 69.98 ± 9.81 | 0.098 | 0.922 |
| Height (cm) | 168.22 ± 8.43 | 167.89 ± 8.11 | 0.225 | 0.823 |
| Diabetes (Yes/no) [n(%)] | 22 (35.5%) / 40 (64.5%) | 20 (32.3%) / 42 (67.7%) | 0.189 | 0.664 |
| Hypertension (Yes/no) [n(%)] | 25 (40.3%) / 37 (59.7%) | 23 (37.1%) / 39 (62.9%) | 0.217 | 0.641 |
| Primary diagnosis on ICU admission, n(%) | | | | |
| Respiratory failure | 28 (45.2%) | 26 (41.9%) | 0.154 | 0.695 |
| Neurological disorders | 15 (24.2%) | 17 (27.4%) | 0.213 | 0.644 |
| Trauma-related | 10 (16.1%) | 12 (19.4%) | 0.324 | 0.569 |
| Others | 9 (14.5%) | 7 (11.3%) | 0.403 | 0.526 |
| Severity scores | | | | |
| APACHE II score | 16.35 ± 4.22 | 15.89 ± 3.91 | 0.705 | 0.482 |
| ISS score | 18.52 ± 6.17 | 17.91 ± 5.85 | 0.534 | 0.594 |
| Pre-existing respiratory conditions, n(%) | | | | |
| COPD | 12 (19.4%) | 10 (16.1%) | 0.301 | 0.583 |
| Asthma | 4 (6.5%) | 3 (4.8%) | 0.157 | 0.692 |
| Chronic bronchitis | 6 (9.7%) | 5 (8.1%) | 0.115 | 0.735 |
| Pneumonia at admission | 18 (29.0%) | 16 (25.8%) | 0.174 | 0.676 |
| PEEP ($cmH_2O$) | 8.27±1.55 | 8.05±1.37 | 0.782 | 0.436 |
| $FiO_2$ (%) | 55.34±12.33 | 53.74±11.22 | 0.961 | 0.339 |

($PaCO_2$) compared with the control group ($P < 0.05$). Additionally, the $PaO_2/FiO_2$ (PF) ratio was significantly higher in the experimental group post-treatment, indicating better oxygenation efficiency. Although tidal volume increased in the experimental group, the difference did not reach statistical significance ($P > 0.05$), as shown in Figure 2.

## Comparison of Clinical Outcomes

Clinical outcome analysis revealed that patients in the experimental group had a significantly shorter duration of mechanical ventilation (10.22 ± 3.88 vs 12.55 ± 4.67 days, P = 0.021) and ICU stay (15.67 ± 4.76 vs 18.89 ± 5.12 days, P = 0.032) compared to the control group. However, no statistically significant difference was observed in 28-day mortality between the two groups (11.3% vs 19.4%, P = 0.077), as shown in Table 2.

## Improvement of Delirium and Psychological Score

The results of psychological scores showed that the delirium scores, HAMA scores and HAMD scores of the experimental group after treatment were significantly lower than those of the control group (P<0.001), as shown in Table 3.

## Incidence of Adverse Events

Analysis of adverse events showed that the overall incidence was significantly lower in the experimental group than in the control group (25.8% vs 61.3%, P < 0.001). Specifically, the incidence of skin pressure ulcers (6.5% vs 17.7%, P = 0.033) and delirium (14.5% vs 29.0%, P = 0.017) was significantly reduced. Although the differences in accidental extubation and falls from bed were not statistically significant (P = 0.087 and 0.184, respectively), a decreasing trend was still observed in the experimental group, as presented in Table 4.

# Discussion

Mechanical ventilation remains a life-saving intervention for critically ill patients in the intensive care unit (ICU), but it is associated with various complications, including ventilator-associated pneumonia, ICU-acquired weakness, delirium, and unplanned extubation. These complications not only prolong ICU stay and increase healthcare costs but also

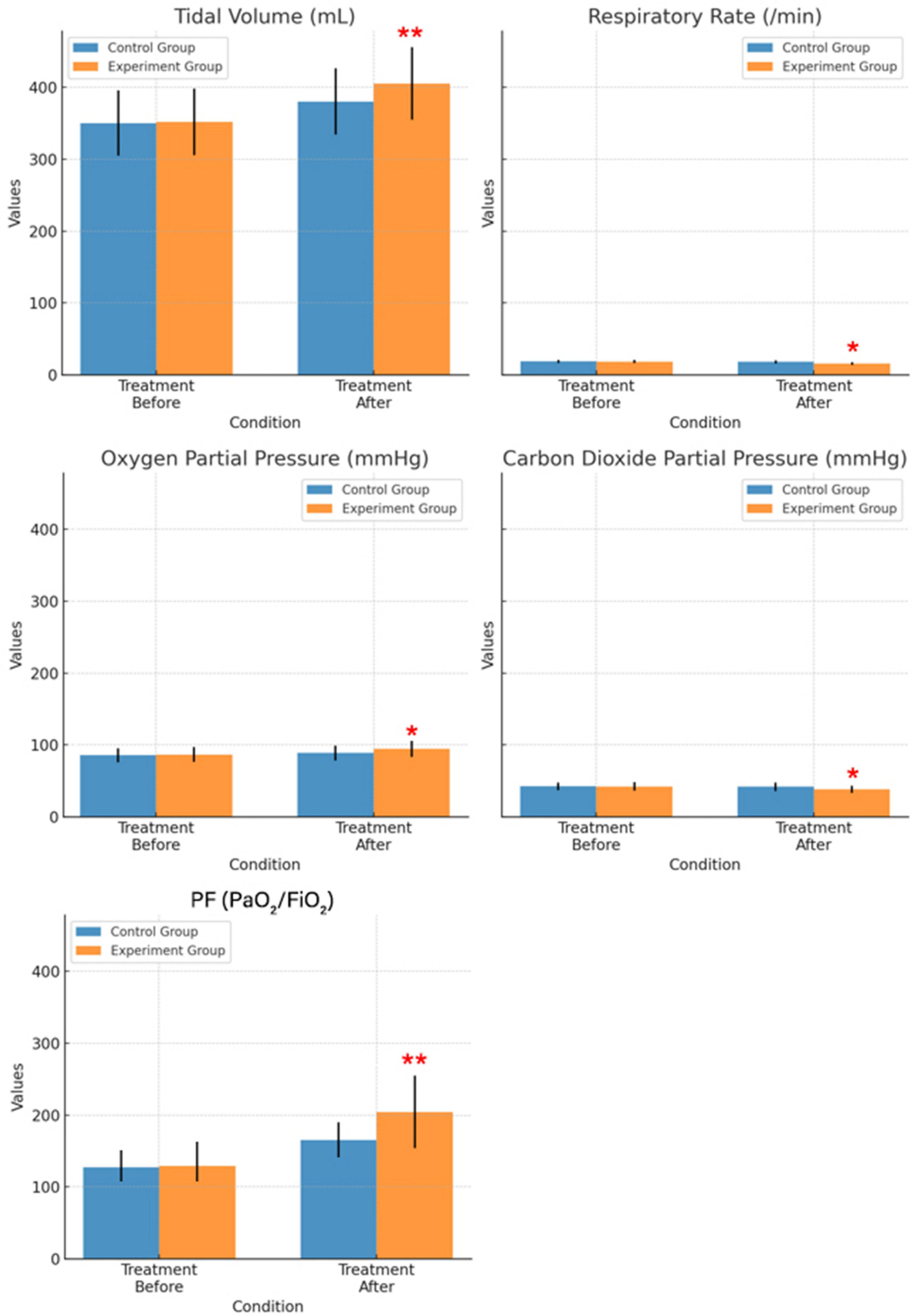


**Figure 2** Comparison of improvement of respiratory function indexes. *p < 0.05, **p < 0.01 vs control group at the same time point.

negatively affect long-term functional recovery and quality of life.[10,11] Therefore, optimizing nursing strategies to improve clinical outcomes in mechanically ventilated patients has become a key focus in critical care.

The present study demonstrates that integrating Orem's Self-Care Deficit Nursing Theory with early rehabilitation training significantly improves respiratory function, reduces psychological distress, shortens mechanical ventilation duration and ICU length of stay, and lowers the incidence of adverse events compared to standard ICU care. These findings highlight the clinical value of combining structured self-care principles with proactive rehabilitation interventions in the ICU setting.[12] Orem's self-care model emphasizes patient-centered care by identifying individual self-care deficits and tailoring nursing support accordingly through three systems: full compensation, partial compensation, and

**Table 2** Comparison of Important Clinical Outcomes

| | Mechanical Ventilation Time (days) | Length of Stay in ICU (Days) | 28-Day Mortality Rate [n(%)] |
|---|---|---|---|
| Control group (n=62) | 12.55 ± 4.67 | 18.89 ± 5.12 | 12 (19.4) |
| Experimental group (n=62) | 10.22 ± 3.88 | 15.67 ± 4.76 | 7 (11.3) |
| $\chi^2$ | 5.323 | 4.716 | 3.284 |
| P | 0.021 | 0.032 | 0.077 |

**Table 3** Comparison of Improvement in Delirium and Psychological Scores

| | n | Delirium Score | | HAMA Score (Score) | | HAMD Score (Score) | |
|---|---|---|---|---|---|---|---|
| | | Pre-Treatment | Post-Treatment | Pre-Treatment | Post-Treatment | Pre-Treatment | Post-Treatment |
| Control group | 62 | 8.22 ± 2.56 | 7.88 ± 2.45 | 21.55 ± 8.89 | 19.98 ± 8.76 | 19.87 ± 7.99 | 18.45 ± 7.56 |
| Experimental group | 62 | 8.15 ± 2.61 | 5.43 ± 2.11 | 21.67 ± 8.95 | 14.32 ± 7.85 | 20.07 ± 8.11 | 12.89 ± 6.92 |
| t | - | 1.016 | 6.935 | 0.072 | 4.284 | 0.141 | 5.112 |
| P | - | 0.312 | <0.001 | 0.943 | 0.001 | 0.888 | 0.001 |

**Table 4** Comparison of Adverse Event Rates

| | n | Accidental Extubation | Fall Out of Bed | Skin Pressure Sore | Delirium | Total |
|---|---|---|---|---|---|---|
| Control group [n(%)] | 62 | 4 (6.5) | 5 (8.1) | 11 (17.7) | 18 (29.0) | 38 (61.3) |
| Experimental group [n(%)] | 62 | 1 (1.6) | 2 (3.2) | 4 (6.5) | 9 (14.5) | 16 (25.8) |
| $\chi^2$ | – | 2.937 | 1.769 | 4.562 | 5.662 | 14.467 |
| P | – | 0.087 | 0.184 | 0.033 | 0.017 | 0.001 |

supportive-educative.[13] This systematic approach aligns well with the goals of early rehabilitation, which aims to restore physical function and promote independence as early as possible during ICU admission. Compared to conventional ICU rehabilitation—which often focuses on passive care or delayed mobilization—Orem-based care encourages active patient participation, enhances motivation, and builds self-efficacy, all of which are crucial for recovery.[14,15]

Several studies have supported the benefits of early rehabilitation in mechanically ventilated patients, showing improvements in muscle strength, cognitive function, and mental health.[16,17] However, few have integrated these efforts within a robust theoretical framework like Orem's. This study fills this gap by demonstrating how Orem's theory can guide personalized rehabilitation planning and enhance its effectiveness through structured self-care education and support.

For example, our results showed that patients in the experimental group had significant improvements in respiratory rate, $PaO_2$, and $PaCO_2$ levels, along with higher $PaO_2/FiO_2$ ratios compared to the control group. These findings suggest better oxygenation and gas exchange efficiency following the combined intervention. These results are consistent with previous studies that have shown improved respiratory parameters with early mobilization and physiotherapy,[18] but our study adds novelty by incorporating a theoretical nursing model to guide the process systematically.

In terms of psychological outcomes, the experimental group demonstrated significantly lower scores on delirium assessments, HAMA, and HAMD scales post-intervention. This indicates that the Orem-based rehabilitation approach effectively alleviates anxiety and depression in ICU patients. This effect may be attributed to enhanced patient engagement, increased sense of control, and reduced sensory deprivation—all of which are central to both early rehabilitation and Orem's philosophy of promoting self-care. These findings align with those of Deng et al, who reported improved self-efficacy and quality of life among patients receiving Orem-guided care.[19,20] Regarding clinical outcomes, the experimental group experienced shorter durations of mechanical ventilation and ICU stays, suggesting that the combined intervention accelerates recovery and reduces dependency on life-support measures. These results reinforce the importance of initiating structured rehabilitation early in ICU treatment, especially when guided by a theoretical framework that supports progressive patient autonomy.[21,22]

Adverse event analysis further revealed a significantly lower overall incidence of complications in the experimental group, particularly skin pressure ulcers and delirium. Although no statistically significant differences were observed in accidental extubation or falls from bed, a decreasing trend was noted, indicating potential benefits with larger sample sizes or extended follow-up periods.[23,24]

Despite these promising findings, several limitations must be acknowledged. First, this study was conducted at a single center with a relatively small sample size, which may limit the generalizability of the results. Second, although we followed patients during their ICU stay, longer-term follow-up data on functional recovery and quality of life beyond discharge are lacking. Third, while the implementation of the Orem model was standardized, variations in clinical practice across shifts and caregivers may have introduced minor inconsistencies in delivery. Future multi-center trials with larger cohorts and extended follow-up periods are warranted to confirm these findings and explore the broader applicability of this approach.

## Conclusion

In conclusion, this study provides evidence that combining Orem's self-care model with early rehabilitation training can significantly improve the clinical outcomes of mechanically ventilated ICU patients. The integration of a nursing theory into rehabilitation practice offers a novel, structured way to personalize care, enhance patient involvement, and optimize recovery trajectories. These findings contribute to the growing body of literature supporting theory-driven, patient-centered approaches in ICU rehabilitation and underscore the need for wider adoption of such models in clinical practice.

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An unauthorized version of the Chinese MMSE was used by the study team without permission, however this has now been rectified with PAR. The MMSE is a copyrighted instrument and may not be used or reproduced in whole or in part, in any form or language, or by any means without written permission of PAR (www.parinc.com).

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## Disclosure

The authors report no conflicts of interest in this work.

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