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# Effectiveness of a Phase I Cardiopulmonary Rehabilitation Nursing Protocol on Functional Outcomes in Patients after Open Type A Aortic Dissection Surgery: A Case-Control Study

**Hui Yang***

Taihe Hospital, Shiyan 442000, Hubei, China

**Author to whom correspondence should be addressed.*



**Abstract:** *Objective:* To explore the effectiveness of a Phase I cardiopulmonary rehabilitation nursing protocol on functional outcomes in patients after open Type A aortic dissection (TAAD) surgery. *Methods:* A total of 64 patients who underwent open TAAD surgery in the hospital from January 2023 to December 2024 were selected and randomly divided into the control group and the study group using a random number table, with 32 patients in each group. The control group received routine cardiopulmonary rehabilitation intervention, while the study group received a Phase I cardiopulmonary rehabilitation nursing protocol guided by the Theory of Planned Behavior. The 6-minute walk distance (6MWD), Borg Rating of Perceived Exertion (RPE) score, time to first postoperative ambulation, incidence of hypoxemia, incidence of hypoxemia-related complications, and incidence of rehabilitation nursing-related adverse events were compared between the two groups. *Results:* After intervention, the study group had a longer 6MWD, lower Borg RPE score, earlier time to first postoperative ambulation, and lower incidence of hypoxemia than the control group (all $P < 0.05$). There were no statistically significant differences in the incidence of hypoxemia-related complications or rehabilitation nursing-related adverse events between the two groups (both $P > 0.05$). *Conclusion:* The Phase I cardiopulmonary rehabilitation nursing protocol guided by the Theory of Planned Behavior is scientific, feasible, and clinically relevant for TAAD patients. It can improve patients' exercise capacity and reduce the incidence of hypoxemia.

**Keywords:** Type A aortic dissection; Cardiopulmonary rehabilitation; Theory of Planned Behavior; Motor function; Hypoxemia; Rehabilitation nursing

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## 1. Introduction

Type A aortic dissection (TAAD) is one of the most critical cardiovascular emergencies in clinical practice, with an acute-phase mortality rate as high as 73%. Surgical intervention is currently the core treatment modality. However,

postoperatively, patients often experience functional impairments such as decreased exercise tolerance, impaired pulmonary function, and reduced quality of life due to factors including myocardial ischemia, respiratory function suppression, and bed rest immobilization, which significantly increase the risk of long-term cardiovascular events [1]. Therefore, exploring effective postoperative rehabilitation interventions is crucial for improving functional outcomes. The value of cardiopulmonary rehabilitation in improving the functional status of patients with cardiovascular diseases through multidisciplinary comprehensive intervention has been well-documented [2]. However, in clinical practice, TAAD patients often fear activity due to concerns that exercise may increase blood pressure and induce aortic complications. Additionally, significant individual differences in personality traits, family support, and health literacy lead to generally poor exercise adherence [3]. The Theory of Planned Behavior explains the relationship between psychosocial factors and behavior formation. By adjusting patients' behavioral attitudes, strengthening subjective norms, and enhancing perceived behavioral control, it can promote the development of positive behavioral intentions, which have strong explanatory power for individualized behavioral interventions and help correct patients' cognitive biases, addressing the inadequacies of existing Phase I cardiopulmonary rehabilitation protocols in addressing psychosocial factors [4]. Based on this, this study aimed to apply a Phase I cardiopulmonary rehabilitation protocol guided by the Theory of Planned Behavior in post-TAAD surgery patients to improve their aerobic exercise capacity and reduce the risk of hypoxemia.

## 2. Materials and methods

### 2.1. General information

A total of 64 patients who underwent open TAAD surgery in our hospital from January 2023 to December 2024 were selected. They were randomly divided into the control group and the study group using a random number table, with 32 patients in each group. In the control group, there were 20 males and 12 females; aged 42–75 years, with an average of (58.62±7.35) years; body mass index (BMI) ranging from 18.5–27.8 kg/m2, with an average of (23.15±2.41) kg/m2; operation duration ranging from 3.5–6.2 h, with an average of (4.81±0.72) h; preoperative cardiac function classification: 19 cases of Grade II and 13 cases of Grade III. In the study group, there were 19 males and 13 females; aged 41–76 years, with an average of (59.17±7.52) years; BMI ranging from 18.3-28.0 kg/m2, with an average of (23.32±2.38) kg/m2; operation duration ranging from 3.6–6.1 h, with an average of (4.75±0.69) h; preoperative cardiac function classification: 20 cases of Grade II and 12 cases of Grade III. The general data of the two groups were balanced and comparable ($P > 0.05$). This study was approved by the Ethics Committee of our hospital.

### 2.2. Inclusion and exclusion criteria

Inclusion criteria: (1) Diagnosis of TAAD confirmed by imaging examinations, meeting indications for open surgery, and successfully undergoing the operation; (2) Clear consciousness, able to cooperate with rehabilitation training and data collection; (3) Informed consent obtained from patients and their families, who signed the informed consent form.

Exclusion criteria: (1) Complicated with end-stage diseases such as severe liver and kidney failure or malignant tumors; (2) Presence of severe cognitive impairment or mental illness; (3) Postoperative occurrence of severe complications (e.g., infection, massive hemorrhage) requiring delayed rehabilitation intervention; (4) Inability to complete walking tests due to limb dysfunction.

## 2.3. Intervention methods

### 2.3.1. Control group

A routine cardiopulmonary rehabilitation protocol was implemented. Intervention was initiated 24–48 h postoperatively when vital signs were stable, including: (1) Basic health education: Distribution of rehabilitation manuals, and explanation of postoperative activity precautions and hypoxemia prevention knowledge; (2) Exercise guidance: Assistance with bed turning, passive limb exercises, and gradual progression to bedside sitting, standing, and indoor walking; (3) Respiratory function training: Guidance on diaphragmatic breathing and effective cough and sputum excretion training, twice daily, 15–20 minutes per session; (4) Routine condition monitoring: Monitoring of heart rate, blood pressure, blood oxygen saturation, and other indicators.

### 2.3.2. Study group

A Phase I cardiopulmonary rehabilitation nursing protocol guided by the Theory of Planned Behavior was implemented, with the same intervention duration as the control group. The protocol was designed around three core dimensions: "behavioral attitude-subjective norm-perceived behavioral control": (1) Behavioral attitude adjustment: Correction of cognitive biases through one-on-one communication, and explanation of the relationship between exercise and blood pressure control using successful cases to eliminate concerns about "exercise-induced complications"; (2) Subjective norm strengthening: Involvement of family members in rehabilitation plan formulation, guidance on encouraging companionship to create a family support environment; (3) Perceived behavioral control enhancement: Development of individualized exercise prescriptions based on patients' tolerance (e.g., starting with bed ankle pump exercises and gradually increasing exercise intensity and duration), and provision of exercise monitoring bracelets to real-time feedback heart rate and blood oxygen data, thereby enhancing patients' sense of self-control. Meanwhile, the basic rehabilitation content of the control group was integrated to ensure intervention systematicness.

## 2.4. Outcome measures

(1) Exercise capacity indicators: 6-minute walk test was used to assess 6MWD 4 weeks after intervention, and Borg RPE scale (6–20 points, higher scores indicating greater exertion) was used to evaluate exercise tolerance simultaneously; (2) Rehabilitation progress indicator: Recording of time to first postoperative ambulation; (3) Safety and outcome indicators: Statistics of incidence of hypoxemia (blood oxygen saturation < 93% lasting more than 5 minutes), incidence of hypoxemia-related complications (e.g., pulmonary infection, atelectasis), and incidence of rehabilitation nursing-related adverse events (e.g., orthostatic hypotension, wound discomfort) during the intervention period.

## 2.5. Statistical analysis

SPSS 26.0 statistical software was used for data analysis. Measurement data were expressed as mean ± standard deviation (Mean ± SD), and inter-group comparison was performed using an independent samples *t*-test. Count data were expressed as [n (%)], and inter-group comparison was performed using $x2$ test. A *P*-value < 0.05 was considered statistically significant.

# 3. Results

## 3.1. Comparison of 6MWD and Borg RPE score between the two groups

After intervention, the study group had a significantly longer 6MWD and lower Borg RPE score than the control group (both $P < 0.05$) (**Table 1**).

**Table 1.** Comparison of 6MWD and Borg RPE score between the two groups (Mean ± SD)

| Group | n | 6MWD(m) | Borg RPE Score (points) |
|---|---|---|---|
| Control group | 32 | 230.14±30.46 | 12.45±2.12 |
| Study group | 32 | 265.39±32.17 | 10.98±1.84 |
| *t*-value | | 4.501 | 2.962 |
| *P*-value | | <0.001 | 0.004 |

## 3.2. Comparison of time to first postoperative ambulation between the two groups

The time to first postoperative ambulation was 5.12 ± 0.41 days in the control group and 4.71 ± 0.43 days in the study group, with the study group having a significantly earlier time to first ambulation ($t = 3.904$, $P < 0.001$).

## 3.3. Comparison of incidence of hypoxemia, hypoxemia-related complications, and rehabilitation nursing-related adverse events between the two groups

The incidence of hypoxemia in the study group was significantly lower than that in the control group ($P < 0.05$). There were no statistically significant differences in the incidence of hypoxemia-related complications or rehabilitation nursing-related adverse events between the two groups (both $P > 0.05$) (**Table 2**).

**Table 2.** Comparison of incidence of hypoxemia, hypoxemia-related complications, and rehabilitation nursing-related adverse events between the two groups [n (%)]

| Group | n | Hypoxemia | Hypoxemia-related complications (pulmonary infection/atelectasis) | Rehabilitation nursing-related adverse events (orthostatic hypotension/wound discomfort) |
|---|---|---|---|---|
| Control group | 32 | 11(34.38) | 3(9.38) | 2(6.25) |
| Study group | 32 | 4(12.50) | 2(6.25) | 1(3.13) |
| $x^2$-value | | 4.267 | 0217 | 0.350 |
| *P*-value | | 0.039 | 0.641 | 0.554 |

# 4. Discussion

Open TAAD surgery is associated with severe trauma and a prolonged postoperative recovery period. Due to preoperative absolute bed rest, intraoperative trauma, and fear of complications, patients often develop exercise phobia, which leads to poor adherence to conventional rehabilitation protocols and limited functional recovery outcomes. In this study, a Phase I cardiopulmonary rehabilitation nursing protocol was constructed based on the Theory of Planned Behavior, providing a new pathway for postoperative rehabilitation of TAAD patients through three-dimensional interventions (behavioral attitude adjustment, subjective norm strengthening, and perceived

behavioral control enhancement). Its clinical value and feasibility warrant in-depth exploration.

Conventional cardiopulmonary rehabilitation protocols mostly focus on physical function training, while neglecting the impact of patients' psychological cognition and social support on rehabilitation behavior, resulting in low implementation rates [5]. The Theory of Planned Behavior addresses this dilemma through multi-dimensional interventions: correcting patients' cognitive bias that "exercise induces elevated blood pressure" through one-on-one knowledge explanation and sharing of successful cases to establish a positive attitude towards rehabilitation training; mobilizing family members to participate in the formulation of rehabilitation plans, building a family support system to strengthen subjective norms; and developing stepwise goals based on individual tolerance, equipped with real-time monitoring equipment to enhance patients' sense of perceived behavioral control [6]. In this study, there was no significant difference in the incidence of rehabilitation nursing-related adverse events between the two groups, confirming that the protocol can be implemented safely under precise assessment and dynamic monitoring, and has good clinical feasibility.

After intervention, the 6-minute walk distance of the study group was significantly longer than that of the control group, and the Borg Rating of Perceived Exertion score was significantly lower than that of the control group. This result stems from the protocol's dual focus on "physical training + motivation stimulation": at the physical level, individualized training plans were developed based on preoperative assessment of exercise capacity, progressing from passive bed exercises to indoor walking, ensuring the scientificity and gradual progression of training; at the motivation level, cognitive intervention and goal incentives were used to promote patients' transition from "passive cooperation" to "active participation", improving training adherence and effectiveness. This "integrated internal and external" intervention model not only mobilizes the body's motor function but also stimulates subjective initiative, ultimately achieving a significant improvement in exercise capacity.

The incidence of hypoxemia in the study group was significantly lower than that in the control group. The core mechanism lies in the protocol's targeted respiratory function training and improved patient adherence: early diaphragmatic breathing and pursed-lip breathing training can coordinate diaphragmatic movement, increase tidal volume, and improve pulmonary gas exchange function; subsequent breathing exercise training can promote alveolar re-expansion and reduce the risk of atelectasis. Meanwhile, the intervention based on the Theory of Planned Behavior enhances patients' attention to and implementation of respiratory training, ensuring the full exertion of training effects [7]; the improvement of aerobic exercise capacity further increases vital capacity and pulmonary blood flow, forming a positive cycle of "respiratory training—improved exercise capacity—alleviated hypoxemia." Although there was no significant difference in the incidence of hypoxemia-related complications between the two groups, it is speculated to be related to the short intervention period. In the future, the long-term effect of the protocol can be further verified by extending the intervention time.

## 5. Conclusion

In conclusion, the Phase I cardiopulmonary rehabilitation nursing protocol guided by the Theory of Planned Behavior is scientifically feasible for application in patients after TAAD surgery. By correcting cognitive biases, strengthening social support, and optimizing training models, it can not only significantly improve patients' aerobic exercise capacity but also reduce the incidence of hypoxemia without increasing the risk of adverse events, providing a promotable clinical pathway for rehabilitation nursing after TAAD surgery.

## Disclosure statement

The author declares no conflict of interest.

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