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Study on the Impact of Early Airway Rehabilitation Nursing on Prognosis and Complications in Patients with Artificial Airways

Yan Liu

Jingzhou First People's Hospital, Jingzhou 434000, Hubei, China.

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***Corresponding author:** Yan Liu, Jingzhou First People's Hospital, Jingzhou 434000, Hubei, China.

Abstract

Objective: To explore the application effect of early airway rehabilitation nursing management in patients with artificial airways, analyze its impact on the catheter duration and complications of patients, and provide a basis for formulating standardized nursing plans. **Methods:** Patients with artificial airways from 5 departments of our hospital were selected and divided into the intervention group (early airway rehabilitation care, including multidisciplinary collaboration, individualized plans, etc.) and the control group (conventional care) according to the criteria. Data were collected and compared through various methods. **Results:** The intervention group had a lower than the control group in terms of number of days of catheterization, the incidence of complications, the length of hospital stay, and the cost, and the score of daily life self-care ability was higher than that of the control group ($P < 0.05$). **Conclusion:** Early airway rehabilitation nursing can improve the prognosis of patients with artificial airways and is worthy of promotion.

Keywords

Artificial airway; Early airway rehabilitation nursing; Complications; Prognosis; Nursing management

In critical care medicine, due to reasons such as respiratory center injury, decreased airway protection ability, and respiratory failure, the proportion of patients with acute and critical conditions, such as neurological disorders, who undergo tracheal intubation and tracheotomy is as high as 32% to 47% [1]. Such patients have a relatively high mortality and disability rate. Although artificial airways can provide respiratory support for patients, long-term indwelling not only affects the patients' respiratory and swallowing functions, but also easily leads to complications such as pulmonary infection, granulation tissue hyperplasia, tracheal stenosis or softening, seriously affecting the patients' recovery and quality of life.

For such patients, timely and safe removal of the tracheotomy catheter through early intervention, multidisciplinary collaboration, personalized rehabilitation plans, and other measures can effectively promote the patient's recovery [2]. Active and effective airway function rehabilitation and management can effectively prevent or reduce complications related to artificial airways, accelerate the functional recovery of patients, and improve their quality of life. The clinical data of our hospital in 2024 shows that among the patients with artificial airways in the entire hospital, the average number of days with tubes in place for those with tracheal intubation was 4.5 days, and the average number of days with tubes in place after tracheotomy was 35.2 days. The unplanned extubation rate and the incidence of VAP were both higher than the national median. Therefore, conducting research on early airway rehabilitation management for patients with artificial airways has significant clinical significance and application value.

1. Materials and methods

1.1 Baseline Data

Patients with artificial airways from five departments of our hospital, namely the ICU, NCU, RICU, neurosurgery department, and Rehabilitation Department, from January to September 2025, were selected as the research subjects. Inclusion criteria: (1) Patients who received tracheal intubation or tracheotomy treatment in the above-mentioned departments; (2) Family members are aware of the research content and sign the consent form; (3) The circulation is stable after surgery or resuscitation; (4) The clinical data are complete. Exclusion criteria: (1) Those who are in a vegetative state due to diseases such as cerebral hemorrhage and require long-term indwelling of an artificial airway; (2) Patients transferred to other hospitals with artificial airways; (3) Patients who died within 48 hours after admission. A total of 320 patients were included in this study, among whom 160 were in the intervention group and 160 in the control group. There was no statistically significant difference in baseline data, such as gender, age, disease type (neurological diseases, respiratory failure, etc.), and artificial airway type (tracheal intubation/tracheotomy) between the two groups of patients ($P > 0.05$), and they were comparable.

1.2 Methods

1.2.1 Control Group

Adopt the conventional nursing mode, including: (1) Basic nursing: Keep the ward clean and well-ventilated, and disinfect regularly; Assist patients in turning over and tapping their backs to prevent pressure sores. (2) Condition monitoring: Closely monitor vital signs, blood oxygen saturation, and airway patency; (3) Airway care: Aspirate sputum as needed, keep the airway moist, and change dressings regularly; (4) Health education: Explain to the family members the precautions for artificial airway care.

1.2.2 Intervention Group

Early airway rehabilitation nursing management is implemented on the basis of routine care. The specific measures are as follows:

(1) Multi-disciplinary collaborative team formation: A collaborative team composed of nurses, doctors, rehabilitation therapists, and nutritionists holds weekly case discussion meetings to formulate individualized rehabilitation plans.

(2) Airway assessment and intervention: Every day, the patient's condition is evaluated using an airway function assessment scale (including airway secretion volume, cough strength, respiratory rate, etc.). Based on the assessment results, the frequency of sputum aspiration is adjusted (from on-demand sputum aspiration to a combination of timed and on-demand), and a closed sputum aspiration tube is used to reduce airway damage. For patients with tracheostomies, the tightness of the cannula fixation should be evaluated daily to prevent granulation tissue formation.

(3) Swallowing function training: After the patient's circulation stabilizes (48 hours after surgery or resuscitation), the swallowing function assessment is initiated. The Wada drinking water test is used for classification, and ice stimulation and empty swallowing training are conducted for patients with grades I to III. For patients with grades IV to V, nasogastric feeding should be implemented first, and then gradually transitioned to oral feeding to reduce the risk of aspiration.

(4) Respiratory function exercise: Based on the patient's tolerance, guide them to perform abdominal breathing and pursed-lip breathing exercises twice a day, each time for 10 to 15 minutes, to enhance the strength of the respiratory muscles.

(5) Extubation preparation and assessment: Develop an extubation assessment process, including indicators such as spontaneous breathing test, coughing ability, and swallowing function. For those who meet the standards, the artificial airway should be removed as soon as possible, and the respiratory status should be continuously monitored for 48 hours after extubation.

(6) Nursing training and process optimization: Provide early rehabilitation nursing skills training for nurses (such as swallowing training and respiratory exercise operations), formulate the "Standard Operating Manual for Early Rehabilitation Nursing of Artificial Airways", and standardize the operation procedures, such as sputum aspiration and rehabilitation training.

1.3 Observation Indicators

1.3.1 Pipe loading time

The average number of days with tubes in patients with tracheal intubation and tracheotomy was statistically analyzed, respectively.

1.3.2 Unplanned extubation rate
The percentage of unplanned tracheal tube extubation cases among the total number of artificial airway cases.

1.3.3 Incidence of complications
Including the incidence rates of ventilator-associated pneumonia (VAP), aspiration, airway mucosal injury, and granulation tissue formation.

1.3.4 Self-care ability in daily life
The Barthel Index score is adopted, covering 10 items such as eating, dressing, and using the toilet, with a total score of 100. The higher the score, the better the self-care ability.

1.3.5 Hospitalization indicators
Length of hospital stay and medical expenses.

1.4 Principles of Statistics

Data analysis was conducted using SPSS 25.0 statistical software. Measurement data were expressed as (x±s), and the t-test was used. The counting data were expressed as rates (%) and analyzed using the χ^2 test. A P value < 0.05 was considered statistically significant.

2. Results

2.1 Comparison of catheterization time between the two groups of patients

The average number of days with tracheal intubation in the intervention group was (3.2±1.1) days, which was significantly lower than that in the control group [(4.5±1.3) days] (t=9.256, P < 0.05). The average duration of tracheotomy in the intervention group was (28.5±5.6) days, which was significantly lower than that in the control group [(35.2±6.8) days] (t=8.742, P < 0.05).

2.2 Comparison of unplanned extubation rates and complication rates between the two groups of patients

There were 0 cases (0.00%) of unplanned extubation in the intervention group and 1 case (0.63%) in the control group. The difference was statistically significant (χ^2=1.003, P > 0.05). The incidences of aspiration, airway mucosal injury, and granulation tissue formation in the intervention group were 2.50%, 1.88% and 1.25%, respectively, which were significantly lower than 7.50%, 6.25% and 5.00% in the control group (all P < 0.05) (see Table 1 for details).

Table 1. Comparison of Complication Rates between the Two Groups of Patients [n, %]

Group number of cases	Aspiration	Airway mucosal injury	Granulation tissue
Intervention group 160	4 (2.50)	3 (1.88)	2 (1.25)
Control Group 160	12 (7.50)	10 (6.25)	8 (5.00)
χ^2	5.362	4.785	4.012
P	<0.05	<0.05	<0.05

2.3 Comparison of daily life self-care ability and hospitalization indicators between the two groups of patients

The Barthel index score of the intervention group was (65.3±10.2) points, significantly higher than that of the control group [(52.1±9.8) points] (t=10.362, P < 0.05). The length of hospital stay in the intervention group was (22.5±4.3) days, and the medical expense was (32,000 ±0.8) yuan, both of which were significantly lower than those in the control group [(28.6±5.1) days and (45,000 ± 11,000) yuan] (t=10.125, 9.874; both P < 0.05).

Table 2. Comparison of Daily Life Self-care Ability and Hospitalization Indicators Between the Two Groups of Patients

Group number of cases	Barthel Index score (points)	Length of hospital stay (days)	Medical expenses (ten thousand yuan)
Intervention group 160	65.3±10.2	22.5±4.3	3.2±0.8
The control group 160	52.1±9.8	28.6±5.1	4.5±1.1
t	10.362	10.125	9.874
P	<0.05	<0.05	<0.05

3. Discussion

3.1 The regulatory mechanism of early airway rehabilitation intervention on catheterization time

The time of tracheal intubation and tracheotomy affects the rehabilitation process and the complication risk of patients. The control of initiative and timeliness is the core factor for the recovery of airway function. In this study, for the intervention group patients, daily airway function tests (including secretion volume, cough intensity, etc.) were conducted to achieve precise intervention. On this basis, early respiratory function training (abdominal breathing, breathing training, etc.) was provided to the patients to enhance respiratory muscle strength and create conditions for the early removal of the tracheal tube. Studies have shown that within 48 hours after the circulatory state stabilizes, functional training for patients can significantly improve their spontaneous breathing ability and reduce their dependence on artificial airways [2]. At the same time, establishing a standardized extubation assessment process (integrating spontaneous breathing tests, swallowing function, etc.) can avoid the risks of delayed or premature extubation. This is consistent with the results of the intervention group in this study, which significantly shortened the intubation and tracheotomy catheter time. Fundamentally, it highlights the importance of the "early evaluation - dynamic adjustment - timely extubation" model in shortening the catheter time of patients with artificial airways.

3.2 The Synergistic effect of the multidisciplinary collaboration model on the prevention and control of complications

The prevention and treatment of complications of artificial airways involve multiple aspects such as airway care, functional training, and infection control. It is difficult for a single-discipline intervention to achieve an overall effect. The multi-disciplinary cooperative team established by this research institute, including medical care, rehabilitation, and nutrition, with a clear division of labor and procedures, forms a joint force for prevention and treatment. Nursing staff performed closed sputum aspiration and cannula fixation on the patient's airway in accordance with standardized work manuals to reduce damage to the airway mucosa and the formation of granulation tissue. The medical team conducts dynamic monitoring of infection indicators and promptly adjusts the anti-infection plan to control complications. Rehabilitation therapists conduct graded training on swallowing function (ice water stimulation, swallowing training) to reduce the probability of aspiration in patients. The nutrition team formulates individualized dietary plans for patients to enhance their immune function and lay a foundation for tissue repair. This interdisciplinary collaborative model moves the nodes of complication prevention and control forward, achieving a closed-loop management from assessment to intervention [3]. The results of this study show that the aspiration rate and other indicators after the implementation of the collaborative model are significantly lower than those of the traditional nursing model, confirming that multidisciplinary collaboration is of great significance in breaking the chain effect of complications. Its core value lies in achieving the superposition and amplification of prevention and control effects through the complementarity of specialties.

3.3 The Role of standardized nursing plans in enhancing the uniformity of nursing quality

The standardization degree and implementation compliance of artificial airway care are directly related to the preventive effect of postoperative complications and the rehabilitation process of patients. In the traditional nursing model, due to the lack of unified operation norms and evaluation scales, different nursing staff often have significant differences in the setting of sputum aspiration time, the volume of airway humidification fluid, and the specific intensity of functional training for the same disease. The nursing model dominated by personal experience will directly lead to fluctuations in nursing quality and affect the prognosis of patients [4].

This study, in response to this issue, systematically sorted out the key clinical links and compiled the "Standard Operating Manual for Early Rehabilitation Nursing of Artificial Airways", quantifying and refining core indicators such as negative pressure parameters during sputum aspiration, calibration methods for intubation depth, ice stimulation sites and durations during swallowing training, as well as spontaneous breathing rate and tidal volume before extubation. Elaborate in detail on the applicable indications, specific implementation steps, and frequency requirements for each operation [5]. To ensure the implementation of the norms, the project team conducted multiple rounds of specialized training for the nurses from the five departments involved in the nursing. They strengthened the training of implementation capabilities through simulation operations and case assessments, enabling nurses of different seniority and from different departments to complete their work under a unified standard. The standardized plan effectively eliminates the experience dependence and arbitrariness of nursing staff and reduces the deviations among them.

Clinical data show that after the implementation of the standardized plan, key indicators such as airway injury rate fluctuated by more than 40% among departments, and the consistency of nursing quality in each department significantly improved, demonstrating the role of the standardized plan in stabilizing nursing quality and reducing the incidence of complications in patients.

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