Pulmonary Rehabilitation Nursing Care for a Stroke Patient after Tracheotomy: A Case Report

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Abstract

We report the pulmonary rehabilitation nursing experience of a stroke patient following tracheostomy. Key nursing interventions included: assessing respiratory movement and airway symptoms to provide a basis for care planning; continuous airway management with dynamic adjustment of airway clearance protocols; implementing stepwise pulmonary rehabilitation training to improve lung function; providing nutritional support to improve nutritional status; and improving swallowing function to reduce or prevent overt or covert aspiration, thereby enhancing patient quality of life. After 25 days of hospitalization, the patient underwent successful decannulation, achieved spontaneous breathing without dyspnea, and returned to normal family life.

Full Text

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Pulmonary Rehabilitation Nursing for a Stroke Patient After Tracheotomy: A Case Report

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【Abstract】 This article summarizes the nursing experience of pulmonary rehabilitation in a stroke patient after tracheotomy. Key nursing points included: assessing respiratory movement and airway symptoms to provide a basis for developing the nursing plan; implementing continuous airway management with

dynamic adjustment of airway clearance protocols; conducting stepwise pulmonary rehabilitation training to improve lung function; providing nutritional support to improve the patient' s nutritional status; and improving swallowing function to reduce or prevent overt or silent aspiration and enhance quality of life. After 25 days of hospitalization, the patient was successfully decannulated, able to breathe spontaneously without dyspnea, and returned to normal family life.

【Keywords】 Stroke; Tracheotomy; Pulmonary rehabilitation; Nursing

Introduction

Stroke has become the leading cause of death and disability in China in recent years. The more severe the stroke, the higher the proportion of patients requiring tracheotomy. According to statistics, 15%-35% of severe stroke patients require tracheotomy [**?**]. Although tracheotomy is an emergency life-saving procedure, the complications associated with long-term intubation pose numerous safety risks. Pulmonary rehabilitation, through professional respiratory training and physical therapy, can significantly improve patients' lung function and respiratory efficiency, increase vital capacity, and enhance muscle strength and endurance. Therefore, pulmonary rehabilitation serves as the cornerstone of early recovery for stroke patients after tracheotomy and is crucial and indispensable for improving respiratory function and quality of life. This article reports the relevant data on pulmonary rehabilitation nursing for a stroke patient after tracheotomy to provide reference for the nursing care of such patients.

1. Clinical Data

1.1 General Information

Patient Yin, male, 51 years old, was admitted to our hospital on November 25, 2023, with left limb weakness accompanied by speech, cognitive, and swallowing disorders for over one month. Diagnoses included: (1) intracerebral hemorrhage in the brainstem; (2) *Pseudomonas aeruginosa* pneumonia; (3) tracheostomy status; and (4) grade 3 hypertension (very high-risk group). The patient suddenly collapsed and lost consciousness at home on October 8, 2023. After emergency admission, he received endotracheal intubation with ventilator assistance, dehydration to reduce intracranial pressure, anti-infection treatment, gastric protection, and symptomatic support. He subsequently developed recurrent pulmonary infections. Sputum culture revealed *Pseudomonas aeruginosa*, with abundant, viscous, yellow sputum. Anti-infection treatment was continued. For further rehabilitation, he was transferred to our Department of Cardiopulmonary Rehabilitation. After meticulous multidisciplinary diagnosis, treatment, and nursing care, the patient improved and was discharged. The nursing experience during his hospitalization is summarized below.

1.2 Treatment and Outcome

Upon admission, the patient had an indwelling metal tracheostomy tube. Auscultation revealed coarse breath sounds in both lungs with prominent rales. He had poor appetite, an indwelling gastric tube, was emaciated with poor nutritional status, had a left renal cyst, and an indwelling urinary catheter with yellow urine. Laboratory results showed: white blood cell count $16.68\$\times 10^9/L; neutrophil count 12.59\times\$10\hat{}9/L$; hemoglobin 84 g/L; albumin 33.4 g/L; C-reactive protein 60.50 mg/L. Blood gas analysis showed: pH 7.412, PO2 57 mmHg, PCO2 29.7 mmHg. Chest CT revealed: (1) inflammation in the apical and posterior segments of the right upper lobe, lateral segment of the right middle lobe, and bilateral lower lobes; and (2) bilateral small pleural effusions.

After admission, an integrated treatment protocol was implemented by physicians, nurses, and therapists, including anti-infection therapy with anti-inflammatory and expectorant medications, airway humidification with 0.9% saline, a fluid intake plan, monitoring of intake and output, physical therapy-assisted sputum removal by therapists, continuous airway management, control of pulmonary inflammation, and consultation with the nutrition department to formulate a daily dietary plan. During hospitalization, the patient experienced mucus plugging of the tube. After comprehensive assessment, the small-diameter metal cannula was replaced with a subglottic drainage tracheostomy tube. For deep-seated mucus crusts, the airway clearance protocol was modified, switching from 0.9% saline humidification to a heated high-flow humidification device combined with manual hyperinflation for sputum removal. After airway clearance, the patient developed intractable hiccups. Starting with feeding management, the dietary plan was adjusted to postpyloric feeding. Through a combination of medication and external diaphragmatic pacing, the hiccups improved significantly.

On December 13, tracheostomy tube occlusion was attempted. Fever occurred on the second day. Analysis revealed that during the occlusion training, the tracheostomy tube occupied most of the airway space, forcing airflow through the narrow gap between the tube and trachea, which prevented effective sputum expectoration and worsened the pneumonia. Based on this, the airway clearance method was changed from manual hyperinflation to Active Cycle of Breathing Technique (ACBT). After the inflammation was controlled, the patient' s peak cough flow was tested at 450 L/min. On December 20, the tracheostomy tube was directly removed. No abnormalities occurred after removal, and the patient returned to normal family life on January 13, 2024.

A multidisciplinary pulmonary rehabilitation team was established, comprising one cardiopulmonary rehabilitation physician, one traditional Chinese medicine physician, one nutrition physician, one rehabilitation therapist, one cardiopulmonary rehabilitation specialist nurse, and five rehabilitation nurses, who jointly formulated the diagnosis, treatment, and nursing plan.

2. Nursing Points

2.1.1 Assessment of Respiratory Movement and Airway Symptoms to Provide Basis for Nursing Plan Development

Before pulmonary rehabilitation, the patient' s respiratory movement and airway symptoms were systematically assessed. Assessment contents included: (1) Detailed history taking, evaluation of respiratory pattern and frequency, and assessment of dyspnea using the Borg Scale. The patient exhibited thoracic breathing at 25 breaths/min with a Borg dyspnea score of 4. (2) Bedside ultrasound assessment of diaphragmatic function showed a diaphragmatic excursion of 0.84 cm. (3) Sputum assessment revealed grade 3 yellow-white viscous sputum, with 24-hour sputum volume of 50 mL, sputum volume score of 1, quantitative cough score of 3, and peak expiratory flow of 60 L/min.

2.1.2 Continuous Airway Management with Dynamic Adjustment of Airway Clearance Protocol

Most tracheostomy patients have abundant sputum and difficulty expectorating. Additionally, stroke may cause weakened cough reflex and insufficient cough strength due to nerve damage, leading to inadequate sputum removal. Therefore, sputum clearance is particularly important for stroke patients after tracheotomy. This patient had abundant, viscous sputum with difficult expectoration and recurrent pulmonary infections. The following nursing measures were implemented: (1) Airway humidification with 0.9% saline 1-2 mL every 2 hours. (2) Turning and percussion every 2 hours, with postural drainage for 10-15 minutes according to patient tolerance, and suctioning as needed [**?**], maintaining airway retained sputum volume $ $5 mL. (3) Fluid management with a drinking plan: 200 mL of water every two hours from 6:00 to 20:00, divided into 8 servings, for a total daily fluid intake of 1600 mL. Intake and output, urine volume, urine color, and body weight were monitored, with the plan adjusted timely according to the patient' s condition and actual needs.

Despite these measures, the patient experienced mucus crust plugging on day 13 of hospitalization. The small-diameter metal cannula was replaced with a subglottic drainage tracheostomy tube. Injector humidification was changed to a heated high-flow humidification device combined with manual hyperinflation for sputum removal [**?**]. Before hyperinflation, the patient was turned and percussed, and sputum was suctioned with negative pressure. A simple resuscitation bag was connected to an oxygen tube at 8-10 L/min flow rate and attached to the tracheostomy tube. The bag was squeezed evenly to deliver a tidal volume 1.5 times the patient' s usual tidal volume, with expiratory time adjusted to 3-5 seconds, respiratory rate controlled at 10 breaths/min, and 10-15 seconds of breath-hold after each ventilation. During exhalation, the bag was released quickly. After hyperinflation, sputum was suctioned using aseptic technique, 5 times/week, 10 min/session, once daily, for a 28-day cycle. After these interventions, the patient' s sputum became thin and yellow with reduced

volume.

On December 13, tracheostomy tube occlusion was attempted. Fever occurred on the second day. Analysis revealed that during occlusion training, the tracheostomy tube occupied most of the airway space, forcing airflow through the narrow gap between the tube and trachea, which prevented effective sputum expectoration and worsened the pneumonia. Therefore, the airway clearance method was changed from manual hyperinflation to Active Cycle of Breathing Technique (ACBT). The head of the bed was elevated, and the patient was placed in a sitting position with relaxed lumbar spine, neck, and shoulders. ACBT was initiated after the patient' s breathing stabilized. The breathing control phase: the patient was instructed to breathe relaxedly with normal tidal volume, keeping the upper chest, shoulders, and neck relaxed while actively contracting the lower chest and diaphragm for 8 seconds. Thoracic expansion exercises: the patient took slow, deep breaths, held breath for 3 seconds after maximal inspiration, then performed pursed-lip breathing to slowly exhale, repeated 3 times. Breathing control was performed until normal respiratory frequency was restored, followed by 3 thoracic expansion trainings, then breathing control again. The forced expiration technique phase: 2 huffs at low lung volume with abdominal muscle contraction to increase huff flow rate and volume, followed by huffing at high lung volume, twice daily for 5-10 minutes each session. After these interventions, the patient could effectively expectorate sputum, and pulmonary infection was controlled.

2.2 Implementation of Stepwise Pulmonary Rehabilitation Training to Improve Lung Function

Based on guidelines and nursing assessment results [**?**], the following nursing measures were implemented for the patient' s insufficient diaphragmatic activity and weak cough capacity. The training was conducted in two phases: Phase one during bed rest included suggestive breathing, butterfly breathing, and diaphragmatic resistance training. Suggestive breathing: the patient was assisted to flex knees, relax abdomen, chest, and shoulders, with hands placed on the left and right upper abdomen. During inspiration, the abdomen slowly rose while hands applied counterpressure; during expiration, lips were pursed into an "O" shape, abdomen sank, and hands descended, applying slight pressure at the end of expiration to increase intra-abdominal pressure and further elevate the diaphragm. Each session lasted 5-10 minutes, 2-3 times daily. Butterfly breathing: the patient placed crossed hands behind the head, inhaled slowly while extending arms backward and upward as far as possible, then slowly exhaled through pursed lips while bringing arms close to the cheeks. Each session lasted 5-10 minutes, 2-3 times daily. Diaphragmatic resistance training: sandbags weighing 0.5-2 kg were placed on the patient's upper abdomen, with weight increased progressively. The patient inhaled through the nose with abdomen rising, then exhaled slowly through pursed lips with abdomen sinking, maintaining an inspiration-to-expiration ratio of 1:1.5-2, 2 sets daily, 5-10 minutes per

set.

After guiding the patient to change from supine to sitting position, phase two training in sitting position included blowing paper strips, respiratory training devices, and tracheostomy tube occlusion training. A soft paper strip was prepared for the patient to blow from below to make it flutter, 2 sets daily, 5-10 minutes per set. The patient took two deep breaths, then on the third exhalation placed the mouthpiece of a respiratory trainer and forcefully exhaled to lift the ball, 2 sets daily, 5-10 minutes per set. For this patient, progressive occlusion was implemented, from 1/3 occlusion to 1/2 occlusion, then to complete occlusion, allowing gradual adaptation. Through stepwise pulmonary rehabilitation training, the patient was successfully and safely decannulated.

2.3 Provision of Nutritional Support to Improve Nutritional Status

After airway clearance, this patient developed intractable hiccups [**?**]. After literature review, the following treatments were implemented. Starting with feeding management, the dietary plan was adjusted to postpyloric feeding using a nutrition pump at a constant rate, but hiccups did not improve significantly. Medication combined with external diaphragmatic pacing was also minimally effective. On December 12, based on external diaphragmatic pacing, traditional Chinese medicine acupressure was applied, kneading Zanzhu (BL2), Neiguan (PC6), Zhongwan (CV12), and Baihui (GV20) acupoints with finger pads. Acupuncture was performed combining scalp and abdominal acupuncture. Scalp acupoints included Baihui (GV20), Sishencong (EX-HN1), and bilateral stomach area of the head. Abdominal acupoints included Zhongwan (CV12), Xiawan (CV10), Qihai (CV6), Guanyuan (CV4), Yindu (KI19), and Huaroumen (ST24), combined with electrical stimulation by adjusting current intensity and duration. The patient' s hiccups improved significantly. Nutritional solution was pumped at 60 mL/h and gradually increased to 100 mL/h. During this process, the dietary plan and volume were gradually adjusted according to the patient' s condition, with nutritional solution gradually reduced and homogenized diet increased. On January 2, pumping was gradually discontinued, and the patient was completely fed homogenized diet through the gastric tube. Then, a food portioning method was used to redesign the dietary plan with dynamic adjustment to ensure nutritional intake reached over 95% of basal requirements.

2.4 Improvement of Swallowing Function to Reduce or Prevent Overt or Silent Aspiration and Enhance Quality of Life

Swallowing disorder is one of the important factors affecting recurrent pulmonary infection after tracheostomy decannulation [**?**]. If patients cannot swallow independently or are prone to choking after eating, recurrent aspiration pneumonia will affect their recovery. Swallowing assessment of this patient showed: Repetitive Saliva Swallowing Test 2 times, Water Swallow Test grade 5, and videofluoroscopic swallowing study results: cheek puffing, lip pursing, and lip smacking were performed well, but flexibility of lip, tongue, and mandibular

function decreased; soft palate elevation was adequate; swallowing initiation was slightly delayed with paste consistency; epiglottic closure was suboptimal with residue in valleculae and pyriform sinuses; aspiration occurred with thin liquids.

The following swallowing function training methods were implemented: (1) The patient was guided to perform tongue exercises including tongue protrusion, tongue flicking, tongue rolling, tongue circling, and licking mouth corners; sensory stimulation using an electric toothbrush to gently stimulate the palate, tongue base, and posterior pharyngeal wall; taste stimulation using cotton swabs dipped in different fruit or vegetable juices to stimulate taste buds on the tongue surface; and head control training including neck extension, lateral flexion, and rotation. All exercises were performed 2 sets daily, 5-10 minutes per set. (2) Based on guidelines and videofluoroscopic swallowing study results [**?**], a single-bolus volume was determined, and the patient was fed paste-consistency food orally combined with side-lying swallowing, head-nod swallowing, and effortful swallowing techniques. After 4 days, the patient could eat paste-consistency food orally without choking, with significantly improved self-care ability. After feeding training, the patient still had choking when drinking water orally. By using thickeners for water intake, the gastric tube was successfully removed.

Discussion

Tracheotomy is the most effective life-saving treatment for stroke patients in critical condition. However, it alters the normal anatomical structure of the respiratory system, and inappropriate treatment can lead to difficult decannulation later. As clinical evidence of pulmonary rehabilitation effectiveness continues to grow, awareness of its clinical importance is also increasing. Pulmonary rehabilitation helps improve dyspnea, increase decannulation success rates, and enhance rehabilitation discharge rates. Moreover, the equipment and technical threshold for implementing respiratory rehabilitation is low, costs are not high, and it is easy to popularize. It is hoped that through this effective case report, from individual to population, continuous optimization and in-depth research will benefit more patients.

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Note: Figure translations are in progress. See original paper for figures.