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Observation on the Effect of Specialized Respiratory Tract Care in Preventing Pulmonary Infection after Cardiothoracic Surgery

Qing Huang

Taizhou Second People's Hospital, Taizhou 225500, Jiangsu, China

Abstract: *Objective:* To compare the application effects of routine care and routine care combined with specialized respiratory tract care in patients after cardiothoracic surgery. *Methods:* This study involved 102 patients who underwent cardiothoracic surgery in our hospital from September 2024 to December 2025. They were randomly divided into a control group (51 cases) and an observation group (51 cases). The control group received routine postoperative care for cardiothoracic surgery, while the observation group received specialized respiratory tract care in addition to routine care. The postoperative recovery, effective expectoration rate, and incidence of postoperative pulmonary complications were compared between the two groups. *Results:* The observation group had shorter ICU stays, drainage tube indwelling times, and hospital stays than the control group, with $p < 0.05$. The effective expectoration rate in the observation group was higher than that in the control group, with $p < 0.05$. The total incidence of postoperative pulmonary complications in the observation group was lower than that in the control group, with $p < 0.05$. *Conclusion:* Adding specialized respiratory tract care to routine postoperative care in cardiothoracic surgery can effectively improve the effective expectoration rate, reduce the incidence of pulmonary complications, and promote postoperative recovery in patients.

Keywords: Cardiothoracic surgery; Postoperative; Pulmonary infection; Respiratory tract; Specialized care

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1. Introduction

Cardiothoracic surgery is a core method for treating organic lesions of the heart and thoracic organs. The large surgical trauma, tracheal intubation during surgery, and manipulation of thoracic organs can significantly interfere with the patient's respiratory function. Additionally, factors such as postoperative incision pain, bed rest, and decreased respiratory muscle strength can easily lead to sputum accumulation, inadequate pulmonary ventilation, atelectasis, and other issues, thereby inducing pulmonary infection [1]. Pulmonary infection is one of the most common and high-incidence complications after cardiothoracic surgery. It not only prolongs the patient's recovery period, increases the risk of secondary complications

such as pleural effusion and respiratory failure, but also increases the patient's physical suffering and economic burden. In severe cases, it can endanger the patient's life safety and is a key risk factor affecting the prognosis of cardiothoracic surgery. Currently, routine care models are commonly used for patients after cardiothoracic surgery in clinical settings, but these care measures are relatively general and lack specificity [2]. With the continuous updating of modern surgical care concepts, refined and specialized care has become the mainstream trend for preventing postoperative complications. Specialized respiratory tract care focuses on the postoperative respiratory function characteristics and high-risk factors for infection in cardiothoracic patients, formulating targeted and systematic intervention measures that can precisely compensate for the shortcomings of routine care. However, the standardized application effects of this care model in preventing pulmonary infections after cardiothoracic surgery and its impact on the overall postoperative recovery of patients still require further systematic verification. Based on this, this controlled study was conducted.

2. Materials and methods

2.1. General information

This study selected 102 patients who underwent surgical treatment in the cardiothoracic surgery department of our hospital from September 2024 to December 2025 as the research subjects. They were randomly divided into two groups using a random number table method. The above general baseline data were comparable between the two groups, with $p > 0.05$. This study was approved by the Medical Ethics Committee of our hospital.

2.1.1. Control group

28 males and 23 females; aged 32–75 (53.68 ± 6.42) years; surgical types: 22 cardiac surgeries, 16 pulmonary lobectomies, 8 esophageal surgeries, and 5 mediastinal surgeries.

2.1.2. Observation group

29 males and 22 females; aged 30–74 (52.95 ± 6.81) years; surgical types: 21 cardiac surgeries, 17 pulmonary lobectomies, 9 esophageal surgeries, and 4 mediastinal surgeries.

2.2. Diagnostic criteria

This study referred to the diagnostic criteria for postoperative pulmonary infection in the "Chinese Adult Hospital-Acquired Pneumonia and Ventilator-Associated Pneumonia Diagnosis and Treatment Guidelines (2018 Edition)" [3].

2.3. Inclusion criteria

Patients who met the indications for cardiothoracic surgery, underwent their first routine surgical treatment for the heart, lungs, esophagus, mediastinum, or other cardiothoracic conditions, had a smooth surgical process, and were successfully transferred to the ICU or general ward for subsequent treatment and care after surgery; were conscious and able to cooperate with postoperative care, expectoration, and rehabilitation interventions; had complete clinical data, voluntarily participated in this study, signed an informed consent form, and were able to cooperate with the entire study process.

2.4. Exclusion criteria

Patients with pre-existing active pulmonary infections, severe emphysema, respiratory failure, severe asthma, or other serious respiratory diseases before surgery; those with severe liver and kidney failure, coagulation disorders, advanced malignant tumors, or severe autoimmune diseases; long-term smokers who did not quit smoking before surgery; long-term users of immunosuppressants; and patients with severely compromised immunity.

2.5. Dropout and exclusion criteria

Patients who actively requested to withdraw from the study, gave up treatment, or transferred to another hospital during the study process and were unable to complete the entire observation period; those who did not strictly adhere to the research care plan, privately changed the care method, or interrupted the intervention, affecting the accuracy of experimental data; those who developed other nosocomial infections or complications during the study period that interfered with the judgment of pulmonary infection observation indicators.

2.6. Methods

The control group received routine postoperative care:

(1) Basic condition monitoring

After surgery, closely monitor vital signs such as body temperature, heart rate, blood pressure, blood oxygen saturation, and respiratory rate. Observe for any bleeding or exudation at the incision site, properly secure various drainage tubes, maintain tube patency, and record the color, volume, and characteristics of the drainage fluid. After the patient is transferred to the ICU and general ward, complete the handover of the patient's condition according to the department's routine procedures.

(2) Basic respiratory tract care

Conduct routine nebulization inhalation twice daily as prescribed by the doctor after surgery. When the patient expresses a desire to expectorate, encourage them to cough and expectorate on their own. If the sputum is thick and difficult to expectorate independently, perform simple suctioning. Regularly auscultate the lung's breath sounds and promptly inform the doctor of any abnormalities for handling.

(3) Posture and activity care

Provide routine bed rest posture care after surgery. Once vital signs are stable, guide the patient to change their posture independently.

(4) Basic health education and dietary care

Briefly explain postoperative precautions and dietary restrictions, instruct the patient to consume high-protein, light, and easily digestible foods, and verbally remind them to drink small amounts of water.

(5) Ward management

Routinely open windows for ventilation and clean and disinfect the floor daily, adhering to the basic hospital infection management requirements of the ward.

The observation group fully adopted the routine care content of the control group while adding specialized respiratory tract care:

(1) Respiratory tract health education and psychological intervention

Immediately after surgery, provide one-on-one explanations of the hazards of postoperative pulmonary

infection and sputum retention, demonstrate correct coughing and breathing techniques, and alleviate the patient's fear and resistance to expectorating due to incision pain. Share rehabilitation cases to enhance cooperation. Instruct the patient and their family to drink sufficient water after surgery, with a daily intake controlled between 1500 and 2000 mL to dilute the sputum.

(2) Multimodal analgesia and effective cough guidance

Implement multimodal analgesia by combining a patient-controlled analgesia pump with analgesic drugs to minimize chest wall incision pain and eliminate the patient's fear of coughing due to pain. Guide patients on effective expectoration techniques based on their type: for explosive coughing, take a deep breath, hold it, contract the abdomen, and then suddenly open the glottis to cough forcefully; for segmented coughing, cough softly and continuously in segments, suitable for patients with poor tolerance to incision pain. Regularly supervise and practice these techniques 3-4 times daily.

(3) Standardized airway humidification and nebulization intervention

In addition to routine nebulization, use continuous oxygen heating and humidification to maintain respiratory tract mucosa moisture and prevent airway dryness and sputum crusting. Adjust nebulization drugs and frequency based on sputum viscosity. Increase nebulization frequency for patients with grade III sputum viscosity to enhance sputum dilution.

(4) Postural drainage and mechanical/manual percussion for sputum expectoration

Assist the patient in assuming a semi-reclining or lateral position based on the surgical site and lung lesion location to promote bronchial sputum drainage by gravity. Perform this twice daily for 15–20 minutes each time, avoiding the hour after meals. The nursing staff should cup their hands and percuss the patient's chest and back evenly from bottom to top and from outside to inside, with a force appropriate to the patient's tolerance, avoiding the surgical incision, heart, and breast areas. Perform this after nebulization, 10–15 minutes each time, to loosen deep airway sputum.

(5) Systematic respiratory function training

Initiate training immediately after the patient regains consciousness and vital signs stabilize, twice daily for 15–20 minutes each time: ① Diaphragmatic breathing: Place hands on the upper abdomen, inhale to expand the abdomen, and exhale to contract it, breathing slowly and evenly. ② Pursed-lip breathing: Inhale through the nose and exhale slowly through pursed lips to prolong exhalation time and improve lung ventilation. ③ Depending on the patient's recovery, add balloon blowing exercises to promote lung re-expansion. Both groups received continuous care until the day before discharge.

2.7. Observation indicators

(1) Postoperative recovery

Record the ICU stay duration, drainage tube indwelling time, and hospital stay duration for both groups.

(2) Effective expectoration rate

Effective expectoration is defined as the patient's ability to smoothly expectorate airway sputum through independent coughing or simple assisted percussion, resulting in clear airways and a significant reduction or disappearance of lung auscultation rales without the need for negative pressure suction intervention. Ineffective expectoration is defined as difficulty in independent coughing, persistent or increased lung wet rales, and the necessity of negative pressure suction to clear sputum.

(3) Incidence of postoperative pulmonary complications, including pulmonary infection and atelectasis.

2.8. Diagnostic criteria for postoperative pulmonary infection

(1) Fever ≥ 38.0°C in the axillary temperature 48 hours or more after surgery, excluding infections at other sites such as incision or urinary tract infections;
(2) Presence of persistent respiratory symptoms such as cough, expectoration, chest tightness, shortness of breath, or dyspnea;
(3) Auscultation of localized or diffuse wet rales or decreased breath sounds in the lungs;
(4) Blood tests indicating a significant increase in white blood cell count and neutrophil percentage;
(5) Chest X-ray/CT showing new inflammatory infiltrates or patchy shadows in the lungs. A diagnosis can be confirmed if ≥3 of the above criteria is met.

2.9. Statistical analysis

The study data were analyzed using SPSS 26.0 statistical software. Normally distributed measurement data are presented as ($\overline{x} \pm s$), and intergroup differences were compared using the *t*-test. Count data are presented as frequencies and percentages (%), and intergroup differences were compared using the χ^2 test. A *p*-value < 0.05 was considered statistically significant.

3. Results

3.1. Postoperative recovery

The observation group had shorter ICU stays, drainage tube indwelling times, and hospital stays than the control group, with $p < 0.05$. See **Table 1**.

Table 1. Postoperative recovery [$\overline{x} \pm s$]

Group	Number of cases	ICU observation time (h)	Drainage tube indwelling time (d)	Hospital stays (d)
Control group	51	78.12 ± 10.13	5.75 ± 1.59	15.39 ± 2.82
Observation group	51	54.19 ± 8.32	4.32 ± 1.36	11.56 ± 2.23
χ^2 value		13.037	4.881	7.608
p value		< 0.001	< 0.001	< 0.001

3.2. Effective expectoration rate

The effective expectoration rate in the observation group was higher than that in the control group, with $p < 0.05$. See **Table 2**.

Table 2. Effective expectoration rate [n/%]

Group	Number of cases (n)	Effective sputum excretion	Ineffective sputum excretion
Control group	51	35 (68.63)	16 (31.37)
Observation group	51	46 (90.20)	5 (9.80)
χ^2		7.256	
P		0.007	

3.3. Incidence of postoperative pulmonary complications

The overall incidence of postoperative pulmonary complications in the observation group was lower than that in the control group, with $p < 0.05$. See **Table 3**.

Table 3. Incidence of postoperative pulmonary complications [n/%]

Group	Number of cases (n)	Pulmonary infection	Atelectasis	Total incidence
Control group	51	8 (15.69)	5 (9.80)	13 (25.49)
Observation group	51	2 (3.82)	1 (1.96)	3 (5.88)
χ^2				7.413
p				0.006

4. Discussion

Cardiothoracic surgery involves significant trauma, with intraoperative tracheal intubation and manipulation of thoracic organs easily damaging the respiratory mucosa. Coupled with factors such as postoperative incision pain, prolonged bed rest, and decreased respiratory muscle strength, patients commonly experience difficulties in expectorating sputum and sputum retention, thereby substantially increasing the risk of complications such as pulmonary infections and atelectasis. In this study, the control group received routine care, which merely included basic disease monitoring, simple nebulization inhalation, and oral health guidance. The nursing measures were relatively general and lacked systematic, individualized interventions for respiratory management, making it difficult to fundamentally address issues such as poor expectoration and decreased airway defense capabilities in patients, thus revealing shortcomings in nursing interventions [4].

The results of this study showed that the observation group had shorter ICU observation times, drainage tube indwelling times, and hospital stays compared to the control group ($p < 0.05$). The reasons for this are as follows: specialized respiratory care focuses on core aspects such as airway management, expectoration intervention, and respiratory function training, enabling timely airway clearance, reducing the occurrence of pulmonary inflammation, and lowering the probability of secondary pleural effusion and infection. This helps stabilize the patient's vital signs more quickly, shortening the duration of ICU monitoring. Additionally, smooth sputum evacuation and improved pulmonary status contribute to the earlier reduction and achievement of standards for thoracic drainage fluid, shortening the drainage tube indwelling time. Faster recovery of various indicators ultimately effectively reduces the overall hospital stay [5].

The results of this study indicated that the observation group had a higher effective expectoration rate than the control group ($p < 0.05$). The reasons for this are as follows: specialized respiratory care alleviates incision pain through multimodal analgesia, removing the psychological barrier of patients being afraid to cough due to fear of pain. Combined with continuous airway humidification, individualized frequency nebulization therapy to dilute sputum, and physical methods such as postural drainage and standardized chest and back percussion to loosen deep airway sputum, patients are guided step-by-step to master techniques such as abdominal breathing, pursed-lip breathing, and effective coughing based on different types. These multi-pronged approaches comprehensively improve expectoration effectiveness from aspects such as subjective cooperation, sputum characteristics, physical drainage, and respiratory movements, significantly enhancing the effective expectoration rate [6].

The results of this study demonstrated that the observation group had a lower total incidence of postoperative pulmonary infections and atelectasis compared to the control group ($p < 0.05$). The reasons

for this are as follows: sputum retention is a core factor inducing postoperative pulmonary complications in cardiothoracic surgery. A large number of secretions accumulating in the airways easily leads to bacterial growth and compression of lung tissue, thereby triggering pulmonary infections and atelectasis. Specialized respiratory care involves early health education and psychological intervention to improve patient compliance, combined with comprehensive respiratory assessments throughout the process and sterile operation management, forming a complete system for preventing pulmonary infections. This reduces lung tissue compression and inflammatory invasion, lowering the risk of postoperative pulmonary-related complications from the source [7]. Additionally, staged respiratory function training and early activity guidance can gradually restore patients' pulmonary ventilation and gas exchange functions, promoting lung re-expansion and further reducing the incidence of atelectasis [8].

5. Conclusion

In summary, combining specialized respiratory care with routine postoperative care in cardiothoracic surgery can enhance patients' expectoration effectiveness, reduce pulmonary complications, and accelerate postoperative recovery.

Disclosure statement

The author declares no conflict of interest.

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