The Impact of Cardiac and Thoracic Surgeries on Pulmonary Function and Nursing Strategies

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Abstract: Cardiac surgery and thoracic surgery can have multiple impacts on patients' pulmonary function. This article analyzes the related effects from three aspects: limited pulmonary ventilation function, pulmonary gas exchanges dysfunction and increased risk of postoperative pulmonary complications. At the same time, perioperative nursing measures were proposed for different types of patients, including preoperative, intraoperative, and postoperative nursing, and detailed data was used to analyze the nursing effectiveness. It's hoped to provide practical guidance for the clinical nursing of patients in cardiac and thoracic surgery, thereby improving their postoperative pulmonary function, reducing the incidence of complications, and enhancing their overall therapeutic effect.

***Keywords*:** cardiac surgery; thoracic surgery; pulmonary function; nursing strategies

1. Introduction

Cardiac and thoracic surgeries are the main methods for treating cardiovascular and pulmonary diseases in clinical practice. However, during the operation process, it often causes varying degrees of damage to the patient's pulmonary function. Surgical procedures have a direct or indirect impact on the integrity of the chest, the normal physiological structure of the lungs, and the neuro muscular regulatory mechanisms related to respiration. For example, thoracotomy surgery can disrupt the skeletal support and muscle balance of the sternum, thereby altering the pressure distribution in the chest and affecting normal breathing. Meanwhile, due to the effects of intraoperative anesthesia, manipulation of thoracic visceral organs, and postoperative pain stress, a series of changes in pulmonary function can occur. Common situations include inadequate lung ventilation and weakened lung defense mechanisms. These changes not only increase the risk of pulmonary complications for patients after surgery, but also prolong their hospital stay, which has a significant impact on their recovery process and quality of life. Therefore, further understanding the changes in pulmonary function of patients after cardiac and thoracic surgery and developing corresponding nursing measures are of great practical significance for improving the quality of life of patients.

2. The impact of cardiac and thoracic surgeries on pulmonary function

2.1 Limited pulmonary ventilation function

During the surgical procedure, thoracotomy surgery can disrupt the overall structure of the chest, reduce its compliance, and cause contraction of the respiratory muscles. Especially during the surgery process, there will be a lot of pain after the surgery because the ribs need to be stretched open or some muscles need to be removed. Therefore, patients generally do not breathe heavily or cough, which leads to a decrease in lung capacity and tidal volume, and a faster breathing rate. However, effective ventilation will be reduced. In addition, operations such as pulling and squeezing chest organs during surgery process can also cause irritation to the pleura and lung tissue, leading to reflexive bronchospasm and increased airway resistance, preventing airflow from entering the lungs and affecting their ventilation capacity. For example, studies have shown that after surgery, patients' lung capacity decreases by 30% to 40%, tidal volume decreases by 25%, and maximum ventilation restriction occurs in the early postoperative period, gradually improving with wound healing. However, this long-term effect seriously affects the patient's respiratory function.

2.2 Pulmonary gas exchanges dysfunction

Cardiac and thoracic surgeries can affect blood circulation and gas exchange in the lungs. Postoperative trauma, inflammatory reactions, and other factors can cause pulmonary vasoconstriction and spasm, thereby reducing pulmonary artery blood flow and causing ventilation/blood flow imbalance in the lungs. In addition, surgical procedures cause edema and exudation of alveolar epithelial cells, thereby affecting the diffusion of oxygen and CO2. For example, in cardiopulmonary bypass (CPB) surgery, due to the contact between blood and artificial materials, as well as the release of inflammatory mediators, postoperative lung exchange dysfunction can lead to damage to pulmonary micro-vascular endothelial cells, resulting in symptoms such as hypoxemia. According to relevant data, approximately 30% to 40% of patients will experience varying degrees of hypoxemia after CPB surgery, with arterial oxygen partial pressure dropping to 60-80 mmHg. Severe ARDS is a major disease that seriously endangers human health. Currently, there are no effective drugs in clinical practice, which seriously affects the quality of life of patients.

2.3 Increased risk of postoperative pulmonary complications

Due to the decreased ventilation and gas exchanges capacity of the lungs, patients are prone to pulmonary complications after surgery. Atelectasis is the most common disease in clinic therapy. The main reason is that patients have a large number of sputum retention, bronchial obstruction, reduced elasticity of lung tissue, etc. after surgery, which leads to abnormal expansion of alveoli, and eventually leads to alveoli collapse. Pulmonary infections are also quite common, as surgical trauma can weaken the immune system, leading to a decrease in respiratory defense capabilities. At the same time, there may be difficulty in draining phlegm, which can cause bacteria to grow and multiply in the lungs. In addition, there are some serious complications such as respiratory failure. For example, in patients undergoing cardiac surgery at a major hospital, postoperative pulmonary complications account for 20% to 30%, of which 10% to 15% is atelectasis. About 8% to 12% of patients will develop lung infections, and 2% to 5% of patients will experience respiratory failure. This complication not only brings pain to patients, but also imposes a great burden on them, which can cause them to stay in the hospital for an additional one to two weeks. Some patients may experience serious complications, thereby threatening their lives.

3. Nursing strategies

3.1 Preoperative nursing

It is very important to conduct a comprehensive evaluation of the patient's pulmonary function before surgery. A detailed examination should be conducted on the patient's lung ventilation and gas exchange function. If there are lung diseases such as chronic obstructive pulmonary disease, asthma, etc., active treatment is needed to maintain stable pulmonary function. For example, in patients with COPD, preoperative use of bronchodilators or corticosteroids can significantly improve pulmonary function index, such as increasing FEV1 by 15% to 20%. Patients can be guided to do respiratory function training to strengthen respiratory muscles and improve lung ventilation efficiency. A study on preoperative respiratory training showed that during one to two weeks of training, patients' respiratory muscle strength can be improved by 20% to 30%, and lung capacity and volume can also be improved. Some detailed explanations were given to the patients, explaining the specific surgical procedures to reduce their fear and enhance their sense of cooperation. In addition, preventive measures such as quitting smoking and preventing respiratory infections should be taken before surgery. After stopping smoking for 2-4 weeks, the viscosity of respiratory secretions significantly decreases, and the amount of sputum produced also decreases by 30% to 40%.

3.2 Intraoperative nursing

During the operation, nursing staff should closely monitor the patient's vital signs, adjust the depth of general anesthesia and ventilation parameters appropriately to ensure sufficient oxygen supply and normal CO2 excretion. Collaboration with the surgeon should be strengthened during the operation to minimize tension and damage to the lungs and thoracic organs. For patients who undergo long-term surgery or have a higher risk of postoperative pulmonary complications, lung protective ventilation can be used. Reasonable positive end expiratory pressure (PEEP) ventilation can prevent alveolar collapse and improve oxygen supply. Research has shown that appropriate PEEP can maintain alveolar opening and reduce atelectasis by 20% to 30%. During this process, it is necessary to maintain a stable body temperature of the patient to prevent adverse reactions such as vasoconstriction and abnormal coagulation function caused by excessive temperature. During surgery, warming devices such as infusion sets and blankets can be used to keep the patient's temperature within 36-37 ℃, in order to prevent phenomena such as pulmonary vasospasm and tissue hypoxia caused by high body temperature.

3.3 Postoperative nursing

After surgery, appropriate posture nursing should be taken for patients. Depending on different surgical procedures and the specific situation of the patient, a semi recumbent or inclined position can be adopted to facilitate breathing and drainage. Raising the bed by 30-45° after surgery is beneficial for reducing the diaphragm, increasing chest volume, and improving ventilation capacity. During the treatment process, attention should be paid to caring for the patient's respiratory tract. At the same time, it is important to encourage and assist patients in coughing and expectoration in the early stages. During the treatment process, methods such as nebulization inhalation and chest physical therapy can be used to dilute phlegm and facilitate its elimination. Nebulized inhalation with ambroxol can reduce sputum viscosity by 40% to 50%. Turning over and patting the back for chest physical therapy, 3-4 times a day, is beneficial for loosening and expelling phlegm. Nursing staff need to strengthen the observation of patients' respiratory status, conduct regular pulmonary function tests, and pay attention to blood oxygen saturation and gas analysis in order to timely detect and treat pulmonary complications. If atelectasis occurs, methods such as bronchoscopy suction can be used to alleviate it, which is beneficial for lung re-expansion. After bronchoscopy treatment, 70% to 80% of patients with atelectasis can recover in a short period of time. For patients with pulmonary infections, sputum samples should be collected in a timely manner, drug sensitivity tests should be conducted, and anti-infective drugs should be used correctly. During this process, it is important to provide nutritional support to the patient to enhance their immunity, accelerate the recovery of pulmonary function, and promote their physical recovery. Providing a high protein, high calorie, and high vitamin diet for patients after surgery, usually 1.2-1.5 grams/kg of protein, can increase the level of human serum albumin within 1-2 weeks, promote wound healing and body recovery.

4. Analysis of nursing effectiveness

A total of 100 patients who underwent cardiac and thoracic surgeries from January 2024 to July 2024 were selected for this research. They were randomly divided into two groups (a control group and an observation group), with 60 patients in each group. The male to female ratio of the control group is 32:18, with an age range between 30 and 60 years old and an average age of 48.8 ± 0.5 years old. The male to female ratio in the observation group is 33:17, with an age range of 32 to 62 and an average age of 49.5 ± 0.6 years old. Statistical analysis was conducted on the two sets of data ($P>0.05$), indicating that the two groups can be compared and studied. The control group received routine nursing, while the observation group received perioperative nursing. By observing three indicators of pulmonary function, incidence of pulmonary complications, and patient recovery process, the effectiveness of cardiac and thoracic surgical nursing was explored. This study collected data and followed the procedure to record various observation indicators of patients in detail. After the data collection was completed, this study used SPSS 22.0 as the main research tool for data analysis, and the comparison of differences between groups was conducted using the $\chi 2$ test. P-value is less than 0.05 indicates a statistically significant difference. The final analysis yielded the following data:

4.1 Significant improvement in pulmonary function indicators

The comparison of the effects of two groups of lung function indicators is shown in Table 1 below.

Table 1. Comparison of the effects of two groups of lung function indicators

Group	FVC	PEF	FEV1	FEF25%~75%
Control Group	1.61±0.50	3.85±0.93	1.81±0.50	1.92±0.88
Observation Group	3.45±0.63	5.85±1.26	2.93±0.70	3.66±0.58
P	P<0.05	P<0.05	P<0.05	P<0.05

According to the comparison in Table 1, it can be concluded that the pulmonary function indicators of the control group were lower than those of the observation group ($P<0.05$), indicating that there is a significant difference between the two groups. It also demonstrated that the perioperative nursing strategies taken by the observation group can improve patients' pulmonary function.

4.2 The incidence of pulmonary complications has significantly decreased

Comparison of incidence of complications between two groups is shown in Table 2 below.

Table 2. Comparison of incidence of complications between two groups [n (%)]

Group	Incidence of Complications
Control Group	20%
Observation Group	10%
P	P<0.05

According to the data on the incidence of pulmonary complications in Table 2, the incidence of complications in the control group was 20%, while that in the observation group was 10%. Statistical analysis was conducted between the two groups (P<0.05), indicating a significant difference between the two groups and demonstrating that perioperative nursing can reduce the incidence of complications in patients.

4.3 The patient's rehabilitation process is effectively accelerated

The comparison of rehabilitation process effects between two groups of patients is shown in Table 3 below

Table 3. Comparison of rehabilitation process effects between two groups of patients

Group	Postoperative bed rest activity time (per day)	Hospitalization days (days)
Control Group	4.8±0.6	15±0.6
Observation Group	3.5±0.3	10±0.4
P	P<0.05	P<0.05

According to the analysis of the rehabilitation process related indicators in Table 3, it can be concluded that the control group had a postoperative bed rest time of 4.8 ± 0.6 days, while the observation group had a bed rest time of 3.5 ± 0.3 days. In terms of hospitalization days, the control group had a duration of 15 ± 0.6 days, while the observation group had a duration of 10 ± 0.4 days. Statistical analysis was conducted between the two groups (P<0.05), indicating a significant difference between the two groups. This also demonstrates that providing perioperative nursing to patients can accelerate their recovery process.

5. Summary

The impact of cardiac surgery and thoracic surgery on pulmonary function is relatively serious, and comprehensive, systematic, and targeted nursing strategies are of great significance in improving patient prognosis. Accurate preoperative evaluation and sufficient psychological preparation provide a solid foundation for the patient's surgery; Strengthening intraoperative collaboration and meticulous nursing can alleviate pulmonary function damage during surgery; After surgery, scientific rehabilitation treatment and prevention of complications can effectively promote the patient's pulmonary function and overall recovery. In this way, the incidence of postoperative pulmonary complications can be minimized, thereby improving the efficacy and quality of life of patients undergoing cardiac and thoracic surgery, promoting early recovery and discharge, and restoring normal life.

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