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The Application Effect of Predictive Nursing on Cardiopulmonary Rehabilitation of Patients Undergoing Heart Valve Surgery with Extracorporeal Circulation

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Abstract: *Objective:* To evaluate the application effect of predictive nursing on patients undergoing heart valve surgery with extracorporeal circulation (ECC). *Methods:* 92 ECC patients admitted to the hospital between July 2021 and July 2023 were selected and grouped by random number table method; the observation group practiced predictive nursing, while the reference group practiced conventional nursing. The cardiopulmonary rehabilitation and other indexes were compared between the groups. *Results:* The postoperative rehabilitation time of the observation group was shorter than that of the reference group, the treatment compliance was higher than that of the reference group, the cardiopulmonary function indexes were all better than that of the reference group, and the complication rate was lower than that of the reference group ($P < 0.05$). *Conclusion:* The implementation of predictive nursing for ECC patients can promote postoperative rehabilitation, improve patients' treatment compliance, and enhance the cardiopulmonary rehabilitation effect, and nursing safety is high.

Keywords: Predictive nursing; Heart valve extracorporeal circulation surgery; Cardiopulmonary rehabilitation; Treatment compliance; Complications

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1. Introduction

The etiology of heart valve disease is valve closure insufficiency or valve stenosis, and extracorporeal circulation (ECC) surgery is mostly practiced, which can restore the cardiopulmonary function of patients. However, this surgical method is highly invasive and may lead to postoperative fluctuations in the patient's condition, affecting the function of vital organs such as the heart, brain, and lungs, thereby potentially reducing the effectiveness of the surgery [1]. In order to ensure the smooth operation and safety of ECC surgery, clinical medicine mostly carries out nursing interventions. Conventional nursing typically focuses on monitoring physiological changes and providing perioperative guidance. However, it may be less timely and has a higher

risk of complications, making it somewhat limited. In contrast, predictive nursing takes a comprehensive approach by considering individual differences and disease states, offering more targeted and purposeful care. It can anticipate potential nursing risks in advance, leading to more effective outcomes [2]. Based on this, 92 ECC patients were selected in this study to evaluate the intervention effect of predictive nursing.

2. General information and methods

2.1. General information

The study selected 92 cases of ECC patients from July 2021 to July 2023, which were divided by random number table method. There were 46 cases in the observation group, male:female was 25:21; aged 34 to 79 (45.32 ± 2.91) years old; among them, there were nine cases of valvuloplasty and 37 cases of valve replacement. In the reference group, there were 46 cases, male:female was 24:22; aged 31 to 77 (45.97 ± 2.80) years old; among them, there were seven cases of valvuloplasty and 39 cases of valve replacement. $P > 0.05$ when comparing the data between the two groups.

Inclusion criteria: diagnosis of heart valve disease that met the relevant criteria of "Guidelines for the Management of Patients with Heart Valve Disease (2014)"; meeting the indications for ECC surgery; clear consciousness and ability to cooperate with the study; informed and consent to the study. Exclusion criteria: lack of clinical data; language and communication barriers; severe liver/brain disorders; history of myocardial infarction; and withdrawal during the study.

2.2. Methods

In the reference group, routine nursing was carried out: preoperative knowledge of disease and surgery was explained, psychological status was assessed, and verbal guidance was provided; during surgery, all surgical operations were coordinated, and several signs of patients were monitored; after surgery, medication and dietary guidance were provided, correct coughing methods were demonstrated, and patients were accompanied to exercise cardiopulmonary function, such as assisted turning, passive movement of limbs, semi-sitting training, bedside sitting up training, and getting out of bed activities.

The observation group implemented predictive nursing: (1) Forming a team: The team leader was a specialist nurse, and the team members were five responsible nurses. The team leader provided comprehensive training in nursing knowledge, refined the nursing tasks of each team member, and coordinated the perioperative nursing process, so as to comprehensively optimize the skill level of the nursing staff. (2) Preoperative care: Educational materials, such as graphic brochures and educational videos, were distributed to patients to predictively explain perioperative nursing problems, focusing on popularizing the technological maturity of ECC surgery, surgical steps, surgical cooperation, anesthesia protocols, surgical safety, and rehabilitation training measures, to eliminate the blind spots of the patient's knowledge of the surgery. (3) Postoperative care: (a) Monitoring care: After being transferred to the ward, the patient's vital signs were continuously monitored, emergency equipment and various emergency medications were prepared, and urine protein levels, blood pressure readings, and electrocardiogram (ECG) indicators were intermittently checked; (b) Pain care: Visual Analog Scales were distributed, with a total score of 10 points. For those scoring below 3 points, light music can be played and meditation training can be guided to help shift the patient's attention and reduce their focus on pain. For scores between 4 and 6 points, physical pain relief methods, such as limb massage or external chest band fixation, can be employed. For those scoring above 7 points, pain relief medications such as diclofenac sodium and ibuprofen can be administered according to medical instructions; (c) Complications care: Oxygen

therapy and anticoagulant care were provided. Vital signs such as blood pressure, heart rate, and temperature were monitored every hour to promptly detect early signs of hypoxemia. Based on arterial blood gas analysis results, ventilator settings were adjusted appropriately. After discontinuing the ventilator, position changes and chest percussion were performed every 2 hours. The patient was maintained in a head-down, feet-up position or in a forward-leaning position with arms naturally hanging down. They should breathe through the nose, take a deep breath, hold it briefly, apply appropriate pressure to the chest and abdomen, and assist in expectoration to facilitate mucus removal; (d) Cardiopulmonary rehabilitation training: Once the patient's condition stabilizes, abdominal pursed-lip breathing exercises were conducted. The patient was seated with arms naturally hanging down, breathing through the nose while pushing out the abdomen to increase intra-abdominal pressure. The lips were then pursed, and the patient exhaled slowly over 4 to 5 seconds. Simultaneously, combined with suggested breathing exercises, the patient laid supine with hands crossed on the upper abdomen. The patient was guided to inhale slowly while pushing the abdomen up. The nurse applied pressure with both hands on the abdomen for resistance training. Afterward, the patient exhaled slowly, allowing the abdomen to sink, with continued pressure at the end of exhalation for further resistance training. These exercises were performed three times daily, each session lasting 10 to 20 minutes. The responsible nurse accompanied the patient throughout the training, promptly identified and corrected any errors, and provided positive feedback. (4) Discharge guidance: On the day before discharge, a self-made health education manual was provided, detailing information on medication knowledge, dietary dos and don'ts, rehabilitation training methods, and psychological adjustment. Patients were informed of the time for follow-up outpatient visits. The role of family members was emphasized in providing supervision and companionship, encouraging and supporting the patient at home. Additionally, contact information, such as phone numbers and WeChat IDs, were included. Patients and their families were invited to join a WeChat group, where they were encouraged to ask questions actively. One-on-one answers were then provided to address their concerns.

2.3. Observation indicators

(1) Postoperative recovery time: This includes the time of first gas passage and bowel movement and hospitalization time.

(2) Treatment compliance: A self-made compliance questionnaire was distributed; full compliance means active and full cooperation with surgical treatment; basic compliance means basic cooperation with surgical treatment; non-compliance means non-cooperation with surgical treatment.

(3) Cardiopulmonary function indexes: The right ventricular stroke work index (RVSWI), left ventricular systolic pressure (LVSP), and left ventricular stroke work index (LVSWI) were assessed by ultrasound diagnostic instrument. Lung function indicators such as pulmonary vascular resistance (PVR), pulmonary compliance (CL) and airway resistance (Raw) were assessed by blood gas analyzer.

(4) Complication rate: Complications include pulmonary atelectasis, hypoxemia, coagulation abnormality, cardiac arrhythmia, and pulmonary infection.

2.4. Statistical methods

Data processing was completed by SPSS21.0 software, measurement data were compared and tested by *t*-test, and count data were compared and tested by χ^2, with $P < 0.05$ indicating that the difference was statistically significant.

3. Results

3.1. Comparison of postoperative recovery time between the two groups

The postoperative recovery time of the observation group was shorter than that of the reference group ($P < 0.05$), as shown in **Table 1**.

Table 1. Comparison of postoperative recovery time between the two groups [mean ± standard deviation (SD)]

Groups	Time to first gas passage (hours)	Time to first bowel movement (hours)	Length of hospital stay (days)
Observation group (n = 46)	20.19 ± 2.75	21.27 ± 2.91	14.22 ± 2.06
Reference group (n = 46)	34.25 ± 2.80	28.53 ± 2.94	20.29 ± 2.18
t	24.298	11.903	13.726
P	0.000	0.000	0.000

3.2. Comparison of treatment adherence between the two groups

The treatment adherence of the observation group was higher than that of the reference group ($P < 0.05$), as presented in **Table 2**.

Table 2. Comparison of treatment adherence between the two groups [n (%)]

Groups	Full compliance	Basic compliance	Non-compliance	Compliance rate
Observation group (n = 46)	24	21	1	97.83 (45/46)
Reference group (n = 46)	20	19	7	84.78 (39/46)
χ^2	-	-	-	4.929
P	-	-	-	0.026

3.3. Comparison of cardiopulmonary function indexes between the two groups

Before nursing, there was no difference in the comparison of the cardiopulmonary function indexes of the two groups ($P > 0.05$). After nursing, the cardiopulmonary function indicators of the observation group were better than those of the reference group ($P < 0.05$), as shown in **Table 3**.

Table 3. Comparison of cardiopulmonary function indexes between the two groups (mean ± SD)

Groups	RVSWI ($g/m \cdot m^2$)		LVSP (mmHg)		LVSWI ($g/m \cdot m^2$)	
	Before nursing	After nursing	Before nursing	After nursing	Before nursing	After nursing
Observation group (n = 46)	5.65 ± 0.81	4.28 ± 0.31	17.58 ± 2.67	12.63 ± 2.08	43.59 ± 4.99	12.61 ± 2.31
Reference group (n = 46)	5.67 ± 0.78	4.85 ± 0.39	17.54 ± 2.70	15.73 ± 2.11	43.52 ± 4.87	15.89 ± 2.40
t	0.121	7.760	0.071	7.096	0.068	6.678
P	0.904	0.000	0.943	0.000	0.946	0.000
Groups	**PVR ($dyn \cdot s \cdot cm^{-5}$)**		**CL (ml/cmH_2O)**		**Raw (ml/cmH_2O)**	
	Before nursing	**After nursing**	**Before nursing**	**After nursing**	**Before nursing**	**After nursing**
Observation group (n = 46)	36.56 ± 3.94	47.51 ± 3.18	44.35 ± 4.19	35.19 ± 3.84	5.41 ± 0.56	6.95 ± 1.27
Reference group (n = 46)	36.52 ± 3.91	39.75 ± 3.11	44.42 ± 4.23	40.08 ± 3.95	5.44 ± 0.51	6.41 ± 1.20
t	0.049	11.833	0.080	6.020	0.269	2.096
P	0.961	0.000	0.937	0.000	0.789	0.039

3.4. Comparison of the complication rate between the two groups

The complication rate of the observation group was lower than that of the reference group ($P < 0.05$), as presented in **Table 4**.

Table 4. Comparison of complication rate between the two groups [*n* (%)]

Groups	Pulmonary atelectasis	Hypoxemia	Coagulation abnormalities	Arrhythmia	Pulmonary infection	Complication rate
Observation group ($n = 46$)	1	0	0	1	0	4.35 (2/46)
Reference group ($n = 46$)	2	1	1	3	1	17.39 (8/46)
χ^2	-	-	-	-	-	4.039
P	-	-	-	-	-	0.045

4. Discussion

Heart valve disease is a more common type of disease in cardiac surgery, which will significantly increase the patient's cardiac load, leading to transmural blood abnormalities, which in turn reduces the quality of life [3]. It is highly prevalent in middle-aged and elderly people, and the disease is located in the tricuspid and mitral valves, etc., and is easily combined with heart failure. The common treatment for this disease is ECC surgery, and mainly valve replacement, which can be used to replace stenotic valves or incomplete valves with prosthetic valves to improve cardiac function. The success rate is high, but postoperative complications are common. For this reason, effective and comprehensive care is needed in the perioperative period [4].

Predictive care belongs to the individual, refined, and comprehensive nursing measures, which can predictively assess and analyze the patient's disease condition, discover the potential risks of surgery, analyze the patient's potential nursing problems, and then provide targeted care to ensure the smooth progress of surgery [5,6]. Its goal is to identify and detect nursing risks at an early stage, to develop preventive measures, to reduce patients' surgical pain, and to improve their long-term quality of life. It requires continuous assessment and feedback and excellent clinical judgment and specialized skills to provide high-quality care. This nursing care can individualize the nursing plan, comprehensively assess the patient's medical history, health status, and lifestyle, and take into account the patient's individual differences, so the nursing care measures are highly scientific and targeted [7,8].

The results showed that the postoperative recovery time of the observation group was shorter than that of the reference group; the treatment adherence of the observation group was higher than that of the reference group; after the nursing care, the cardiorespiratory function indexes of the observation group were better than that of the reference group; and the complication rate of the observation group was lower than that of the reference group ($P < 0.05$). The reason is that predictive care can be given to cardiopulmonary function training after the patient's condition is stabilized, to enhance the diaphragm's exercise capacity, restore lung ventilation, and reduce myocardial oxygen consumption, thus it can improve alveolar ventilation, significantly expand the thorax, and then restore the patient's cardiopulmonary function [9,10]. This nursing care includes monitoring care, pain care, and other measures, which can relieve pulmonary compression, increase tidal volume, expand the alveoli in the collapsed state, so it can prevent pulmonary atelectasis or hypoxemia, improve sputum coughing ability, and reduce pulmonary infection. This nursing care is more detailed, can create a close nurse-patient relationship, and correct the patient's misperception of ECC, thus reducing their negative psychology and

improving their confidence in recovery [11].

5. Conclusion

In conclusion, the implementation of predictive nursing care for ECC patients can shorten the postoperative recovery time, improve the patient's adherence to treatment and cardiopulmonary rehabilitation, and reduce complications, which shows significant nursing advantages.

Disclosure statement

The author declares no conflict of interest.

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