Revista Argentina de Clínica Psicológica
2020, Vol. XXIX, N°3, 826-833
DOI: 10.24205/03276716.2020.904

Clinical Nursing Coordination Points of Extracorporeal Membrane Oxygenation (ECMO) in the Treatment Process

Lei Shi[a], Jing Wang[b*]

Abstract

Objective: The purpose was to analyze and study clinical nursing coordination points of extracorporeal membrane oxygenation (ECMO) in the treatment process.

Methods. The clinical data of 100 critically ill patients treated in our hospital from January 2018 to January 2020 were retrospectively analyzed. The patients were randomly divided into test group and control group with 50 cases in each group. Patients in the control group were given routine clinical nursing while those in the test group were given intensive clinical nursing, and the therapeutic effects of the two groups were compared.

Results. The auxiliary time of ECMO in the test group (14.37±1.78) d was significantly better than that in the control group (13.18±1.42) d, and the difference was statistically significant (t=3.695, P = 0.000). The hospital stays in the test group (36.27±1.56) d was significantly better than that in the control group (41.33±2.07) d, and the difference was statistically significant (t=13.804, P = 0.000). The total incidence of complications was 8% in the test group and 32% in the control group, and the difference was statistically significant (x^2=9.000, P=0.003). The oxygen metabolism parameters in the test group were significantly better than those in the control group after treatment, and the difference was statistically significant (p<0.05). The on-board success rate, total offline rate and overall survival rate of the test group were 100%, 88%, 83% respectively, which were significantly better than 87%, 65%, 64% of the control group, and the difference was statistically significant (p<0.05).

Conclusion. Standardized ECMO clinical specialist nursing process can effectively shorten the ECMO auxiliary time and hospital stay, reduce clinical complications, improve various oxygen metabolism parameters of patients and improve the survival rate when ECMO rescue is given to critically ill patients.

Keywords: extracorporeal membrane oxygenation (ECMO); treatment process; clinical nursing

Introduction

Extracorporeal membrane oxygenation (ECMO) mainly provides sustained extracorporeal breathing and circulation for patients with severe cardiopulmonary dysfunction to continue and maintain their lives (Al et al.,2019; AlsalemiAbdullah et al.,2020). The core of ECMO is the blood pump (artificial heart) and membrane lung (artificial lung), providing long-term cardiopulmonary support for patients with cardiopulmonary failure. Concerning patients with systemic inflammatory response syndromes such as respiratory failure caused by infection or physical trauma, the most important thing in the rescue process is to correct hypoxemia. Mechanical ventilation can not effectively improve it while ECMO can provide oxygen to the body without relying on lung tissue, earning precious time for rescuing severe patients (Ana et al.,2019; Bethany et al.,2018; Bouabdallaoui et al.,2018; Danielle et al.,2018). The working principle of ECMO is to drain the venous blood in the patient to the outside, and then exchange the gas through the oxygenator, convert the venous blood into arterial blood and then injected it into the artery or vein, which temporarily replaces the human cardiopulmonary function(FalkLars et al.,2019). As a new technology to

[a] Department of Emergency Medicine,Qilu Hospital, Cheeloo College of Medicine, Shandong University,Ji'nan, Shandong, 250012, China
[b] Department of Critical Care Medicine,Qilu Hospital, Cheeloo College of Medicine, Shandong University,Ji'nan, Shandong, 250012, China
**Corresponding Author: Jing Wang*

rescue critically ill patients, ECMO is difficult to implement and has a high clinical risk. Therefore, the key to successfully rescue critically ill patients is to be familiar with clinical nursing coordination points of ECMO (Formica et al.,2019; Hancock et al.,2018). This paper retrospectively analyzed the clinical data of 100 critically ill patients treated in our hospital from January 2018 to January 2020. The patients were randomly divided into test group and control group with 50 cases in each group. The report is summarized as follows.

1. Materials and Methods

1.1 General Information

The clinical data of 100 critically ill patients treated in our hospital from January 2018 to January 2020 were retrospectively analyzed. The patients were randomly divided into test group and control group with 50 cases in each group. In the test group, there were 24 males and 26 females with an average age of （37.24±2.31） years old, including 17 cases of cardiogenic shock, 16 cases of acute myocardial infarction, 13 cases of pulmonary embolism, and 4 cases of viral pneumonia. In the control group, there were 27 males and 23 females with an average age of （36.94±2.53） years old, including 15 cases of cardiogenic shock, 18 cases of acute myocardial infarction, 11 cases of pulmonary embolism, and 6 cases of viral pneumonia. There was no significant difference in general clinical data between the two groups ($p < 0.05$), which was of significance for further study. The study was approved by the hospital ethics committee, and the patients and their families knew the purpose and process of the experimental study, and signed the informed consent.

1.2 Methods

Patients in the control group were given routine clinical nursing in hospital to closely monitor the the changes in various physiological indexes of them, analyze their blood flow and oxygen saturation, and make appropriate adjustments accordingly.

In the test group, intensive clinical nursing was adopted with the specific implementation steps as follows: (1) ECMO equipment: ECMO machine and emergency drive device (manufacturer: Fresenius AG, Germany), ECMO ambulance, variable temperature water tank, portable oxygen cylinder, full temperature activated coagulation time instrument (manufacturer: Shanghai Ouqi Electronics Technology Co., Ltd.), pipe clamp, coupling agent, cutting instrument package, electrical plug board, ECMO record sheet, etc. (2) ECMO consumables: cap, sharp blade, disposable medical mask, sterile gloves, No. 4 silk thread, vascular suture, disinfectant, large angle needle, silk thread with needles, disposable nail bag, heparin, cotton pad, Ringer lactate solution, arterial intubation, sterile gauze, extension tube, sterile film, heparin cap, tee joint. Materials and equipment were managed by the hospital extracorporeal circulation team. (3) ECMO treatment process: a. Firstly, the patient's cardiopulmonary function was scientifically evaluated, and the on-board indication and clinical treatment mode were determined. b. The clinical treatment plan of ECMO was designated according to the patient's condition evaluation. The attending doctor actively explained the ECMO treatment steps and relevant precautions to the patient's family members. C. Checked the ECMO equipment and consumables. D. Checked the air source, power supply, water tank and determine whether there were errors in the connection direction of the pipeline. e. Pre-charged the ECMO kit, exhausted the gas in the pipeline, installed the front and back side branch pipelines of the oxygenator, and turned the machine for standby after pre-charging. f. Vital signs of patients were closely monitored during ECMO catheterization and consumables were replaced correctly. The machine was started after catheterization with the flow adjusted to a reasonable range. All items used for ECMO operation were prepared to ensure the normal operation of machine. Blood gas and ACT value were detected and analyzed regularly. g. After evaluation by the attending doctor, ECMO could be removed from the patient, and the patient’s blood vessels were repaired in time. Then the machine could be shut down. (4) Operation management: a. At the beginning of ECMO, it was kept at a high flow rate as far as possible with a rotational speed controlled at 60-80 ml/(kg.min). As the patient's condition gradually stabilized, the flow rate was reduced according to the cardiopulmonary function of the patient. b.The indicators of the patient were monitored dynamically during ECMO treatment, including the blood pressure, heart rate, body temperature, electrolyte, blood gas, oxygen saturation, etc. Based on the indicators above, the auxiliary flow, pump speed and water tank temperature, etc. were adjusted accordingly. (5) Clinical nursing cooperation: a. During the rescue process, the patient was in critical condition with the respiratory failure, which was life-threatening. Therefore, the hospital should not only select medical personnel skilled in ECMO technology to carry out rescue operations, but also require relevant nursing personnel with a high sense of dedication and responsibility, which would boost the rescue success rate and ensure the patient's life safety. b. Because the patient using ECMO had a longer treatment time, involving many devices and pipes, and the patient had lower immunity during hospitalization, the infection rate of the patient was increased. In order to reduce the infection of patients, nursing staff should prepare a separate monitoring and treatment room to make protective isolation for patients, disinfect the room continuously for 24 hours and strictly control its entry and exit of personnel. Disinfectant should be used to scrub the patient's bedside cabinet, bed and guardrail. Sterile operation should be strictly carried out and catheters should be maintained daily to prevent shedding, and bloodstream infection.

1.3 Observation Indexes

The indexes of patients in two groups were recorded, including ECMO auxiliary time, hospital stay, complication rate (hemolysis, hemorrhage, infection, nervous system injury, renal complications, cardiovascular complications), oxygen metabolic parameters (arterial partial pressure of oxygen, venous oxygen saturation, arterial oxygen saturation, oxygen delivery index, oxygen consumption index), on-board success rate, total offline rate and overall survival rate.

1.4 Statistical Methods

The experimental data were statistically analyzed and processed by SPSS19.0 software. The count data were tested by χ^2, expressed by n(%), and the measurement data were measured by t test, expressed by ($\bar{x}$±s). The difference was statistically significant when p < 0.05.

2. Results

2.1 Comparison of ECMO Auxiliary Time Between Two Groups of Patients, as shown in Figure 1.

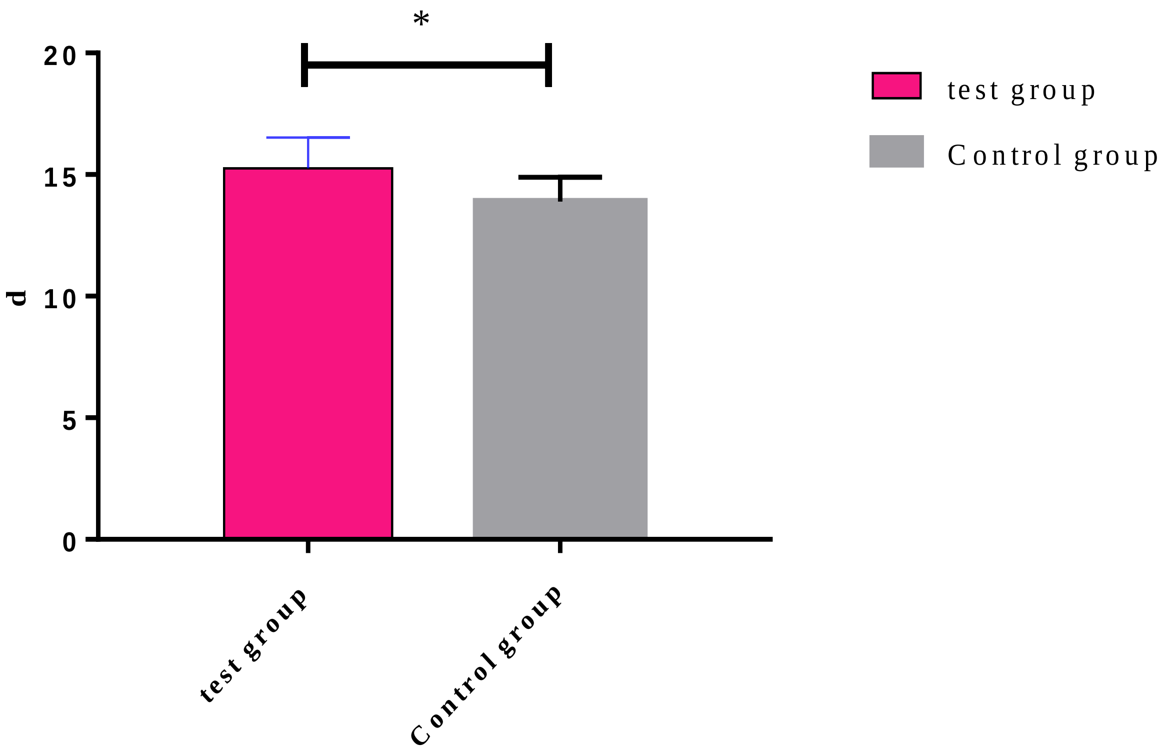

Figure 1. **Comparison of ECMO Auxiliary Time Between Two Groups of Patients**

Note: The abscissa represented group and the ordinate represented ECMO auxiliary time. The ECMO auxiliary time was (14.37±1.78) d in test group and (13.18±1.42) d in control group. * indicated that there was a significant difference in the ECMO auxiliary time between the two groups（t=3.695，p=0.000）.

2.2 Comparison of Hospital Stay Between Two Groups of Patients, as shown in Figure 2.

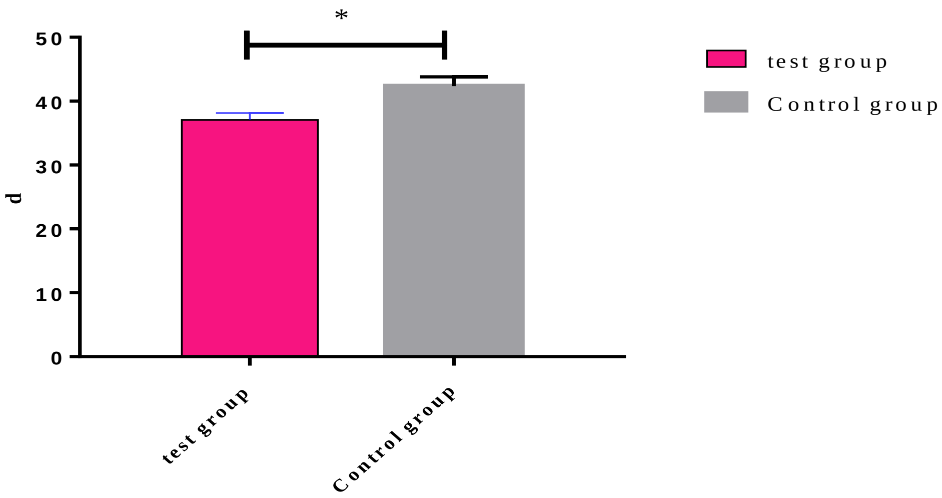

Figure 2. **Comparison of Hospital Stay Between Two Groups of Patients**

Note: The abscissa represented the group and the ordinate represented the hospital stay (d). The hospital stay was (36.2±1.56) d in test group and (41.33±2.07) d in control group. * indicated that there was a difference in the hospital stay between the two groups (t=13.804， p=0.000).

2.3 Comparison of Complications Between Two Groups of Patients

The experimental results showed that the total incidence of complications in test group was significantly lower than that in control group, and the difference was statistically significant (p<0.05), as shown in Table 3.

Table 3. **Comparison of Complication Rate Between Two Groups of Patients [case (%)]**

Group	n	Hemolysis	Hemorrhage	Infection	Nervous system injury	Cardiovascular complications	Renal complications	Total incidence
Test Group	50	1（2%）	0	0	1（2%）	2（4%）	0	8%
Control Group	50	3（6%）	4（8%）	3（6%）	2（4%）	3（6%）	1（2%）	32%
X2		1.042	4.167	3.093	0.344	0.211	1.010	9.000
p		0.307	0.041	0.079	0.558	0.646	0.315	0.003

2.4 Comparison of Oxygen Metabolism Parameters Between Two Groups of Patients

The experimental results showed that the oxygen metabolism parameters of test group after clinical nursing treatment were significantly better than those of control group, and the difference was statistically significant (p<0.05), as shown in Table 4.

Table 4. **Comparison of Oxygen Metabolism Parameters Between Two Groups of Patients**

Group	n	Arterial partial pressure of oxygen（mm Hg）	Arterial oxygen saturation（%）	Venous oxygen saturation（%）	Oxygen delivery index（mL/ min · m2）	Oxygen consumption index（mL/ min · m2）
Test group	50	109.85±5.81	98.13±1.94	75.23±7.51	652.23±38.41	204.27±37.23
Control group	50	74.23±3.67	93.54±2.21	63.24±6.37	682.24±35.14	235.41±32.24
t		13.530	11.037	8.609	4.076	4.471
p		0.000	0.000	0.000	0.000	0.000

2.5 Comparison of On-board Success Rate, Total Offline Rate and Overall Survival Rate Between Two Groups of Patients, as shown in Figure 5.

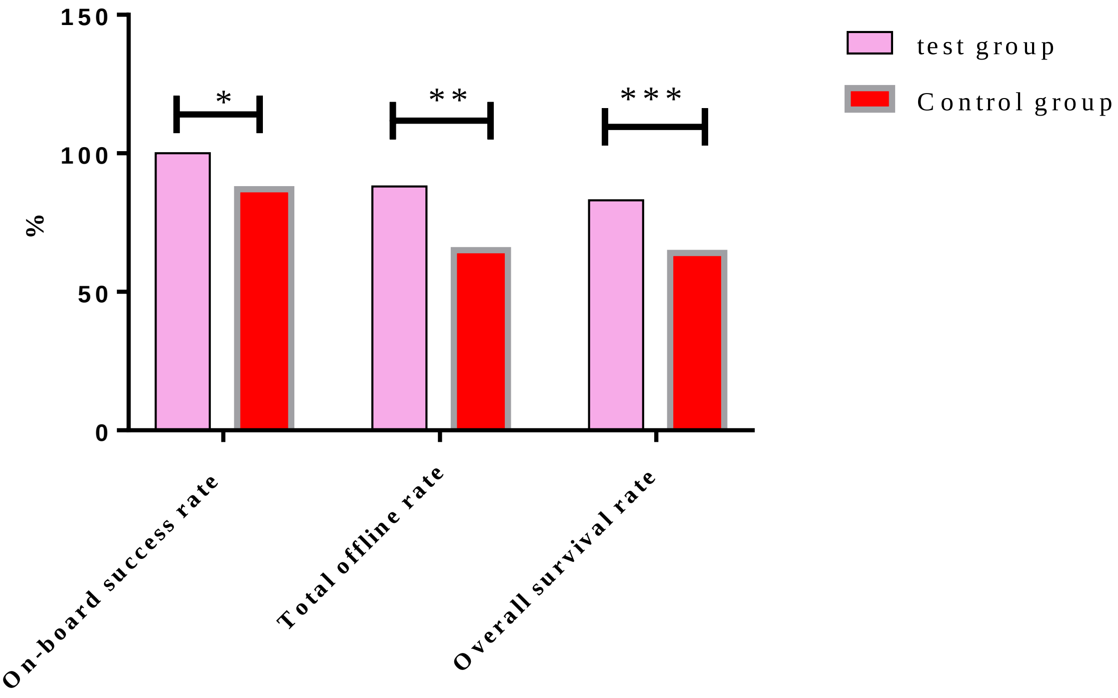

Figure 5. **Comparison of On-board Success Rate, Total Offline Rate and Overall Survival Rate Between Two Groups of Patients**

Note: The abscissa represented on-board success rate, total offline rate and overall survival rate, and the ordinate represented %. * indicated that there was a difference in the on-board success rate between the two groups (x^2=13.90, p=0.000); ** indicates that there was a difference in the total offline rate between the two groups (x^2 = 14.713, P = 0.000); *** indicated that there was a difference in the overall survival rate between the two groups (x^2 = 9.267, P = 0.002).

3. Discussion

With the continuous progress of medical research in recent years, ECMO has become an effective method to treat patients with cardiopulmonary failure (Hayangak et al.,2020). This technology provides stable oxygen supply and circulating blood volume for patients with severe respiratory failure, which is conducive to the gradual rehabilitation of the patient's brain, heart, lung and other functions, and provides valuable time for subsequent clinical rescue (Johnk et al.,2018; Judy et al.,2019; Kelly et al.,2020). The key to the application of ECMO treatment technology is clinical nursing, which requires the joint operation of medical staff. This study found that the total incidence of complications was 8% in the test group and 32% in the control group, and the difference was statistically significant (x^2=9.000, P = 0.003). When the patient is treated with ECMO, routine clinical nursing will lead to various clinical complications, which affects the treatment effect to a certain extent and reduces the off-line rate and survival rate of patients (Kjaergaard et al.,2019; Laurend et al.,2020; Lindsey et al.,2018; Macielak et al.,2019). Therefore, as nursing staff, it is necessary to fully understand and master the patient's condition and treatment contraindications, analyze the possible causes of complications, and formulate specific defensive measures (Maue et al.,2019). For example, hemorrhage and infection are common complications in the treatment of many patients. Analysis shows that patients' hemorrhage may be related to their own platelet dysfunction and systemic anticoagulation. For this reason, deep vein catheterization, arterial blood pressure monitoring and other operations should be completed before treatment to minimize or avoid such adverse conditions during treatment (Mehaffey ,2018;

Morrisette et al.,2020). In the process of ECMO treatment, the hospital should protect and isolate the patients, strictly implement preventive measures in the ward, and continuously disinfect the environment for 24 hours to ensure sterile operation and prevent the occurrence of bloodstream infection (Muhammed et al.,2019).

ECMO adjuvant therapy can only temporarily provide life support for patients, but can not treat the disease directly. Therefore, monitoring various physiological parameters during the adjuvant therapy becomes the key to prolong the lives of patients. Nursing staff need to continuously monitor various oxygen metabolism parameters of patients, and focus on dynamic monitoring of venous oxygen saturation. Venous oxygen saturation refers to the oxygen saturation in pulmonary artery blood and mainly reflects tissue oxygenation, which is a concentrated manifestation of oxygen utilization, blood gas exchange and tissue circulation state(Naeem et al.,2019; Patel et al.,2020). Normally, venous oxygen saturation should be maintained at 65%-75%. The low value indicates that the patient has symptoms of dyspnea and hypoxia, and need to be examined again for blood gas analysis. In this study, venous oxygen saturation in the test group was (75.23 +7.51) % and (63.24 +6.37) % in the control group. Studies pointed out that (Scettri et al.,2019). placing the ECMO-treated patient in an independent ward for treatment could reduce cross-infection of patients. Performing catheter care at the same time could effectively reduce the interference of external factors. The overall survival rate of the patients was significantly increased by strengthening the sense of responsibility and improving of the operation level among the medical staff. The overall survival rate of patients in the test group (83%) was significantly higher than that of the control group (64%), which fully demonstrated that intensive clinical care controlled the clinical hemorrhage and infection, reducing mortality. Relevant research shows that(Tiana et al.,2018). a series of uncontrollable emergency situations will occur in the actual rescue process, which requires hospitals to establish a high-quality professional rescue team and formulate emergency contingency plans. Departments should organize medical staff to conduct ECMO operation and training, constantly carry out simulated actual combat training, summarize experience in clinical practice, and ensure that more nursing staff master standardized ECMO operation process.

In conclusion, standardized ECMO nursing is of great significance for rescuing critically ill patients. Intensive clinical care can shorten the time of adjuvant treatment and hospitalization, reduce the incidence of complications, improve various oxygen metabolism parameters, and increase the on-board success rate, total offline rate and overall survival rate.

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