 DOI: 10.19600/j.cnki.issn2152 – 3924.2026.01.009

Nursing Care of a Child with Acute Fulminant Myocarditis Treated by Extracorporeal Membrane Oxygenation

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Abstract This paper summarizes the nursing experience of a child with acute fulminant myocarditis. Key nursing measures include establishing a multidisciplinary team to jointly formulate diagnosis and treatment plans; implementing refined volume management, anticoagulation management, and ventilator management during extracorporeal membrane oxygenation; providing personalized nutritional support for the child; and strengthening the prevention and management of complications. After active treatment and nursing care, the child recovered well and was successfully transferred out of the intensive care unit.

Key words Extracorporeal membrane oxygenation, Acute fulminant myocarditis, Nursing care

1 Introduction

Acute Fulminant Myocarditis (AFM) is a common pediatric disease characterized by acute onset, rapid progression, and poor prognosis. Its main clinical manifestations are mostly life-threatening malignant arrhythmia, cardiac pump failure, and cardiogenic shock, which can rapidly progress to multiple organ failure or even cardiopulmonary arrest[1–2]. Without timely and effective treatment, the mortality rate can be as high as 75%. Currently, traditional treatment methods are difficult to achieve ideal results. Extracorporeal Membrane Oxygenation (ECMO) can provide partial or full support for patients with severe cardiopulmonary failure, allowing damaged organs to obtain sufficient rest time and significantly improving the survival rate of patients with cardiopulmonary failure[3–4]. However, the development of pediatric ECMO technology in China lags behind that of adults, with relatively insufficient experience and technology, and there are still many considerations in the implementation process. In December 2021, the Pediatric Intensive Care Unit (PICU) of Shiyan Taihe Hospital successfully treated a child with acute fulminant myocarditis using veno-arterial (V-A) ECMO, achieving satisfactory results. The report is as follows:

2 General information

The child, a 10-year-and-1-month-old boy weighing 42 kg, was transferred to PICU from another hospital at 20 : 08 on December 23, 2021, due to "abdominal pain, poor appetite, and mental malaise for 3 days, accompanied by 6 episodes of vomiting". Upon admission, the child was in extremely poor mental state, with muffled heart sounds, blood pressure of 82/56 mmHg, and cyanosis and coolness of the extremities. Laboratory examination results after admission showed: white blood cell count 9.60×10^9/L, neutrophil percentage 71.1%, alanine aminotransferase 122 U/L, aspartate aminotransferase 321 U/L, blood uric acid 491.00 umol/L, urea nitrogen 17.34 mmol/L, creatine kinase 1 496 IU/L, creatine kinase isoenzyme 227 IU/L, N-terminal pro-B-type natriuretic peptide 6 333.2 ng/L, and high-sensitivity troponin 19.58 ng/mL. Electrocardiogram (ECG) showed: accelerated junctional rhythm; abnormal Q waves in leads II, III, and avF; ST-T changes (ST segment elevation of 0.1 – 0.8 mV in V1 – V4 in a coved upward pattern, and horizontal ST segment depression of 0.1 – 0.2 mV in V5 – V6); V1 presented an R-type pattern with ST segment elevation.

Echocardiography showed no obvious cardiac valve or myocardial lesions. Initial diagnosis: cardiogenic shock, fulminant myocarditis, multiple organ dysfunction syndrome.

At 21 : 40 on December 23, 2021, the child's ECG monitoring indicated ventricular rhythm with a heart rate of 130 beats per minute. An immediate ECG examination was performed, showing: wide QRS complex tachycardia; ST-T changes (ST segment elevation of 0.5 – 0.8 mV in V1-V2-V3 in a coved upward pattern, and peaked T waves in V2-V3). Lidocaine 30 mg was immediately administered intravenously, but the rhythm did not convert to sinus rhythm. Polymorphic ventricular rhythm was still observed on ECG monitoring. At 21 : 47, electrical defibrillation was performed once, but the child remained in persistent ventricular rhythm with a heart rate fluctuating between 100 – 130 beats per minute. At 21 : 50, amiodarone 150 mg was slowly injected intravenously, and the child converted to sinus rhythm but reverted to ventricular rhythm after about 2 sec. Therefore, continuous intravenous maintenance of amiodarone was given, with heart rate fluctuating between 60 – 80 beats per minute and blood pressure between 60-85/45-55 mmHg. At 22 : 10, an emergency hospital-wide consultation was conducted, and ECMO treatment was planned. After communicating the condition with the parents at 23 : 27, endotracheal intubation was performed with invasive mechanical ventilation, followed by V-A ECMO treatment. During ECMO treatment, the rotation speed was maintained at 2 590 revolutions per minute, blood flow at approximately 2.56 L/min, oxygen concentration at 60%, and oxygen flow rate at 3 L/min. Meanwhile, adequate sedation and analgesia, high-dose hormone

Received: November 3, 2025 Accepted: January 16, 2026
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pulse therapy, intravenous immunoglobulin support, anti-infection, anti-virus, organ protection, anti-arrhythmia, anticoagulation, and myocardial nutrition treatments were administered.

3 Results

After ECMO initiation, the child's condition gradually improved. The ECMO was successfully weaned after 82 hours of smooth operation at 09 : 34 on December 27, 2021. The child was transferred to the general ward for treatment on December 30, 2021, and discharged from the hospital on January 4, 2022, with full recovery.

4 Nursing experience

Although pediatric ECMO technology has developed rapidly in China in recent years, there is limited experience accumulation and significant regional differences, with no established standards. The incidence of complications, mortality rate, and disability rate remain relatively high[5], thus requiring more refined management during treatment.

4.1 Volume management Since most of the blood flow provided by V-A ECMO is non-pulsatile perfusion, hemodynamic parameters such as central venous pressure (CVP) and invasive arterial blood pressure (ABP) are prone to instability[6], posing certain difficulties for volume monitoring and management. During the first 24 h after ECMO initiation, the child required sufficient volume to correct internal environment imbalance and maintain stable ECMO flow, resulting in a positive fluid balance. Based on the child's echocardiographic evaluation results and hourly fluid intake and output, we administered appropriate fluid replacement as prescribed by the doctor on the principle of "input based on output", while strictly controlling the infusion rate with a target of a constant negative fluid balance of 0 – 10 mL/h. We closely monitored the child's heart rate, blood pressure, CVP, urine output, peripheral perfusion, lactic acid level, and ECMO flow changes. After 24 h of ECMO operation, the child's cardiac function gradually improved. On the basis of ensuring effective ECMO operation and stable vital signs, we continued to monitor the above indicators, appropriately restricted fluid intake and infusion rate, and promoted diuresis, with a target of a constant negative fluid balance of 10 – 20 mL/h to minimize circulatory load. As the child's cardiac function recovered, we gradually reduced ECMO flow and fully restricted fluid intake to prepare for ECMO weaning.

4.2 Anticoagulation management Thrombosis and bleeding are the most common complications during ECMO operation and major causes of patient death[7]. Therefore, appropriate anticoagulation is required during ECMO to avoid thrombosis while preventing bleeding caused by excessive anticoagulation. Currently, there is no unified anticoagulation management protocol for pediatric ECMO in China. For this child's anticoagulation management, we drew on adult management experience and used unfractionated heparin for anticoagulation, with dynamic monitoring of activated clotting time (ACT) and activated partial thromboplastin time (APTT). Before ECMO catheterization, heparin 2 500 U was injected intravenously for anticoagulation, and catheterization was performed 5 min later when ACT was > 180 sec. Two hours after ECMO operation, re-examination of ACT and APTT showed ACT 168 sec and APTT 40.3 sec. Therefore, anticoagulation therapy was initiated with unfractionated heparin 5 U/(kg · h), followed by re-examination of ACT every 4 h and APTT every 8 h. We also closely observed changes in the child's pupil size, bleeding around puncture sites, subcutaneous bleeding, and the presence of thrombosis in the entire circuit, oxygenator, and centrifugal pump head. During ECMO operation, the child's ACT fluctuated between 183 – 214 sec and APTT between 52 – 73.9 sec. Under continuous sedation and analgesia, the pupil diameter was 2 mm with decreased light reflex. No obvious bleeding around puncture sites or subcutaneous bleeding was observed, nor was significant thrombosis detected.

4.3 Nutritional support Studies have shown that critically ill patients requiring ECMO support are prone to increased catabolism, negative nitrogen balance, insulin resistance, and insufficient nutrient delivery, resulting in a higher risk of acquired malnutrition. Therefore, accurate assessment of the nutritional status of children receiving ECMO support and proper timing and method of nutrient intervention are key links in optimizing ECMO management[8-9]. The child had poor appetite before admission, and laboratory examination after admission showed albumin 28.82 g/L and prealbumin 106.60 mg/L, indicating a certain degree of malnutrition. In the early stage of ECMO operation, due to the need for blood volume supplementation, the multidisciplinary team decided to provide the child with a certain amount of parenteral nutrition support after consultation. Therefore, within the first 48 h of ECMO operation, 10 g of albumin was administered intravenously daily as prescribed, supplemented with 200 mL/d of self-prepared parenteral nutrition preparation. The self-prepared parenteral nutrition preparation had a total caloric intake of 150 kcal/(kg · d), with a ratio of carbohydrates, proteins, and fats of 5 : 3 : 2, and appropriate addition of other nutrients to meet the child's nutritional needs. Parenteral nutrition was stopped after 48 h, and nutritional support was provided entirely through enteral nutrition. Meanwhile, experts from the Nutrition Department were invited to guide the enteral nutrition method for the child at the earliest opportunity. After evaluation by nutrition experts, a nasogastric tube was placed for the child 4 h after ECMO initiation, followed by nasogastric feeding of 50 mL of homogenized diet prepared by the Nutrition Department according to the child's condition every 6 h. After 24 h, it was transitioned to 50 mL every 4 h, and gradually increased to 100 mL every 4 h. Before each nasogastric feeding within 24 h, bedside ultrasound was used to monitor gastric residual volume, and feeding was only performed if there was no gastric residue or the residual volume was < 50 mL. During the entire enteral nutrition support period, the child's digestion and absorption status and the presence of feeding intolerance such as diarrhea and abdominal distension were closely observed.

4.4 Prevention of infection Due to the underlying diseases of critically ill children, intestinal flora translocation, immune system damage caused by ECMO, and microbial colonization of catheters, children have a high risk of acquired nosocomial infections, which threaten their lives[10]. Therefore, active prevention and control of nosocomial infections are essential. After ECMO initiation, the child was given piperacillin/sulbactam prophylactically to prevent infections, but prophylactic use of antibiotics cannot completely prevent nosocomial infections during ECMO support. To this end, the child was placed in a single room, and sufficient rapid hand sanitizers were provided at the door, beside the bed tower, and other locations to facilitate hand hygiene among medical staff, reducing the possibility of nosocomial infections from the source. At the same time, in strict accordance with relevant guidelines and standards, we strengthened infection prevention for three major catheters (endotracheal tube, urinary catheter, central venous catheter, and ECMO catheter) to avoid nosocomial infections caused by human factors. In addition, the quality of basic nursing also affects the occurrence of nosocomial infections to a certain extent. Therefore, under the guidance of the Nursing Department, the ECMO nursing team formulated a detailed basic nursing plan, including eye care, oral care, body wiping with chlorhexidine solution, and skin care. Through the joint efforts of all medical staff, the child had no nosocomial infections during hospitalization.

5 Summary

Pediatric ECMO technology is still in its infancy in China. The entire operation process is extremely challenging and complex, requiring high comprehensive technical and collaborative capabilities of the management team, often necessitating strong collaboration among multiple disciplines, professions, and departments[11]. The child in this case had acute fulminant myocarditis with rapid progression. The multidisciplinary collaborative team leveraged their respective advantages to quickly initiate treatment. Through a series of refined management measures, the child successfully withdrew from ECMO and was discharged with full recovery.

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