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Nursing Practice of Successful Treatment for an Elderly Patient with Fulminant Myocarditis Using ECMO Combined with IABP

Meng Chen, Liping Fan

The First Affiliated Hospital of Chongqing Medical University, Chongqing 400042, China

Abstract: This paper summarizes the nursing experience of a 65-year-old elderly patient with fulminant myocarditis complicated by cardiogenic shock who received veno-arterial extracorporeal membrane oxygenation (V-A ECMO) combined with intra-aortic balloon pump (IABP) support therapy. The core nursing measures included: establishing a multidisciplinary collaboration team to implement daily goal management; standardized anticoagulation monitoring; refined hemodynamic management; stepped respiratory support; and early rehabilitation intervention. After 9 days of ECMO support combined with 5 days of IABP support, the patient's cardiac and respiratory functions recovered. The patient was discharged on the 42nd day and was fully recovered during the follow-up on the 60th day. This case suggests that refined nursing care for ECMO combined with IABP is the key to the treatment of fulminant myocarditis.

Keywords: Fulminant myocarditis; Extracorporeal membrane oxygenation (ECMO); Intra-aortic balloon pump (IABP); Geriatric nursing; Multidisciplinary collaboration

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1. Introduction

Fulminant myocarditis is a special and most severe type of diffuse myocarditis, characterized by an acute onset and extremely rapid disease progression. Patients quickly develop hemodynamic abnormalities and severe arrhythmias, and may be secondary to or accompanied by respiratory failure and hepatorenal failure, with an extremely high early mortality rate [1]. The mortality rate of patients with fulminant myocarditis during hospitalization in large hospitals is as high as 45–55.6% [2]. The rates of cardiogenic death and heart transplantation in patients 60 days and 1 year after discharge are 27.8% and 39.4%, respectively [3]. The adoption of a "comprehensive treatment plan based on life support" can significantly improve the survival rate of patients and optimize their long-term prognosis [3]. Among them, mechanical circulatory support measures such as extracorporeal membrane oxygenation (ECMO) and intra-aortic balloon pump (IABP), as well as respiratory support, are the core components of the "comprehensive treatment plan based on life support" for fulminant myocarditis. Our hospital admitted a 65-year-old elderly female patient with fulminant myocarditis on June 18, 2024. The patient successfully withdrew from treatment after 9 days of veno-arterial (V-A) mode ECMO combined with 5 days of IABP treatment, was discharged with improvement on the 42nd day, and was fully recovered without complications during the follow-up on the 60th day after discharge.

2. Clinical data

2.1. General information

A 65-year-old female patient was admitted to the hospital on June 18, 2024, due to “cough and fever for 1 week, with aggravation and generalized pain for 1 day”. She was diagnosed with “fulminant myocarditis, cardiogenic shock, acute heart failure, and type I respiratory failure”. She had previously undergone radical mastectomy for breast cancer. Admission physical examination: Body temperature 36.4℃, pulse 135 beats/min, respiration 28 breaths/min, blood pressure 103/78 mmHg. The patient was conscious but in poor mental state, with pale complexion, cold extremities, and fecal incontinence. Bedside echocardiography showed generalized hypokinesis of the left ventricular wall accompanied by impaired left ventricular diastolic function, with an ejection fraction (EF) of 18%. The myocardial enzyme test results show as follows: Troponin is 0.98 ng/ml, Creatine Kinase-MB (CK-MB) is 67 ng/ml, Myoglobin is > 900 ng/ml, and N-terminal pro-B-type Natriuretic Peptide (NT-proBNP) is 34,000 ng/ml. Arterial blood gas analysis (with an oxygen concentration of 41%) showed: pH 7.04, $PaCO_2$ 26 mmHg, PaO_2 89 mmHg, Na 132 mmol/L, Lac 15.9 mmol/L, Hct 51%, Glu 30.7 mmol/L, HCO_3^- 7.0 mmol/L, and BE -22.4 mmol/L; contrast-enhanced chest CT revealed possible scattered inflammation in both lungs, thickening of the bronchial walls in both lungs, and possible interstitial pulmonary edema in both lungs.

2.2. Treatment and outcome

The patient was in critical condition, and the indications for extracorporeal membrane oxygenation (ECMO) use (cardiogenic shock with EF < 20% complicated by acute respiratory and circulatory failure) were clear. On June 18, veno-arterial ECMO (VA-ECMO) support was initiated. The patient received non-invasive ventilator-assisted ventilation (in ST mode, with inspiratory positive airway pressure (IPAP) of 10 cmH_2O, expiratory positive airway pressure (EPAP) of 6 cmH_2O, and FiO_2 of 50%), subclavian vein catheterization for central venous pressure monitoring, and peripheral arterial catheterization via the right radial artery for continuous invasive blood pressure monitoring. Additionally, treatments included norepinephrine for blood pressure elevation, remifentanil for analgesia, dexmedetomidine for sedation, methylprednisolone sodium succinate for anti-inflammation, immunoglobulin for immune regulation, sodium bicarbonate for acidosis correction, fructose sodium diphosphate and coenzyme Q10 tablets for myocardial nutrition, and intravenous albumin supplementation. On June 20, bedside lung ultrasound indicated atelectasis in both lungs, so orotracheal intubation was performed for invasive ventilator-assisted ventilation (in VC-AC mode, with FiO_2 of 60% and tidal volume (VT) of 400 ml). During the treatment, dynamic echocardiographic monitoring was conducted (EF gradually recovered from 18–53%). On June 24, intra-aortic balloon pump (IABP) was implanted for assistance. On June 25, prone position ventilation and stepwise anti-infective therapy (cefoxitin → piperacillin-tazobactam → imipenem/vancomycin/tigecycline combination regimen) were administered, which successfully controlled secondary septic shock and mixed infections (bacterial/fungal/viral). On June 26, the ECMO catheter was removed; on June 28, prone position ventilation was terminated and the IABP catheter was withdrawn. During the treatment process, early enteral and parenteral nutrition support was provided, with meticulous regulation of fluid volume (negative balance strategy), coagulation function (component blood transfusion), and immune status (hormones + gamma globulin). After two cycles of tracheal intubation and weaning, the patient ultimately achieved significant recovery of cardiac function (EF 62%), normalization of inflammatory indicators (procalcitonin (PCT) 0.15 ng/ml), and compensation of respiratory function (peripheral capillary oxygen saturation (SpO_2) ≥ 95% under nasal cannula oxygen inhalation). She was discharged after 46 days of treatment under multidisciplinary collaboration.

3. Nursing care

3.1. Multidisciplinary collaboration model

In a multidisciplinary collaborative team, each member undertakes specific responsibilities to ensure that patients receive comprehensive and efficient treatment and care. By integrating the professional roles of cardiologists, respiratory therapists, ECMO specialist nurses, and rehabilitation therapists, a management system featuring "dynamic division of labor - standardized processes - real-time collaboration" was established: Cardiologists take the lead in optimizing hemodynamics; Respiratory therapists implement individualized ventilation strategies; ECMO specialist nurses accurately perform anticoagulation monitoring and circuit safety maintenance; Rehabilitation therapists develop stepwise activity plans. The team unifies treatment goals through daily joint ward rounds.

3.2. Standardized anticoagulation monitoring

Anticoagulation management is a crucial link in ensuring treatment success and reducing complications.

Unfractionated heparin is the most commonly used drug in anticoagulation management for ECMO and IABP [4]. The heparin dose should be adjusted individually based on the patient's body weight, liver and kidney function, as well as the risks of bleeding and thrombosis. Heparin is administered via continuous infusion at a rate of 5–20 U/kg/h [5]. For elderly patients, the initial dose needs to be reduced, usually with a loading dose of 50–70 U/kg and a maintenance dose of 5–10 U/kg/h [6]. In the initial stage: Monitor the Activated Clotting Time (ACT), Activated Partial Thromboplastin Time (APTT), and anti-Xa factor activity every 2 hours. The target values are as follows: ACT: 180–210 seconds [7]; APTT: 50–70 seconds [8]; Anti-Xa factor activity: 0.3–0.7 IU/mL for ECMO alone [9], and 0.2–0.4 IU/mL for combined ECMO and IABP therapy [10]. After stabilization: Extend the monitoring interval to 4–6 hours, and prioritize APTT values as the main reference index for adjusting heparin dosage. Monitor antithrombin III (ATIII) and thrombelastogram (TEG) daily. The target value for ATIII is > 80% [11], and the TEG R-time should be 2–3 times the baseline.

In specific cases (e.g., patients with heparin allergy or heparin-induced thrombocytopenia), direct thrombin inhibitors (DTIs) such as bivalirudin may be considered. The initial dose of bivalirudin is 0.05–0.2 mg/kg/h, with a target APTT of 60–80 seconds [11].

3.3. Refined hemodynamic management

Patients on Extracorporeal Membrane Oxygenation (ECMO) experience significant hemodynamic disturbances, requiring precise intervention through multi-dimensional monitoring and dynamic adjustments. Refined hemodynamic management entails integrating real-time monitoring, dynamic parameter adjustments, and multi-disciplinary collaboration. By leveraging the synergistic effects of ECMO and Intra-Aortic Balloon Pump (IABP), circulatory support is optimized, and the hemodynamic status of elderly patients with fulminant myocarditis is accurately regulated to reduce the risk of complications and promote cardiac function recovery.

3.3.1. Dynamic monitoring of key indicators

Real-time monitoring of heart rate, blood pressure, cardiac output (CO), pulmonary artery pressure (PAP), pulmonary capillary wedge pressure (PCWP), lactate levels, and oxygen saturation (SpO_2) is conducted. In conjunction with echocardiography, left ventricular ejection fraction (LVEF) and cardiac function status are evaluated [12].

3.3.2. Parameter optimization and synergistic regulation

Dynamic adjustments are made based on ECMO flow (2.5–4 L/min) and IABP counterpulsation ratio (1:1). The IABP is used to reduce left ventricular afterload and improve coronary perfusion, while ECMO maintains oxygenation and circulatory support [13].

3.3.3. Elderly patient-specific management

More stringent hemodynamic targets are set, where mean arterial pressure (MAP) $\geq$ 65 mmHg and central venous oxygen saturation ($ScvO_2$) > 70%. Over-reliance on vasoactive drugs is avoided, and goal-directed strategies (such as lactate clearance rate monitoring) are prioritized [14].

3.3.4. Complication prevention

Close observation of hemodynamic fluctuations is essential to prevent hypotension, cardiogenic shock, and pulmonary edema. The synergistic use of IABP and ECMO reduces left ventricular pressure and minimizes myocardial damage [15]. Bleeding and thrombotic complications during ECMO have a significant impact on patient prognosis; the incidence of bleeding during treatment is 26%, which is associated with systemic heparinization anticoagulation, massive destruction of coagulation factors in the circulating blood, and thrombocytopenia. During treatment, close attention should be paid to the patient’s central nervous system and gastrointestinal symptoms. For catheterization, ultrasound-guided percutaneous puncture should be used to avoid repeated punctures, minimizing damage and bleeding at the catheter insertion site. The bleeding status at the intubation site should also be closely monitored.

3.4. Circuit safety maintenance

Circuit safety maintenance is a core component in the nursing care of elderly patients with fulminant myocarditis undergoing combined ECMO and IABP therapy.

3.4.1. Strict fixation and monitoring

Dedicated staff ensure the secure fixation of arteriovenous catheters and ECMO circuits to prevent dislodgement or kinking. Meanwhile, close monitoring of hemodynamic parameters such as flow rate, pressure changes and limb perfusion is performed to avoid thrombosis or ischemia [12].

3.4.2. Aseptic technique and infection prevention

Infection is a common complication during ECMO circulation, with an incidence ranging from 5.7% to 64%.

When conditions permit, patients should be placed in a single-room positive-pressure ventilation ward, with restrictions on the flow and number of personnel. Dedicated nursing staff should be assigned to each patient, and protective isolation measures should be implemented for the patient. Bed units and equipment should be wiped and disinfected daily with 75% disinfectant wipes. The ward surfaces and floors should be disinfected twice daily with 1000 mg/L chlorine-containing disinfectant, and the patient's body should be wiped with 2% chlorhexidine 2–3 times daily. Bundle strategies should be adopted to prevent catheter-related bloodstream infections. Strict adherence to aseptic principles is required, and the integrity of the circuit should be checked regularly to prevent leakage or connector detachment, thereby reducing the risk of infection [12].

3.4.3. Dynamic assessment and complication management

Combined with hemodynamic monitoring, complications such as bleeding, thrombosis, and pulmonary hemorrhage should be promptly identified and managed. Meanwhile, multi-disciplinary collaboration is utilized to optimize circuit management. Larger catheters (> 20 Fr) are one of the main risk factors for limb ischemia. The incidence of lower limb ischemia complications during ECMO is as high as 10–70%, and combined IABP and ECMO therapy also increases the risk of acute limb ischemia. In addition, common complications include thromboembolism and air embolism. ECMO specialist nurses should check the normal operation of the centrifugal pump and oxygenator every 2 hours, observe whether there is thrombus formation in the circuit, and adjust the dosage of anticoagulant drugs or replace the circuit as prescribed by the doctor. Every 2 hours, the nurse should observe the patient's skin temperature, skin color, and dorsal pedal artery pulsation. Bedside vascular ultrasound examination of the extremities should be performed daily. This patient did not experience complications such as lower limb ischemia or thrombosis during ECMO operation, and the ECMO device was successfully removed on June 26, 2024.

3.4.4. Body positioning and nursing coordination

The patient should be maintained in an appropriate body position to avoid compression or kinking of the circuit. Meanwhile, seamless handover should be achieved through nursing records to ensure the continuity of treatment.

During the operation of ECMO and IABP, the membrane lung and circuit of this patient functioned well without clot formation. Bedside color Doppler ultrasound of the extremities showed no lower limb deep vein thrombosis.

3.5. Stepwise respiratory support strategy

Mechanical ventilation should be initiated in patients with fulminant myocarditis who develop severe respiratory failure (e.g., $PaO_2/FiO_2 < 150$ mmHg, respiratory rate > 30 breaths per minute, disturbance of consciousness, etc.) and fail to respond to previous respiratory support.

3.5.1. Parameter setting

During ECMO (Extracorporeal Membrane Oxygenation), a lung-protective ventilation strategy should be adopted. The tidal volume is set to 4–6 mL/kg (based on ideal body weight), PEEP (Positive End-Expiratory Pressure) ≥ 8 cmH_2O, and FiO_2 (Fraction of Inspired Oxygen) ≤ 50% to avoid lung injury caused by high PEEP.

3.5.2. Mode selection

Priority should be given to Pressure-Controlled Ventilation (PCV) or Synchronized Intermittent Mandatory Ventilation (SIMV). These modes help reduce interference from spontaneous breathing and lower the risk of

Ventilator-Associated Lung Injury (VILI).

3.5.3. Specific adjustments for elderly patients

Due to the decreased lung compliance in elderly patients, the tidal volume should be reduced (target: 4–5 mL/kg). Meanwhile, close monitoring is required to ensure that the plateau pressure ≤ 24 cmH_2O and driving pressure ≤ 14 cmH_2O.

3.5.4. Complication prevention

Reduce the risk of ventilator-associated pneumonia through ventilator humidification, as-needed suctioning, and postural drainage. Monitor blood gas analysis and hemodynamic changes to avoid carbon dioxide retention caused by overventilation.

3.5.5. Weaning criteria

Weaning from mechanical ventilation should be carried out gradually and transitioned to high-flow nasal cannula oxygen therapy when the patient's spontaneous breathing is stable ($SpO_2 \geq 90\%$, respiratory rate < 28 breaths per minute, $PaCO_2$ < 45 mmHg, oxygenation index > 200 mmHg) and there are no signs of respiratory failure.

3.6. Early rehabilitation intervention

Early rehabilitation for ECMO patients should be centered on multidisciplinary collaboration. Through evidence-based nursing, phased and individualized activity training, respiratory intervention, and psychological support are implemented. Combined with dynamic monitoring and synchronization with ECMO weaning, this approach can significantly improve muscle function, shorten hospital stay, and reduce the risk of ICU-Acquired Weakness (ICU-AW), providing a scientific basis for patients' functional recovery.

3.6.1. Early activity and physical therapy

A multidisciplinary team including rehabilitation therapists, nurses, respiratory therapists conduct collaboration and assessment to dynamically evaluate hemodynamics, oxygenation status, and rehabilitation progress, and adjust intervention plans accordingly. Implement progressive training such as bed exercises, sitting, standing, and walking, combined with active resistance training such as quadriceps resistance training and passive stretching exercises to prevent muscle atrophy and enhance muscle strength. Improve lower limb blood circulation and promote muscle function recovery through bedside cycling and ankle pump exercises.

Phased goals can be formulated based on the patient's condition (e.g., ECMO type, underlying diseases). For example, passive activities are performed in the first week, sitting is attempted in the second week, and a gradual transition to walking is made in the third week.

3.6.2. Respiratory training and airway management

High-frequency oscillation therapy, cough training, and airway clearance techniques are used to prevent pulmonary infection and improve oxygenation status.

3.6.3. Psychological support and analgesic management

Alleviate anxiety and depression, and improve patient compliance through sleep intervention, psychological counseling, and analgesic measures. Provide psychological support using ICU diaries combined with positive psychological suggestion.

4. Summary

The application of ECMO (Extracorporeal Membrane Oxygenation) combined with IABP (Intra-Aortic Balloon Pump) in the treatment of elderly patients with fulminant myocarditis demonstrates the key role of refined nursing in the management of patients with complex critical illnesses. By establishing a multidisciplinary collaborative team, implementing standardized anticoagulation monitoring, conducting refined hemodynamic management, providing stepped respiratory support, and carrying out early rehabilitation interventions, the nursing team can effectively address the characteristics of elderly patients, such as fragile physiological functions and high risk of complications, thereby significantly improving the success rate of treatment. In this case, with 9 days of ECMO support and 5 days of IABP assistance, the patient successfully recovered cardiopulmonary function and achieved early rehabilitation, was discharged on the 42nd day, and was fully recovered at the 60-day follow-up. This fully proves the clinical value of the combination of ECMO and IABP with refined nursing strategies in the treatment of elderly patients with fulminant myocarditis.

Disclosure statement

The authors declare no conflict of interest.

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