Supplementary material

1. Establishment of extracorporeal membrane oxygenation (ECMO)

The establishment and management of ECMO were conducted through a systematic approach involving equipment preparation, patient indications, and procedural steps.

(1) ECMO Equipments

ECMO Equipment: All patients were supported using a centrifugal pump to maintain blood circulation. The ECMO system components, including cannulas, circulation pipelines, membrane lungs, and centrifugal pump heads, were coated with heparin to ensure anticoagulation.

(2) Indications for ECMO

The indications for initiating ECMO were as follows: (a) Cardiac arrest: For patients experiencing cardiac arrest due to a reversible cause who failed to restore spontaneous circulation after high-quality cardiopulmonary resuscitation or experienced recurrent cardiac arrest with an inability to maintain an autonomous heart rhythm. (b) Fulminant myocarditis: Promptly initiated in cases of fulminant myocarditis with hemodynamic instability. (c) Failure of IABP: When intra-aortic balloon pump (IABP) use failed to improve circulation. (d) Cardiogenic shock: A cardiac index below 2.0 L/(m2·min), blood lactate levels above 2 mmol/L, and progressive worsening. (e) Cardiac and Pulmonary Indications: Conditions such as inability to wean from extracorporeal circulation post-cardiac surgery, severe cardiogenic shock, acute respiratory failure, acute lung injury (ALI), Acute Respiratory Distress Syndrome (ARDS) or severe pulmonary infection.

(3) Tube Connections

Venous return tubes were connected to the centrifugal pump inlet and the blood oxygen saturation connector. The tube was cut 20 cm from the pump inlet and fitted with a side-hole connector and a three-way valve to monitor negative pressure. Inlet and outlet tubes of the membrane lung were connected to ensure proper blood flow direction.

(4) Tube Priming

Tubes were primed with CO2 to eliminate gas. Venous and arterial tubes were clamped, and internal circulation tubes were sealed with a three-way valve. The centrifugal pump was primed with 1000 mL of gravity-driven drainage, degassed and closed. Membrane lungs and blood collection tubes were primed with human albumin or other solutions, and excess fluids were removed.

(5) Insertion Site

Venous-to-arterial cannulation (VA-ECMO) was performed for all patients. Protamine sulfate was administered post-cannulation to neutralize heparin.

(6) ECMO Management

Anticoagulation management involved adjusting the heparin dosage based on Activated Clotting Time (ACT), with a target range of 140–180 seconds. Platelet levels were closely monitored, and transfusion was performed if the platelet count dropped below 50 × 109/L to prevent bleeding complications. Vasopressors such as dopamine and dobutamine were administered at the initiation of ECMO to maintain a mean arterial pressure (MAP) of 50 mmHg and were gradually adjusted during the weaning process as the patient’s condition improved. Flow management was maintained within a target range of 40–60 mL/kg·min, and venous oxygen saturation was kept at ≥70%, with membrane lung oxygen concentration between 40%–70% and arterial oxygen partial pressure around 150 mmHg. Respiratory parameters were controlled using synchronized intermittent ventilation, with Fraction of Inspired Oxygen (FiO2) levels set between 0.3–0.6. The respiratory rate was maintained at 12–30 breaths/min, and tidal volume was set at 8–10 mL/kg. Positive end-expiratory pressure was maintained between 4–6 cmH2O to optimize ventilation and oxygenation. To monitor the patient’s overall circulatory and respiratory status, both echocardiography and hemodynamic parameters were used. These assessments provided critical insights into the patient’s response to ECMO support and guided adjustments in management.

(7) ECMO Weaning

Gradual weaning was initiated as cardiac and pulmonary functions improved. ECMO was discontinued when the auxiliary flow was reduced to 10%–20% of the full flow.

2. Nutritional management

All patients on ECMO followed a standardized enteral nutrition strategy.

(1) Nutritional Assessment and Goals: ① A comprehensive nutritional assessment should be conducted upon patient admission to determine the Basal Metabolic Rate (BMR) and daily energy requirements. ② Generally, it is recommended that daily energy intake be based on the patient’s weight (kg) multiplied by 25–30 kcal/kg (depending on the patient’s activity level and condition) to meet energy needs.

(2) Protein Intake: For patients supported by ECMO, it is recommended that daily protein intake reach 1.5–2.0 grams per kg of body weight to promote tissue repair and immune function. For example, for a patient weighing 70 kg, the target protein intake should be 105–140 grams.

(3) Food Choices: ① High-protein foods: Lean meats (such as chicken, turkey, beef, pork), fish (such as salmon, tuna), eggs (such as chicken eggs), dairy products (such as milk, yogurt, cheese), legumes (such as black beans, lentils, chickpeas), nuts (such as almonds, walnuts). ② Ways to Supplement Protein: (a) Use high-protein drinks (such as protein powder or nutritional supplement drinks) to increase daily protein intake. (b) Add protein supplements (such as whey protein or casein) to the diet.

(4) Dietary Fiber and Hydration: During the recovery phase of acute gastrointestinal injury, appropriately increase soluble fiber (such as oats, apples, carrots) to promote gut health. Ensure adequate hydration, typically recommending a daily fluid intake of 30–35 mL/kg of body weight, adjusted according to the patient’s fluid balance and urine output.

(5) Nutritional Support Methods: (a) Oral Nutrition: If the patient can tolerate it, oral intake should be prioritized. (b) Enteral Nutrition: For patients who cannot eat orally, consider using an enteral feeding tube, providing specialized enteral nutrition formulas to ensure the target nutritional intake is met. (c) Parenteral Nutrition: If necessary (*e.g.*, severe gastrointestinal dysfunction), parenteral nutrition can be considered to ensure sufficient energy and protein intake.

(6) Example Nutritional Support Plan: ① Breakfast: 1 cup of milk (8 g protein), 2 eggs (12 g protein), 1 slice of whole wheat bread. ② Lunch: 150 g of chicken breast (approximately 35 g protein), 1 cup of cooked lentils (approximately 18 g protein), 1 serving of leafy greens. ③ Dinner: 150 g of fish (approximately 30 g protein), 1 cup of rice, 1 serving of vegetables. ④ Snack: 1 cup of yogurt (approximately 8 g protein), a handful of nuts (approximately 6 g protein).

(7) Monitoring and Adjusting: Regularly monitor the patient’s weight and laboratory markers (such as albumin, creatinine, *etc*.) to assess nutritional status and treatment effectiveness. Adjust the nutritional support strategy based on the patient’s actual condition and recovery progress.