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ORIGINAL ARTICLE

Application and Care of Extracorporeal Membrane Pulmonary Oxygenation Technology in Critically Ill patients at Medical University-Affiliated Hospital

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ABSTRACT

Aim: To examine the efficacy and nursing strategies involved in using extracorporeal membrane oxygenation (ECMO) technology for critically ill patients at the Xiangshan Hospital, a tertiary grade B hospital in China.
Methods: This study investigates the efficacy and nursing strategies associated with applying extracorporeal membrane oxygenation technology in critically ill patients within a tertiary grade B hospital in China.
Results: Following timely intervention and care, eight of the 19 patients were successfully weaned off ECMO and transferred to the ward. Two patients were discharged after treatment was discontinued due to severe cerebral dysfunction, one was discharged following the discontinuation of treatment due to a severe pulmonary infection, and eight patients succumbed to their conditions.
Conclusion: ECMO technology, as an advanced life support mechanism, delivers vital oxygenation and circulatory support during cardiopulmonary failure, allowing crucial time for subsequent therapeutic interventions. Nursing plays a central role in ECMO therapy, involving patient monitoring, comprehensive care, and complication prevention. It is essential for nursing staff to have specialized knowledge and skills to maintain the optimal performance of ECMO equipment and ensure patient safety.
Keywords: extracorporeal membrane pulmonary oxygenation; critical care; nursing care.

INTRODUCTION

Extracorporeal Membrane Oxygenation (ECMO) technology has become a critical intervention in the management of critically ill patients worldwide, with its use significantly increasing, particularly during the COVID-19 pandemic. This trend highlights ECMO's potential in supporting patients with severe respiratory failure and its vital role in addressing public health crises[1]. Recent advancements in ECMO technology have notably improved patient survival rates and reduced complications. For instance, ECMO therapy has been shown to significantly enhance survival outcomes in adult patients with acute fulminant myocarditis (AFM). A single-center study reported an increase in the survival rate of AFM patients from 66.7% in 2003 to 89.1% in 2022[2]. ECMO has also shown significant efficacy in treating severe acute respiratory distress syndrome (ARDS). As a modified extracorporeal circulatory system, ECMO facilitates gas exchange and systemic perfusion when cardiopulmonary function is impaired, thereby improving survival rates and therapeutic outcomes for ARDS patients[3]. Research suggests that ECMO use in lung transplantation enhances postoperative outcomes[4], although challenges persist in areas such as patient selection, anticoagulation, and complication management[5,8]. Transporting patients on ECMO remains a key area of research due to the associated risks[7]. Advances in technology, including improved pumps, cannulas, and oxygenators, have strengthened extracorporeal life support (ECLS) by reducing initial priming volumes and bleeding complications[8]. ECMO's application in trauma care is expanding, with its life-saving potential increasingly recognized despite uncertainties in indications. While ECMO holds promise for advancing primary healthcare, its broader implementation is hindered by technical limitations[9].

ECMO technology offers considerable potential to improve the quality of primary healthcare services, particularly in county-level hospitals. However, its adoption in these settings remains constrained, primarily due to a lack of technical expertise, which limits the effective treatment of critically ill patients. Successful ECMO treatment requires coordinated, high-quality teamwork, and the implementation of standardized care and management strategies is essential for minimizing complications[10,11]. Ensuring the quality of care is critical in ECMO therapy, as improvements in care quality can significantly enhance patient survival rates. The present study explores the application and nursing care of ECMO technology in a tertiary grade B hospital in China, aiming to address the challenges of its implementation and improve outcomes for critically ill patients.

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General Information

Patient Collection: A cohort of 19 patients who underwent ECMO treatment between April 2023 and May 2024 at the Xiangshan Hospital of Wenzhou Medical University, Ningbo, China, as a county hospital, was analyzed. The cohort included 13 males and 6 females, with ages ranging from 10 to 87 years and a mean age of 47 years. Among these patients, 11 were conscious, while eight were comatose, as indicated by a Glasgow Coma Scale score below 6. The underlying conditions included chronic cardiac insufficiency in two patients, chronic liver disease in one patient, diabetes mellitus in five patients, and hypertension in three patients.

Primary Diseases and Comorbidities: The primary morbidities identified included acute ST-segment elevation myocardial infarction in four patients, fulminant myocarditis in four patients, out-of-hospital cardiac arrest following cardiopulmonary resuscitation in seven patients, hyperkalemia in one patient, novel coronavirus pneumonia in one patient, pulmonary embolism in one patient, and postoperative multiple injuries in one patient. Cardiac arrest occurred in 12 patients before ECMO intervention.

Treatment

ECMO Treatment: All patients underwent ECMO therapy, with cannulation access established through the femoral artery and femoral vein. The cannulation procedure was performed using ultrasound-guided percutaneous arterial and venous puncture techniques. In parallel, patients received supplementary therapies, including mechanical ventilation, anticoagulation, anti-infection measures, analgesia, and sedation.

ECMO Model Selection: The veno-arterial (V-A) ECMO mode was used in 16 cases, while the veno-venous (V-V) ECMO mode was employed in three cases. Among these, 11 cases involved the combination of ECMO with continuous renal replacement therapy (CRRT).

Nursing Care/Pipeline Care

Significance of Pipeline Care: Pipeline care is essential in the management of ECMO, acting as the critical "lifeline" that connects the patient to the ECMO machine. The quality of pipeline care directly influences the success or failure of the treatment. The primary goal of pipeline care is to ensure unobstructed blood flow and to prevent complications such as thrombosis, infection, and bleeding. Effective pipeline care helps reduce the risk of these complications, thereby enhancing patient safety and improving the success rate of ECMO therapy. Moreover, pipeline care includes maintaining patient comfort and alleviating psychological stress, both of which are crucial for the patient's overall recovery.

Specific Measures for Pipeline Care: Specific measures for pipeline care include the following:

1. Tube Fixation: Use specialized fixation devices to secure the tubes and prevent displacement or dislodgement due to patient movement.
2. Tube Patency Assessment: Regularly assess the tubes for any kinks, pressure points, or blockages to ensure they remain open and allow unobstructed blood flow. It is recommended to perform patency assessments every two hours and document the findings accordingly.
3. Monitoring of Hemorrhage and Fluid Exudation: It is crucial to carefully monitor for any signs of blood or fluid leakage at the pipeline connection sites. Early detection and intervention are vital to prevent local infections or hematoma formation. Leakage of blood and fluids increases the risk of infection and thrombosis, requiring prompt and appropriate management.
4. Infection Control: Strict adherence to aseptic techniques is necessary, along with routine dressing changes to prevent both local and systemic infections. Tube dressings should be replaced every 48 hours, and antimicrobial dressings should be used to reduce infection risks.
5. Maintenance of the Piping System: Regular inspection of the piping system, including tubes, fittings, and pump heads, is essential to ensure there are no fractures or leaks. Daily integrity checks of the piping system are recommended, with accurate records maintained for these inspections.
6. Patient Education: Educating patients and their families on the importance of proper care is vital for enhancing their involvement and improving adherence to treatment protocols. Active engagement of patients has been shown to significantly improve clinical outcomes.

Management of Complications during ECMO Treatment: Patients undergoing ECMO therapy may experience complications such as bleeding, clotting disorders, and infections, all of which necessitate meticulous management.

Management of Bleeding and Coagulation Complications: Monitoring coagulation function: Regular assessment of coagulation parameters, including Activated Clotting Time (ACT) and Activated Partial Thromboplastin Time (APTT), is essential. The anticoagulation regimen should be adjusted immediately to ensure ACT remains within the target range of 180-200 seconds. A triple lumen deep vein catheter is recommended for Central Venous Pressure (CVP) monitoring to facilitate effective management of bleeding and coagulation complications.

Anticoagulation management requires optimizing the dosage of anticoagulant medications according to the patient's coagulation status. Evidence suggests that precise anticoagulation management significantly reduces the risk of both bleeding and thrombosis.

Infection Control: Strict adherence to aseptic procedures is essential and includes the regular replacement of tube dressings, and monitoring of patient temperature, white blood cell count, and procalcitonin (PCT) levels. Early detection and prompt management of infections are critical to ensuring patient safety.

Infection surveillance entails performing regular blood cultures and pathogenetic tests to identify sources of infection, enabling the timely implementation of targeted therapeutic interventions.

Management of Additional Complications: Cardiac function monitoring: Continuous monitoring of cardiac function, including heart rate, heart rhythm, and blood pressure, is essential for the early detection and management of cardiac insufficiency. In patients with concurrent renal insufficiency, timely initiation of blood purification therapy is vital to maintain electrolyte and fluid balance effectively.

Nutritional Support: Developing tailored nutritional support programs based on the specific conditions of individual patients is essential for enhancing immune function and promoting recovery capacity.

Psychological Care: During ECMO treatment, patients and their families often experience significant psychological stress, making psychological care an integral part of the recovery process. Regular psychological assessments should be performed for both patients and their families to identify any potential issues early on. Providing emotional support and counseling is essential to alleviate anxiety and fear. Encouraging family involvement in the care process can also enhance the patient's sense of belonging and security.

Collaborative Multidisciplinary Care: The efficacy of ECMO treatment relies on the collaborative efforts of a multidisciplinary team, which includes physicians, nurses, respiratory therapists, dietitians, and other healthcare professionals. This team regularly convenes for case discussions and consultations. An information technology platform facilitates effective information sharing, providing real-time updates on changes in the patient's condition and treatment plans ensuring synchronization of information among team members. Besides, at least one joint check-up should be conducted weekly to promptly identify and address any issues that may arise during the patient's treatment.

In conclusion, the management of ECMO pipelines and complications is essential for the success of ECMO therapy. Through careful nursing interventions, ECMO-related complications can be effectively prevented and managed, thereby enhancing patient comfort, satisfaction, and ultimately improving therapeutic outcomes and survival quality. Optimizing ECMO nursing practices in county hospitals is critical for raising the standard of primary healthcare services and improving the prognosis of critically ill patients.

RESULTS

Following prompt treatment and care, eight of the 19 patients were successfully weaned off ECMO and transferred to the ward. Two patients were discharged after discontinuing treatment due to severe cerebral dysfunction, and one patient was discharged after discontinuing treatment due to a severe pulmonary infection. Unfortunately, eight patients succumbed to their conditions.

DISCUSSION

Effectiveness of ECMO Technology Application: Integrating ECMO technology has significantly improved the success rates of resuscitating critically ill patients, providing a crucial advantage in patient rescue efforts. The findings of this study suggest that ECMO technology markedly enhances the efficacy of rescue interventions for critically ill patients.

Importance of care: ECMO technology plays a pivotal role in treating critically ill patients, especially within county hospital settings, where its successful implementation is crucial for improving patient survival rates. Effective management of ECMO relies on two core components: pipeline care and complication management. Both are essential for ensuring the safety and efficacy of ECMO treatment.

Prevention and Management of Complications: The prevention and management of complications are critical for improving the success rate of ECMO treatment. Complications like bleeding, coagulation disorders, and infections require vigilant monitoring

and prompt intervention to ensure the best possible outcomes for patients.

CONCLUSION

Integrating ECMO technology into county hospitals is highly significant, especially for improving the resuscitation success rates of critically ill patients. ECMO, as an advanced life-support modality, provides crucial oxygenation and circulatory support during cardiopulmonary failure, granting essential time for subsequent therapeutic interventions [12]. In managing critically ill patients, ECMO technology not only increases survival rates but also creates better conditions for patient recovery [13]. Nevertheless, the effective deployment of ECMO technology depends heavily on the presence of a skilled nursing team. Nurses play a critical role in ECMO therapy, which includes monitoring patients, providing care, and preventing complications. Nursing personnel must have specialized knowledge and skills to ensure the proper functioning of ECMO equipment and maintain patient safety [14]. Furthermore, it is crucial for the nursing team to collaborate effectively with the multidisciplinary team to refine the patient's treatment plan and improve overall outcomes [15].When implementing ECMO technology in county hospitals, it is not enough to focus solely on providing advanced equipment and skilled technicians. The development and training of the nursing team must also be prioritized. Systematic training programs and simulation exercises can help nursing staff develop proficiency in ECMO-related operational skills and emergency response capabilities. This approach minimizes the risk of errors during actual practice and increases the success rate of patient rescue efforts, ultimately enhancing patient survival and recovery[16].

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Ethical Consideration: This study was approved by the Ethics Committee of Xiangshan First People's Hospital Healthcare Group (Approval No.: XSYY-2025-605). the committee waived patient's written consents due to anonymous data and retrospective study in nature. The study complied with the Declaration of Helsinki and its amendments.

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