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NURSING CARE OF AN ADULT PATIENT UNDERGOING VENO- VENOUS EXTRA CORPOREAL MEMBRANE OXYGENATION (VV ECMO)

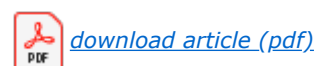
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ABSTRACT

In today's dynamic medical environment, evolving technologies and advanced life-saving therapies pose new challenges to nursing care. One of the pioneering achievements in this field is veno-venous ECMO (extracorporeal membrane oxygenation) therapy, which plays a key role in the treatment of adult patients with severe respiratory failure. ECMO, also known as artificial respiratory support, is a revolutionary step towards more effective care for critically ill patients. This article is devoted to a deeper understanding of the role of nurses in the care of an adult patient undergoing venovenous ECMO therapy.

Venovenous ECMO therapy is a procedure in which a patient's blood is pumped outside the body, where it is oxygenated, and then reintroduced into the circulation. For adult patients with advanced respiratory failure who do not achieve effective improvement with traditional treatment methods, ECMO often becomes the last resort. However, the complex nature of this therapy requires commitment and expertise from nurses to provide effective patient care.

One of the main challenges that venovenous ECMO therapy poses to nurses is monitoring the patient's precise physiological parameters. Strict control of blood pressure, oxygen levels and organ perfusion becomes crucial to the success of therapy. Nurses therefore act as guardians of physiological stability, constantly reacting to possible instabilities and adjusting the parameters of the device under control.

It is also worth emphasizing that nursing care for a patient undergoing venovenous ECMO therapy is not limited only to technical aspects. The comprehensiveness of this type of treatment is also associated with concern for the patient's psychosocial aspects. Long-term connection to an ECMO device can cause emotional and mental stress in the patient, which makes the support of nurses in the field of psychological care extremely important. Nurses act as both medical professionals and empathetic companions in difficult times, which translates into the overall success of therapy. The article will also focus on nurses' protocols for

dealing with a patient undergoing venovenous ECMO therapy. From an excellent understanding of device maintenance to effective communication with the entire healthcare team, nurses play a key role in ensuring safe and effective therapy. As technology advances and life therapies become more advanced, nurses' skills are continually improved to meet the demands of modern medical care.

Keywords: intensive care nursing, ECMO, ARDS

INTRODUCTION

ECMO (extracorporeal membrane oxygenation), i.e. extracorporeal blood oxygenation, is a technique that uses extracorporeal blood circulation to oxygenate it and eliminate carbon dioxide as a result of the action of the oxygenator. Such therapy can be used in the veno-venous system (VV ECMO) or veno-arterial system (VA ECMO). These options differ significantly from each other. VA ECMO therapy provides a bridge between the patient's lungs and heart. Venous blood is collected from the inferior or superior vena cava or right atrium and goes to the oxygenator. The oxygenated blood there returns to the patient through a cannula inserted into a large artery. This therapy is used for potentially reversible or irreversible heart failure. It can also be used as a bridge for patients waiting for a heart transplant. For ECMO therapy, a double-lumen cannula can also be used. The flows in this cannula must be lower, but it allows for physiotherapy and faster mobilization of the patient. This type of cannula is routinely inserted in newborns. VV ECMO therapy is used when there are potentially reversible lung function disorders in which mechanical ventilation alone does not allow for proper gas exchange. In this therapy, blood is taken from the inferior vena cava and after passing through the oxygenator, it goes to the right atrium through a cannula in the superior vena cava. It should be remembered that this therapy does not cure the patient's lungs, but allows the patient to survive when gas exchange disturbances are so great that mechanical ventilation is insufficient. It also allows you to eliminate the risk of lung damage associated with respiratory therapy in patients with severe ARDS (acute respiratory distress syndrome). [1,2,3]

INDICATIONS FOR THE USE OF VV ECMO THERAPY

The use of this therapy is indicated in patients with acute respiratory failure in whom, despite the use of high levels of oxygen in the breathing mixture and advanced mechanical ventilation techniques, hypoxemia and hypercapnia persist, which may lead to deterioration of the patient's condition or even death. Basic qualification criteria for ECMO therapy is based on the Berlin ARDS criteria and at least one of the following criteria:

- $\text{PaO}_2/\text{FiO}_2 < 80$ for ≥ 3 hours despite $\text{VT } 6 \text{ ml kg}^{-1}$ and $\text{PEEP} \geq 5 \text{ cm H}_2\text{O}$ and the use of alveolar recruitment described above,
- $\text{pH} < 7.25$ for ≥ 3 hours.

Auxiliary criterion:

- $\text{pH} < 7.2$; $\text{paCO}_2 > 80 \text{ mmHg}$,
- Static compliance $< 0.5 \text{ ml/kg/cmH}_2\text{O}$,
- $\text{PIP} > 40 \text{ cm H}_2\text{O}$ with $\text{TV} \leq 6 \text{ ml/kg}$,
- Oxygenation index $\text{OI} > 60$ for 30 min or > 35 for 6 hours [$\text{OI} = (\text{MAP} \times \text{FIO}_2 \times 100)/\text{PaO}_2$] MAP - average airway pressure,
- Chest radiography revealed extensive opacification in at least two quadrants.

An alternative is the Murray Scale ($\text{LIS} > 3.0$). [1,2,4,5]

CONTRAINDICATIONS TO VV ECMO THERAPY

In accordance with national guidelines, we distinguish absolute and relative contraindications to the use of extracorporeal blood oxygenation. Absolute contraindications include:

- preceding respiratory therapy with high peak airway pressure or high oxygen concentration in the breathing mixture for a period exceeding seven days. In addition to using such mechanical ventilation, you can consider administering nitric oxide to the patient by inhalation or high-frequency oscillatory ventilation,
- systemic disease with unfavorable prognosis, regardless of the effectiveness of ARDS treatment,
- irreversible damage to the central nervous system, encephalopathy,
- liver cirrhosis with ascites, history of bleeding from esophageal varices,
- malignant tumor with poor prognosis,

- chronic respiratory pathology with poor prognosis,
- intracranial bleeding and other absolute contraindications to anticoagulation,
- chronic pulmonary hypertension,
- severe left or right ventricular failure diagnosed before hypoxemia occurred,
- conscious declaration of the patient's refusal to consent to ECMO treatment.

We consider relative contraindications to:

- age over 70,
- AIDS,
- body weight over 150 kg,
- other disease factors that may reduce the effectiveness of ECMO therapy. [1,2,6,7]

MONITORING A PATIENT UNDERGOING ECMO THERAPY

The basic parameters that should be monitored during therapy include:

- arterial blood gases to assess acid-base balance, at least every 3 hours,
- invasive blood pressure measurement,
- monitoring the value of central venous pressure, taking into account the limitation of the possibility of correct interpretation of the result due to the suction of blood by the centrifugal pump,
- kidney function parameters,
- ventilation parameters including: VT, f, FiO₂, PIP, lung compliance, PEEP; recorded in the documentation at least twice a day,
- lactate level in the body,
- ACT or APTT; at least every six hours,
- PTT, D-Dimers, fibrinogen concentration, INR, antithrombin concentration, platelet count; at least once a day,
- chest X-ray; at least every three days,
- every hour, the parameters visible on the device should be recorded: blood flow, number of pump revolutions, pressure before and after the oxygenator.

Additionally, if the capabilities of the center where the therapy is carried out allow it, you can monitor:

- hemodynamic parameters including the amount of extravascular water in the lungs using transpulmonary thermodilution,
- transesophageal echocardiography to assess the position of the cannula and the functioning of the heart valves,
- tomographic examination according to clinical indications.[1,7]

THERAPY-RELATED COMPLICATIONS

ECMO therapy is, of course, a great opportunity for patients, but it carries the possibility of complications that are directly related to the patient and technical problems resulting from the operation of the device. The most common complications associated with the patient include:

- haemolysis,
- bleeding (the incidence may be up to 30%),
- thrombocytopenia/HIT (heparin induced thrombocytopenia),
- infection (e.g. catheter-related, respiratory)
- embolic complications,
- neurological complications including cognitive disorders,
- multi-organ failure,
- barotrauma,
- metabolic disorders,
- complications related to the insertion of cannulas for ECMO therapy.

The most common technical problems and device malfunctions include:

- removal or displacement of the cannula,
- disconnection or damage to the circuit,
- inhalation of air through the ECMO system during therapy,
- pump dysfunction,
- oxygenator dysfunction related to clotting or wear,
- disorders related to incomplete bleeding of the circuit,
- heater-cooler dysfunction, [1,8,9,10]

THE ROLE AND TASKS OF THE NURSE DURING VV ECMO THERAPY.

The nursing team plays an important role during ECMO therapy. The care of such a patient is the responsibility of people working in intensive care units who know the principles of treatment and are familiar with the operation of the ECMO device. Please remember that the basic supervision of this patient is the same as any other patient in the ICU. Blood pressure, heart rate and possible changes in the ECG, temperature, central venous pressure, and diuresis are monitored. A neurological assessment (assessment of pupils, level of consciousness) and a physical assessment (skin moisture, visible sweating of the patient, assessment of peripheral hypoperfusion) are also performed. Additional activities that should be monitored are related to the therapy device and hazards that may be associated with the treatment. Activities performed on a patient undergoing extracorporeal blood oxygenation can be divided into those related to the device and those related to the patient. Tasks include: to the nursing team related to the device include:

SYSTEM OBSERVATION:

- The monitors of the ECMO device should be directed towards the door to the room so that all members of the therapeutic team can observe any problems from the moment they cross the threshold of the room,
- Assessment of the arrangement of gas hoses (oxygen and air) for dangerous bends or stresses and their correct fastening,
- Evaluation of cannulas for therapy. You should start by assessing the suture fixation to see if there has been any change in position. Then, the entire circumference is assessed using a flashlight and we pay attention to any clots and/or fibrin present. Additionally, the nursing team assesses the color of the blood in the cannulas. The blood in the outflow cannula is dark red (deoxygenated blood) and in the insertion cannula it is light red (oxygenated blood),
- The cannula inserted into the femoral vein should be placed with the drain at approximately 40 cm. in the limb axis. However, cannulas with a drain in the superior vena cava can be attached, for example, to the patient's head with a bandage. However, make sure that the pressure is not too great, as it may contribute to the development of a bedsore. The drains should lie freely so that they do not pull the cannulae,
- In the event of a failure or disconnection of the system, there should always be clamping forceps for the drains with the patient,
- The limb temperature, color and heart rate should be monitored on the limb to which the ECMO cannula is placed. This is associated with cannulation complications that may lead to ischemia or thrombosis. Daily measurement of thigh circumference will allow for quick diagnosis of venous flow disorders and the formation of a possible hematoma.

MONITORING DEVICE PRESSURES

Monitoring blood pressure allows for early detection of dysfunctions in the therapy. It is important to remember that what is important is the evolution of these pressures, not a single measurement. The nursing team's tasks include hourly recording of blood flow, pump revolutions, and pressure before and after the oxygenator. Three pressures are commonly measured

- Pvein: it shows the pressure value in the cannula supplying blood to the oxygenator. The pressure value should not exceed -100 mmHg. An increase in pressure may indicate hypovolemia and/or flow disturbances in the cannula,
- Part: is the pressure after the oxygenated blood leaves the oxygenator. The pressure value should be within 200-250 mmHg. The increase in pressure may be caused by kinking or clotting in the cannula draining blood to the patient and/or an increase in preload in the patient,
- ΔP : Is the result of the pressure difference inside the oxygenator (Pint), and Part

($\Delta P = \text{Pint-Part}$). The difference between the pressures should not exceed 50 mmHg. If the increase in ΔP pressure exceeds 20 mmHg within an hour, we can expect clotting in the oxygenator. Changes in this pressure depend mainly on anticoagulation and changes in flow. [11,12,13]

AREA OF ACTIVITIES OF THE NURSING TEAM IN DIRECT PATIENT CARE

1. Prevention and early detection of infection.

Like all cannulas, these ECMO devices provide a route for pathogens to enter the patient's body. Their diameter and the place of insertion (the femoral vein causes the risk of contact with stool, and the internal jugular vein increases the risk of water getting into the place of cannula insertion when washing the patient) increase the risk of infection of the patient.

Nursing activities and patient observation should focus on:

- Using protective barriers and observing aseptic rules,
- Daily assessment of the injection site, i.e. redness, swelling or bleeding. To enable observation, transparent dressings are recommended, preferably with chlorhexidine, to reduce the possibility of infection,
- Assessment of compatibility of the dressing and injection. Observe for possible cannula movement. The nursing documentation should include a note about the depth of the puncture. Additionally, you can mark a given depth on the cannula.

2. Patient skin care

Anti-decubitus prevention is a challenge for the nursing team in most patients in Intensive Care Units (ICU). This is the result of long-term immobilization of the patient in bed. In a patient undergoing ECMO therapy, additional problems will include: pressure of the cannulas on the skin, deep analgosedation, and constant infusion of heparin, which may promote abrasions and hematomas. However, this does not change the fact that skin care should be carried out as for any other patient. It is recommended that:

- Skin care every two hours,
- The use of foam dressings or hydrocolloids that protect the skin against the pressure of the cannulas. Horizontal tubular caps, which include hydrocol, can be used to attach the cannulas. They reduce the area of damaged skin.
- To protect the facial skin, a soft type of attachment is recommended. Plastic attachments may increase pressure on the skin
- If the patient requires shaving of the facial hair or a specific area of the skin, it is recommended to use clippers or electric razors. The use of classic shavers increases the risk of skin disruption and bleeding,
- Changing the position of the patient's body resulting, for example, from the desire to care for the skin on the back, the need to change the bed linen, or to wash the patient's toilet, may result in impaired blood flow, resulting in desaturation and hemodynamic disturbances. When preparing to perform such activities, you should gather the appropriate number of people and delegate one person to secure the drains. If there are no contraindications, the patient should lie at an angle of 15-30 degrees. [4,11,14,15]

3. Other care activities

Nursing care of an adult patient undergoing venovenous ECMO therapy requires special attention, knowledge and commitment from medical staff. Below are some key nursing activities that are important when caring for a patient using this advanced form of respiratory support:

- Monitoring pain and sedation of a patient with VV ECMO. Nursing activities may cause an increase in blood pressure and tachycardia in the patient. Appropriate assessment improves patient comfort and reduces the risk of the patient waking up and accidental extubation. Analgosedation in VV ECMO in the first days of its use is deep and results from serious lung damage. Please remember that the membrane in the oxygenator captures drugs and reduces the effect of individual drugs (e.g. midanium, propofol and opioids),
- Due to continuous anticoagulation, care activities such as toileting the bronchial tree and oral cavity should be performed extremely carefully. Oral care according to generally available recommendations every 6-8 hours as VAE prevention. Suctioning secretions from the bronchial tree only when necessary. Remembering to select the appropriate catheter size and apply appropriate suction force

(-80 mmHg to -120 mmHg),

- Gastric tube insertion and bladder catheterization must be performed with particular care to avoid bleeding, which may be difficult to control. Each exchange should be well thought out by the therapeutic team. It is recommended to insert the tube through the oral cavity.
- The use of stool collection systems is not recommended in patients on ECMO because it increases the risk of damage to the rectum. However, if it is necessary to use such a set, the duration of its use should be shortened as much as possible.
- Eye care should be based on three groups of interventions: preventing the eyes from drying out, observing the palpability of the eyelids every 2-4 times a day and maintaining eye hygiene. [4,11,15,16,17,18]

The complexity of venovenous ECMO therapy requires many skills from nurses, from operating advanced equipment to caring for the patient. Continuous improvement in knowledge and practice is necessary to ensure the highest standard of care for patients undergoing this advanced form of therapy.

PREVENTION OF COMPLICATIONS, TASKS OF THE NURSING TEAM

1. The risk of bleeding during ECMO therapy is high, therefore the role of the nursing team is a comprehensive assessment of the patient, which will allow for the detection of pathology at an early stage and the implementation of appropriate intervention, the assessment concerns:

- neurological condition for possible bleeding. It involves observing the pupils, their reactivity, size and position. The patient's level of consciousness and response to decreasing doses of sedative medications should also be assessed.
- pulmonary secretions for possible signs of bleeding. In order to minimize the risk, it is recommended to warm and ensure adequate humidification of the respiratory tract,
- patient's urine; bleeding is indicated by light red urine,
- digestive tract; involves observing the stool for bleeding and stomach contents through a feeding tube. If there are no external signs of bleeding, gastric lavage can be performed,
- bleeding from the nose, throat and ear; is quite easy to notice. In case of nosebleeds, pressure on the nostrils may initially be applied. If this does not help, hemostatic dressings are applied to each nostril. The last resort is to use a probe with a pressure balloon (may be a urinary catheter). In case of bleeding from the oral cavity, blood and saliva should still be suctioned from the oral cavity with caution. Care should be performed using a soft stick and gauze pads soaked in water. Using products containing alcohol may encourage further bleeding. In case of heavy bleeding, oral tamponade is recommended by an otolaryngologist. [19,21,23]

2. Thromboembolic risk

Appropriate continuous anticoagulation prevents bleeding and the formation of thrombin and clots in the system. The nursing team uses a flashlight to observe the system and document any changes detected. This allows you to prevent, among others: ECMO failure or brain damage in the patient. Therefore, you need to acquire the ability to distinguish clots:

- Small clots are considered to pose no major risk, mainly located at the top of the oxygenator, where there is little chance of avoiding blood stasis,
- Clots that pose a threat to the patient and the functioning of the device are considered to be large clots that disrupt blood flow, effective gas exchange and cause changes in device pressures. Clots that form in the oxygenator on the side of the blood return to the patient may, if they break off, lead to a stroke in the patient. If clots pose a risk to the patient or may interfere with the effect of the therapy, the kit should be replaced. [20,24,27]

3. Haemolysis

Hemolysis during therapy may be caused by several factors, e.g. chaotic pump operation, membrane damage or cannula clotting. It is most often the result of damage to blood cells, causing them to rupture and bleed. Clinical signs of hemolysis can be observed by the nursing team by observing the urine. Characteristic dark color. If the patient is undergoing renal replacement therapy, the effluent in hemolysis is characterized by a "tea color". Failure to properly monitor the patient may result in the development of other internal or external bleeding, which may lead to the development of DIC syndrome. [20,25,27]

4. Accidental decannulation

This is a rare complication that occurs mainly when the patient changes position or goes to the toilet. The risk of its occurrence can be minimized by a designated person constantly monitoring the cannulas, drains, oxygenator, and endotracheal tube while performing activities with the patient. Before any manipulations, all fastenings should be checked (presence of sutures in the place of cannulae insertion, proper adhesion of fixing dressings). If decannulation has occurred, clamp the cannulas as quickly as possible with forceps and call a cardiac surgeon and a perfusionist. [20,25,27]

5. Hypothermia

ECMO therapy, which is often accompanied by renal replacement therapy, results in a large amount of blood leaving the patient's body. This may cause your body temperature to drop. In some situations, lowering the patient's temperature is beneficial; reduces the demand for oxygen and the production of carbon dioxide. If hypothermia becomes unfavorable for the patient it should be; check the operation of the heater-cooler in the ECMO set (in case of problems, call a perfusionist), apply thermal insulation of the ECMO system and active heating of the patient using special devices.[1,4,11,15]

DISCUSSION AND CONCLUSION

ECMO therapy is hope for patients with heart and/or lung failure. There are many indications for the use of therapy. However, before using it, you must also take into account factors that prevent or significantly limit the effectiveness of the treatment. Caring for a patient undergoing ECMO therapy requires extensive knowledge and experience of the nursing team. In addition to carrying out a large number of medical orders, the nursing team must identify and prevent problems related to the ECMO set, patient care, and intravenous injections, and thoughtfully plan and assess the risk of performing all activities with the patient, and if an adverse event has already occurred, they must detect and resolve it.

Summarizing the article about nursing care of an adult patient undergoing venovenous ECMO therapy, a picture emerges of the comprehensive and extremely demanding role of nurses in this area of medicine. ECMO therapy, an advanced method of artificial respiratory support, is a last resort for patients with severe respiratory failure. A key aspect of nursing care is precise monitoring of the patient's physiological parameters to ensure effective therapy. Nurses also play an important role as psychosocial support, understanding patients' emotional difficulties associated with long-term treatment. Nurse protocols include not only technical operation of the ECMO device, but also effective communication with the medical team. As technology advances and life therapies evolve, nurses' skills are continually improved to meet the challenges of modern medical care. It is worth emphasizing that their involvement is not limited only to technical aspects, but also includes concern for the patient's mental well-being. Understanding the role of nurses in the care of a patient undergoing venovenous ECMO therapy is crucial for effective and contemporary health care in a medical environment, where technologies and therapies are evolving, posing new challenges to nursing care.

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