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EXTRACORPOREAL MEMBRANE OXIGENATION (ECMO): MAIN COMPLICATIONS

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ABSTRACT

The Extracorporeal Membrane Oxigenation (ECMO) is considered a complex circulatory assistance therapy, requiring a multidisciplinary work for its use. Although there has been a significant increase in the rates of use of this hemodynamic support in recent years, with greater safety, complications can still be observed. In this context, the present study aims to identify the main complications during ECMO. It is configured in an integrative review of literature consisting of national and international scientific articles on the subject indexed in the period from 2010 to 2016. Eleven scientific articles were selected, demonstrating that 40.3% of the population studied had renal complications; 36.8% hematologic complications; 16,2% vascular complications; 14.1% infection; 8.8% neurological dysfunction and 20.1% mechanical complications with the ECMO circuit. The development of conduits that stimulate a safety culture is a requirement in hospital institutions. In this perspective, the use of preventive measures of a multidisciplinary nature may contribute to the consolidation of patient safety during mechanical circulatory support with ECMO.

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INTRODUCTION

Cardiovascular diseases are considered the leading cause of death worldwide (WHO, 2017). The high prevalence of these diseases has elevated the use of mechanical circulatory assistance in more complex cases. In this context, there were continuous modifications of the old devices and the emergence of new technologies in this area. Facing this scenario, professionals who work directly in the care of patients using mechanical circulatory support face challenges in the process of adaptation and search for knowledge (Queiroz *et al*., 2012). The use of mechanical circulatory support devices has made it possible to stabilize many patients who have an indication of this intervention. Among the mechanical circulatory support devices available, Extracorporeal Membrane Oxigenation (ECMO) has been gaining prominence due to its effectiveness. The term "ECMO" was initially used to describe the long-term extracorporeal support that focused on the oxygenation function.

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Subsequently, more emphasis was placed on the removal of carbon dioxide, and the term "extracorporeal carbon dioxide removal" was created. Subsequent to this, "circulatory support" was used for postoperative cardiac surgery. Because of its wide applicability, a new term has also been used to describe this technology: extracorporeal life support (ECLS) (Cruz-Berger, 2011). The ECMO is a temporary mechanical device (days to weeks) for cardiac or pulmonary support (partial or total) during cardiopulmonary insufficiency, leading to organ recovery or transplantation. It is indicated in cases of severe acute heart or pulmonary insufficiency with high risk of mortality. The severity of the disease and mortality risk may vary according to the situation and age group. Of the 13,712 cases of ECMO for pulmonary support in adults enrolled in the Extracorporeal Life Support Organization, there was a 66% survival and 57% of the 12,566 cases of ECMO for cardiac support, survival was 57% (ECLS, 2017). Also, can be considered a most complex circulatory assistance therapy available, and the multidisciplinary teamwork is indispensable. It requires much of the organizational structure of any hospital institution that proposes to do so. Many hospitals face great challenges in incorporating these new technologies, making adequate preparation, such as the adaptation of the hospital

team and structure, essential (Queiroz *et al*., 2012). In relation to the multiprofessional interaction, it is possible to emphasize the relationship between perfusionists, physicians, physiotherapists and nursing as a fundamental factor for the high level of safety in the maintenance of ECMO in Intensive Therapy. In this respect, considering its applicability at the national level, the perfusionist is the most qualified for the preparation and installation of the circuit of this mechanical circulatory support device. Despite technological advances favoring increased rates of use of this hemodynamic support with greater safety, complications can still be observed, which are still present in patients undergoing this therapy (Sangalli *et al*, 2014). Undesirable complications not attributed to the natural course of the underlying disease can be defined as Adverse Events (AEs). Its occurrence characterizes the distance between ideal care and real care, with 50% to 60% of AEs being considered preventable (Galotti, 2004). Within this premise, the present study aims to identify the main complications during ECMO through an integrative literature review.

MATERIALS AND METHODS

It is configured as an integrative review of literature consisting of national and international scientific articles on the proposed theme. The research was conducted in databases of the Scientific Electronic Library Online (Scielo), Latin American and Caribbean Literature in Health Sciences (Lilacs) and in the International Literature in Health Sciences (Medline) and Virtual Health Library (Bireme). Indexed articles were used in the period from 2010 to 2017 using the descriptors: extracorporeal membrane oxygenation and complications, including those with adult participants with veno-arterial (V-A) or veno-venous (V-V) support.

RESULTS AND DISCUSSION

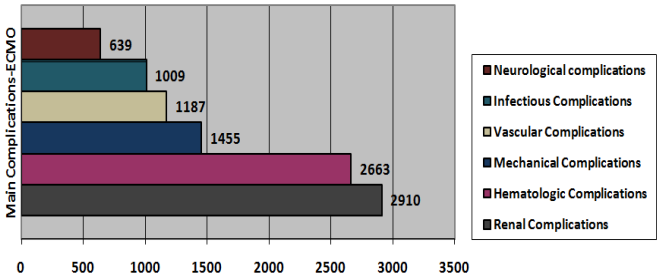
Eleven scientific articles were selected because they were directly related to the analysis theme. The Table 1 describes the main complications presented during ECMO therapy, being discriminated according to author, type of study, year of publication, number of patients studied and type of ECMO that was used. The articles analyzed demonstrate that 7,287 patients underwent V-V and V-A ECMO therapy.

Table 1. Main complications during ECMO. Santa Maria / RS, 2018

Author	Type of Study	Year	Patients	Type of ECMO	Main Complications
Rastan et al.	Retrospective analysis	2010	517	V-A	Renal failure with need of hemodialysis (65%); bleeding (58%); neurological complications (17.4%); gastrointestinal complications (18.8%); cannulated limb ischemia (5.4%).
Sun et al.	Retrospective analysis	2010	334	V-A/V-V	Mechanical complications - circuit (61.1%); bleeding (49.4%); vascular complications (41.6%); infection (13.45%); pulmonary complications (6.9%); cardiac tamponade (9.9%).
Bisdas et al.	Retrospective analysis	2011	143(V-A) 31 (V-V)	VA-VV	Vascular complications(8,6% V-A; 1,4% V-V).
Schimidt et al.	Retrospective analysis	2012	220	V-A	Pneumonia associated with mechanical ventilation (55%); bloodstream infection (18%); mediastinitis (11%); infection at the cannulation site (10%).
Aubron et al.	Prospective analysis	2013	105(V-A) 53 (V-V)	V-A/V-V	Bleeding (32.4%: V-A; 17%: V-V); neurological complications (0.9%: V-A, 1.9% V-V); vascular complications (9.5%: V-A; 0% -V-V); bloodstream infection (13.3% V-A,
Zangrillo et al.	Systematic review and meta-analysis	2013	1763	V-A/V-V	Renal failure (52%); bleeding (33%);sepsis (26%); hemolysis (18%); ischemia (10%); venous thrombosis (10%); neurological complications (8%) and coagulopathy (5%).
Aziz et al.	Retrospective analysis	2014	101	V-A	Peripheral vascular complications in 18 patients (17.8%); of these, two (11%) were for conservative treatment and 16 (89%) required surgical intervention; 8 (44.44%) of whom required femoral endarterectomy with angioplasty; in one patient amputation was required.
Cheng et al.	Systematic review	2014	1866	V-A	Acute renal failure (55.6%); significant bleeding (40.8%) and significant infection (30.4%); Ischemia end (16.9%); compartment syndrome (10.3%); amputation of lower limbs (4.7%); neurological complications (13.3%);
Novaretti e Santos	Action- research	2014	16	V-V	Mechanical complications: need to use a safety system to maintain flow (25%); exhaustion of the console battery during transport (18.75%); leakage in circuit connector (6.25%); inadequate circuit assembly (6.25%); no identification of the console voltage (6.25%); circuit pipe knocking.
Gray et al.	Retrospective analysis	2015	2000	V-A/V-V	Bleeding (39%); renal failure with need of dialysis or hemofiltration (31%); hemolysis (19%); arrhythmia (20%); new infection (13%); exchange of oxygenator (9%); clot in the circuit (26%); cannula problem (17%); neurological complications (8%); air embolism in the circuit (8%); malfunction (2%).
Ranney et al.	Retrospective analysis	2017	132	V-A	Distal perfusion cannulation (14.3%) and cannulation without distal perfusion (22.7%)

The main complications described in the publications were grouped according to the physiological or mechanical system involved. Complications of renal origin (renal damage, acute renal failure with or without hemodialysis) were present in

40.3% of the patients, being considered the most common during ECMO therapy, followed by hematological complications that occurred in 36.8% % (bleeding, cardiac tamponade or coagulopathy). It was also evidenced that 16.2% of patients developed vascular complications (limb ischemia, pseudoaneurysm, compartment syndrome or amputation), 14.1% presented some type of infection (bloodstream, surgical or pulmonary site), 8.8% developed neurological dysfunction (ischemic or hemorrhagic stroke) and 20.1% had some mechanical complications with the circuit, oxygenator, centrifugal pump or ECMO console (Graph 1).



Graph 1. Main complications in ECMO

The renal complications may be considered the most common complications in patients with ECMO. Considering this scenario, renal protection measures should be adopted, such as: optimization of renal perfusion through maintenance of adequate cardiac output, volume replacement based on a reliable water balance, correction of acidosis and pharmacological optimization (Santos *et al*, 2006). Already in the first minutes of the beginning of the therapy with the ECMO occurs an inflammatory response of the organism, which favors a state of hypercoagulability, requiring anticoagulation to avoid the formation of thrombi in the circuit. However, excessive anticoagulation may result in hematologic complications, requiring monitoring through Activated Coagulation Time and Activated Partial Thromboplastin Time (Stephen *et al*, 2014). In relation to the performance of the oxygenation membrane, it can be evaluated by measuring the pre and post-membrane pressure differences and its capacity for gas exchange by the results of the gasometry samples. With regard to the heat exchanger, its function is to compensate for the loss of temperature during ECMO. The circulating water in the system is heated, being indicated to be close to 37ºC to compensate for the loss of heat in the rest of the circuit, and should not exceed the limit of 40ºC, in cases of extreme necessity, for the prevention of complications, such as hemolysis and forming bubbles (Allen *et al*, 2011). Regarding vascular complications, the tip of the cannulated limb should be examined at regular intervals to check for pulse, temperature, color, capillary filling, and the distal doppler can be used every 4 hours. It is also recommended to compare the oxygen saturation of the cannulated limb toe and the extremity of one of the upper limbs13. Cannulation strategies that provide distal limb perfusion may be considered as an alternative for the prevention of ischemia (Wong *et al*, 2017). Some of the measures that have been shown to be effective in controlling infection in ECMO include standard measures such as proper hand washing prior to performing any procedure on the patient, antibiotic prophylaxis at the time of insertion of the cannula, as well as the use of chlorhexidine gluconate in the preparation of the pre-insertion skin and later in the dressing changes (Timsit, 2009). Neurological assessment may also be considered an important intervention in an intensive care setting. The identification of symptoms and symptoms associated with the imbalance of central nervous system functions directly implies the basic needs of the patient (Amorin *et al*, 2013). Unintentional complications resulting from ineffective care can be characterized as AEs (Souza *et al*,2011), which result in some type of harm to the patient, which may be: physical, social and / or psychological. Both can prolong hospitalization time, as well as cause injury, suffering, disability or death (WHO, 2009). The occurrence of AEs represents the performance of the health services, being directly related to the quality and reliability of the system measured, mainly by the health indicators. Given this, we must track and control the occurrence of complications, since they are in health care quality indicators, reflecting the need for investment in continuing education and recognition of error as an integral part of a safety culture between the health team (Novaretti *et al*, 2014). In Brazil, the National Sanitary Surveillance Agency stresses that the movement for patient safety aims at reviewing care processes, preventing errors in health services. It underscores the need to implement a safety and quality plan to ensure the absence of adverse events, errors and incidents, or to minimize their occurrence (ANVISA, 2009).

Conclusion

It is possible to consider that the safety in ECMO is directly linked to the early recognition of complications that may occur, as well as to the preventive resolution of these. Good practices based on effective team communication, interdisciplinary commitment to patient care, continuing education and exemplary leadership are key determinants of critical patient safety. The implementation of conduits that stimulate a safety culture is a requirement in hospital institutions. At present, all the topics involving patient safety have gained space and credibility, resulting in a remarkable improvement in the quality of the processes, which is considered a breakthrough in the health area in an attempt to reduce morbidity and mortality rates in intensive therapy. The use of preventive measures to complications has become a necessity in favor of the safety culture directed to the maintenance of ECMO in intensive therapy. Its approach is multidisciplinary, however, it is necessary to train professionals involved in care to ensure patient safety during this therapy. From this perspective, it is essential that professionals involved in direct patient care perform their function efficiently, in such a way as to ensure patient safety for the maintenance of this device. For this, it is necessary to adopt measures that aim at the improvement of the work developed.

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