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AN ASSESSMENT OF PERCEPTION, PREVALENCE, AND ATTITUDES TOWARD USING ECMO AMONG RESPIRATORY THERAPISTS IN SAUDI ARABIA

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ACCEPTANCE

This thesis, AN ASSESSMENT OF PERCEPTION, PREVALENCE, AND ATTITUDES TOWARD USING ECMO AMONG RESPIRATORY THERAPISTS IN SAUDI ARABIA, by Fatimah Shaker Alkhamis was prepared under the direction of the Master's Thesis Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Master of Science in Respiratory Therapy at the Byrdine F. LewisCollege of Nursing and Health Professions, Georgia State University. The Master's Thesis Advisory Committee, as representatives of the faculty, certify that this thesis has met all standards of excellence and scholarship as determined by the faculty.

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Dedication

First ever, I would start by thanking God for giving me the wisdom, strength, protection, health, skills, and all blessings in my entire life.

I dedicate this achievement to the most beautiful parents with love and effort who have accompanied me in this process, without hesitating at any moment of seeing my dreams come true, which are also their dreams. Thanks for all that you have done for me.

To my husband, no word can express my deeply thankful for you. I am forever grateful for the endless love and inspiration, unmeasurable support, and love that helped me achieve one of my most significant accomplishments.

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Fatimah S. Alkhamis

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THE PERCEPTIONS, PREVALENCE, AND ATTITUDES TOWARD USING ECMO AMONG RESPIRATORY THERAPISTS IN SAUDI ARABIA

By

Fatimah Alkhamis, BSRT

(Under the Direction of Dr. Lynda Goodfellow)

ABSTRACT

Background: Despite the growing research about the effectiveness of using Extracorporeal membrane oxygenation (ECMO) in different countries, there is a lack of research that addresses Respiratory therapists (RTs') practice, perception, and prevalence regarding the use of ECMO specifically in Saudi Arabia. Therefore, it is essential to evaluate RTs' perceptions, prevalence, and attitudes toward working with ECMO patients in Saudi Arabia to address the need for designing a target intervention to improve the awareness of understanding ECMO, generate advanced practitioners, enhance the healthcare quality, and decrease mortality.

Purpose: The primary purpose of this study was to evaluate the perception, prevalence, and attitudes toward the application of ECMO among respiratory therapists in Saudi Arabia.

Methods: A cross-sectional study was designed with 28 survey-based questions divided into four sections: demographic data, general questions about using ECMO, general questions about the knowledge of using ECMO, and general questions about the attitudes toward using ECMO among RTs in SA. Data were analyzed using descriptive statistics and the Chi-square tests. A convenience sample of Respiratory Therapists working in Saudi Arabia was collected online through social media platforms (Twitter, Facebook, and WhatsApp).

Results: A total of 49 RTs responded. More than half of the respondents were male 29 (60.4%), and 19 (39.6%) were female. The majority of respondents were working in urban regions (76.6%), 12.8% (n=6) of respondents were in suburban areas, and only 10.6% (n=5) were in rural areas. Approximately half of the respondents revealed they were uncomfortable with their knowledge while working with patients on ECMO (45.8%). Also, sixteen (34%) of respondents were uncomfortable with their knowledge when decisions are made in their unit relating to the initiation and withdrawal of the ECMO circuit. In comparison, they were knowledgeable in managing the mechanical ventilation of patients receiving ECMO (37.5%). The findings showed that most respiratory therapists working in intensive care units (ICU), most likely the cardiovascular ICU that provides ECMO (52.1%). However, most of them learned about ECMO from their college or university studies. Still, most hospitals did not offer ECMO training for RTs in SA (41.4%). Also, significant differences were received in RTs' attitudes toward ECMO depending on their working area (urban, suburban or rural).

Conclusion: The respiratory therapists showed a limited perception regards working with ECMO patients. However, the findings of this study revealed the experience positively impacts the perception of working with ECMO patients. This study found that education programs and country regions affect the practicing and understanding the patients in ECMO. Future studies should include a larger sample size and compare respiratory therapists to other ICU professionals in managing ECMO patients.

Keywords: perception, prevalence, attitudes, using ECMO, respiratory therapists, SA.

CHAPTER I
INTRODUCTION

What is ECMO?

Extracorporeal membrane oxygenation (ECMO), or extracorporeal life support (ECLS), is an external system with an artificial lung and heart to support the human anatomical lungs or heart and lungs. It is used for patients who cannot provide an adequate amount of oxygen and do not respond to conventional therapy (IWASHITA, 2020). However, ECMO is not considered treatment but rather is a technology that provides partial or total support with circulatory and pulmonary systems. Generally, it is used with patients who have a respiratory failure or cardiopulmonary failure. Additionally, it is used with other machines to control perfusion and gas exchange to stabilize and help patients recover from disease or injury. The most important adjunct therapies used with ECMO include mechanical ventilation, dialysis, and ventricle assisting device to increase the survival rate (Vuylsteke et al.,2017).

Background

History

The early pioneers of cardiopulmonary bypass (CPB) illustrated that using this technology as temporary life support was disappointing for patients with acute cardiac or respiratory failure by using rotating disc oxygenators to expose the blood directly to oxygen, since most patients (90%) died and no difference revealed before and after applying the ECMO. Therefore, the surgeons and researchers purposed to develop the heart and lungs mechanical could resume the cardiorespiratory function and help support the heart and lung temporarily (Melrose et al., 1953& Kernan et al., 1957). However, in 1869 Ludwig and Schmidt created the first artificially oxygenated blood by shaking blood with air through a balloon. Then, in 1882 Von Schröder used the oxygenator through a bubble to oxygenate the isolated kidney. After that, many other studies developed the oxygenator in that era, but the major

problem was forming a blood clot when they mixed the gas with blood. Many physicians stopped ECMO with their patients until Jay Maclean discovered heparin in 1916. In 1929, the first whole-body extracorporeal perfusion was successfully performed on a dog in Russia by Brukhonenko and Tchetchuline. Also, the first successful ECMO cardiopulmonary bypass in a human was reported in 1953 by Gibbon (Lim,2006).

Oxygenators are artificial devices that substitute for anatomical lungs by exchanging oxygen and carbon dioxide in blood during surgical procedures, which progressed during the first two decades of the 19th century (Lim,2006). However, the studies in 1979 revealed the failure of using ECMO in adult centers to show no benefit of supporting adults patients with ECMO. Accordingly, it suffered a significant setback in its widespread adoption (Cavarocchi, 2017), which stopped offering ECMO in most adult centers (Vuylsteke et al.,2017). On the other hand, infant and pediatric centers were still using ECMO since the clinicians observed that ECMO in pediatrics successfully supported them and proved to be an essential life-saving treatment (Wolfson 2003). Subsequently, the Extracorporeal Life Support Organization was established in 1989 (Extracorporeal Life Support Organization - ECMO and ECLS, 2021& Vuylsteke et al.,2017).

By the late 20th century, further advances in circuits occurred; earlier ECMO circuits had silicone membranes and used roller pumps were complicated with wetting (Yeager et al., 2017). Therefore, this decade saw the introduction of polymethylpentene (PMP) oxygenators that reduced the wetting issue of previous membranes (Yeager et al., 2017). Also, this new ECMO now boasts reduced hemolysis, heparin use, transfusion requirements, and fewer complications (Cavarocchi, 2017).

By the mid-2000s, ELSO data demonstrated that ECMO is primarily used for congenital and pediatric diseases; ELSO began creating guidelines for training, staffing, and equipment (Cavarocchi, 2017).

The 21st century is the second generation of ECMO; the clinicians started to support the lungs and heart with ECMO until the patient's recovery (Vuylsteke et al.,2017). The modern ECMO machine utilizes centrifugal pumps and PMP membranes by this time, and some models now combine the pump and oxygenator together (Cavarocchi, 2017). Though it is still different in how it is used and implemented between centers (Cavarocchi, 2017), the role of ECMO remains a bridge to recovery or transplant as it is not treatment (Yeager et al., 2017). Also, in 2020 the COVID-19 pandemic ECMO became an essential treatment for adult patients with respiratory failure. However, researchers continue to explore a new dominant for using ECMO with different patients (Vuylsteke et al.,2017).

How does ECMO work?

ECMO is pulmonary and circulatory function supported with devices outside of the body. Depending on the patient's disease, it works by inserting one or two large cannulas into arteries or veins through the neck or groin (the cannula is significant to take the blood from the patient's body to the ECMO circuit). Then, the ECMO circuit will provide gas exchange, temperature regulation, and pumped back into the patient (cardiac output) either through the aorta or right atrium, depending on the type used (Extracorporeal Life Support Organization - ECMO and ECLS, 2021).

There are two types of ECMO: the first type is using for lung and heart support (provide function of gas exchange C.O.), called Venoarterial (VA) ECMO, while another type is using only to support function of the lungs (provide gas exchange); it is called Venovenous (VV) ECMO, and this type of ECMO is most common to use. However, the providers of ECMO must decide which type is suitable depending on the patient illness (Bartlett et al., 2010).

In Venoarterial (VA) ECMO, blood flow starts at 50-60 mL/kg/min, and the blood drained out from the body through the large vein and returns after warming into the large artery. Therefore, two cannulas must be inserted into the neck or groin to allow the blood to move through the ECMO circuit

and gas exchange provided by the ECMO circuit both oxygen transfer and carbon dioxide transfer even when the heart is weak to pump the blood (Bartlett et al., 2010). While in Venovenous (VV) ECMO, blood flow starts as initial setting at 60-80 mL/kg/min. In this type, the surgeon can either place two cannulas or one cannula with two lumens into the major veins (femoral or internal jugular). Venous blood drained from a major vein and pumped back into the patient via major vein (Patel et al., 2019).

The team for ECMO includes:

1. Medical and Surgical intensivists trained in in the use of ECLS.
2. Emergency medicine ECLS physicians.
3. Cardiovascular surgeons.
4. ECLS trained nurses.
5. Perfusionists.
6. Respiratory therapists.
7. Physical therapists.
8. Social workers.
9. Pharmacists.
10. Dieticians (Extracorporeal Life Support Organization - ECMO and ECLS, 2021).

Indications for ECMO:

VA-ECMO is indicated in patients with refractory cardiogenic shock who have an underlying potentially reversible heart condition like acute myocarditis. Also, this type of ECMO was indicated for weaning from cardiopulmonary bypass after cardiac surgery, cardiac transplantation, pulmonary hypertension (after pulmonary endarterectomy), and post-cardiac arrest (as part of Advance Life Support) (Guillermo et al., 2012).

On the other hand, VV- ECMO is indicated in patients with ARDS who have underlying potentially reversible acute respiratory failure. Additionally, failed lung transplant graft, trauma (pulmonary contusion), and pulmonary embolism patients were indicated for VV- ECMO. The team of ECMO has the responsibility to decide if the patient needs ECMO or not (Guillermo et al., 2012).

Contraindications for ECMO:

The most contraindication of ECMO in Patients with irreversible organ damage, multiorgan failure. Also, it is not recommended for patients who cannot be anticoagulated. Severe aortic regurgitation or aortic dissections are contraindications for VA-ECMO. Generally, ECMO therapy is continuous progress, so involving an ECMO specialist in discussing indications and contraindications for each patient's condition is preferable (Guillermo et al., 2012).

In Saudi Arabia (SA), the respiratory therapy program provides a very brief overview about using ECMO. Also, respiratory therapists can register for ECMO courses to get professional certification and train more in a hospital to use the ECMO. The course about using ECMO is deficient or lacking in SA. Therefore, more work in educating RTs to understand the ECMO professionally in SA with different patients' diseases is required to improve the education and healthcare quality.

Problem Statement

Due to the deficiency of educating RTs about using ECMO in SA and insufficient information about ECMO in respiratory care programs, and no known studies in SA involving RTs regarding ECMO, a greater focus on teaching the RTs student to understand the ECMO is needed. Additionally, mechanical ventilation settings are important in ECMO patients to minimize further lung damage and improve outcomes. Therefore, it is crucial to help the RTs understand how they will manage the ventilator inpatient with ECMO and improve the quality of education in SA (Schmidt et. al., 2014). This study will explore the Respiratory therapists' (RTs) perception and prevalence of using ECMO in Saudi

Arabian hospitals. This is essential to develop the RTs' skills and practice in managing patients with ECMO.

Significance of the Study

ECMO is being more and more utilized (more prevalent) in healthcare today. There is a significance to this trend that impact the providers' knowledge of management of patients on ECMO. Therefore, this study is significant to enhance the awareness of the need to understand the ECMO to generate advanced practitioners, improve the quality of healthcare and decrease mortality in SA.

Purpose of study

This study aims to determine the prevalence, perception, and attitudes of using ECMO among Saudi Arabian RTs. This is crucial to understand how ECMO is used to assess the RTs' perception of ECMO in Saudi Arabia.

The primary study questions are:

1. To what extent are Saudi Arabian RTs knowledgeable about ECMO?
2. To what extent are Saudi Arabian RTs familiar with managing the patient on mechanical ventilation with ECMO?
3. To what extent are regions impacting the attitudes of Saudi Arabian RTs in understanding ECMO?

Hypothesis

The hypothesis from this study is very few RTs in SA know the ECMO use due to low information in the respiratory care program in SA. Also, many RTs are unfamiliar and faired to manage the ventilator with ECMO patients due to the lack of ECMO devices in the hospital to develop the RTs in using ECMO.

Summary

In summary, the chapter mentioned the critical information about ECMO. It started with highlighting the ECMO means and vital information about the history of ECMO and how it developed during the time until today. The information above illustrated the process of applying ECMO in patients and described ECMO types with indications. Also, this chapter mentioned the benefits of educating the fundamentals of the ECMO in respiratory care programs in SA to help RTs be familiar with taking care of ECMO patients, and more comfortable with using MV with ECMO patient. However, the respiratory care program provides very little information about using ECMO in SA. Therefore, the research questions about the perception, prevalence, and attitudes of using ECMO among RTs in SA is helpful for Saudi Arabian RTs to be familiar with using ECMO and show the positive impact on education quality, patients, and healthcare quality.

Chapter II

REVIEW OF THE LITERATURE

Overview

This literature review is an overview of the previously published research on ECMO. The aims of this chapter are to illustrate the topic from different angles, show the conflicting viewpoints related to ECMO, and establish the evidence that indicates the necessity of the current study. The data was collected through searching in PUBMED and Google Scholar databases by using the following keywords: ECMO, ECMO in Saudi Arabia, ECMO patients, supporting pediatrics with ECMO, using ECMO in trauma, supporting adult patients with ECMO, relating ECMO with a respiratory therapist, ECMO in Australia, and ECMO in the UK. The research revealed the significant relevance of literature exploring the level of ECMO awareness in improving practitioners and decreasing the mortality rate and morbidity. This chapter investigated the relevant articles about ECMO and is divided as follows:

- ECMO use and effectiveness in adults and pediatrics.
- Perception and prevalence of using ECMO globally among critical care practitioners.
- ECMO related to respiratory care.
- ECMO in Saudi Arabia.

The results showed a diversity of publications that reviewed ECMO use based on research. However, a lack of studies evaluated the prevalence, awareness, and attitudes among RTs to understand ECMO particularly in Saudi Arabia. The articles were arranged based on questions that related to using ECMO among RTs as follows:

1. To what extent are Saudi Arabian RTs knowledgeable about ECMO?
2. To what extent are Saudi Arabian RTs familiar with managing the patient on mechanical ventilation with ECMO?

3. To what extent are regions impacting the attitudes of Saudi Arabian RTs in understanding ECMO?

ECMO use and effectiveness in adults and pediatrics

The use of ECMO technology has been effective since it was presented. Many researchers have investigated the efficacy of using ECMO in different critical care patients by comparing the survival rate before and after applying ECMO with various diseases (Eldredge et al. ,2019).

Eldredge et al. (2019) reviewed the effectiveness of using ECMO in ARDS patients related to burn injury to decrease the mortality rate. The study included eight patients who applied for ECMO (pediatric and adult patients) admitted to the Burn Trauma Intensive Care Unit (BTICU) with severe ARDS and burned injury between 2006 and 2016. The results showed that only one of the totals died after ECMO, four were discharged to acute rehabilitation, and three were released to their home. Therefore, this study explored that ECMO is helpful to diminish the mortality rate and increase the survival rate in patients with ARDS related to burn injury.

Adults:

Lindén et al. (2000) evaluated the relation of using Extracorporeal membrane oxygenation (ECMO) with adult acute respiratory distress syndrome (ARDS) patients in survival rate. The study included seventeen ARDS patients observed in the Intensive Care Unit, Astrid Lindgren Children's Hospital at Karolinska Hospital, Stockholm, Sweden, supported by venovenous or venoarterial ECMO with minimal sedated and received pressure support ventilation. The patients had been supported with mechanical ventilation before the ECMO and inhaled nitric oxide (NO). Also, the patients had been using the prone position treatment pre-ECMO applied. Sixteen of seventeen ECMO patients had stable hemodynamics, and only one case with unstable conditions. However, 13 patients were survived after 3 to 52 days on ECMO. The cause of death in non-survivor patients is related to severe intracranial

complications that lead to cerebral infarction. As a result, a high rate of survival in ARDS adult patients supported by ECMO and pressure ventilation with minimal sedation can be observed. The complications related to surgical treatment during ECMO are acceptable, and bleeding problems can be controlled but require an immediate and aggressive approach.

On the other hand, Hermann et al. (2019) conducted a study about using ECMO without an anticoagulation system in adult patients with severe thrombocytopenia. The study included seven patients supported by ECMO and observed for 44 days without anticoagulation system. The outcomes showed that six patients died; the reasons beyond passed were intracranial hemorrhage in one patient, three had a multi-organ failure (MOF), and two patients discontinued the therapy. One severe thrombocytopenia patient had survived and was released home. Based on the findings of this study, severe thrombocytopenia in adult patients supported with ECMO without an anticoagulation system is related to an increased mortality rate in the hospital.

Pediatrics:

Extracorporeal membrane oxygenation (ECMO) effectively supports post-cardiotomy in pediatric patients with refractory cardiac failure disorder. Walters et al. presented retrospectively reviewed ten years prior experience with pediatric ECMO in cardiac surgical patients to identify risk factors for hospital death. The study included 73 pediatric patients who were used from medical records at Children's Hospital of Michigan between August 1984 and February 1994 with congenital heart disease who were placed on ECMO. The patients were divided into pre-cardiotomy patients (n=7) and post-cardiotomy patients (n=66) placed on ECMO. However, post-cardiotomy patients group patients were divided into two subgroups. The first group included seventeen patients who couldn't wean from cardiopulmonary bypass (CPB) and were placed on ECMO while they still in the operating room (2A subgroup), and the second subgroup included 49 patients weaned from CPB after cardiac surgical repair (2B subgroup). As a result, 42 of all 73 patients survived: for the pre-cardiotomy patients group, five of

7 patients in group were survived, 22 patients from the second group could not be weaned from ECMO support and died, and 44 patients were successfully weaned from ECMO, but six of them were died after decannulation due to high right atrial pressure. Therefore, ECMO is the most effective rescue for pediatric cardiac surgical patients with refractory hemodynamic deterioration after being successfully weaned from cardiopulmonary bypass. Also, high right atrial pressure after decannulation of ECMO is a serious independent predictor of failure of myocadiac recovery and hospital death.

In 2004, Flamant et al. conducted a study that included 151 patients in Trousseau Hospital, Paris, from January 1,1996 to December 31, 2003to explain the characteristics of children patients under one year with severe respiratory syncytial virus (RSV) bronchiolitis who supported by mechanical ventilation (MV) or/and extracorporeal membrane oxygenation (ECMO). All patients were supported with a volumetric ventilator (Drager Evita4) and given antimicrobial treatment. ECMO treated only 14 patients in total, and the data illustrated that the frequency of bronchopulmonary dysplasia (BPD) was significantly higher than non- ECMO patients. However, the survival rate was 71.4%, and only four patients died. The mean duration of ECMO for survivors was 12.1 days. Therefore, ECMO can help to decrease the mortality rate for bronchopulmonary dysplasia patients in ventilated children with bronchiolitis (Flamant et al., 2004).

Furthermore, Barbaro et al. (2018) performed a study to compare severe acute respiratory failure children's patients with supported and non-supported ECMO in term of mortality rate and functional status. The study included 879 children without ECMO support, and 61 children patients supported by ECMO with severe ARDS. The mortality rate was measure at 90 days for both groups. The results showed no significant difference among the ECMO and non- ECMO patients and no difference in the change in cerebral functional status (Barbaro et al., 2018).

Perception and prevalence of using ECMO globally among critical care practitioners

Management of ECMO patients is required in the intensive care unit (ICU). According to Gannon et al. (2020), establishing an ECOM training program is essential for critical care practitioners due to the rapid growth of using ECMO in ICU to optimize clinical outcomes. The authors used the study to evaluate the development and implementation of a multidisciplinary ECMO training program service across the intensive care units (ICU) between October 2018 and January 2019 at Vanderbilt University Medical Center in the United States. The study included 97 critical care clinicians who received a rapid ECMO training program. Pre- and post-program written examinations assessed perceptions of content and delivery of the ECMO program. The results showed that positive outcomes and applicable to improving education and safe care.

Additionally, ECMO complications are reduced and progress critical care due to advanced technology. In 2020, Lepper et al. assessed the perception of using ECMO in 94 European centers to manage prolonged extracorporeal life support by using a survey. From 94 center responses, the most common case of using ECMO as a bridge to recovery (64%) or transplantation (20%). However, 37% of the center participants support the patient from 14 to 21days, 30% from 21 to 28 days, and 28% for more than 28 days as prolonged treatment. Therefore, significant differences prevail among European ECMO centers concerning local perception and patient management in prolonged extracorporeal membrane oxygenation (Lepper et al., 2020).

A study was completed by JAMA (2009) to review the characteristics of all patients with influenza A(H1N1) developed to severe acute respiratory distress syndrome (ARDS) treated with ECMO through novel influenza (H1N1) pandemic in Australia and New Zealand in 2009 winter. The study was included 68 patients who received ECMO in 15 intensive care units (ICUs). However, patients had severe respiratory failure supported by advanced mechanical ventilatory before the application of ECMO. The median (IQR) duration of ECMO support was ten days. As a result, 48 of the 68 patients had been discharged from ICU, 32 had survived and discharged from the hospital,16

continued as hospital inpatients, 14 patients had died, six remained in the ICU, and 2 of 6 patients were still supporting with ECMO. Therefore, the number of using ECMO through the 2009 winter influenza A(H1N1) winter pandemic significantly increased for ARDS patients leading to the survival of the most patients in this pandemic, and that helped to enhance health care planning and clinical management for critically ill patients, especially with severe ARDS patients to survived and decrease the mortality rate (JAMA, 2009).

ECMO related to Respiratory Care

ECMO is useful to use with severe respiratory failure to improve oxygenation and decrease the mortality rate by allowing the lungs to rest and recover (Culbreth et al., 2016). Culbreth et al. (2016) conducted a systematic review about the potential complications with adding prone positioning therapy with ECMO in severe respiratory failure adult patients to decrease the mortality rate and optimize alveolar recruitment. The study included seven articles that fit with study criteria. The results presented that there was no ECMO cannula removal in all the studies. However, two articles reported bleeding in the cannula, and one study reported bleeding from the chest cannula. Two studies showed hemodynamic instability through prone position therapy and adverse hemodynamic episode. Therefore, using the prone position therapy with ECMO in severe respiratory failure needed more studies to assess the clinical efficacy and to study potential complications.

Camporota et al. (2015) conducted a survey study in 173 adults respiratory ECMO centers to describe how adult ECMO centers manage mechanical ventilation and related interventions. The results illustrated that the pressure control mode was the most commonly used in mechanical ventilation, and the PEEP was between 15 to 20 cmH2O. However, recruitment maneuvers were never used in 34.1% of centers or used daily in 13.2%. The survey reported using either a "lung rest" (45.7%) or an "open lung" strategy (44.2%). Only 24.8% used chest CT to guide mechanical ventilation. Adjunctive treatments were never or occasionally used. Only 10% of centers extubated patients on ECMO, mainly in more

experienced centers. 71.3% of centers performed a tracheostomy on ECMO, with significant variability in timing. Only 27.1% of ECMO centers had a protocol for mechanical ventilation on ECMO. Therefore, the clinicians' training background and the experience did not influence the approach to ventilation which recommended the necessity to determine the best practice of mechanical ventilation during ECMO and its impact on patient outcomes.

Schmidt et al. (2019) completed a prospective cohort study of patients supported with ECMO for severe acute respiratory distress syndrome (ARDS) during one year for 23 international ICUs from 10 countries participated in evaluating the outcomes of current mechanical ventilation practices in patients treated with ECMO. The study included 350 patients with severe ARDS supported with ECMO, and the data was collected daily for pre and post ECMO mechanical ventilation settings. However, the settings of MV were significantly decreased after using ECMO. The result showed a lack of association between ventilator settings during the first two days of ECMO and survival in multivariable analysis.

In 2020, Giraud et al. conducted a cohort study about using ECMO in acute respiratory distress syndrome (ARDS) patients related to coronavirus-2019 (COVID19). The study involved Geneva University Hospital ICU in 137 patients supported by VV-ECMO. The findings showed that 40% of all patients survived, and the survivors had a significantly short time on a ventilator. However, all patients who were ECMO supported after seven days on ventilator ultimately died. Thus, the study suggests that using ECMO can be safe and reduce the mortality rate in early implementation on severe COVID-19 patients with refractory hypoxemia.

In 2015, Kalzén et al. conducted a study to investigate long-term survival for adults after VV-ECMO correlates to time on ECMO. The study included 273 adult patients staying on VV-ECMO. The results reported that the best outcomes for a patient with a short time stay on ECMO after 90 days was 74%. However, the total of patients who stayed for more than 56 days on ECMO was six patients, and

only two survived. Therefore, this study emphasized that supporting long-term patients with ECMO is associated with an increase in the mortality rate.

ECMO in Saudi Arabia

There is an overall lack of research involving respiratory therapists' perceptions and competence regarding ECMO, especially in Saudi Arabia. This alone suggests that there is a need for more studies to incorporate perceptions, the overall prevalence of use, and the understanding of the daily practices of respiratory therapists with ECMO patient in SA. However, there were various studies in SA related to using ECMO in different patients and diseases.

The King Faisal Specialist Hospital and Research Center (KFSH&RC) in Riyadh, Saudi Arabia, started to provide an ECMO program in 2004 for different specialists based on the Extracorporeal Life Support Organization (ELSO) guidelines to improve the team quality, educational structure and to provide safer care to patients in the hospital. Furthermore, between 2014 and 2015, KFSH&RC provided ECMO supports to survive six patients after lung transplant and three patients with acute lung injury. Also, 66 survived and venoarterial ECMO decannulation by 56 in 2014 and 2015. Therefore, the outcomes illustrated that a developed ECMO program could improve patient outcomes and provide safe services (Al Dalaty & Badruddin, 2017).

Shalaby (2017) conducted a study about morbidly obese with severe ARDS patients on ECMO at King Fahd hospital ECMO center in Jeddah, Saudi Arabia. The study involved two groups of patients with acute respiratory distress syndrome (ARDS) placed on ECMO. The first group included twenty-eight obese patients with a body mass index (BMI) of more than 30 kg/m2, and the second group contained twenty-one non-obese patients. The results explained that the survival rate for the first group was 71% compared with the second group. Only nine of 21 patients survived after 90 days on ECMO. Consequently, the use of ECMO in obese patients is realizable to decrease the rate of mortality.

Conclusions

Many studies showed the effectiveness of using ECMO in pediatric patients with different disease processes. However, there were conflicting studies about using ECMO in adult patients, but most studies presented the effectiveness of using ECMO in pediatric patients. Overall, the prevalence of using ECMO various from one country to another. However, there is a lack of research involving the respiratory therapists' perceptions and prevalence of using ECMO in SA. Therefore, the current study is crucial to explore the prevalence, educational level, and attitudes among RTs to use ECMO in Saudi Arabia in order to inform the interventions to increase educational awareness for RTs.

CHAPTER III
METHODOLOGY

This descriptive study investigated the prevalence, attitudes, and perception of using ECMO among RTs in Saudi Arabia. This chapter will illustrate the methods and procedures applied in this study by answering the following questions:

1. To what extent are Saudi Arabian RTs knowledgeable about ECMO?
2. To what extent are Saudi Arabian RTs familiar with managing the patient on mechanical ventilation with ECMO?
3. To what extent are regions impacting the attitudes of Saudi Arabian RTs in understanding ECMO?

Instrumentation

The instrument of this study is used based on two surveys. The first survey was established by Dao et al. (2021) to evaluate the ethical factors determining ECMO allocation during the COVID-19 pandemic, and the second survey was developed by Hodgson et al. (2020) to assess the ECMO practice in 23 Australian adult intensive care units. Th researcher combined the two surveys after obtaining permission from both authors to modify and use each survey in this study. Also, the researcher conducted a literature review that evaluated the use of ECMO as a Bridge to Lung Transplantation in the United States in the current survey (Tsiouris et al.,2018). However, the survey includes 28-items divided into four sections to collect data from participants. These sections included: demographic data, general questions about using ECMO, general questions about the ECMO knowledge, and general questions about the attitudes toward using ECMO among RTs in SA. The survey was administered through an online link sent to the participants through social media educational accounts such as Twitter, Telegram, and WhatsApp. These accounts are created by RT celebrities and followed by enormous numbers of

RTs. This survey contains multiple-choice questions modified to accurately evaluate respiratory therapists' perceptions, attitudes, and prevalence of ECMO use in SA.

Study Design

This study used a crossed-section, descriptive research design to evaluate the prevalence, attitudes, and perceptions of using ECMO among RTs in Saudi Arabia. A cross-sectional with a self-administered survey was delivered electronically and used to collect data from respiratory care practitioners to report their use and knowledge about ECMO.

Informed Consent

Informed consent was obtained by asking individuals if they the "agree" to the informed consent in order to proceed with the survey questionnaire. Participants were informed that they have the right to withdraw at any time without answering questions if they feel uncomfortable. The informed consent letter for this study can be found in Appendix B.

Sample

The study sample consisted of a convenience sample that includes respiratory therapists working either in an urban, suburban or rural area in Saudi Arabia. The survey was composed of four question types: multiple-choice questions (MCQs), Rating scales questions, Likert scales questions, Yes or No questions. The target population and inclusion criteria included all qualified and accredited RTs who have any respiratory care certificate, including diploma, bachelor's, master's, or Ph.D. degree, and work in any hospital or university in Saudi Arabia. Participants were provided the survey and given a cover letter that informed them about the purpose of the present study and assured them of confidentiality. RT students, interns, and other healthcare providers were excluded.

Data Collection and Analysis

Georgia State University Institutional Review Board (IRB) approved the study. Most importantly, confidentiality was implemented as no names or identifying information on the survey folder and data collection. Upon receiving IRB approval, an online link to the survey was distributed through social media platforms (Twitter, Telegram, and WhatsApp). After the first week of distributing the survey, a reminder was sent to social media, and the survey was closed after two weeks from the first day of the post. The latest version of the Statistical Package for the Social Sciences (SPSS version 27) analyzed and collected data. The descriptive statistics analysis was used, including frequencies, means, and standard deviation, to describe the age and demography of the population, knowledge, and familiarity. Attitudes about understanding ECMO were determined by using a Chi-squared test analysis of variance to compare the respiratory therapists' perceptions about ECMO with whether the RT was employed in an urban, suburban, or rural area. A p-value <0.05 was considered statistically significant.

Summary

This chapter illustrated the main point about the methods, instruments, study design, and sample population that used in the present study. Also, the procedure for data collection and the methods of data analysis were presented to evaluate the primary aims of this study, including the prevalence, knowledge, and attitudes of understanding ECMO among RTs.

CHAPTER IV

FINDINGS

The main purpose of this chapter is to describe the perception, prevalence, and attitudes about using ECMO among RTs in Saudi Arabia. Information about the sample's demographics as well as the findings of the statistical analysis are presented in this chapter.

Research questions

1. To what extent are Saudi Arabian RTs knowledgeable about ECMO?
2. To what extent are Saudi Arabian RTs familiar with managing the patient on mechanical ventilation with ECMO?
3. To what extent are regions impacting the attitudes of Saudi Arabian RTs in understanding ECMO?

Demographic findings

The study included a convenience sample of respiratory therapists who are working in Saudi Arabia. A total of 49 responses were collected. More than half of respondents were male 29 (60.4%), and 19 (39.6%) were female, and 77.1% (n=37) of them between 20 to 30 years old, 14.6% (n= 7) between 31 to 35 years, 6.3% (n=3) from 36 to 40, and only 2.1% (n=1) more than 40 years old. Thirty-nine (81.3%) of respondents are working in government hospital while 18.8% (n=9) are working in private hospital, thirty-six (76.6%) in urban area, 12.8% (n=6) in suburban area, and only 10.6% (n=5) in rural area. The majority of respondents are respiratory therapists' staff 74.5% (n=35), and 12.8% (n=6) education coordinators, and only 12.8% (n=6) are directors/ managers. However, most respondents are working in units that support adult and pediatric/neonatal patients 56.3% (n=27), 18 (37.5%) are working in adults' units only, and 6.3% (n=3) are working in pediatric/neonatal unit (See table 1).

Table 1: Demographic characteristics of survey respondents.

Demographic Variable		n (%)
Gender	Male	29 (60.4%)
	Female	19 (39.6%)
Age	20 – 30 years.	37 (77.1%)
	31-35 years.	7 (14.6%)
	36- 40 years.	3 (6.3%)
	41+ years.	1 (2.5%)
Type of hospital	Government	39(81.3)
	Private	9 (18.8%)
Working Area	Urban	36 (76.6%)
	Suburban	6 (12.8%)
	Rural	5 (10.6%)
Role in the department	Director/manager	6 (12.8%)
	Education Coordinator	6(12.8%)
	Staff	35 (74.5%)
Unit	Adult	18 (37.5%)
	Pediatric/neonatal	3 (6.3%)
	Both	27 (56.3%)

Finding Related to Research Question 1

The first question asked, "To what extent are Saudi Arabian RTs knowledgeable about ECMO?" Data results are tabulated in Table 2, including statements, frequencies, percentages of survey questions measuring the knowledge level of RTs among ECMO in Saudi Arabia (See table 2).

Table 2: finding Related to Research Question 1: the knowledge of RTs in SA among ECMO.

Survey Statement	n (%)
1. I am comfortable with my knowledge when using ECMO. • Disagree • Completely disagree • Agree • Completely agree	 22 (45.8) 12 (25%) 9 (18.8) 5 (10.4%)
2. I am comfortable with my knowledge of decisions are made in my unit relating to starting and stopping ECMO. • Disagree	 16 (34%)

• Agree • Completely disagree • Completely agree	13 (27.7%) 12 (25.5%) 6 (12.8%)
3. I am comfortable with my knowledge of the management of the mechanical ventilation of patients receiving ECMO. • Agree • Disagree • Completely agree • Completely disagree	 18 (37.5%) 14 (29.2%) 8 (16.7%) 8 (16.7%)

In general, the respondents reported disagreement with the statement that "I am comfortable with my knowledge when using ECMO." with 22 responses (45.8%) which were higher numbers correspond with a disagreement with the statements compared to lower numbers who strongly agreed with 5 (10.4%). Likewise, the statement "I am comfortable of my knowledge with decisions made in my unit relating to starting and stopping ECMO." reported a lower number of agreements with n= 6 (12.8%) frequencies. Whereas the statement, "I am comfortable with my knowledge of the management of the mechanical ventilation of patients receiving ECMO." received a most robust agreement with 18 (37.5%) (See table 2).

Finding Related to Research Question 2

The second question asked," To what extent are Saudi Arabian RTs familiar with managing the patient on mechanical ventilation with ECMO?" responses to survey statements regarding familiarity with using ECMO were tabulated and presented in table 3.

Table 3: Finding Related to Research Question 2, RTs familiarly in SA regard ECMO.

Survey Statement	n (%)
4. Do you work in a unit that provides ECMO? • Yes. • No.	 25 (52.1%) 23 (47.9%)

5. How did you learn about ECMO? • At college. • Others. • At the ECMO conference. • Course from Extracorporeal Life Support Organization (ELSO).	 36 (73.5%) 7 (14.3%) 5 (10.2%) 1 (2%)
6. What type of ECMO training does your hospital provide for Respiratory therapists? • none. • bedside. • External. • internal. • simulator. • accreditation. • Credentialing.	 24 (41.4%) 15 (25.9%) 10 (17.2%) 5 (8.6%) 2 (3.4%) 2 (3.4%) 0 (0%)
7. For what reasons is ECMO support provided? • Respiratory. • Cardiac. • Cardiopulmonary resuscitation (CPR). • Not applicable.	 40 (53.3%) 33 (44%) 1 (1.3%) 1 (1.3%)
8. Based on your practice, what is your favored strategy for observing anticoagulation amid ECMO support? • Activated clotting time (ACT). • Partial thromboplastin time (PTT). • Other. • Thromboelastogram (TEG).	 19 (38.8%) 19 (38.8%) 9 (18.4%) 2 (4.1%)
9. Based on your practice, what are your favored insertion and exertion cannulation plots for Venovenous (VV) ECMO? • Femoral vein->ECMO->return to IJ or subclavian vein • Femoral vein->ECMO->return to femoral vein • Dual-lumen Avalon cannula in upper body vein • Other	 20 (40.8%) 12 (24.5%) 9 (18.4%) 8 (16.3%)

10. Based on your practice, what are your favored insertion and exertion cannulation plots for Venoarterial (VA) ECMO?	
• femoral vein->ECMO->femoral artery.	23 (46.9%)
• femoral vein->ECMO->axillary artery.	10 (20.4%)
• Central cannulation.	10 (20.4%)
• IJ or subclavian vein->ECMO->axillary artery.	6 (12.2%)
• Other.	0 (0%)
11. Based on your practice, which choice underneath most precisely reflects the utilize of VV vs. VA ECMO in your center?	
• VV ECMO is the preferred initial mode of ECMO therapy, VA ECMO is reserved for cases where VV ECMO is unsuccessful.	14 (28.6%)
• Our program does not utilize VV or VA ECMO.	11 (22.4%)
• Other.	11 (22.4%)
• VA ECMO is used as the initial mode ECMO therapy in selected cases (e.g., severe Right ventricular (RV) with pulmonary hypertension).	8 (16.3%)
• VA ECMO is the preferred initial mode of ECMO therapy.	5 (10.2%)
12. In your center, which staffs apply in ICU to care for ECMO patients bedside?	
• ECMO-trained clinicians [registered nurse (RN) or respiratory therapist] and perfusionist at patient bedside 24/7.	16 (32.7%)
• Other.	13 (26.5%)
• ECMO-trained clinicians [RN or respiratory therapist] at patient bedside 24/7, with perfusionist backup support in hospital.	10 (20.4%)
• ECMO-trained clinicians [RN or respiratory therapist] at patient bedside 24/7, with perfusionist backup support out of hospital.	3 (6.1%)
• ICU RN and respiratory therapist at patient bedside 24/7, with perfusionist backup support.	7 (14.3%)

13. Does your ICU have a written clinical practice for ECMO clinical management at your hospital? • No • Yes	 27 (55.1%) 22 (44.9%)
14. Does your ICU have documented criteria on the timing of ECMO initiation in a deteriorating patient? • No • Yes	 25 (51%) 24 (49%)
15. Does your ICU have a written clinical practice guideline that outlines the training requirements needed by staff involved with ECMO at your hospital? • No • Yes	 26 (53.1%) 23 (46.9%)
16. Does your ICU have documented criteria for ECMO patient selection? • Yes • No	 28 (57.1%) 21(42.9%)

Overall, the findings show that most respiratory therapists are working in the unit provide ECMO (52.1%). Still, most hospitals did not offer ECMO training for RTs in SA (41.4%). Also, more than half of respiratory therapists in SA learned about ECMO from their college (73.5%). They became more familiar with ECMO depending on their practice in the hospital. However, the majority of respiratory therapists reported that ECMO provided for a respiratory problem only with a number of 40 (53.3%). Also, 19 (38.8%) of respondents preferred Activated clotting time (ACT) and Partial thromboplastin time (PTT) as a strategy for observing the anticoagulation aim of ECMO support.

Based on RTs practice regarding ECMO in SA, 20 (40.8%) favored insertion in the femoral vein and exertion from Internal Jugular or subclavian vein cannulation plots for Venovenous (VV) ECMO. However, 23 (46.9%) favored insertion in the femoral vein and exertion from femoral artery cannulation plots for venoarterial (VA) ECMO. Additionally, 14 (28.6%) selected VA ECMO as the initial mode of ECMO therapy reserved for cases where VV ECMO is unsuccessful (See table 3).

The findings illustrated that most ICUs in SA provide ECMO trained clinicians [registered nurses or respiratory therapists] with perfusionists at the patient bedside 24/7 to take care of ECMO patients with a total number of 16 (32.7%). Also, most ICUs in SA did not write clinical management for ECMO (55.1%) and did not write criteria on the timing of ECMO initiation in a deteriorating patient (51%). Besides, most ICUs in SA did not outline the training requirements needed by staff involved with ECMO (53.1%).

Moreover, the findings related to the statement "Does your ICU have documented criteria for ECMO patient selection?" revealed the most significant number of ICUs in SA have written document criteria for ECMO patient selection (57.1%) (See table 3).

Finding Related to Research Question 3

The third question asked," To what extent are regions impacting the attitudes of Saudi Arabian RTs in understanding ECMO?". In general, the data received a stronger agreement in the question #17 statement, "implementing evidence-based guidelines for ECMO would be beneficial to improve therapist practices." with an n=27 (56.3%) (see table 4).

Table 4: Finding Related to Question #17 in the Survey.

Survey Statement	n (%)
17. Do You believe that implementing evidence-based guidelines for ECMO would be beneficial to improve therapist practices?	
• Completely agree.	27 (56.3%)
• Agree.	21 (43.8%)
• Disagree.	0 (0%)
• Completely disagree.	0 (0%)

Also, the Chi-square test was used to compare RTs attitudes between those who are working in urban and suburban or rural areas with understanding ECMO were tabulated and presented in table 5.

Table 5: Finding Related Research Question 3, comparisons of ECMO attitudes between Saudi Arabian RTs working in urban vs. suburban or rural hospitals (n= 49).

Survey Statement	Urban (n=)	suburban or Rural (n=)	Chi-Square, df, p-value
18. The reason of why ECMO is not utilized more often to patients because of:			
A. ECMO is not utilized because of lack of institutional commitment to ECMO.			
• Strongly Disagree	5	1	χ^2= 7.74, df =5, p= 0.17
• Disagree	4	0	
• Somewhat disagree	6	0	
• Somewhat agree	7	2	
• Agree	11	4	
• Strongly Agree	3	4	
Total (n=)	36	11	
B. ECMO is not utilized because of inadequate personnel bedside care of the ECMO patient in the ICU.			
• Strongly Disagree	7	1	χ^2= 11.05, df =5, p= 0.05
• Disagree	0	3	
• Somewhat disagree	3	1	
• Somewhat agree	5	1	
• Agree	14	4	
• Strongly Agree	7	1	
Total (n=)	36	11	
C. ECMO is not utilized because of initiating and maintaining ECMO support is too costly.			
• Strongly Disagree	6	1	χ^2= 10.2, df =5, p= 0.07
• Disagree	8	0	
• Somewhat disagree	0	2	
• Somewhat agree	9	2	
• Agree	9	4	
• Strongly Agree	4	2	
Total (n=)	36	11	
D. ECMO is not utilized because of lack of surgeon interest/expertise in ECMO.			
• Strongly Disagree	9	0	χ^2= 18.92, df =5, p= 0.002
• Disagree	4	1	
• Somewhat disagree	4	0	
• Somewhat agree	9	1	
• Agree	10	5	

• Strongly Agree	0	4	
Total (n=)	36	11	
19. To what extent do each of the following factors below be included in decisions about starting ECMO in your unit? A. ECMO would be started depending on the probability of survival. • Always • Often • Sometimes • Never • Has not arisen but would consider it	 19 10 7 0 0	 4 2 0 2 2	χ^2= 16.78, df = 4, p= 0.002
Total (n=)	36	10	
B. ECMO would be started depending on expected duration on ECMO. • Always • Often • Sometimes • Never • Has not arisen but would consider it	 8 10 13 4 1	 2 5 0 0 4	χ^2= 15.01, df =4, p= 0.005
Total(n=)	36	11	
C. ECMO would be started depending on predicted length of survival post ECMO. • Always • Often • Sometimes • Never • Has not arisen but would consider it	 12 13 9 2 0	 3 4 0 0 4	χ^2=16.54, df =4, p= 0.002
Total(n=)	36	11	
D. ECMO would be started depending on predicted quality of survival post ECMO. • Always • Often • Sometimes • Never • Has not arisen but would consider it	 12 9 12 3 0	 3 4 0 0 4	χ^2= 18.16, df =4, p= 0.001
Total(n=)	36	11	
E. ECMO would be started depending on pre-existing disability. • Always • Often	 11 7	 3 4	χ^2= 12.21, df =4, p= 0.016

• Sometimes • Never • Has not arisen but would consider it	14 2 2	0 0 4	
Total(n=)	36	11	
F. ECMO would be started depending on functional status. • Always • Often • Sometimes • Never • Has not arisen but would consider it	12 11 11 0 2	3 4 0 2 1	χ^2= 10.73, df =4, p= 0.03
Total(n=)	36	10	
G. ECMO would be started depending on age. • Always • Often • Sometimes • Never • Has not arisen but would consider it	13 12 9 0 2	5 2 0 1 1	χ^2= 7.55, df =4, p= 0.11
Total(n=)	36	9	
H. ECMO would be started depending on the patient is a Health Care Worker or no. • Always • Often • Sometimes • Never • Has not arisen but would consider it	9 0 8 14 5	0 8 1 1 0	χ^2= 35.28, df =4, p= < 0.001
Total(n=)	36	10	
I. ECMO would be started depending on the patient has dependents or not. • Always • Often • Sometimes • Never • Has not arisen but would consider it	7 6 9 12 2	1 5 1 1 0	χ^2= 7.53, df =4, p= 0.11
Total(n=)	36	8	
J. ECMO would be started depending on the positive social value (e.g. scientist, police) • Always • Often • Sometimes • Never • Has not arisen but would consider it	5 7 8 16 0	1 3 2 0 4	χ^2= 19.35, df =4 , p= < 0.001

Total(n=)	36	10	
K. ECMO would be started depending on negative social value (e.g., violent criminal). • Always • Often • Sometimes • Never • Has not arisen but would consider it	 8 2 9 12 5	 2 4 2 1 0	χ^2= 10.67, df =4, p= 0.06
Total (n=)	36	9	
L. ECMO would be started depending on the number of ECMO beds already occupied. • Always • Often • Sometimes • Never • Has not arisen but would consider it	 8 8 12 5 3	 0 5 1 0 2	χ^2= 9.04, df =4, p= 0.05
Total (n=)	36	8	
20. In thinking about the probability of survival at what point you would not start ECMO? Probability of survival (%): 0% 1% 2% 3% 4% 5% 6% 7% 8% 9% 10%	 4 4 3 1 4 7 4 3 3 1 2	 0 1 0 0 1 3 2 2 1 1 0	χ^2= 25.03, df =5, p= < 0.001
Total (n=)	36	11	
21. The reason of why age is included in decisions about ECMO because of: A. Age is relevant because older patients would not survive even if they were treated with ECMO. • Strongly Disagree • Disagree	 5 7	 0 0	

• Somewhat disagree • Somewhat agree • Agree • Strongly Agree	7 7 10 0	0 9 0 2	χ^2= 30.63, df =5, p= < 0.001
Total(n=)	36	11	
B. I would be better to treat a younger patient rather than older patient with ECMO even if they had identical chance of survival. • Strongly Disagree • Disagree • Somewhat disagree • Somewhat agree • Agree • Strongly Agree	 4 5 5 14 4 4	 0 0 0 0 11 0	χ^2= 17.45, df =5, p= 0.004
Total(n=)	36	11	
C. Age is relevant because younger patients will potentially survive for longer (e.g., more years) after ECMO. • Strongly Disagree • Disagree • Somewhat disagree • Somewhat agree • Agree • Strongly Agree	 10 7 6 8 3 2	 3 0 0 1 7 0	χ^2= 24.84, df =5, p= < 0.001
Total (n=)	36	11	
D. Age is relevant because older patients are less likely to have dependents. • Strongly Disagree • Disagree • Somewhat disagree • Somewhat agree • Agree • Strongly Agree	 6 8 6 6 10 0	 0 0 0 9 0 1	χ^2= 47, df =5, p= < 0.001
Total (n=)	36	10	
E. Age is relevant because older patients have already lived longer. • Strongly Disagree • Disagree • Somewhat disagree • Somewhat agree	 11 8 8 9	 0 0 0 0	χ^2= 37.43, df =5, p= < 0.001

• Agree • Strongly Agree	0 0	8 3	
Total (n=)	36	11	
22. What is the time point where ECMO would be considered for a patient? A. ECMO would be considered if patient was not intubated but has escalating O2 requirements (>80% by face mask or high flow) with limited mobility. • Strongly Disagree • Disagree • Somewhat disagree • Somewhat agree • Agree • Strongly Agree	 15 8 10 3 0 0	 0 0 0 4 5 2	χ^2= 23.95, df =5, p= < 0.001
Total (n=)	36	11	
B. ECMO would be considered if patient was intubated with stable hemodynamics and adequate oxygenation and ventilation. • Strongly Disagree • Disagree • Somewhat disagree • Somewhat agree • Agree • Strongly Agree	 17 12 0 7 0 0	 0 0 6 0 4 1	χ^2= 47, df =5, p= < 0.001
	36	11	
C. ECMO would be considered if patient was intubated with stable hemodynamics but deteriorating oxygenation and ventilation. • Strongly Disagree • Disagree • Somewhat disagree • Somewhat agree • Agree • Strongly Agree	 0 0 0 13 13 10	 6 2 1 0 0 2	χ^2=37.7 , df =5, p= < 0.001
Total (n=)	36	11	

Significant differences in RTs' attitudes about using ECMO leads to a high perception and understanding of ECMO in urban areas due to the increased utilization of ECMO. Generally, the results showed a significant difference in not utilizing the ECMO because of lack of surgeon interest/expertise in ECMO (p-value = 0.002). In addition, there was a significant difference among decisions about starting ECMO depending on the probability of survival (p-value= 0.002), depending on expected duration on ECMO (p-value= 0.005), depending on predicted length of survival post ECMO (p-value=0.002), depending on predicted quality of survival post ECMO (p-value= 0.001), depending on pre-existing disability (p-value= 0.016), depending on functional status (p-value= 0.03), depending on the patient is a Health Care Worker or no (p-value= <0.001), and depending on the positive social value (p-value= <0.001). Likewise, there was a significant difference in not starting ECMO depending on the probability of survival (p-value= < 0.001) (See table 5).

Significant differences were received in the age is included in decisions about ECMO because older patients would not survive even if they were treated with ECMO (p value= < 0.001), it would be better to treat a younger patient rather than older patient with ECMO even if they had identical chance of survival (*p* value= 0.004), younger patients will potentially survive for longer after ECMO (*p* value= < 0.001), and older patients are less likely to have dependents (*p* value= < 0.001), older patients have already lived longer (*p* value= < 0.001). Significant differences were also found in the time point where ECMO would be considered for a patient if a patient was not intubated but had escalating O2 requirements (>80% by face mask or high flow) with limited mobility, if a patient was intubated with stable hemodynamics and adequate oxygenation and ventilation, and if a patient was intubated with stable hemodynamics but deteriorating oxygenation and ventilation (*p* value= <0.001). However, the results showed no significant difference in the other survey statements regarding the RTs' attitudes toward using ECMO (See table 5).

Summary

A total of 49 RTS were surveyed from different areas in SA. More than half of the respondents were male 29 (60.4%), and 19 (39.6%) were female. Thirty-nine (81.3%) of respondents are working in government hospitals, while 18.8% (n=9) are working in a private hospital, and thirty-six (76.6%) of them in urban areas, 12.8% (n=6) in a suburban area, and only 10.6% (n=5) in a rural area. The findings revealed that RTs reported the strongest agreement on their knowledge to manage mechanical ventilation with ECMO patients, with a total number of 18 (37.5%). Also, the findings showed that most respiratory therapists working in the unit provide ECMO, which makes them familiar with ECMO. Moreover, RTs differed in their attitudes toward understanding ECMO depending on utilizing ECMO in their working area (urban, suburban or rural).

CHAPTER V

INTEREPTATION OF FINDINGS

The purpose of this chapter is to elaborate on the findings presented in the previous chapter. In addition, this chapter includes an overview of the study, a discussion of findings, implications for research, limitations, recommendations, and conclusions.

Overview of the study

This research aimed to evaluate the perception, prevalence, and attitudes of using ECMO among respiratory therapists in SA. The following questions were used to guide the study:

1. To what extent are Saudi Arabian RTs knowledgeable about ECMO?
2. To what extent are Saudi Arabian RTs familiar with managing the patient on mechanical ventilation with ECMO?
3. To what extent are regions impacting the attitudes of Saudi Arabian RTs in understanding ECMO?

Discussion

The first question asked, "To what extent are RTs knowledgeable about ECMO?" The overview findings revealed that most RTs showed comfortability with their knowledge of managing the mechanical ventilation of patients receiving ECMO.

On the other hand, most RTs in SA are uncomfortable with their knowledge when using ECMO, and decisions are made in units relating to starting and stopping ECMO, which may be explained by the shallow educational programs available in SA. This is consistent with other studies on the perception when Gannon et al. (2020) investigated that establishing an ECOM training program is essential for critical care practitioners due to the rapid growth of using ECMO in ICU to optimize clinical outcomes. Moreover, the King Faisal Specialist Hospital and Research Center (KFSH&RC) in Riyadh, Saudi Arabia, illustrated that providing an ECMO program for different specialists improved patient outcomes

and provided safe services. Therefore, the findings from this study emphasize the need to establish an educational program regarding ECMO for RTs in SA to improve the outcomes and increase the survival rates by enhancing the practitioners' academic level.

The second question asked, “To what extent are Saudi Arabian RTs familiar with managing the patient on mechanical ventilation with ECMO??” The Overall findings showed that most respiratory therapists working in the unit provide ECMO. The result goes in the same direction as JAMA (2009) when he explained that the number of using ECMO through the 2009 winter influenza A(H1N1) was significantly increased for ARDS patients, leading to the survival of most patients in this pandemic. This study stresses that ECMO is helpful to enhance health care planning and clinical management for critically ill patients to survive and decrease the mortality rate. Also, Giraud et al. in 2020 investigated that using ECMO can be safe and reduce the mortality rate in early implementation on severe COVID-19 patients with refractory hypoxemia. Moreover, results indicated that RTs in SA learned about ECMO from their college and became more familiar with managing the patient on ECMO with mechanical ventilation depending on their practice in the hospital. Therefore, the demand for using ECMO is significantly increased due to the progress of ECMO.

The third question asked," To what extent are regions impacting the attitudes of Saudi Arabian RTs in understanding ECMO?". The data revealed a stronger agreement for the statement "implementing evidence-based guidelines for ECMO would be beneficial to improve therapist practices," which emphasized the need to establish a guideline with a protocol for ECMO in ICU will be helpful when using ECMO to follow the criteria. Furthermore, there were significant differences in utilizing ECMO, including age, probability of survival, and time point in urban and suburban or rural regions. However, there was no significant difference in other statements related to attitudes of using ECMO in SA between an urban area and suburban or rural area. Therefore, the attitudes toward using ECMO differ in some aspects between studies in different countries, which means understanding these practices may vary from one region to another based on their received education and experiences. Also,

practices may vary from one hospital to another based on the area, which means that the insignificance can be attributed to ECMO being a relatively new technology in progress. This is related to Lepper et al. study when they evaluated using ECMO in 94 European centers to manage prolonged extracorporeal life support by using a survey to investigate significant differences among European ECMO centers concerning local perception and patient management in prolonged extracorporeal membrane oxygenation.

Implications for practice

The findings of this study provide an in-depth insight into educational programs and guidelines in hospitals for managing patient on ECMO. Having policies is crucial in managing ECMO patient to enhance the outcomes and reduce the probability of mortality. Also, this study adds to the extant literature by assessing the relationship between experience in ECMO and levels of knowledge to increase the survival rate addresses the need to enhance the clinical experience in managing ECMO patient through simulation sessions in the hospital to improve ECMO understanding and clinical outcome. The information of this study may be used to design an educational program to enhance understanding of the evidence-based guideline practices regarding ECMO patient in hospitals settings. Additionally, these findings address the need to improve clinical experience among critical care professionals, especially for respiratory therapy departments, by establishing a protocol for managing the patient on mechanical ventilation with ECMO to enhance the staff's quality and performance.

Limitations

Several limitations were experienced in this study. First, this study consisted of a small sample size of RTs in SA working in suburban and rural areas, which led to difficulties in comparing the data with each region. Second, there were difficulties in comparing this study to other studies correlated with using ECMO among respiratory therapists; there is a need for more evidence due to insufficient research conducted on using ECMO among RTs. Fourth, social media may limit the generalized results because people who are recruited on social media may be younger and more affluent than the general population

(Levine et al., 2011). Despite the limitation, this is the first study exploring the perception, prevalence, and attitudes of using ECMO among respiratory therapies. Therefore, more extensive samples must be conducted to reach more conclusive results.

Recommendations

Due to the limited literature, future research studies are recommended on perceptions, prevalence, and attitudes of using ECMO among RTs. Replication of the study to seek a larger sample size and compare using ECMO among respiratory therapists in SA to other RTs in other countries is recommended. It is also recommended to compare the using ECMO among RTs with other ICU professionals like nurses and physicians.

Conclusion

This study investigated the perception, prevalence, and attitudes of using ECMO among respiratory therapies in SA. Overall, RTs showed a limited perception of understanding ECMO. Also, the study findings revealed that experience positively impacts the perception of using ECMO. Lastly, this study found that country regions affect the practicing and understanding the using ECMO.

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APPENDIX A: IRB APPROVAL

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February 02, 2022

Principal Investigator: Lynda T Goodfellow

INSTITUTIONAL REVIEW BOARD

Mail: P.O. Box 3999 In Person: 3rd Floor Atlanta, Georgia 30302-3999 58 EdgewoodPhone: 404/413-3500 FWA: 00000129

Key Personnel: Alkhamis, Fatimah S; Goodfellow, Lynda TStudy

Department: Respiratory Therapy

Study Title: The extent of perception, and prevalence of using Extracorporeal membrane oxygenation (ECMO) among respiratory therapists in Saudi Arabia

Submission Type: Exempt Protocol Category 2IRB

Number: H22304

Reference Number: 368105

Determination Date: 02/01/2022

Status Check Due By: 01/31/2025

The above-referenced study has been determined by the Institutional Review Board (IRB) to be exempt from federal regulations as defined in 45 CFR 46 and has evaluated for the following:

1. Determination that it falls within one or more of the eight exempt categories allowed bythe institution; and
2. Determination that the research meets the organization's ethical standards

If there is a change to your study, you should notify the IRB through an Amendment Applicationbefore the change is implemented. The IRB will determine whether your research continues to qualify for exemption or if a new submission of an expedited or full board application is required.

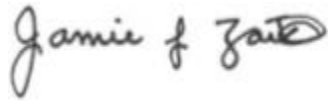
A Status Check must be submitted three years from the determination date indicated above.When the study is complete, a Study Closure Form must be submitted to the IRB.

This determination applies only to research activities engaged in by the personnel listed on this document.

It is the Principal Investigator's responsibility to ensure that the IRB's requirements as detailed in the Institutional Review Board Policies and Procedures for Faculty, Staff, and Student Researchers (available at gsu.edu/irb) are observed, and to ensure that relevant laws and regulations of any jurisdiction where the research takes place are observed in its conduct.

Any unanticipated problems resulting from this study must be reported immediately to the University Institutional Review Board. For more information, please visit our website at www.gsu.edu/irb.

Sincerely,



Jamie Zaikov, IRB Member

APPENDIX B: INFORMED CONSENT

APPENDIX B: INFORMED CONSENT

Georgia State University

Informed Consent

Title: AN ASSESSMENT OF PERCEPTION, AND PREVALENCE OF USING ECMO AMONG RESPIRATORY THERAPISTS IN SAUDI ARABIA.

Principal Investigator: Goodfellow, Lynda T.

Student Principal Investigator: Alkhamis, Fatimah S.

Procedures

You are being asked to take part in a research study. If you are qualified as an accredited Respiratory Therapist who has a respiratory care certificate including diploma, bachelor's, master's, or Ph.D. degree, and work in any hospital or university in Saudi Arabia, please continue reading. As a user of social media educational accounts, such as Twitter, Telegram, and WhatsApp, you are invited to participate in an online study. In this invitation is a link to introduce you to the content of the survey. If you are willing, you can consent to begin the survey. After you provide your consent, a survey will appear, and it will not take more than 10 minutes of your time to complete. Please note that Respiratory Therapy students, interns, and non-respiratory therapists are excluded from participation.

Voluntary Participation and Withdrawal

You do not have to be in this study. You may skip questions or stop participating at any time.

Contact Information

If you have any questions, please contact Fatimah Alkhamis, at 470-424-0903 or falkhamis2@student.gsu.edu or Dr. Lynda T Goodfellow at LTGoodfellow@gsu.edu who is supervising Ms. Alkhamis during this study.

Consent

Participation and completing the survey has no known risks and will serve no personal benefit. The survey has no direct or personal information that will be used to identify you in order to protect your confidentiality. In addition, all information collected through this survey will remain confidential and will be considered as results that will be used for the current research study. Should you thankfully agree to participate in the study and complete the survey, you will be asked to check the agree button. Should you opt out of the survey, check the do not agree button and thank you for your time.

- I agree to participate in the study.
- I do not agree to participate in the study.

APPENDIX C: SURVEY QUESTIONNIRE

APPENDIX C: SURVEY QUESTIONNIRE

Part1: General questions about using Extracorporealmembrane oxygenation (ECMO):

1. Do you work in a unit that provides ECMO?

   ◯ Yes
   ◯ No

2. How did you learn about the ECMO?

   ◯ At college.
   ◯ At ECMO conference.
   ◯ Course from Extracorporeal Life Support Organization
   ◯ (ELSO).Other: _____

3. What type of ECMO training does your hospital provide for Respiratorytherapists?

   Check all that apply.

   ☐ External.
   ☐ internal.
   ☐ simulator.
   ☐ bedside.
   ☐ accreditation.
   ☐ credentialing.
   ☐ none.

4. For what reasons is ECMO support provided? (choose all that apply):

   Check all that apply.

   ☐ Cardiac.
   ☐ Respiratory.
   ☐ Cardiopulmonary resuscitation (CPR).
   ☐ Not applicable.

5. Based on your practice, what is your favored strategy for observing anticoagulation amid ECMO support?

- ◯ Activated clotting time (ACT).
- ◯ Partial thromboplastin time (PTT).
- ◯ Thromboelastogram (TEG).
- ◯ Other: _____.

6. Based on your practice, what is your favored insertion and exertion cannulationplots for Venovenous (VV) ECMO?

- ◯ Femoral vein->ECMO->return to IJ or subclavian vein
- ◯ Femoral vein->ECMO->return to femoral vein
- ◯ Dual-lumen Avalon cannula in upper body vein
- ◯ Other: _____

7. Based on your practice, what are your favored insertion and exertion cannulationplots for Venoarterial (VA) ECMO?

- ◯ femoral vein->ECMO->femoral artery.
- ◯ femoral vein->ECMO->axillary artery.
- ◯ IJ or subclavian vein->ECMO->axillary artery.
- ◯ Central cannulation.
- ◯ Other: _____

8. Based on your practice, which choice underneath most precisely reflects theutilize of VV vs. VA ECMO in your center?

- ◯ Our program does not utilize VV or VA ECMO.
- ◯ VV ECMO is the preferred initial mode of ECMO therapy. VA ECMO is reserved for cases where VV ECMO is unsuccessful.
- ◯ VA ECMO is used as the initial mode ECMO therapy in selected cases (e.g. severe Right ventricular (RV) with pulmonary hypertension).
- ◯ VA ECMO is the preferred initial mode of ECMO
- ◯ therapy.Other: _____

9. In your center, which staffs apply in ICU to care ECMO patient bedside?

- ◯ ECMO-trained clinicians [registered nurse (RN) or respiratory therapist] and perfusionist at patient bedside 24/7.
- ◯ ECMO-trained clinicians [RN or respiratory therapist] at patient bedside 24/7, with perfusionist backup support in hospital.
- ◯ ECMO-trained clinicians [RN or respiratory therapist] at patient bedside 24/7, with perfusionist backup support out of hospital.
- ◯ ICU RN and respiratory therapist at patient bedside 24/7, with perfusionist backup support.
- ◯ Other: _____

10. Does your ICU have a written clinical practice for ECMO clinical managementat your hospital?

- ◯ Yes
- ◯ No

11. Does your ICU have documented criteria on the timing of ECMO initiation in adeteriorating patient?

- ◯ Yes
- ◯ No

12. Does your ICU have a written clinical practice guideline that outlines the training requirements needed by staff involved with ECMO at your hospital?

- ◯ Yes
- ◯ No

13. Does your ICU have documented criteria for ECMO patient selection?

- ◯ Yes
- ◯ No

Part 2: General questions about knowledge of ECMO:

14. I am comfortable with my knowledge when using ECMO.

- ◯ Completely agree.
- ◯ Agree.
- ◯ Disagree.
- ◯ Completely disagree

15. I am comfortable of my knowledge with decisions are made in my unit relatingto starting and stopping ECMO.

- ◯ Completely agrees.
- ◯ Agree.
- ◯ Disagree.
- ◯ Completely disagree.

16. I am comfortable with my knowledge in management the mechanicalventilation of patients receiving ECMO.

- ◯ Completely
- ◯ agree.
- ◯ Disagree
- ◯ Completely disagree.

Part 3: General question about attitudes of using ECMO:

17. Do You believe that implementing evidence-based guidelines for ECMO wouldbe beneficial to improve therapist practices?

- ◯ Completely agree.
- ◯ Agree.
- ◯ Disagree.
- ◯ Completely disagree.

18. The reason of why ECMO is not utilized more often to patients because of:

	Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree
ECMO is not utilized because of lack of institutional commitment to ECMO.						
ECMO is not utilized because of inadequate personnel bedside care of						

the ECMO patient in the ICU.						
ECMO is not utilized because of initiating and maintaining ECMO support is too costly.						
ECMO is not utilized because of lack of surgeon interest/expertise in ECMO.						

19. To what extent do each of the following factors below be included in decisionsabout starting ECMO in your unit?

	Always	Often	Sometimes	Never	Has not arisen but would consider it
ECMO would be started depending on the probability of survival.					
ECMO would be started depending on expected duration on ECMO					
ECMO would be started depending on predicted length of survival post ECMO					
ECMO would be started depending on predicted quality of survival post ECMO					
ECMO would be started depending on pre-existing disability					
ECMO would be started depending on functional status					
ECMO would be started depending on age					
ECMO would be started depending on the patient is a Health Care Worker or no					
ECMO would be started depending on the patient has dependents or not					
ECMO would be started depending on the positive social value (e.g. scientist, police)					
ECMO would be started depending on negative social value (e.g., violent criminal)					
ECMO would be started depending on the number of ECMO beds already occupied					

20. In thinking about the probability of survival at what point you would not startECMO? *

	0	1	2	3	4	5	6	7	8	9	10
Probability of survival (%)	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

21. The reason of why age is included in decisions about ECMO because of:

	Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree
Age is relevant because older patients would not survive even if they were treated with ECMO.						
Age is relevant because age predicts the chance of the patient surviving.						
It would be better to treat a younger patient rather than older patient with ECMO even if they had identical chance of Survival.						
Age is relevant because younger patients will potentially survive for longer (e.g., more years) after ECMO.						
Age is relevant because older patients are less likely to have dependents.						
Age is relevant because older patients have already lived longer.						

22. What is the time point where ECMO would be considered for a patient?

	Strongly disagree	Disagree	Somewhat disagree	Somewhat agree	Agree	Strongly agree
ECMO would be considered if patient was not intubated but has escalating O2 requirements (>80% by face mask or high flow) with limited mobility						
ECMO would be considered if patient was intubated with stable hemodynamics and adequate oxygenation and ventilation						
ECMO would be considered if patient was intubated with stable hemodynamics but deteriorating oxygenation and ventilation						

Part 4: Demographics:

23. Age:

- ◯ 20 – 30 years.
- ◯ 31-35 years.
- ◯ 36- 40 years.
- ◯ 41+ years.

24. Gender:

- Male.
- Female.

25. Type of institution

- Governmental Hospital.
- Private hospital.

26. Location of institution:

- Urban.
- Suburban.
- Rural.

27. Indicate your role in the respiratory therapy department:

- Director/manager.
- Education.
- Coordinator.Staff.
- Other: _____

28. Does your unit support adult or pediatric/neonatal patients, or both?

- Adult.
- Pediatric/Neonatal.
- Both.