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An Assessment of the Knowledge, Perception, and Prevalence of Using APRV on ARDS Patients among Respiratory Therapists in the Eastern Province, Saudi Arabia

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AN ASSESSMENT OF THE KNOWLEDGE, PERCEPTION, AND PREVALENCE OF USING APRV ON ARDS PATIENTS AMONG RESPIRATORY THERAPISTS IN THE EASTERN PROVINCE, SAUDI ARABIA.

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ACCEPTANCE

This thesis, AN ASSESSMENT OF THE KNOWLEDGE, PERCEPTION, AND PREVALENCE OF USING APRV ON ARDS PATIENTS AMONG RESPIRATORY THERAPISTS IN THE EASTERN PROVINCE, SAUDI ARABIA, by Mohammad Al Obead 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. Lewis College 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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AUTHOR'S STATEMENT

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ABSTRACT

Background: Acute respiratory distress syndrome (ARDS) is one of the most serious and fatal diseases in intensive care units throughout the world with high mortality rates. The mode airway pressure release ventilation (APRV) showed significant outcomes when used with ARDS patients mainly resulting in mortality reduction. There are no studies have tested the knowledge and perception regarding APRV and ARDS besides the APRV prevalence in Saudi Arabia (SA).

Purpose: This study was aimed to survey respiratory therapists (RTs) as they are the most involved practitioners for this type of disease and assess their knowledge and perception of using APRV on patients with ARDS and explore the prevalence of using APRV mode in the Eastern Province (EP) of SA.

Methods: A cross sectional study was designed as self-administered survey based on current literature and research. The survey was examined for face validity by five respiratory therapy educators from Georgia State University. The survey instrument includes three sections to collect data from participants. The population of this study was a non- probability convenience sample. Participants were limited to RTs only and all other healthcare providers were excluded. An online link was sent to 116 RTs from six hospitals, divided equally to three government and three private hospitals.

Results: A total of 52 returned surveys were received with a response rate of 44.8%. The majority of participants were bachelor's degree holders (90.2%). Also, majority of them had less than eight years of experience (78.4%). Our results revealed that the RTs had a moderate amount of knowledge about ARDS and APRV mode (63.2%). The vast majority of hospitals in the EP were provided with APRV mode (96.1%). Significantly, results showed that APRV was used by more than 80% of the respondents, half of whom had positive outcomes when using APRV. Patients with ARDS were the most common disease when APRV was applied (98%). There were few significant differences found between the two types of hospital therapists in terms of APRV usage (p=0.0002 and p= 0.006). However, other aspects like APRV-ARDS knowledge, perception, and ARDS protocol and practices showed no significant differences between participants in the two groups.

Conclusion: This study showed that the vast majority of hospitals were fully supplied with the mode and most of the EP RTs have used the mode APRV. This study identified a gap in literature which revealed limited data involving RTs knowledge and perceptions with APRV used as treatment for ARDS. This study opens the window for further studies on RTs, involving APRV and ARDS in Saudi Arabia. Future research is highly recommended to be with the use of larger sample number and to include multiple regions of the country.

Dedication

First of all, to God be the glory. Thank you God for every day for everything that happens to me. You have blessed me more than I deserve. It always seems impossible, until it’s done.

This study is wholeheartedly dedicated to my parents, who were and remain my guides and teachers throughout my life. My father, I admire you for all the things you have taught me since the first day of my life, you are to me what to earth is the sun. My mother, thankful for carrying me for nine months and delivering me to the world, cannot express my gratitude to you. I am beyond thankful for your endless efforts, supports, and love. I know you suffered a lot in raising me. I wish I could reward you with as much as you did for me. God, “ Lower unto them the wing of humility out of mercy and say, “My Lord! Have mercy upon them as they raised me when I was small”. My brothers Majed and Ali, my sister Zainab, I know that I have been away from you, but believe me, my soul was and is still with you the whole time. Thank you so much for your unconditional love. I wish you all the best in your life's journey and hope you reach the highest levels of education and happiness.

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Chapter I

INTRODUCTION

Background

What is ARDS?

Acute Respiratory Disease Syndrome (ARDS) is one of the most serious and fatal diseases in intensive care units (ICUs) throughout the world (Bellani et al., 2016). This disease is characterized mainly by poor oxygenation, bilateral lung infiltration, and acute onset. In 1994, ARDS was defined by the American-European Consensus Conference (AECC) as"…the acute onset of hypoxemia, defined as arterial partial pressure of oxygen to fraction of inspired oxygen ([PaO_2/FIO_2]≤200 mm Hg), with bilateral infiltrates on frontal chest radiograph with no evidence of left atrial hypertension"(AECC,1994). One requirement for the definition of ARDS is that patients must show no cardiogenic edema. Acute Lung Injury (ALI) is similar to ARDS, and shares a similar definition and criteria, but ALI can be considered a less severe form of ARDS with a hypoxemia criterion [PaO2/FIO2] of ≤300 mm Hg (Bernard et al., 1994). Thus, all patients with ARDS are suffering acute lung injury, but not all patients with acute lung injury will progress into ARDS (Ranieri, et al., 2012). The AECC definition has provided a significant impact on clinicians and clinical researchers through addressing treatment and prevention of ARDS. Although AECC definition has advanced ARDS knowledge and practice, it has many limitations which explored by the Berlin definition (Ranieri, et al., 2012).

The European Society of Intensive Care Medicine endorsed by the American Thoracic Society (ATS) and the Society of Critical Care Medicine (SCCM) developed what is known as the Berlin definition in 2011. The Berlin definition identified and introduced the AECC defintion'

limitations by providing new data, which included epidemiological, physiological, and clinical trials to address the limitations. The Berlin study defined ARDS as "a type of acute diffuse, inflammatory lung injury, leading to increased pulmonary vascular permeability, increased lung weight, and loss of aerated lung tissue, with hypoxemia and bilateral radiographic opacities, associated with increased venous admixture, increased physiological dead space and decreased lung compliance"(Ranieri, et al., 2012). ARDS patients must be identified within 7 days of recognition of the underlying risk factor to be regarded as an acute process. Most patients with ARDS were diagnosed within 72 hours, by a chest x-ray (CXR) with bilateral opacities associated with pulmonary edema. Also, a PaO_2/FiO_2 (P/F) ratio <300 with a minimum of 5 cmH_2O of positive end-expiratory pressure (PEEP) or continuous positive airway pressure (CPAP) was identified. Lastly, respiratory failure should not be explained by cardiac failure or fluid overload. The classification of ARDS in the Berlin definition was also based on oxygenation severity. It was categorized based on the degree of hypoxemia by three stages: mild ($PaO_2/ FIO_2 \leq$ 300 mm Hg), moderate ($PaO_2/ FIO_2 \leq$ 200 mm Hg), and severe ($PaO_2/ FIO_2 \leq$ 100 mm Hg) (Ranieri, et al., 2012).

Etiology

ARDS has many risk factors affiliated with the disease. Shaver and Bastarache classified the causes of ARDS into two causes: direct and indirect lung injury. Direct injury, estimated to cause approximately 55% of ARDS cases, was local damage to the lung tissue caused by direct pulmonary injury. It included but was not limited to pneumonia, aspiration, lung contusion, and drowning. Indirect injury, estimated by 45% of ARDS cases, was a systemic disorder that diffusely damaged the lung. This included sepsis, cardiopulmonary bypass, pancreatitis, drug overdose, and burns. Pneumonia, a lung infection caused by bacteria, viruses, and fungi, was the most common

cause of direct injury. On the other hand, sepsis, which was a serious and widespread infection of the bloodstream, was the most common cause of indirect injury (Shaver and Bastarache, 2014). Greater understanding of the causes of ARDS among health care practitioners (HCPs), as defined in the United States of America (USA) as individuals who are licensed or authorized by a state to provide health care services, could aid in the recognition and identification of patients before they progress into ARDS from ALI, which could prevent further complications and improve patient outcomes (The NPDB Guidebook, n.d.).

ARDS Mortality

Since the disease was identified as ARDS, many studies have focused on its mortality. The mortality rates of ARDS ranged between 30% to 60% globally (Roy et al., 2013). In 2004, Brun-Buisson et al reported that 216 (57.9%) of 401 ARDS patients studied in their trial, died. This was considered to be the highest mortality rate among all studies which involved ARDS over the last two decades. Another study conducted by Howard and colleagues between 2005-2013, collected data from 621 intubated patients and classified them into three groups: non-hypoxemic, hypoxemic, and ARDS. Of 621 patients, 183 patients developed ARDS (29.4%). In terms of mortality rates, ARDS group reported the highest mortality (35%), compared to (27% and 14%) in hypoxemic and non-hypoxemic group, respectively. Moreover, ARDS patients had the longest hospital and ICU stays between groups (Howard et al, 2015). The largest study conducted on ARDS patients was an international and multicenter study (LUNG SAFE). This study was conducted in 459 ICUs from 50 different countries across 5 continents. The prevalence of ARDS was counted as 10.4% of ICUs admission. The main outcome of the study was the incidence of ARDS in ICUs which was also significantly associated with high mortality rates (40.4%). Severe

ARDS showed the highest rate of mortality among the grade of severity with a 46.1% mortality rate. Mild and moderate ARDS showed lower percentages (34.9% and 40.3%, respectively) (Bellani et al., 2016). These high mortality rates, as high as 40% to 50%, were resulted from under recognition of ARDS (Sun, Liu, Li, You, & Zhao, 2020). Thus, introducing new strategies to recognize and identify ARDS could improve patients' outcomes.

The variation in mortality percentages from ARDS were ambiguous and has led to the need for investigating the reasons why. The high rates of mortality were likely due to many reasons, one of which was the inconsistency in managing the disease. For example, the practice of using APRV versus using conventional modes of ventilation when treating ARDS patients. Another reason could be the variation in the levels of knowledge among HCPs to recognize and treat the disease. Also, the absence of a treatment plan plays a role. These factors indicate there is a significant variation between ARDS management and the HCPs practices leading to these high death numbers from inappropriate management (especially in terms of mechanical ventilation (MV)).

In Saudi Arabia (SA), there is a lack of information regarding ARDS and its mortality rates. A study in Northern Region recruited 68 patients with ARDS characteristics. ARDS was confirmed by the Berlin definition in 38 of them (55.9%). Out of 38 confirmed ARDS cases, 29 died. The mortality rate was 76.3% (Ahmed et al., 2020).

What is APRV?

APRV was first described by Stock and colleagues in 1987 and defined as continuous positive airway pressure (CPAP) with a brief release to eliminate carbon dioxide (CO_2) while

allowing the patient to spontaneously breathe throughout the respiratory cycle during MV(Stock, Downs, & Frolicher, 1987). The importance of spontaneous breathing was illustrated by facilitating CO_2 removal. The study revealed the augmentation of spontaneous breathing increased the functional residual capacity (FRC) and improved the distribution of ventilation inside the lungs' alveoli. All were visible advantages of spontaneous breathing reflected by the diaphragmatic contraction that opposes alveolar compression. Ventilation with APRV enhanced with spontaneous breathing resulted in less atelectasis formation (Hedenstierna, et al., 1994).

In general, very few studies about ARDS across SA exist. No studies on the use of APRV in SA have been conducted, nor on its use on ARDS patients. It is particularly important to examine the impact of APRV use on ARDS patients. Overall, from previous studies, it is clear that there is a need to improve the management of patients with ARDS.

Treatment

Various treatments and strategies for patients with ARDS are often employed. Unfortunately, no treatment plan has demonstrated clinical efficacy. Most commonly, the clinical practice for ARDS is to treat the underlying cause of the disease. Since the most common cause of ARDS is lung injury, preventing it is vital to preemptively establish its effectiveness. To prevent ARDS, there are many ventilator strategies used, such as low tidal volume lung protective strategy, open lung approaches to ventilation, and Airway Pressure Release Ventilation (APRV). APRV is a new ventilatory strategy that uses an inverse ratio ventilation and has significant positive outcomes when used with ARDS patients mainly resulting in oxygen improvement and less duration on MV (Bellani et al., 2016). However, the best strategy to treat ARDS patients remains uncertain. APRV showed a reduction in incidence of barotrauma, a type of lung injury, when

treating patients with severe hypoxemia, such as patients with ARDS (Lim et al., 2016). This is believed to be the key to avoid ARDS from happening by preventing lung injuries from happening. Some studies demonstrated a correlation between recognizing and preventing ALI to preventing ARDS (Hoegl & Zwissler, 2017).

Statement of problem

Overall, a paucity of research about ARDS in SA was found. As ARDS has high mortality rates, and because little is known about APRV usage on patients with ARDS in SA, studies are needed to fill in this gap. Identifying the level of respiratory therapists' (RTs) knowledge and perception, and the prevalence of using APRV would be helpful in improving RTs attitudes, skills, and practices in the treatment and management of ARDS.

Purpose of the study

Due to the recent demonstrated preliminary efficacy of APRV for ARDS patients in western countries and the lack of information about using this mode in SA, this study is essential to explore, quantify, and identify to what extent of RTs knowledge and how widely the APRV mode is used in SA. The aim of this study is to survey RTs and assess their knowledge and perception of using APRV on patients with ARDS, and to explore the prevalence of using APRV mode in the Eastern Province (EP) of SA. This will allow for a greater understanding of the level of RTs' knowledge pertaining to the APRV mode on patients with ARDS. The extent of using APRV mode among HCPs in the EP will be documented. This is important to determine in order to manage patients with ARDS properly.

Significance of the study

Focusing on HCPs' knowledge about the disease and treatment is crucial and known to be a cornerstone of preventing ARDS mortality rates from increasing (Dushianthan, et al., 2014). Therefore, we conducted a survey designed to explore three fundamentals: the prevalence of using APRV, the perception and knowledge of ARDS and APRV among the RTs, who are the most involved in the disease process and its management.

- Research questions:

1. What do RTs in the EP know about ARDS and APRV mode?
2. What do RTs in the EP perceive the value of the APRV mode?
3. To what extent was the APRV mode applied to ARDS patients in the EP and is there difference between hospitals in terms of ARDS protocol and practices?
4. What is the difference between government and private hospitals in terms of RTs knowledge and perception about ARDS and APRV?

Hypothesis

In this research, we hypothesized that not many RTs in SA have the knowledge to effectively utilize the APRV mode on ARDS patients. APRV is commonly used as a rescue mode in the management of ARDS. RTs knowledge about the disease and APRV management are significantly important. By evaluating this gap in knowledge, education materials can be created and used to facilitate the RTs' understanding of the APRV mode and its efficacy.

Summary

This study will answer the questions pertaining to the RTs knowledge regarding ARDS and APRV usage on patients diagnosed with ARDS. The target population of this study are RTs as they are the most involved practitioners who manage MV for this type of disease. Moreover, no studies have tested the level of knowledge among RTs about ARDS and APRV besides the APRV prevalence in SA. Investigating the level of knowledge is important because a better understanding of the causes behind the high death numbers is needed. Moreover, APRV showed a better survival rate when compared to other modes (Jain et al, 2016).

Chapter II

LITERATURE REVIEW

INSTRUMENTS

The literature review was performed through searching in PUBMED and Google Scholar databases by using the following terms: “knowledge of Respiratory Therapists”, “Respiratory Therapists perception”, “APRV on ARDS patients”, “ APRV use”, “ Respiratory Therapists in Saudi Arabia”, “ ARDS knowledge”, “APRV knowledge”, “APRV in Saudi Arabia”, “ARDS strategies”, and “Prevalence of APRV”. The results showed no publication in both databases in regard to some terms like “Prevalence of APRV” and “APRV knowledge”. However, some studies were found which involved RTs in SA in general, but not many studies about RTs knowledge regarding MV. To the best of our knowledge, this is the first study to explore the use of APRV mode across the SA.

Research Questions

In this chapter, many questions were searched in the literature. The questions were related to the APRV and ARDS knowledge among RTs as following:

1. What do RTs in the EP know about ARDS and APRV mode?
2. What do RTs in the EP perceive the value of the APRV mode?
3. To what extent was the APRV mode applied to ARDS patients in the EP and is there difference between hospitals in terms of ARDS protocol and practices?
4. What is the difference between government and private hospitals in terms of RTs knowledge and perception about ARDS and APRV?

ARDS strategies

In the last two decades, the ARDS mortality rates have not declined and remained approximately 40% (Nieman et al., 2016). Many studies have indicated high mortality rates of ARDS (Brun-Buisson et al., 1994; Howard et al., 2015; Bellani et al., 2016). Mortality reached as high as 57.9% in the Brun-Buisson study. This raises concerns about the high percentages and the high risk of serious adverse events. Uncertain pathogenesis of the disease, treatment, mode of ventilation, and the low perception of ARDS among HCPs are all areas of concern that need further investigation. Yet, the mechanism of developing the disease is not fully understood (Sun, Liu, Li, You, & Zhao, 2020). Some studies suggested that the primary physiologic factor of the disease is alveolar edema (Ranieri, et al, 2012; Diamond, 2020; Sun, Liu, Li, You, & Zhao, 2020). Alveolar edema is a result of increased pulmonary capillary permeability combined with alveolar-capillary membrane damage (Kollisch-Singule et al., 2020). If no preventive interventions are taken, alveolar edema may lead to many complications including gas exchange impairment and surfactant function alteration which both cause the lungs to be stiff and ultimately lead to ARDS. The best treatment is to block the development of alveolar edema therefore lowering ARDS occurrence and minimizing its effects. MV is also used to treat and prevent alveolar edema, which is the main factor of ARDS.

MV is known to be the most effective intervention among all methods of treating ARDS. Also, it is the second most frequent used therapeutic method in ICUs (Sun, Liu, Li, You, & Zhao, 2020; Villar & Slutsky, 2010). Over the years, several ventilator strategies were tried and one of the most effective treatments was lung-protective ventilation strategies (LPVS). Wright mentioned that LPVS have four pillars: lower tidal volume, limit plateau pressure (Pplat) to less than 30 cm H2O, optimize PEEP to adequate levels, and limit the FiO_2 to as low as possible (Wright, 2014).

More recent data support the use of low tidal volume (6-8 mL/kg IBW) compared to high tidal volume (10-12 mL/kg) because of the positive outcomes in shortening ICU stays, less lung injuries, and lower mortality rates (Brower et al., 2000; Neto et al., 2012; Barbas, 2017). ARDS is mostly refractory to treatment, and the optimal mode of ventilation is ambiguous and not yet acknowledged (Lim et al., 2016). However, recent studies tested the use of APRV mode and found that it may prevent alveolar damages. Moreover, *The 30 years of evolution of APRV* study showed that there was no study with a significant negative outcome when using the APRV mode (Jain et al., 2016). Thus, APRV might be introduced as an effective mode of ventilation to treat patients with ARDS as it may reduce mortality rates, and reducing the hospital and ICU stays as shown in previous studies. Significantly, APRV can prevent alveolar edema that caused ventilator-induced lung injury (VILI) (Miller et al., 2016).

APRV on animals

Since the APRV mode was introduced, several studies have tested its efficacy and safety on animals. Studies on pigs, dogs, and rabbits were conducted before conducting a trial on humans. Stock et al (1987), first described the APRV mode, and found that APRV has no negative outcomes on the cardiopulmonary system on dogs. Not only did it improve oxygenation, but it lowered the partial pressure of carbon dioxide (PaCo2) levels and peak inspiratory pressure (PIP) leading to lower incidence of lung injury. In 2014, Carvalho et al used pig models with moderate ARDS and found a similar finding to Stock et al. The conclusion demonstrated APRV lowered lung injury and improved oxygenation when compared to conventional modes of ventilation. Carvalho et al findings incorporated using APRV with the augmentation of spontaneous breathing. Furthermore, the higher the spontaneous breathing levels, the better outcomes in terms of distribution of ventilation, peak and mean airway pressures, and transpulmonary pressure. Recent studies have

tested the efficacy of this application on rats, and showed that preemptive APRV can prevent the factors that induce ARDS. Two groups of rats were placed on volume control mode and the other group on the APRV mode. The APRV group showed a significant improvement in lung function which results in oxygenation improvement. Also, the incidence of pulmonary edema and the pathogenesis of ARDS were decreased in the second group, resulting in preventing the development of ARDS (Roy et al., 2013). These findings highly suggest that an early application of APRV will result in a significant difference.

These animals' studies are very important and could change the trends on treating and preventing ARDS in humans. More research is needed to identify the efficacy of APRV on humans as it on animals and these can lead to improvement in ARDS management practices. Research suggests that the preemptive application of APRV is beneficial and can prevent ARDS from occurring if applied early (Jain et al., 2016).

Systematic review of APRV on humans

In 2016, Jain and colleagues reviewed all the last 30 year APRV studies that had been published in PubMed. The studies were on both human and animals. Jain et al divided human studies into two main categories: first, fixed-setting APRV (F-APRV) in which the release time is fixed and left the same with no change during ventilation period. Second, personalized setting-APRV (P-APRV) in which a HCP manipulates and makes corrections based on changes in lungs mechanics by relying on the expiratory flow curve. Jain and his colleagues separated studies that have been done on animals from human based experiments. From the reviewed papers, it was found that APRV had no significant complications. However, a positive impact on oxygenation was found (Jain et al, 2016).

Characteristics and outcomes of APRV on ARDS patients

According to Jain et al, most published papers from 1980's to the late 1990's were completed on humans using F-APRV. These studies showed no significant improvement in oxygenation when comparing APRV with conventional positive pressure ventilation (CPPV). Oxygenation remained the same with more than 50% reduction in PIP (Jain et al, 2016). In 2001, Kaplan and colleagues did a crossover experiment to compare inverse ratio positive pressure ventilation (IRPPV) with APRV. They concluded that APRV is highly effective in lowering PIP and the demand for sedation and paralytic agents. Another study was done in 2001 by Putensen et al showed that APRV with spontaneous breathing would keep increased oxygenation and minimized ARDS incidence (Jain et al, 2016). Spontaneous breathing along with APRV have positive impacts on blood flow as proven by Hering and researchers in 2002. They found improved renal blood flow and increased glomerular filtration rate when patients are on APRV and are spontaneously breathing (Jain et al, 2016). Other than improved oxygenation, APRV is believed to decrease CO2 and maintains stable hemodynamics as proven in the retrospective study by Maung et al, in 2012. However, another retrospective case series in 2012 by Maung et al on 362 patients and compared CPPV versus APRV, indicated that APRV increased patients' ventilator days (Jain et al, 2016).

On the other hand, studies on P-APRV from 2009 to the present showed better outcomes in most studies when compared to other ventilation modalities. In 2009, Yoshida and his colleagues contrasted APRV with low tidal volume ventilation (LTV). APRV with spontaneous breathing patients increased mean airway pressure (MAP), enhanced oxygenation, and decreased collapsed alveoli (Jain et al, 2016). According to Jain at al., retrospective case studies showed significant outcomes with APRV compared to CPPV. APRV helps to repair cardiopulmonary

shunt and improving blood flow to both lungs. In addition, APRV can be used in pediatric patients safely (Jain et al., 2016). Another study in 2014 by Yehya et al., compared high frequency oscillatory ventilation (HFOV) to APRV and showed no significant effect in reducing mortality rate compared to HFOV in rescue managements.

Recent studies suggest that early application of APRV yields numerous benefits. In 2017, Zhou et al revealed improvement in oxygenation, lung compliance, and decreased MV and ICU stays. The study design was similar to animal experiments that showed that an early application of APRV led to significant enhancements. A total of 138 patients with ARDS were recruited and distributed randomly into two groups: the first group was the APRV group (n=71) and the second group was the LTV (n=67). The researchers calculated days on MV from enrollment to day 28. The APRV group showed a higher number of days without a ventilator (19 days) compared to the LTV group (2 days). The first group also had a lower ICU mortality rate compared to the second group, (19.7%), (34.4%), respectively. Zhou et al. concluded that early application of APRV led to important findings such as better oxygenation, lower Pplat, and shorter ICU stays (Zhou et al., 2017). This study contains many findings that favor the APRV strategy over the LTV strategy.

Considerable controversy exists over the efficacy of using APRV on patients with ARDS. Most recent data showed a noticeable conflict about the outcomes of APRV. Sun et al, in January 2020, published a systematic review and meta-analysis about safety and efficacy of APRV on patients with ARDS. Sun et al, reviewed most of the studies that compared APRV versus LTV and synchronized intermittent mandatory ventilation (SIMV) groups. Throughout analyzing 14 studies with a total of 2096 patients that met the study's inclusion criteria, meta-analysis revealed a significant improvement on oxygenation (particularly P/F ratio) after 3 days in APRV group compared to non-APRV groups, 75%, 44%, respectively. However, differences between APRV

vs. non-APRV groups in terms of mortality and ICU length of stay were not found to be significant (Sun et al., 2020). It has been noticed that of the 14 included studies, 13 were only from six countries (two Asian, two European, one North American, and one Australian countries). However, only one multicenter study that consisted of 23 countries were included in this study.

In the same way, in October 2020, Ismaeil et al published another systematic review and meta-analysis. Ismaeil et al compared APRV to other conventional ventilation (CV) modes when used on ARDS patients. They included only 6 studies with 375 patients in total. In contrast to Sun study, P/F ratio was not found to be significant in both groups, while APRV showed a significant reduction in mortality and even lower when compared to the CV group (Ismaeil, 2020). In this systematic review, only limited data was known about the population of the included studies, which makes it difficult to compare with the previous study by Sun et al.

The two subsequent systematic reviews, published in January and October 2020, respectively. However, disagreement in findings was observed and thus could be due to the diverse population of patients and the limited available data. Therefore, more studies are needed to establish a standardized protocol for APRV and universal settings for this mode.

APRV may be used as an early treatment for both preventing and treating patients with ARDS, RTs are encouraged to take this mode into consideration to provide the most effective care for ARDS patients. This mode improved patients' outcomes, reduced the number of days on mechanical ventilators and overall hospital stays resulting in reduced mortality rates in ICUs (Miller et al., 2016).

Knowledge and prevalence of ARDS and APRV globally

Not only improving patients' care is important, but HCPs' knowledge also plays an important role in improving patients' outcomes. According to Chia and Clay, the variability in

clinical practices contributed to medical errors and thereby costed high usage of resources in ICUs. Implementing evidence-based protocols can reduce errors and improve patients' morbidity and mortality. MV protocols are crucial and have a significant impact in regard to mortality, VILI, and days on ventilator (Chia & Clay, 2008; Banga& Sasidhar, 2013). Along with protocols, knowledge of HCPs is known to be an essential part of a patient treatment.

Few studies have examined the level of knowledge about ARDS among HCPs in general, and no studies of RTs in particular. In 2014, Dushianthan and colleagues investigated the perception of diagnosis and management of ARDS patients among ICU physicians in the United Kingdom (UK) (n=191). In regard to ventilator strategy, most of MDs used ARDS.net protocol in their management (mainly; targeted tidal volume= 6 ml/kg/PBW, increase PEEP with increase Fio2 requirement using scale). However, few ICU physicians (13%) were using HFOV as a primary ventilation strategy. While advanced ventilation techniques like extracorporeal lung support (ECLS) and APRV were used only by 5% of the participants. Thus, the reason behind the high mortality rates. The study concluded that there is a notable variation in the diagnosis practices and management strategies in UK, suggesting that international standards and guidelines are needed to improve the disease' management (Dushianthan, et al., 2014). Overall, international standards can assist in limiting the ARDS progression and enhancing HCPs knowledge. In the ICUs, RTs are the core in treating such respiratory diseases like ARDS. Therefore, more investigations are required to standardize the disease' management.

Knowledge and prevalence of ARDS and APRV in SA

In general, little is known about the knowledge level pertaining to ARDS among HCPs and RTs across SA. Alotaibi studied the current status of the RTs in SA, and reported the need for

knowledgeable therapists as the profession growing in SA. Alotaibi also highlighted the need for RT education to improve medical care (Alotaibi, 2015). However, most of the studies which focus on the knowledge of practitioners in SA were conducted on the Middle East Respiratory Syndrome Corona Virus (MERS-CoV). Khan et al tested health care workers' (HCWs) knowledge and attitude toward MERS-CoV. A survey was distributed among 280 HCWs in Qassim region and found that the majority showed good knowledge levels but lacked education about the disease management (42%) (Khan, Shah, Ahmad, & Fatokun, 2014). In 2016, Alsahafi & Cheng stated that HCWs had poor knowledge levels about emerging infectious diseases. Furthermore, HCWs (n=1216) require more medical education and training programs to fully understand ARDS in SA. Another study on 339 HCWs knowledge levels in the southern region of SA showed a massive lack of knowledge in some aspects like the method of transmission and the confirmatory diagnostic test, 23.6% and 18.3% of participants, respectively (Abbag et al., 2018). The findings represent a substantial variation regarding HCWs' knowledge regarding MERS-CoV. These data gave a general picture of HCWs in SA and indicated that there is a poor knowledge levels.

Yet, prevalence of using specific mode of ventilation in EP of SA has published. Aljuaid et al have studied the current use of advanced modes of ventilation among RTs. The study revealed a significant finding with approximate 20% of RTs were using APRV mode. According to Aljuaid, more than half of the participants lacked knowledge about the new advanced modes of ventilation. Also, about 23% of the participated RTs were having doubts about these modes (Aljuaid et al, 2019). Thus, provide data in that RTs were not having enough knowledge to apply the new modes and strategies of ventilation which may lead to obstruct the advance approaches of treatment.

A recent study among RTs in SA assessed their knowledge regarding ARDS management updates. This study, published in June 2020, claimed that 83.5% of the participants were practicing

the updated management of ARDS. Additionally, only 50% were using the Berlin definition in their practice. The researchers points out a significant variation between RTs practices and ARDS management updates (Hadadi, Alamoudi, Aldaraweish, & Ghazwani, 2020). There are concerns about these findings and the causes of the variations. Many limitations of the study were noticed. For example, questionnaire method and numbers of participants and hospitals all were not mentioned. However, limited data about the RTs' knowledge and practice regarding ARDS and APRV mode were noticed.

Summary

APRV usage has demonstrated significant improvements on animal models and humans. In regard to patients with ARDS, APRV proved to improve oxygenation, reduced ICU and hospital stays, reduced mortality rates, and maintained a stable hemodynamic status. Moreover, an early application of APRV showed a positive impact on patient' outcomes. "*The 30 years of evolution of APRV"* study reviewed studies on APRV and found that most of studies have positive outcomes. The knowledge of HCPs' plays a primary role in treating patients with ARDS. Few studies have examined the HCPs' knowledge and perception regarding such respiratory disease. Most of the studies were about MERS-CoV' knowledge. Little is known about RTs knowledge regarding ARDS in SA, and there is limited data on the use of APRV mode.

Chapter III

METHODS

In this chapter, we will discuss how the designed methods were utilized in answering the following developed questions:

1. What do RTs in the EP know about ARDS and APRV mode?
2. What do RTs in the EP perceive the value of the APRV mode?
3. To what extent was the APRV mode applied to ARDS patients in the EP and is there difference between government and private hospitals' ARDS protocol and practices?
4. What is the difference between government and private hospitals in terms of RTs knowledge and perception about ARDS and APRV?

Instruments

A cross sectional study was designed as self-administered survey based on current literature and research. The survey was examined for face validity by five respiratory therapy educators from Georgia State University (GSU). The survey instrument includes three sections to collect data from participants. These sections were: demographic data, knowledge and perception about APRV and ARDS, and prevalence of using APRV on ARDS patients. A total of 25 validated questions were approved by the experts and distributed. Because of the current global situation of Coronavirus Disease 2019 (COVID-19), the survey was designed to be as an online link sent to the participants through their E-mail addresses to six hospitals in the EP; three government and three private sectors hospitals.

Confidentiality

The study and the survey were approved by the GSU Institutional Review Board (IRB). Another IRB approval was obtained from Almoosa Specialist Hospital (ASH) in Al Ahsa as they required it. All participants' data were secured, protected, and remained anonymous. Ethical considerations and participants' rights were taken and protected to ensure that all data remained confidential. The study guaranteed to the participants that no risks will result from participation in this study.

Informed consent

An agreement to participate in the study was obtained through checking the "agree" button. After informed consent, participant were able to answer the survey questions. However, when participants didn't feel comfortable to participate in the study, they were having the opportunity to withdraw at any time.

Invitation letter

An official E-mail was sent to each director of the RT department inviting him/her to be part of the study by distributing the survey among the RTs staff. Also, a list of the staffs' official E-mails were obtained from the director of department. The survey was emailed to all determined hospitals' RT departments.

Sample design

The population of this study was categorized as a non- probability convenience sample. This study aimed to include RTs, regardless of their positions and qualifications because of their responsibilities for ARDS patients and their use of the APRV mode of ventilation. The inclusion

criteria included all qualified and accredited RTs who hold a diploma, bachelor, masters, or PhD certificates in respiratory therapy. On the other hand, all other HCPs like nurses, doctors, dentists, and other HCPs were excluded. Additionally, RT students and interns were excluded.

The target hospitals were three government hospitals and three private hospitals in the EP of SA. The government hospitals were the following: Qatif Central Hospital (QCH) in Qatif, Dammam Medical Complex (DMC) in Dammam, and King Fahad Military Medical City (KFMMC) in Dhahran. The private included hospitals were: Al Habib medical group Hospital (HMG) in Qatif, Saudi German Hospital (SGH) in Dammam, and Almoosa Specialist Hospital (ASH) in Al Ahsa.

Data Collection and Analysis

The study was an online survey distributed by the Google Forms website. Once the IRB approval was obtained, an online link was sent to each director of the RT departments and staff E-mails. The first page of the survey obtained an agreement from the participants to be part of the study. Also, it was clarified in the E-mail that participation in this study is not mandatory and that the participant have the right to withdraw at any time without giving any reasons. The survey was composed of two forms of questions: multiple-choice questions (MCQs) and Yes or No questions.

After collecting the data, statistical analysis was done through the Statistical Analysis System (SAS) and the latest version of Statistical Package for the Social Sciences (SPSS v.26.0). The standard deviation, mean, frequency and the participants number with the response rate were calculated, as well as differences among the respondents and hospitals. Statistical tests, including Chi-Square test and Fisher Exact test were computed to examine differences in APRV knowledge and perceptions between government and non-government hospitals.

Summary

In this chapter, the study methods were discussed in terms of the instrument, sample description, inclusion and exclusion criteria, informed consent, IRB approval, and lastly how data were analyzed. The study ensured to the participants that the study was not harmful and their information would be protected. The principal aim of the study was to investigate the level of RTs knowledge regarding the use of APRV on patients with ARDS in SA. After data collection, a statistical analysis was performed to understand the RTs perception about the APRV mode. Also, the researcher was able to identify and compare the difference between the two types of hospitals and have information about the RT departments that used APRV.

Chapter IV
RESULTS

This chapter will discuss the data analysis of the study. The results explained the demographics. Moreover, the results intend to explore the level of RTs knowledge and how they perceive the APRV mode and ARDS. Also, the existence and extend of using APRV mode in the Eastern Province hospitals were demonstrated.

The study purposed to answer the following questions:

1. What do RTs in the EP know about ARDS and APRV mode?
2. What do RTs in the EP perceive the value of the APRV mode?
3. To what extent was the APRV mode applied to ARDS patients in the EP and is there difference between hospitals in terms of ARDS protocol and practices?
4. What is the difference between government and private hospitals in terms of RTs knowledge and perception about ARDS and APRV?

Characteristics of the sample:

The study targeted RTs who worked at hospitals in the Eastern Province of Saudi Arabia. In this study, six hospitals were chosen to represent the region, divided equally into three government and three private hospitals. An online link was sent to 116 RTs, and a total of 52 returned surveys were received with a response rate of 44.8%. Only one RT refused to participate, so a total of 51 usable responses were used in the data analysis. More than half of the participants were male (n=27, 52.9%), whereas females represent 47% of participants (n=24). The respondent's

educational level was mostly from bachelor's degree holders (n=46, 90.2%). The remaining respondents were master's degree holders (n=5, 9.8%). None of the respondents held a diploma or PhD degrees (Figure.1). The vast majority of these RTs graduated from SA (86.3%). Others graduated from the United States and the Philippines, (n=5, 9.8%), and (n=2, 3.9%), respectively. All five participants with master's degrees were graduates of the US. The mean experience years of the participants was calculated and the results showed that the respondents had a mean of 6.2 ± 4.82 SD years. Furthermore, most RTs had eight or fewer years of experience (78.4%). In terms of hospital types, the majority of respondents were from governmental hospitals (n=40, 78.4%), with only 11 participants from the private sector (21.6%). More demographics are demonstrated in detail in the table below (Table.1).

Figure. 1 Qualification

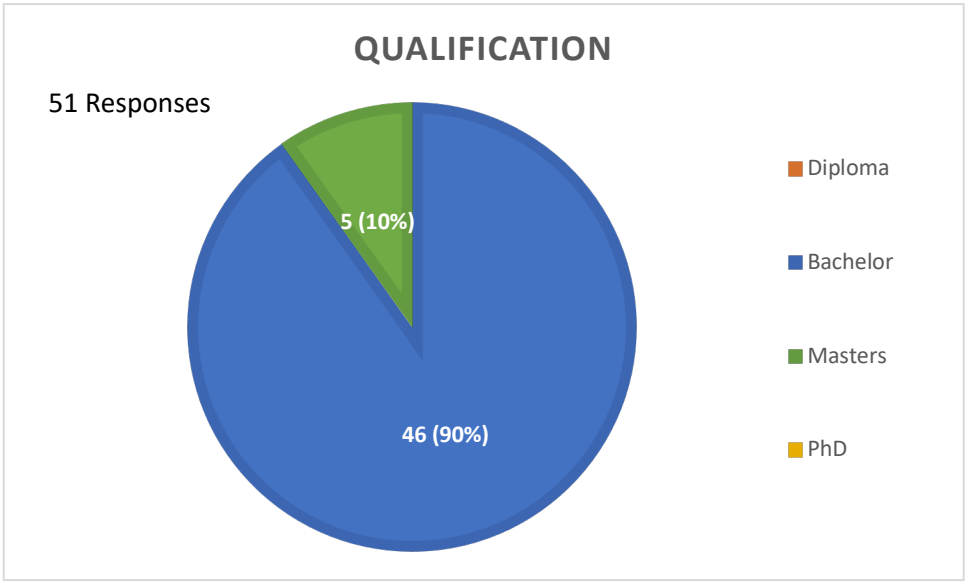


Table. 1 Demographic Data

Characteristics	n, (%)
• **Gender**	
- Male	27 (52.9%)
- Female	24 (47.1%)
• **Qualification**	
- Diploma	0 (0.0%)
- Bachelor	46 (90.2%)
- Masters	5 (9.8%)
- PhD	0 (0.0%)
• **Graduation country**	
- Saudi Arabia	44 (86.3%)
- The United States	5 (9.8%)
- Philippines	2 (3.9%)
• **Hospital type**	
- Government	40 (78.4%)
- Private	11 (21.6%)
• **Hospital Name**	
- Dammam Medical Complex (DMC)	23 (45.1%)
- Qatif Central Hospital (QCH)	14 (27.5%)
- King Fahad Military Medical City (KFMMC)	3 (5.9%)
- AlHabib Medical Group (HMG)	6 (11.8%)
- Almoosa Specialist Hospital (ASH)	3 (5.9%)
- Saudi German Hospital (SGH)	2 (3.9%)
• **Years of experience**	
- 0-3 years	18 (35.3%)
- 4-8 years	22 (43.1%)
- 9-13 years	6 (11.8%)
- 14< years	5 (9.8%)

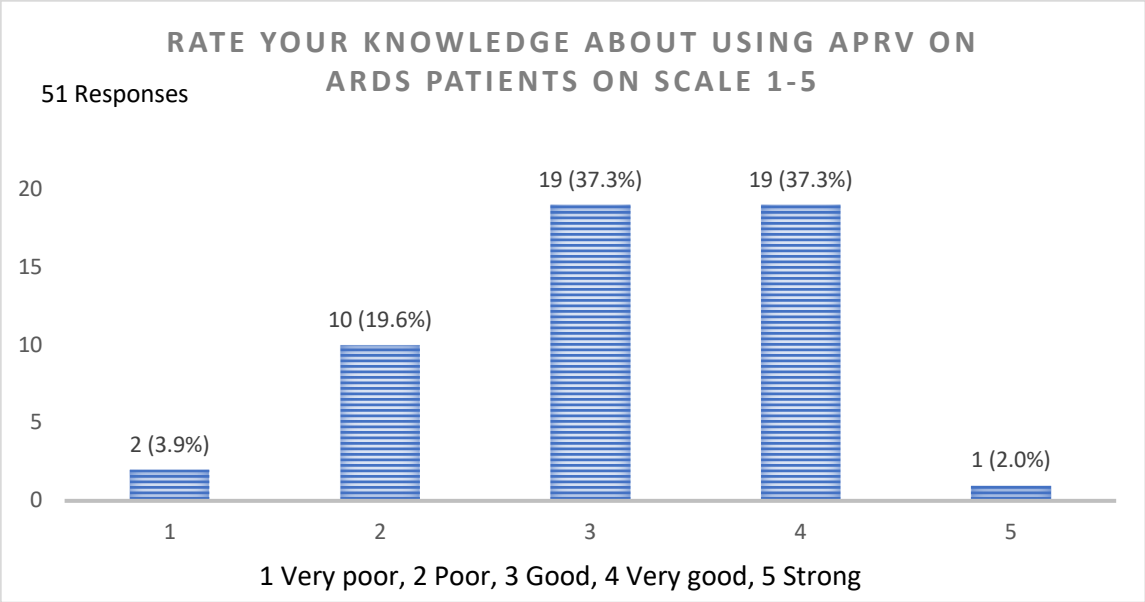
n= 51

RTs knowledge about APRV-ARDS

The primary aim of the study was to measure the level of knowledge regarding APRV applications, APRV outcomes, and other aspects of ARDS. In this section, the first research question was answered. Participants were asked to answer Yes or No and multiple-choice questions to evaluate their comprehension. Additionally, RTs were asked to rate their own knowledge on a scale of 1-5, where 1 represents very poor and 5 represents strong knowledge. The

results showed knowledge levels with a mean of (3.14 ± 0.89 SD), which indicates that the majority of participants had good knowledge level (Figure.2).

Figure. 2 RTs' own rate of knowledge



First, participants were asked whether they knew about APRV mode, and all participants answered yes (n=51, 100%). When asked what APRV referred to, 45 RTs picked the correct answer "Airway Pressure Released Ventilation" (88.2%), while the remaining 6 picked a wrong answer "Adaptive Pressure Regulated Ventilation" (11.8%). Second, in regard to APRV outcomes, participants were asked according to their knowledge to answer Yes or No to the following: APRV tends to injure the lungs if used properly, spontaneous breathing plays a significant role, and if better oxygenation is associated with survival rates, the correct answers were as follows: (64.7%, 98%, and 43.1%), respectively. Third, RTs were asked questions to assess their knowledge about ARDS in more detail. When asked about the Berlin definition of severe ARDS, the results showed that less than half of the participants (47.1%) picked the right answer “Acute onset, bilateral lung infiltration, P/F ratio ≤100 mm Hg on PEEP ≥ 5 cmH2O”. In the same way, when asked about the

greatest cause of ARDS, results found that majority of the participants picked pneumonia (n=40, 78.4%). After pneumonia, there comes sepsis, which is the correct answer, (n=9, 17.6%), and lung contusion (n=2, 3.9%).

On the whole, the total number of correct answers were calculated to measure the knowledge. Participants' highest score was for the question about the significance of spontaneous breathing in APRV (98%). However, the lowest score was when asked about the greatest cause of ARDS where most participants chose pneumonia as the greatest cause of ARDS (78.4%) when sepsis was the right answer (17.6%). Based on the total number of correct answers, we infer that RTs had general knowledge with a mean of 63.22%.

Table. 2 knowledge about APRV-ARDS

Questions	N, (%)
Do you know what APRV mode is	
- Yes	51 (100%)
- No	0 (0.0%)
APRV mode is referred to:	
- **Airway Pressure Released Ventilation**	**45 (88.2%)**
- Adaptive Pressure Regulated Ventilation	6 (11.8%)
- Assisted Pressure Regulated Ventilation	0 (0.0%)
- Airway Pressure Regulated Ventilation	0 (0.0%)
APRV is known to improve oxygenation through changes of transpulmonary pressure that resulted from:	
- **Permitting spontaneous breathing**	**24 (47.1%)**
- All of the above	19 (37.3%)
- Shortening THigh	6 (11.8%)
- Stretching TLow	2 (3.9%)
According to the Berlin definition, severe ARDS is defined as:	
- **Acute onset, bilateral lung infiltration, P/F ratio ≤100 mm Hg on PEEP ≥ 5 cmH2O**	**24 (47.1%)**
- Acute onset, bilateral lung infiltration, P/F ratio ≤ 200 mm Hg on PEEP ≥ 5 cmH2O	18 (35.3%)
- Bilateral lung infiltration, SpO2 ≤90%, P/F ratio ≤100 mm Hg on PEEP ≤5 cmH2O	9 (17.6%)
- Acute onset, bilateral lung infiltration, SpO2 ≤ 90% on PEEP ≥ 5 cm H2O	0 (0.0%)
Based on your knowledge, what is the greatest cause of ARDS?	

- Pneumonia	40 (78.4%)
- **Sepsis**	**9 (17.6%)**
- Lung contusion	2 (3.9%)
- Multi organ dysfunction syndrome	0 (0.0%)
Based on your knowledge, if used properly, does APRV tends to injure the lung?	
- **No**	**33 (64.7%)**
- Yes	18 (35.3%)
Based on your knowledge, does spontaneous breathing plays a significant role in APRV?	
- **Yes**	**50 (98.0%)**
- No	1 (2.0%)
Based on your knowledge, is better oxygenation (PaO2, SPo2) always linked to better survival rate?	
- Yes	29 (56.9%)
- **No**	**22 (43.1%)**

n= 51

*Correct answers are bolded.

RTs Perception about APRV-ARDS

This part of the survey aimed to assess RTs comprehension and how they recognize and apply APRV in patients with ARDS. Besides APRV perception, participants were asked about their perceptions of ARDS. Answering the second question of the study, results revealed sufficient amount of perception among RTs. For instance, the majority of participants were aware of the Berlin definition of ARDS (n=43, 84.3%), which is the most recent definition being used today in clinical management. Moreover, the vast majority of participants agreed that P_{High}, T_{Low} and T_{High} were primarily the appropriate parameters to adjust ventilation in APRV (84.3%, 74.5%, and 60.8%, respectively). In the same way, RTs were able to pick the best answers to parameters that adjust oxygenation in APRV. As shown in Table.3, nearly half of RTs experienced positive outcomes when they used APRV (n=22, 43.1%), while others reported that in the majority of times when using APRV, patients did not improve resulted in failing APRV trials (n=16, 31.4%).

Along with their experience with the mode, more than half of RTs considered the mode to be a rescue mode (n=30, 58.8%). Surprisingly, only two (3.9%) of RTs considered APRV as an initial mode. At the same time, about one-third (29.4%) of the participants recognized APRV as both an initial and a rescue mode (Table.3).

Table. 3 Perception about APRV

Questions	N, (%)
Are you aware of the Berlin definition of ARDS?	
- Yes	43 (84.3%)
- No	8 (15.7%)
In the majority of times you have used APRV on ARDS patients, which of the following best describe the outcomes?	
- Patients revived and outcomes improved (improved means better oxygenation, better hemodynamics, PIP↓)	22 (43.1%)
- Patients don't improve, back to the conventional mode	16 (31.4%)
- I haven't used APRV	7 (13.7%)
- In my hospital they, unfortunately, use it late choice, in that time patient already have been seriously ill and will have poor outcome.	2 (3.9%)
- Patients died	1 (2.0%)
- It differ from case to case but mainly used as rescue mode and it fails at the end	1 (2.0%)
- Outcome improved only if it is used early	1 (2.0%)
- Neutral	1 (2.0%)
Based on your knowledge, which parameter/s is/are you manipulating to adjust the ventilation: (select all that apply)	
- P High	43 (84.3%)
- T Low	38 (74.5%)
- T High	31 (60.8%)
- P Low	14 (27.5%)
- Respiratory Rate	13 (25.5%)
- Intrinsic PEEP	6 (11.8%)
- No, I didn't use APRV and I don't know the answer	4 (7.8%)
Based on your knowledge, which parameter/s is/are you manipulating to adjust the oxygenation: (select all that apply)	
- T High	36 (70.6%)
- P High	31 (60.8%)
- P Low	22 (43.1%)
- T Low	15 (29.4%)
- Intrinsic PEEP	10 (19.6%)
- No, I didn't use APRV and I don't know the answer	4 (7.8%)
- Respiratory Rate	2 (3.9%)

Based on your knowledge, APRV is considered to be:	
- A rescue mode	30 (58.8%)
- Both	15 (29.4%)
- None of the above	4 (7.8%)
- An initial mode	2 (3.9%)

n= 51

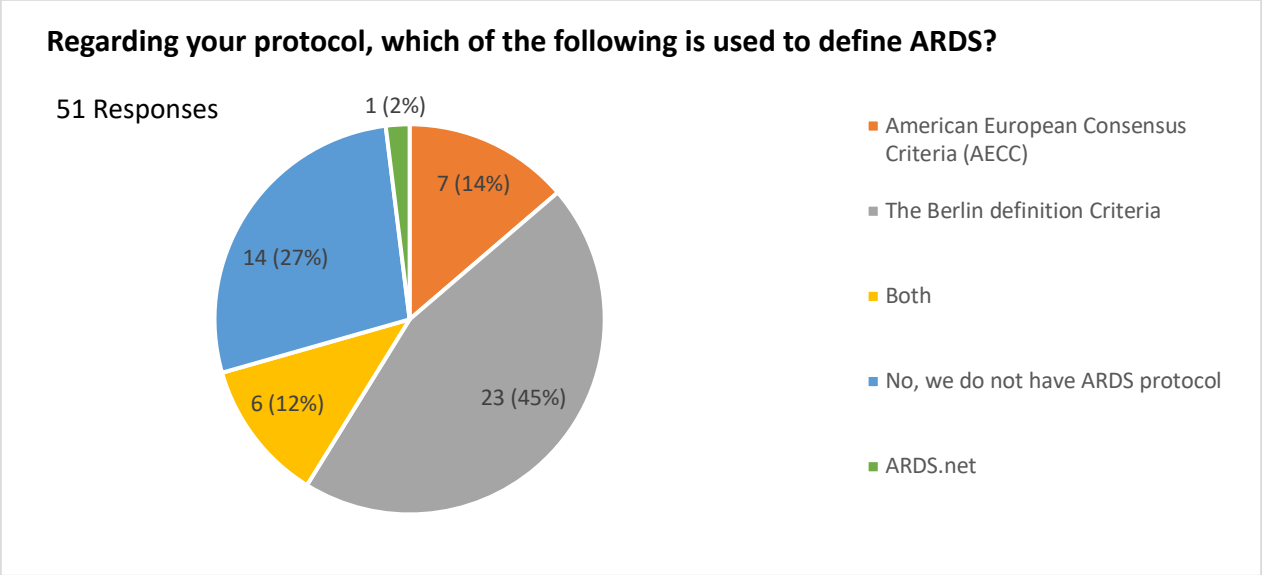
Despite participants showing high levels of perception, a question about the initial settings, left optional, had an adequate response. Almost half of the participants answered this question (n=27, 53%), with the majority of therapists from governmental hospitals (88.9%). The results revealed no consensus in terms of initial settings of APRV among RTs. Since there was no standard answer, initial parameter values were calculated separately. Our data showed that most of RTs used the following values as their initial settings: T_{High} =4 second (30.8%), T_{Low} =0.5 second (33.3%), P_{High} = 30 cmH2O(51.8%), and P_{Low} =0 cmH2O (92.6%). Across all respondents, only two unified answers were found, each with three respondents (22.2%). A note to point out is that all six responses were from government hospitals. The two unified answers were as follows: 1) T_{High} = 3-6s, T_{Low} =0.3-0.6s, P_{High} = 30 cmH2O, and P_{Low} = 0 cmH2O or to eliminate auto PEEP, and 2) T_{High} = 5s, T_{Low} =0.5s, P_{High} = 30 cmH2O, and P_{Low} = 0 cmH2O. Although, we were not statistically able to identify the differences that the government hospitals RTs actually had this unified answer.

The prevalence of using APRV

This section of the study is concerned with the extent of the use of APRV mode in the Eastern Province of Saudi Arabia and whether hospitals in the explored region were supplied with ventilators that were provided with APRV. Also, the ARDS definition was explored through this part. The third question of the research was answered in this section. Among the participants, only

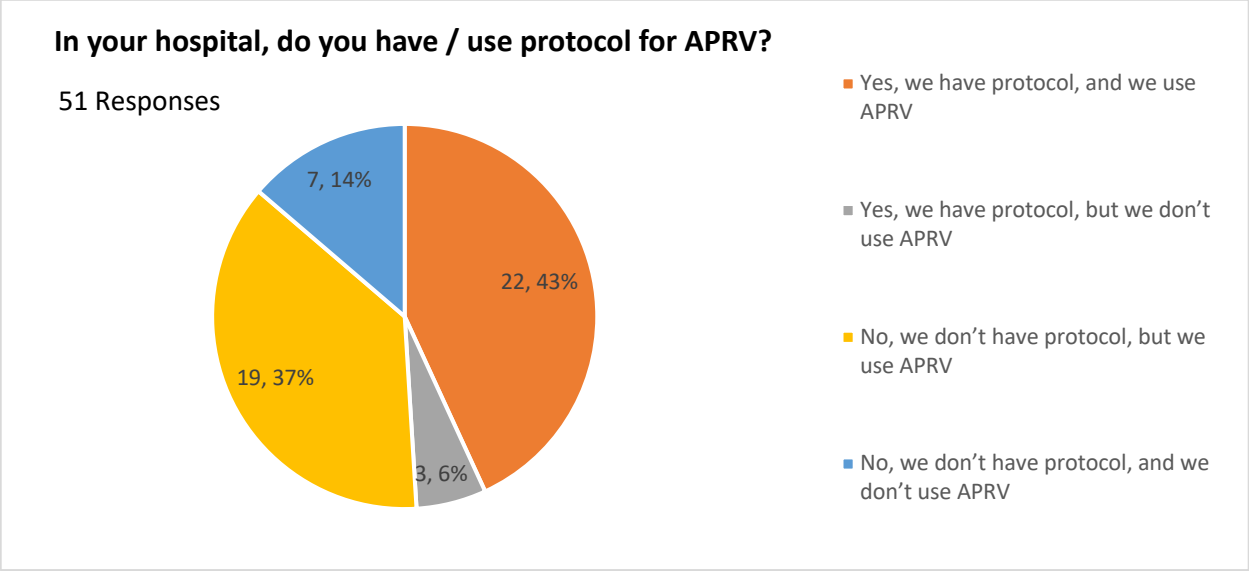
14 RTs (27.4%) alleged not having a protocol for ARDS, whereas the majority of RTs indicated they had an ARDS protocol in their hospital (n=37, 72.6%). More than half of them indicated the use of the Berlin definition (n=23, 45.1%), followed by the American European Consensus Criteria (AECC) (n=7, 13.7%), with only 6 RTs using both definitions in their hospitals (see Figure.3 and Table.4).

Figure. 3 ARDS Definition



Half of the participants declared that APRV was included in their ARDS protocol (51%). The majority of the hospitals were equipped with ventilators that have APRV mode (96.1%). Types of ventilator include Maquet Servo i&u (60.8%), known as Getinge, Drager Evita (41.2%), Hamilton Galileo (33.3%) and others mentioned in Table.3. RTs were also asked about their APRV usage, results showed a total of 22 RTs had the APRV protocol and used the mode at the same time. A total of 19 RTs have used the mode but didn't have a protocol (Figure.4).

Figure. 4 APRV protocol usage



One of the most significant findings in this study is that more than 80% of the respondents have used the mode on patients before. As shown in Table.4, the vast majority of RTs used the mode on ALI/ARDS patients (n=43, 97.7%), followed equally by RTA/Traumatic, cardiac diseases, obstructive lung disease and ARDS due to COVID-19 (n=2, 4.5%) patients. A significant finding about the use of APRV is that more than half of the participants suggested the mode to other RTs and physician (52.9%). Participants were asked regarding physicians' trust and the results showed contradicted responses. Among RTs, 43% used the mode with full trust from physicians compared to those who used the mode with some resistance, and those who haven't use the mode because they face some resistance from physicians, 15.7% and 5.9%, respectively.

Almost 20% of RTs faced some resistance from physicians which indicated lack of communication among RTs and physicians. The lack of communication may result in negative outcomes like poor management and unfortunate consequences resulted from the disagreement.

Ultimately, the superiority of numbers reported using APRV on severe ARDS cases as a last choice (45.1%). Almost 35% believed in that the mode is safe, therefore, they use it. However, only a few divulge their unfamiliarity with the mode (n=7, 13.7%) (see Table.4).

Table. 4 Prevalence of using APRV

Questions	N, (%)
In your hospital, do you have ARDS protocol?	
- Yes	36 (70.6%)
- No	15 (29.4%)
Which of the following is used to define ARDS?	
- The Berlin definition Criteria	23 (45.1%)
- No, we do not have ARDS protocol	14 (27.4%)
- American European Consensus Criteria (AECC)	7 (13.7%)
- Both	6 (11.8%)
- ARDS.net	1 (2.0%)
Is APRV included in your ARDS protocol?	
- Yes	26 (51.0%)
- No	25 (49.0%)
In your hospital, do you have ventilators that have APRV mode?	
- Yes	49 (96.1%)
- No	2 (3.9%)
Which type/s of ventilator have APRV? (select all that apply)	
- Maquet Servo i, u (Getinge)	31 (60.8%)
- Drager Evita	21 (41.2%)
- Hamilton Galileo	17 (33.3%)
- Puritan Bennett	12 (23.5%)
- Mindray sv600	4 (7.8%)
- No, we don't have APRV mode in our ventilators	2 (3.9%)
- General Electric	1 (2%)
In your hospital, do you have / use protocol for APRV?	
- Yes, we have protocol, and we use APRV	22 (43.1%)
- No, we don't have protocol, but we use APRV	19 (37.3%)
- No, we don't have protocol, and we don't use APRV	7 (13.7%)
- Yes, we have protocol, but we don't use APRV	3 (5.9%)
Have you ever used APRV mode on patients?	
- Yes	42 (82.4%)
- No	9 (17.6%)
Which type/s of patients? (select all that apply)	
- ALI/ARDS	43 (97.7%)
- RTA/ Traumatic	2 (4.5%)
- Cardiac diseases	2 (4.5%)
- Obstructive lung diseases (Asthma and COPD)	2 (4.5%)

- ALI/ARDS due to COVID-19	2 (4.5%)
Which of the following is correct in regards to using APRV? (select all that apply):	
- I use it, and I suggested RTs and physicians to use it	27 (52.9%)
- I use it, with physicians' full trust	22 (43.1%)
- I don't use it, because I don't have knowledge and confidence	9 (17.6%)
- I use it, but with some physicians' resistance	8 (15.7%)
- I don't use it, because I face some physicians' resistance	3 (5.9%)
- I don't use it, because I don't believe in APRV	0 (0.0%)
Would you consider using APRV in severe ARDS cases?	
- Yes, as a last choice	23 (45.1%)
- Sure, because it is safe	18 (35.3%)
- No, I am unfamiliar with the mode	7 (13.7%)
- I prefer to use it as early intervention if pt. does not respond to high PEEP	1 (2.0%)
- Only if pt has spontaneous triggering	1 (2.0%)
- I don't know	1 (2.0%)
- No, because it is harmful	0 (0.0%)

n= 51

Relationships and Correlations

In order to find relationship between variables, statistical analysis done through descriptive statistics, Chi-square test, and Fisher test. In this section, research questions fifth, sixth, and seventh were answered.

The difference between government and private hospitals in terms of APRV usage were proposed through four questions. First, if participants have or used APRV protocol at their hospitals. A Fisher test was performed to find an association between the variables. Our analysis showed that there was a significant difference (p=0.0002) between the government and private hospitals in terms of having and or using APRV protocol (Figure.5). Our analysis showed that a total of 22 have used the mode using a protocol (91% from government vs 9% from private sectors). Moreover, it has been found that the percentage of RTs from government hospitals who

didn't have a protocol and used the mode at the same time was relatively higher than those from private hospitals (89% vs 11%). These variances could be due to the relatively low numbers of RTs in private hospitals compared to government hospitals. (see Figure.5)

Figure. 5 Fisher test for APRV usage

The FREQ Procedure

Frequency Percent Row Pct Col Pct	Table of Hospitaltype by APRVprotocol2				
Hospitaltype(Hospital type:)	APRVprotocol2				
	0	1	2	3	Total
0	1 1.96 2.50 14.29	17 33.33 42.50 89.47	2 3.92 5.00 66.67	20 39.22 50.00 90.91	40 78.43
1	6 11.76 54.55 85.71	2 3.92 18.18 10.53	1 1.96 9.09 33.33	2 3.92 18.18 9.09	11 21.57
Total	7 13.73	19 37.25	3 5.88	22 43.14	51 100.00

* Hospital Type:
0 Government
1 Private

* APRV Protocol
0 No, we don't have protocol, and we don't use APRV
1 No, we don't have protocol, but we use APRV
2 Yes, we have protocol, but we don't use APRV
3 Yes, we have protocol, and we use APRV

Statistics for Table of Hospitaltype by APRVprotocol2

Statistic	DF	Value	Prob
Chi-Square	3	20.6660	0.0001
Likelihood Ratio Chi-Square	3	17.4306	0.0006
Mantel-Haenszel Chi-Square	1	8.0623	0.0045
Phi Coefficient		0.6366	
Contingency Coefficient		0.5370	
Cramer's V		0.6366	
WARNING: 63% of the cells have expected counts less than 5. Chi-Square may not be a valid test.			

Fisher's Exact Test	
Table Probability (P)	<.0001
Pr <= P	0.0002

Sample Size = 51

Second, upon analyzing data for consistency regarding the open-ended question about the initial settings for APRV, we found that there was no agreement among participants except for two answers from six government RTs. Since there was no agreement between the answers, we were not able to conduct statistical test to determine the difference between the government and private

hospitals. Third, RTs were asked if they have used the mode on patients before. Chi square test was done to compare between the two types of hospitals. Test result revealed that there was a significant difference (p=0.006) between the two variables. Government RTs had a higher percentage of using the mode on patients compared to RTs from private hospital (90% vs. 46%) (Figure.6).

Figure. 6 Chi-Square test

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
10. Have you ever used APRV mode on patients? * Hospital type:	51	100.0%	0	0.0%	51	100.0%

10. Have you ever used APRV mode on patients? * Hospital type: Crosstabulation

Count

		Hospital type:		
		Government	Private	Total
10. Have you ever used APRV mode on patients?	Yes	36	6	42
	No	4	5	9
Total		40	11	51

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.462[a]	1	.006		
Continuity Correction[b]	5.222	1	.022		
Likelihood Ratio	6.367	1	.012		
Fisher's Exact Test				.015	.015
Linear-by-Linear Association	7.316	1	.007		
N of Valid Cases	51				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 1.94.

b. Computed only for a 2x2 table

Fourth, participants were asked whether they agreed with some of the statements about their APRV usage. Descriptive statistics showed that more than half of the participants used the mode and suggested other RTs and physicians to use the mode (n=27, 52.9%). Remarkably, out of the 27 participants who used the mode, 26 (96%) were from government hospitals. Moreover, most government therapists have used the mode with the full trust of physicians (n=20, 39.2%), compared to two private hospitals therapists (4%). However, some participants have used the mode

even though they faced some resistance from physicians (n=8, 15.7%) with a majority of government workers (n=6). Surprisingly, all participants who did not use the mode because of resistance were from the private sector (n=3, 5.9%). A total of five government and four private hospitals' RTs did not use the mode because they did not have the knowledge and confidence to apply the mode on patients (n=9, 17.6%).

Differences in knowledge and perception among public and private hospitals were assessed through the percentages of corrected answers. Chi-Square tests were used to compare statistically significant differences in APRV knowledge between government and private hospitals. For small expected cell sizes (<5), the Fisher Exact test was used. Overall, our data analysis showed that there were no statistically significant differences between the government and private hospitals RTs in terms of knowledge. Table.5 shows demonstrated the statistical tests for each question as well as the *p* value (Table.5).

Table. 5 RTs Knowledge regarding APRV-ARDS

Knowledge questions	***Statistical tests***	
	Chi-Square	Fisher
- ***APRV mode is referred to***		***p=0.319***
- ***APRV Improving oxygenation through transpulmonary pressure***	***p=0.422***	
- ***The Berlin definition for Severe ARDS***	***p=0.574***	
- ***The greatest cause of ARDS***	***p=0.344***	
- ***APRV tends to injure the lung if used properly***	***p=0.180***	
- ***Spontaneous breathing plays a significant role in APRV***		***p=0.216***
- ***Better oxygenation always linked to better survival rate***	***p=0.861***	

The Fisher Exact test was used to find differences in perception. As shown in Figure.7, no significant difference was found (p= 0.0677) between the government and private hospitals in their

perception of APRV. The majority of government and private therapists considered the mode to be a rescue mode (62.5% and 45.4%, respectively) (Figure.7).

Figure. 7 RTs Perception of APRV

The FREQ Procedure

Frequency Percent Row Pct Col Pct	Table of Hospitaltype by perception				
Hospitaltype(Hospital type:)	perception				
	0	1	2	3	Total
0	25 49.02 62.50 83.33	11 21.57 27.50 73.33	4 7.84 10.00 100.00	0 0.00 0.00 0.00	40 78.43
1	5 9.80 45.45 16.67	4 7.84 36.36 26.67	0 0.00 0.00 0.00	2 3.92 18.18 100.00	11 21.57
Total	30 58.82	15 29.41	4 7.84	2 3.92	51 100.00

* Hospital Type:
0 Government
1 Private

* Perception
0 A Rescue mode
1 Both
2 None of them
3 An initial mode

Statistics for Table of Hospitaltype by perception

Statistic	DF	Value	Prob
Chi-Square	3	9.0293	0.0289
Likelihood Ratio Chi-Square	3	8.7510	0.0328
Mantel-Haenszel Chi-Square	1	2.5003	0.1138
Phi Coefficient		0.4208	
Contingency Coefficient		0.3878	
Cramer's V		0.4208	

WARNING: 63% of the cells have expected counts less than 5. Chi-Square may not be a valid test.

Fisher's Exact Test	
Table Probability (P)	0.0041
Pr <= P	0.0677

Sample Size = 51

To summarize, as illustrated in Table.5 and Figure.7, no significant differences were found between therapists in government and private hospitals regarding APRV and ARDS knowledge and perception.

The fourth research question “What is the difference between government and private hospitals in terms of ARDS protocol and practices?” was answered by interpreting the answers to the following questions:

- Q1: In your hospital, do you have ARDS protocol?
- Q2: Which of the following is used to define ARDS?
- Q3: Does your daily practice follow your hospital protocol?

The first question asked participants about having ARDS protocol. The results indicated that 70.6% of RTs does have an ARDS protocol, whereas 29.4% indicated not having a protocol. Statistical analysis done with Chi-Square test. Our analysis documented no significant difference (p=0.095) between the government and private hospitals in terms of having ARDS protocol. Furthermore, no difference was noticed between the two types of hospitals as the Berlin definition was the most common ARDS protocol used in the Eastern Province (57%). Regarding the third question, based on our analysis we found that most therapists in both private and government hospitals followed their hospitals' protocol in their daily practice (72% and 65%, respectively). Accordingly, both hospitals' RTs were in compliance with their protocols.

Summary

This chapter presents the results from the data received in assisting in answering the research questions. The results revealed that RTs had general knowledge about ARDS and APRV mode (63.2%). The vast majority of hospitals in the Eastern province were provided with APRV mode (96.1%). Significantly, results showed that APRV was used by more than 80% of the respondents, half of whom had positive outcomes when using APRV. Patients with ARDS were the most common disease when APRV was applied (98%).

Moreover, participants perceived APRV as a valuable mode whereas most of them considered the mode as a rescue mode (58.8%) compared to those not considered using the mode

(7.8%). Also, most of the participants showed high levels of perception of ARDS by being aware of the Berlin definition and using it in their hospitals (84.3% and 57%).

Overall, differences between the government and private hospitals were analyzed. We conclude that there were few significant differences found between the two types of hospital therapists in terms of APRV usage (p=0.0002 and p= 0.006) (Figure.5&6). However, other aspects like APRV-ARDS knowledge, perception, and ARDS protocol and practices showed no significant differences between participants in the two groups (see Table.5 and Figure.7).

Chapter V
Discussion

This chapter scrutinize the findings in our research questions. In addition, some of recommendations were listed, the study limitations were also reviewed , and the implication for practice proposed. The research questions discussed here are the following:

1. What do RTs in the EP know about ARDS and APRV mode?
2. What do RTs in the EP perceive the value of the APRV mode?
3. To what extent was the APRV mode applied to ARDS patients in the EP and is there difference between hospitals in terms of ARDS protocol and practices?
4. What is the difference between government and private hospitals in terms of RTs knowledge and perception about ARDS and APRV?

Findings related to RTs knowledge

The first research question asked, "What do RTs in the EP know about ARDS and APRV mode?". According to the data obtained from the results chapter, RTs showed a general level of knowledge pertaining to ARDS and APRV. However, there was a lack of adequate knowledge in ARDS leading cause and ARDS outcomes (17.6% and 43.1%). These finding are consistent with Abbag' et al findings. According to Abbag et al, HCWs in SA had low levels of knowledge in identifying how the disease is transmitted and the diagnostic tools (23.6% and 18.3%) (Abbag et al., 2018). Our findings in regard to the knowledge indicated the need for knowledge improvement among RTs. The gap in knowledge could be related to the need for skilled RTs as the profession continues to expand in SA (Alotaibi, 2015).

Findings related to RTs perceptions

The second question of the research aimed to explore the value of the APRV mode and how RTs in EP perceive it. Moreover, ARDS perception was assessed. Our data revealed that RTs of the EP in SA have very good levels of perception of APRV manipulation. Large numbers of RTs picked the best answers for the primary parameters that adjust ventilation as well as oxygenation parameters. These parameters were consistent with Habashi's article. Habashi recommended the use of chosen parameters previously in order to adjust ventilation and oxygenation based on patients' condition (Habashi, 2005). Additionally, most participants showed a sufficient level of perception, as they had regarded the mode to be used in critical situations as rescue mode. However, this finding did not align with what Habashi and Aljuaid found. Habashi reported that APRV may be used earlier as an initial mode rather than at the late stages of respiratory disease (Habashi, 2005). Furthermore, Aljuaid and colleagues indicated that about 23% of RTs had doubts about APRV and other new modes of ventilation compared to 7.8% in our study (Aljuaid et al, 2019).

However, our results revealed that only 4% of the participants considered APRV as initial mode when treating patients with ARDS which is similar to Dushianthan finding. Dushianthan et al reported that less than 5% of their study participants used APRV as a primary ventilation strategy during the early stages of ARDS (Dushianthan, et al., 2014).

In summary, EP RTs showed sufficient amount of perception in regard to APRV and ARDS. Our finding indicated that most of RTs considered using the mode in rescue management which gave a sight that SA therapists were aware of the mode importance and its advantages. More education is needed to introduce the mode preemptively as suggested by recent literature.

Findings related to the prevalence of APRV

Based on our statistics, results indicated that the vast majority of hospitals were equipped with APRV (96%). Our findings revealed that almost all EP hospitals were equipped with the APRV mode which exclude not using it because of lack of equipment. A question was asked to identify the prevalence of using the mode , "To what extent was the APRV mode applied to ARDS patients in the EP?" Almost all RTs indicated the use of APRV on ARDS patients (98%). Moreover, most RTs indicated having ARDS protocol (n=36,70.6%). It is clear from these findings that the mode is widely used by RTs in the EP especially on patients with ARDS. Furthermore, it is important to note that most of RTs had the mode APRV included in their ARDS protocol.

Additionally, an initial setting for APRV was explored. Since there was no consensus except for two identical answers from three participants in each, statistical analysis was difficult to conduct and therefore the results for differences in terms of initial setting were unattainable.

These findings lead us to refute our hypothesis when we hypothesized that not many RTs knew about APRV. However, the finding regarding the use of the mode as a rescue mode is in line with what we hypothesized earlier in the study.

Findings related to the difference between hospitals

The differences in knowledge and perception in regard to APRV and ARDS between the two type of hospitals were explored. Our results showed no difference among participants from both hospitals types which indicate equal knowledge levels among all RTs in this particular area of the country.

Perception also had no significant difference between the government and private hospitals. Both government and private hospitals regarded the mode as rescue mode. None of RTs from government hospitals considered using the mode as initial ventilatory strategy compared to two RTs from private hospitals. We conclude that no differences were found in association with APRV-ARDS knowledge and perception among RTs in both government and private hospitals.

Findings related to the RTs daily practice in regard to APRV and ARDS protocol showed that almost 32% of participants were not in compliance with their protocols. This percentage reflected the need for exploring the reasons behind this percentage. Adherence to hospitals' protocol is crucial as reported by Borges et al, (2017).

Implications for practice

Findings from this study could provide RT departments in particular, and hospitals in general, a closer insight into detecting weaknesses they might not be aware of. For example, some RTs reported not having an ARDS or APRV protocol. Having a protocol is paramount for reducing the mortality rates for patients with ARDS. This study contains data that may assist in filling the gap between government and private hospitals in terms of RTs' knowledge, perceptions, and numbers. Knowing the knowledge level, as well as perception level, are critical in providing respiratory therapy education for RTs and physicians about APRV in treating respiratory diseases like ARDS. Participants were mostly bachelor's degree holders, and only 5 participants held master's degrees at a US university. There is an obvious lack of master's degree workers in hospitals of EP. Education programs are also vital to RTs in patients' care by providing teaching sessions on new and advanced methods of ventilation. Regarding RTs numbers, our study had a total of 40 RTs from the government compared to 11 RTs from private hospitals, indicating

massive variance reaching triple the number. The gap in numbers should took into consideration especially from the private sector side.

Study limitations

The small sample size was noted to be one of the limitations of this study. Power is an issue as we were unable to conduct statistical tests because our data had small cell sizes. Our study also had a 45% response rate which resulted in failing to generalize our results to the population. This is partly due to several factors, one of which is the low number of RTs in this particular region of the country. Moreover, some RT heads of departments complained of a high load on their staff during the COVID-19 pandemic which aligned with our study, and significantly impacted our response rate. Our recruited sample was comprised of participants with a minimum of a bachelor's degree, which reflects the need for other RTs who had an associate degree (diploma), as it may show some disparity in knowledge. Recall bias could also affect the participants' response regarding APRV, depending on how recently the participants may have used the mode.

Recommendation for future study

In summary, this study identified a gap in literature which revealed limited data involving RTs knowledge and perceptions with APRV used as treatment for ARDS. This study opens the window for further studies on RTs, involving APRV, and ARDS in Saudi Arabia. Future research is highly recommended to be with the use of larger sample number and to include multiple regions of the country.

Conclusion

Since this is the first study to explore the knowledge and perception of APRV mode on ARDS among Saudi RT's, more studies are needed to support what we found. Our study had significant findings which contradict our hypothesis in which there were more than 80% of the participants have used the APRV mode before. However, no significant differences were found between the RTs from private and government hospitals in terms of knowledge and perception. A point to mention is that the vast majority of the EP hospitals were fully supplied with the APRV mode.

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Appendix A: Survey

I. Prevalence of using APRV on ARDS

1. Are you aware of the Berlin definition of ARDS? □ Yes □ No
2. In your hospital, do you have ARDS protocol? □ Yes □ No
3. If yes, regarding your protocol, which of the following is used to define ARDS?
    a) American European Consensus Criteria (AECC)
    b) The Berlin definition Criteria
    c) Both
    d) No, we do not have ARDS protocol
    e) Other _____

4. Does your daily practice follow your hospital protocol?
    □ Yes, I use the same protocol we have
    □ No, I use different protocol
5. Is APRV included in your ARDS protocol? □ Yes □ No
6. In your hospital, do you have ventilators that have APRV mode? □ Yes □ No
7. If yes, which type/s of ventilator have APRV? (select all that apply)
    a) Maquet Servo i, u (Getinge)
    b) Puritan Bennett
    c) Hamilton Galileo
    d) Drager Evita
    e) No, we don't have APRV mode in our ventilators
    f) Other _____

8. In your hospital, do you have / use protocol for APRV?
    a) Yes, we have protocol, and we use APRV
    b) Yes, we have protocol, but we don't use APRV
    c) No, we don't have protocol, but we use APRV
    d) No, we don't have protocol, and we don't use APRV

9. If yes, what are the initial settings for APRV?
    - T_{High} _____ T_{Low}_____ P_{High}_____ P_{Low}_____

10. Have you ever used APRV mode on patients? □ Yes □ No
11. If yes, on which type/s of patients? (select all that apply)
    a) ALI/ARDS
    b) RTA/ Traumatic
    c) Cardiac diseases
    d) Obstructive lung diseases (Asthma and COPD)
    e) Other _____

12. Which of the following is correct in regards to using APRV? (select all that apply):
    a) I use it, with physicians' full trust
    b) I use it, and I suggested RTs and physicians to use it
    c) I use it, but with some physicians' resistance
    d) I don't use it, because I face some physicians' resistance

e) I don't use it, because I don't have knowledge and confidence
f) I don't use it, because I don't believe in APRV

13. Would you consider using APRV in severe ARDS cases?
    a) Sure, because it is safe
    b) Yes, as a last choice
    c) No, because it is harmful
    d) No, I am unfamiliar with the mode
    e) Other _____

14. In the majority of times you have used APRV on ARDS patients, which of the following best describe the outcomes?
    a) Patients revived and outcomes improved (improved means better oxygenation, better hemodynamics, PIP↓)
    b) Patients don't improve, back to the conventional mode
    c) Patients died
    d) I haven't used APRV
    e) Other _____

On scale 1-5, How do you rate your knowledge about using APRV on ARDS patients?
1□ Very poor 2□ Poor 3□Good 4□ Very good 5□ Strong

II. Knowledge about APRV and ARDS

1. Do you know what APRV mode is? □ Yes □ No
2. APRV mode is referred to:
    a) Adaptive Pressure Regulated Ventilation
    b) Airway Pressure Released Ventilation
    c) Assisted Pressure Regulated Ventilation
    d) Airway Pressure Regulated Ventilation

3. Based on your knowledge, which parameter/s is/are you manipulating to adjust the ventilation: (select all that apply)
    a) T_{High}
    b) T_{Low}
    c) P_{High}
    d) P_{Low}
    e) Respiratory Rate
    f) Intrinsic PEEP
    g) No, I didn't use APRV and I don't know the answer

4. Based on your knowledge, which parameter/s is/are you manipulating to adjust the oxygenation: (select all that apply)

a) T_{High}
b) T_{Low}
c) P_{High}
d) P_{Low}
e) Respiratory Rate
f) Intrinsic PEEP
g) No, I didn't use APRV and I don't know the answer

5. APRV is known to improve oxygenation through changes of transpulmonary pressure that resulted from:
   a) Stretching T_{Low}
   b) Shortening T_{High}
   c) Permitting spontaneous breathing
   d) All of the above

1. Based on your knowledge, APRV is considered to be:
   a) An initial mode
   b) A rescue mode
   c) Both
   d) None of the above

2. According to the Berlin definition, severe ARDS is defined as:
   a) Acute onset, bilateral lung infiltration, SpO2 ≤ 90% on PEEP ≥ 5 cm H2O
   b) Acute onset, bilateral lung infiltration, P/F ratio ≤ 200 mm Hg on PEEP ≥ 5 cmH2O
   c) Bilateral lung infiltration, SpO2 ≤90%, P/F ratio ≤100 mm Hg on PEEP ≤5 cmH2O
   d) Acute onset, bilateral lung infiltration, P/F ratio ≤100 mm Hg on PEEP ≥ 5 cmH2O

3. Based on your knowledge, what is the greatest cause of ARDS?
   a) Sepsis
   b) Pneumonia
   c) Lung contusion
   d) Multi organ dysfunction syndrome

4. Based on your knowledge, if used properly, does APRV tends to injure the lung?
   □ Yes □ No
5. Based on your knowledge, does spontaneous breathing plays a significant role in APRV?
   □ Yes □ No
6. Based on your knowledge, is better oxygenation (PaO2, SPo2) always linked to better survival rate? □ Yes □ No

III. Demographics

- Hospital type: □ Government □ Private
- Hospital name: _____
- Gender: □ Male □ Female
- Years of experience: _____
- Qualification: □ Diploma □ Bachelor □ Masters □ PhD
- Graduation country: □ Saudi Arabia □ The United States □ Other:_____

Thanks for agreeing to take part of this survey.
If you have any question or suggestion about this survey, please write it down in the feedback section or through the contact information bellow:

- **Feedback:**

_____
_____
_____

Contact information:

- **Mohammad Alobead: Malobead1@student.gsu.edu Phone: +966561570609.**
  Research advisor Dr. Lynda Goodfellow: Ltgoodfellow@gsu.edu

Appendix B: Invitation Letter

Dear Respiratory therapy directors,

This is Mohammad Al Obead
A master's student at the respiratory therapy department, Georgia State University,
I would like to invite you and your RTs staff to participate in my survey through the link that attached at the end of the email.

Title: KNOWLEDGE AND PREVALENCE OF USING APRV ON ARDS PATIENTS AMONG RESPIRATORY THERAPISTS IN THE EASTERN PROVINCE, SAUDI ARABIA.
Principal Investigator: Dr. Lynda Goodfellow
Student Principal Investigator: Mohammad Al Obead

Dear Respiratory Therapists:

You are invited to take part in a research study. It is up to you to decide if you would like to take part in the study. The purpose of this study is to explore, quantify, and identify to what extent of RTs knowledge and how widely the APRV mode is used? The goals of this study are to survey RTs and assessing their knowledge of using APRV on patients with ARDS and exploring the prevalence of using APRV mode in the Eastern Province of Saudi Arabia.
Your role in the study will take approximately 15 minutes or less of your time. You will be asked to agree to be part of the study and to complete the survey. Participating in this study will not expose you to any more risks than you would experience in a typical day.
Participants will receive no direct benefit for participation in this study. Overall, we hope to gain information that will allow for an understanding of the level of RTs' knowledge about the APRV mode on patients with ARDS. Also, to what extent does the APRV mode apply to patients with ARDS in the Eastern Province of Saudi Arabia. These are important to determine in order to promote a better understanding of managing patients with ARDS.

Please note that your participation is voluntary and that you are free to withdraw at any time without giving any reason. Your medical care, job status, and legal rights are all not being affected. If you do not wish to take part in this study, you may check the disagree button.

Purpose

The purpose of the study is to explore, quantify, and identify to what extent of RTs knowledge and how widely the APRV mode is used? The goals of this study are to survey RTs and assessing their knowledge of using APRV on patients with ARDS and exploring the prevalence of using APRV mode in the Eastern Province of Saudi Arabia. You are invited to take part in this research study because you are a Respiratory Therapist who is the most involved in this disease process and its management. A total of 100 people will be invited to take part in this study.

Procedures

If you decide to take part, you will be asked to click the link and check the agree button. After that, you will be asked to fill out the questionnaire.

- The survey consists of 3 parts.

- A total of 25 questions will be asked.
- The questions are provided with options.
- Please select/ check the best option in favor of each question.
- This survey will take about 10-15 minutes to complete.
- Your response will be used for research purposes and will be strictly confidential and anonymous.

Voluntary Participation and Withdrawal

You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip questions or stop participating at any time. You may refuse to take part in the study or stop at any time.

Contact Information

Please Contact Dr. Lynda Goodfellow at LtGoodfellow@gsu.edu or 404-413-1000 in case any of the following occur:

- If you have questions about the study or your part in it.
- If you have questions, concerns, or complaints about the study.

The IRB at Georgia State University reviews all research that involves human participants. You can contact the IRB if you would like to speak to someone who is not involved directly with the study. You can contact the IRB for questions, concerns, problems, information, input, or questions about your rights as a research participant. Contact the IRB at 404-413-3500 or irb@gsu.edu.

Consent

Your completion and submission of the survey implies that you agree to participate in this research. Please note that you may withdraw at any time by not completing or by clicking the disagree button.

Thank you in advance for your cooperation
Sincerely,
Lynda T. Goodfellow, EdD, RRT, AE-C
Mohammad Al Obead, Bs RT

https://forms.gle/kqwofuhWTc42Ee3v8

Appendix C: Informed Consent

Georgia State University
Informed Consent

Title: KNOWLEDGE AND PREVALENCE OF USING APRV ON ARDS PATIENTS AMONG RESPIRATORY THERAPISTS IN THE EASTERN PROVINCE, SAUDI ARABIA.
Principal Investigator: Dr. Lynda Goodfellow
Student Principal Investigator: Mohammad Al Obead

Dear Respiratory Therapists:

You are invited to take part in a research study. It is up to you to decide if you would like to take part in the study. The purpose of this study is to explore, quantify, and identify to what extent of RTs knowledge and how widely the APRV mode is used? The goals of this study are to survey RTs and assessing their knowledge of using APRV on patients with ARDS and exploring the prevalence of using APRV mode in the Eastern Province of Saudi Arabia.
Your role in the study will take approximately 15 minutes or less of your time. You will be asked to agree to be part of the study and to complete the survey. Participating in this study will not expose you to any more risks than you would experience in a typical day.
Participants will receive no direct benefit for participation in this study. Overall, we hope to gain information that will allow for an understanding of the level of RTs' knowledge about the APRV mode on patients with ARDS. Also, to what extent does the APRV mode apply to patients with ARDS in the Eastern Province of Saudi Arabia. These are important to determine in order to promote better understanding of managing patients with ARDS.

Please note that your participation is voluntary and that you are free to withdraw at any time without giving any reason. Your medical care, job status, and legal rights are all not being affected. If you do not wish to take part in this study, you may check the disagree button.

Purpose

The purpose of the study is to explore, quantify, and identify to what extent of RTs knowledge and how widely the APRV mode is used? The goals of this study are to survey RTs and assessing their knowledge of using APRV on patients with ARDS and exploring the prevalence of using APRV mode in the Eastern Province of Saudi Arabia. You are invited to take part in this research study because you are a Respiratory Therapist who is the most involved in this disease process and its management. A total of 100 people will be invited to take part in this study.

Procedures

If you decide to take part, you will be asked to click the link and check the agree button. After that you will be asked to fill out the questionnaire.

- The survey is consisted of 3 parts.
- A total of 25 questions will be asked.
- The questions are provided with options.
- Please select/ check the best option in favor of each question.
- This survey will take about 10-15 minutes to complete.
- Your response will be used for research purposes and will be strictly confidential and anonymous.

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You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any time. You may skip questions or stop participating at any time. You may refuse to take part in the study or stop at any time.

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Consent

Your completion and submission of the survey implies that you agree to participate in this research. Please note that you may withdraw at any time by not completing or by clicking the disagree button.

Thank you in advance for your cooperation

Sincerely,

Lynda T. Goodfellow, EdD, RRT, AE-C

Mohammad Al Obead, Bs RT

Please note: If you agree to participate in this research, please continue with the survey. You can print a copy of the form for your records.

- o I Agree
- o I Disagree

Appendix D: IRB Approval

INSTITUTIONAL REVIEW BOARD

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

October 20, 2020

Principal Investigator: Lynda T Goodfellow

Key Personnel: Al Obead, Mohammad A; Goodfellow, Lynda

T Study Department: Respiratory Therapy

Study Title: KNOWLEDGE, PERCEPTION, AND PREVALENCE OF USING APRV ON ARDS PATIENTS AMONG RESPIRATORY THERAPISTS IN THE EASTERN PROVINCE, SAUDI ARABIA.

Review Type: Exempt Amendment

IRB Number: H21168

Reference Number: 362742

Approval Date:
10/09/2020

Status Check Due By:
10/08/2023

Amendment Effective Date:
10/16/2020

The Georgia State University Institutional Review Board reviewed and **approved** the amendment to your above-referenced Study.

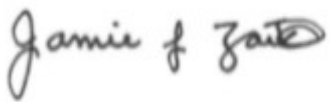
This amendment is approved for the following modifications:

☐ I want to add " hospital name" to the survey.

The amendment does not alter the approval period which is listed above and a status update must be submitted at least 30 days before the due date if research is to continue beyond that time frame. Any unanticipated problems resulting from participation in this study must be reported
to the IRB through the Unanticipated Problem form.

For more information, visit our website at www.gsu.edu/irb.

Sincerely,
Jamie Zaikov, IRB Member



ALMOOSA ACADEMIC AFFAIRS

مستشفى الموسى التخصصي
Almoosa Specialist Hospital

Date:	IRB log No:	Category of Approval:	Affiliation:
10/11/2020	ARC-20.11.3	Expedite	George State University

Study Title:
Knowledge, perception, and prevalence of using APRV on ARDS patients among respiratory therapists in the eastern province, Saudi Arabia.

Dear Mr Mohammed Al Obead

This is to clarify that the IRB has reviewed and approved the study titled in this letter.

Terms and conditions of approval:

- Abide by the rules and regulations of the Government of Saudi Arabia, NCBE.
- The approval of the study is valid for ***One Year***.
- To conduct research as per the approved documents and no amendments maybe made prior to further approval by the IRB.
- The principle investigator is responsible for the document retention and storage for a period of ***3 years*** from study completion.
- The Principle Investigator is expected to submit a Progress Report every ***6 months***.
- At the end of the study, the Principle Investigator must submit Final Report including a conclusion abstract and the manuscript intended for publication.

On behalf of the IRB members, we thank you for submitting your study and wish you the best of luck as you move forward with your research.

Sincerely Yours,

Abbas

Al Moosa Specialist Hospital
Institutional Review Board IRB
H-05-HS-100

Dr Abbas Al Mutair, Ph.D
Chairman of IRB