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Perception and prevalence of utilizing APRV mode with Covid-19 cases among Respiratory Therapists in Saudi Arabia

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Perception and prevalence of utilizing APRV mode with Covid-19 cases among Respiratory Therapists in Saudi Arabia

By

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Under the supervision of Dr. Lynda Goodfellow, EdD, RRT, FAARC

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ACCEPTANCE

This thesis, Perception and Prevalence of Utilizing APRV Mode with Covid-19 Cases among Respiratory Therapists in Saudi Arabia, by Jihad Al Rehaili 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 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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By

Jihad Alrehaili, BSRT

(Under the supervision of Dr. Lynda Goodfellow)

Abstract

Background: Covid-19 is a recent pandemic that spread globally. Consequently, little research focused on Covid-19 that compared different mechanical ventilator modalities that were suitable for these cases. Investigating appropriate mechanical ventilation techniques such as APRV that control the pandemic is necessary to confront any future pandemic. RTs' beliefs and practices of utilizing mechanical ventilation during the Covid-19 pandemic are essential to establish a guideline to manage ventilated Covid-19 cases. **Purpose**: This study aims to evaluate the perception, prevalence, and utilization of APRV mode with Covid-19 patients among respiratory therapists in Saudi Arabia. **Methods**: The study utilized an online, cross-sectional survey with 29 questions administered to a convenience sample of Saudi Arabian RTs. The survey was divided into three sections to obtain information from respondents. These sections are demographic data, perceptions regarding APRV and ARDS, and the prevalence of utilizing APRV on patients with Covid-19 associated ARDS. **Result**: Eighty-six responses were obtained from the online survey that was sent to many respiratory therapy departments in different regions across SA. Two participants refused to participate, and n=47 (54.7%) of responders did not complete the survey, and their answers were excluded. Therefore, n=37 (43%) respondents completed the survey. The majority of respondents were male n=31 (83.8%), whereas the female accounted for n=6 (16.2%) of respondents. Most of the respondents held a bachelor's degree n=32 (86.5%), while only n=5 (13.5%) held a master's degree. There were no responders who held associate or Ph.D. degrees. The result showed there was a high level of confidence among RTs that using APRV with Covid-19 cases was effective with a mean of (2.97± 0.763). Furthermore, the results showed that RTs believed that Covid-19 associated ARDS had a similar clinical picture of non-Covid-19 associated ARDS n=28 (75.7%). A Kruskal-Wallis Test revealed no significant difference in using APRV with Covid-19 cases during the pandemic between the region of practice in Saudi Arabia, Kruskal-Wallis H=3.219, p=.395. Also, the results showed that there was no significant difference among different qualifications (p=0.875). **Conclusion**: The overall level of perception of APRV needs to be improved, which, in turn, can improve and strengthen the management of ARDS and respiratory disorders and increase the average survival rate in Saudi Arabia. More educational sessions and classes are required for this purpose.

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Chapter I

Introduction

Coronavirus disease 2019 (Covid-19) is a serious infectious disease that is caused by coronavirus 2 (SARS-COV-2). The World Health Organization (WHO) declared coronavirus disease 2019 as a pandemic and a public health crisis on March 11, 2020 [Zorbas et al., 2021]. The disease has flu-like symptoms on its presentation and can develop into severe conditions in some individuals [Pascarella et al., 2020]. Severe cases of the disease and the need to use mechanical ventilation support are estimated to be 5%-8% of the cases diagnosed with Covid-19 [Alqahtani et al., 2021]. Some studies claimed that initiating a lung protective strategy with Covid-19 patients is associated with a decrease in pulmonary complications, hospital mortality, and days on mechanical ventilation [Lentz et al., 2020].

Acute respiratory distress syndrome (ARDS) is a heterogeneous syndrome characterized by bilateral infiltrates on x-ray, PaO2/FiO2 ratio <300 mm Hg, and refractory hypoxemia according to the Berlin criteria [Lentz et al., 2020]. While ARDS caused by Covid-19 is mostly like the clinical pictures of the Berlin criteria, it is still a unique clinical syndrome with severe, refractory hypoxemia. The significance of utilizing the APRV mode with ARDS patients caused by Covid-19 is still unclear (Ibarra-Estrada et al., 2022)

Airway pressure release ventilation (APRV) is a ventilation mode characterized by applying two levels of continuous positive airway pressure (CPAP). The high-pressure level is (P_{high}) and the low-pressure level is (T_{low}). Both levels have a preset time that maintains the pressure. The time for the P_{high} is called inspiratory time (T_{high}), and the time for the P_{low} is release time (T_{low}) [Ibarra-Estrada et al., 2021]. Recent studies showed the significance of implementing APRV with ARDS cases, but these studies are conducted in small clinical trials

and have limited data. However, APRV has significantly improved oxygenation and respiratory system compliance in ARDS cases [Zhou et al., 2017].

Respiratory Therapists (RT) are crucial medical practitioners who are trained in dealing with respiratory illnesses and crises. Since the Covid-19 pandemic overwhelmed and challenged healthcare practitioners, studies and clinical trials are highly needed to find proper strategies that confront any future pandemic. RTs were crucial during this pandemic due to their experiences and the high demand for mechanical ventilation [Roberts et al., 2020]. According to Saudi Ministry of health, confirmed Covid-19 cases between Mar 2020 and Oct 2021 were more than 800 thousand cases [MOH].

Problem Statement

Covid-19 was a recent pandemic that spread globally. Consequently, little research focused on Covid-19 that compared different mechanical ventilator modalities that were suitable for these cases. Investigating appropriate mechanical ventilation techniques that control the pandemic is necessary to confront any future pandemic. RTs' beliefs and practices of utilizing mechanical ventilation during the Covid-19 pandemic are essential to establish a guideline to manage ventilated Covid-19 cases.

Purpose of the study

This study aims to evaluate the perception, prevalence, and utilization of APRV mode with Covid-19 patients among respiratory therapists in Saudi Arabia. Also, this study showed the prevalence rate of using APRV mode with Covid-19 cases in different regions of Saudi Arabia. The research questions that will be answered in this study are:

1- What was the perception of utilizing APRV mode with Covid-19 patients among RTs in Saudi Arabia?

2- What was the prevalence of using APRV mode with Covid-19 patients between different regions in Saudi Arabia?

3- To what extent did education affect applying APRV mode among SA RTs?

Significance of the study

Respiratory therapy is a profession that has expanded in the field of cardiopulmonary therapy. RTs played a vital role in confronting the recent Covid-19 pandemic crisis. Therefore, this study contributes by improving the knowledge of advanced mechanical ventilation modes. Also, the study addresses the importance of implementing the APRV mode in Covid-19 cases. Moreover, the study can assist researchers who examine the effectiveness of APRV ventilation. This may improve the quality of patient care in the hospital during emergencies.

Assumptions

The several assumptions related to this study are:

1- Using standard ventilatory management protocols with Covid-19 cases among Saudi RTs is limited [Alqahtani et al, 2021].

2- In ventilated Covid-19 cases, APRV may enhance oxygenation, alveolar ventilation, and CO2 clearance [Mahmoud et al., 2021].

3- RTs in the middle and eastern regions of Saudi Arabia have the most application of APRV with Covid-19 cases.

Definition of Terms

1- Coronavirus disease 2019 (Covid-19): an infectious disease that affects the lung and is caused by the SARS-CoV-2 virus.

2- Acute respiratory distress syndrome (ARDS): is an acute respiratory illness characterized by bilateral chest radiographical opacities with severe hypoxemia due to non-cardiogenic pulmonary edema.

3- Airway pressure release ventilation (APRV) is a pressure-controlled mode of ventilation that delivers an almost continuous positive pressure with intermittent, time-cycled, short releases at a lower pressure in which spontaneous breathing is encouraged.

4- Respiratory Therapist (RT) is a healthcare provider specializing in cardiopulmonary therapy.

Limitations

The study examined RTs in Saudi Arabia and their perceptions and prevalence. Therefore, it will be generalized to only one population group. An online survey was sent to 13 respiratory therapy department directors in Saudi Arabia by email. Therefore, it might decrease the validity and reliability of the responses.

Delimitations

This study is limited to RTs in Saudi Arabia, and other clinicians using mechanical ventilation are excluded. Also, due to the higher demand for RTs during the pandemic, many students and interns were working in the hospitals; however, these groups will not be included in the study.

Summary

Mechanical ventilation is a crucial tool that saves critically ill patients' lives in hospitals. Since the need for mechanical ventilation increased and the demand for qualified and trained practitioners significantly increased during Covid-19, research that investigates the perceptions and prevalence is needed. During the Covid-19 pandemic, RTs who were experts in using mechanical ventilation were at the frontline to fight the pandemic and help people. Therefore, utilizing proper mechanical ventilation management is necessary to overcome the pandemic. One of the evidence-based practices with mechanical ventilation is using advanced modes with ARDS. APRV is one of these modes that enhances oxygenation with inverse-ratio ventilation. Many studies were conducted around the world regarding the using APRV mode in Covid-19 cases; however, to the best of the author's knowledge, this is the first study that was conducted in Saudi Arabia.

Chapter II

Literature Review

The following literature reviews demonstrate a review of the works completed by other scholars that are connected to the knowledge and prevalence of using APRV with Covid-19 cases. This literature review's main goal is to show the research gap that exists in this field of study. The databases used to derive the sources were PubMed, Google Scholar, and Saudi Digital Library SDL. Search keywords used in the search were "Covid-19", "APRV", "APRV with Covid-19", "APRV with ARDS", "Respiratory Therapist in Saudi Arabia", and "Ventilator management with Covid-19". The results show many studies regarding Covid-19 ventilatory management, but only two studies were conducted in Saudi Arabia. Also, several studies related to APRV, and ARDS were found.

This chapter is divided into five sections: a background of the recent Covid-19 disease, an overview of ARDS caused by Covid-19, a discussion of APRV with ARDS, using APRV with Covid-19, and APRV use in Saudi Arabia, during the Covid-19 pandemic.

Background of Covid-19

One of the main infections that primarily affects the human respiratory system is the coronavirus. The Middle East respiratory syndrome (MERS)-Cov and the severe acute respiratory syndrome (SARS)-Cov are two examples of coronavirus that previously caused epidemics and have been classified as being serious threats to public health. Hospitalizations in hospitals with an initial diagnosis of pneumonia of an unknown cause were reported in late Dec 219 (Lu et al., 2020; Rothan & Byrareddy, 2020). The WHO stated that SARS-CoV-2 had the potential to spread globally and spark a pandemic outbreak on February 24, 2020, (Sharma et al., 2021). In addition to affecting the respiratory tract and causing pneumonia,

Covid-19 also impacted the gastrointestinal GI, nervous, or cardiovascular systems (Safiabadi Tali et al., 2021).

The major source of contamination is human-to-human aerosol transmission, which typically occurs through contaminated droplets, hands, or surfaces. Through direct contact with mucosal membranes, virus particles are present in the respiratory system secretions of an infected individual and can spread to other people. (Adhikari et al., 2020; Pascarella et al., 2020). The most popular technique for detecting Covid-19 is still real-time reverse transcription-PCR (RT-PCR) (LeBlanc et al., 2020; Safiabadi Tali et al., 2021). However, other techniques should be considered to diagnose Covid-19 like radiological, serological, and molecular diagnostic methods (Boger et al., 2021).

From an asymptomatic illness to severe respiratory failure, COVID-19 symptoms can differ from person to person (He et al., 2020). In roughly 80–90% of cases, the infection is mild or asymptomatic. Only 10% of cases progress to a serious state, which includes dyspnea, hypoxemia, and extensive (> 50%) radiological lung parenchyma involvement (Pascarella et al., 2020). Common symptoms include fever, cough, fatigue, mild shortness of breath, sore throat, headache, and conjunctivitis (Yang et al., 2020). Only 5% of patients progress to a critical situation, which includes respiratory failure, pneumonia, shock, multiorgan failure, and, in the most severe cases, death, which is usually typically because of ARDS development and multiorgan failure (Pascarella et al., 2020; Xu et al., 2020). The virus is more likely to cause severe interstitial pneumonia, acute respiratory distress syndrome (ARDS), and subsequent multiorgan failure in elderly and multimorbidity patients. However, severe lung injury can occur at all ages affected by the virus (Pascarella et al., 2020).

Covid-19 associated ARDS

Acute respiratory distress syndrome (ARDS) is a complex and heterogeneous syndrome (Thompson et al., 2017). The sudden onset of noncardiogenic pulmonary edema, hypoxemia, and the requirement for mechanical ventilation are the hallmarks of (ARDS), a major cause of respiratory failure in critically ill patients. Approximately 10% of all patients in intensive care units around the world develop ARDS, which most frequently develops in the context of pneumonia, sepsis, aspiration of gastric contents, or severe trauma (Matthay et al., 2019). Inflammation resulting in organ and systemic lung damage is a consistent phenomenon of ARDS. COVID-19 has also been linked to severe hyperinflammatory, cytokine-mediated lung damage (Lentz et al., 2020; Zhou et al., 2020). Non-cardiogenic pulmonary edema and protein-rich fluid leaks are caused by damage to the alveolar epithelium and endothelium [17]. Therefore, affected surfactant, alveolar edema, hemorrhage, decreased lung compliance, increased ventilation-perfusion mismatch, and right-to-left shunting (Lentz et al., 2020; Luks & Swenson, 2020; Thompson et al., 2017). In COVID-19 individuals, this pattern of diffuse alveolar damage has also been observed (Lentz et al., 2020). ARDS was present in most (67–85%) of the patients admitted to an ICU with a confirmed infection of SARS-CoV-2 (Pan et al., 2020).

Healthcare workers from all around the world have been working to treat COVID-19 patients while discovering any potential distinctive characteristics of the illness caused by this unique infection. Whether ARDS caused by SARS-CoV-2 infection has a distinct phenotype that should change current evidence-based management techniques for ARDS, especially those related to ventilator management (Bain et al., 2021; Fan et al., 2020; Rice & Janz, 2020).

(Haudebourg et al., 2020) conducted a prospective monocentric observational study to describe the comparison of Covid-19-associated ARDS with non-Covid-19-associated ARDS in terms of respiratory mechanics and lung recruit ability. Thirty patients in each group were included in this study, and the Berlin definition was used to decide the presence of ARDS. Non-Covid-19 ARDS etiologies were pneumonia (n = 27), pulmonary vasculitis (n = 2), and noncardiogenic shock (n = 1). The author found no difference in respiratory mechanics between Covid-19-related ARDS and non-Covid-19- related ARDS. These mechanics include driving pressure, respiratory compliance, and respiratory resistance. However, lung recruitment was found higher in patients with Covid-19 associated ARDS. In general, Haudebourg et al (2020) study's findings conclude that both groups have heterogeneous respiratory mechanics and a similar clinical picture.

A similar prospective observational cohort study by Bain et al (2021) compared the physiologic parameters, biomarkers, and clinical outcomes of Covid-19- related ARDS and ARDS caused by other etiologies of pneumonia. The study compared 27 Covid-19 ARDS patients with non-Covid-19 ARDS patients with viral ARDS (n = 14), bacterial ARDS (n = 21), and negative-culture pneumonia ARDS (n = 30). Overall, the static compliance, hypoxemic indices, and carbon dioxide clearance showed no differences between the groups. However, delivered minute ventilation was found to be lower in Covid-19 patients compared to bacterial and negative-culture ARDS. Also, IL-6 levels were lower in patients with Covid-19 compared to bacterial and culture-negative ARDS, but not with viral ARDS. Prolonged mechanical ventilation duration and slower weaning from mechanical ventilation were noticeable with Covid-19 ARDS. Furthermore, Bain et al (2021) cites the most frequent rescue maneuvers for gas exchange used with Covid-19 ARDS more than non-Covid19 ARDS. These maneuvers include prone positioning (70.4%, $P < 0.01$), continuous

neuromuscular blockade (74.1%, $P < 0.01$), and extracorporeal membrane oxygenation (ECMO) (28%, $P < 0.01$).

Another comparison study between Covid-19 and non-Covid-19 ARDS by (Beloncle et al., 2021) aims to compare the baseline values and longitudinal changes in the ventilatory ratio (VR), oxygenation parameters, and respiratory system compliance (CRS) between the two groups. 112 Covid-19 and 198 non-Covid-19 ARDS were included in the study. The baseline values were collected on day 0 in both groups, while the changing parameters were recorded at 1, 3, and 7 days after the cases confirmed of ARDS in the two groups. Beloncle et al (2021) observed that patients with Covid-19 ARDS have lower ventilatory ratio (VR) than the non-Covid-19 ARDS group on day 1, but this changed dramatically on day 7 with an increase in VR value with the Covid-19 group. Moreover, the finding of CRS was significantly higher with Covid-19 ARDS on day 1, but, CRS on day 7 was the same in both groups.

APRV with ARDS

Mechanical ventilation is a crucial tool that is used in clinical practice with patients who have significant breathing complications. Some respiratory disease that requires mechanical ventilation developed into acute respiratory distress syndrome (ARDS). Mechanical ventilation support is the main treatment or management of ARDS due to the absence of pharmacological therapies (Fan & Stewart, 2006). Clinicians have developed many ventilatory techniques to manage ARDS. The conventional protective lung strategy is a method where the ventilator set a low tidal volume combined with a high PEEP level to prevent over-distension and enhance lung recruitment. However, the mortality rate is still significant for patients who received this method (Zhou et al., 2017). Recent studies have

recommended using new open-lung ventilation strategies with ARDS patients (Facchin & Fan, 2015). Airway pressure release ventilation (APRV) is an alternative open-lung strategy mechanical ventilation mode that recruits the lung by using high mean airway pressure. This mode is considered by clinicians when the plateau pressure is more than 30 cm H2O, FIO2 is more than 0.6 mm Hg, PEEP is more than 15 cm H2O, and SaO2 is less than 90% (Stawicki et al., 2009).

APRV was described by Stock and Downs in 1987 as a ventilatory mode with a prolonged continuous positive airway pressure (CPAP) to ensure adequate airway opening and a release time to eliminate CO2 (Jain et al., 2016). This mode is considered a pressure control mode with 2 levels of CPAP (P_{high} and P_{low}) that have a preset time (inspiratory time called T_{high} and expiratory time called T_{low}) and the patient is allowed to breathe spontaneously during both levels (Mireles-Cabodevila & Kacmarek, 2016). APRV has the concept of inverse the inspiratory to expiratory (I:E) ratio to ensure a shortened expiratory time that keeps alveoli open with adequate tidal volume. Although many studies have evaluated the effectiveness of this mode, still there is a gap in the knowledge of how to initiate the mode and the titration recommendations among clinicians (Fredericks et al., 2020). However, early implementation of APRV with ARDS patients has improved oxygenation, reduced sedation, decreased plateau pressure (P_{plt}), and shortened the length of stay in the ICU (Zhou et al., 2017).

Mireles-Cabodevila & Kacmarek (2016) evaluated the advantages and disadvantages of using APRV as the primary mode in ARDS. The evaluation between the pros and cons was based on three characteristics. First is safety, to prevent lung injury. Second, patients' comfort should be maintained via patient-ventilator synchrony. Most therapists think APRV will reduce the work of breathing (WOB), thus there will be more synchrony between the patient and the ventilator. The authors mentioned studies that showed a trend of desynchrony.

Finally, decreasing the duration of mechanical ventilation in APRV compared to conventional ventilator modes. Mireles-Cabodevila & Kacmarek (2016) report that there are no data that support that the patients have a chance to disconnect from the ventilator in APRV faster than in conventional modes. However, one study confirmed a longer length of mechanical ventilation with APRV rather than in patients with conventional ventilation modes.

Zhou et al (2017) discussed the benefit of early implementation of APRV over a low tidal volume (LTV) strategy in patients with ARDS. This study was conducted on 138 patients who received mechanical ventilation and randomly divided these patients into two groups, who received APRV or LTV. The results showed that the APRV group with a lower number of days in the ICU compared to the LTV group. Also, the APRV group had a mortality rate lower than LTV. Moreover, early implementation of APRV has been shown to improve lung compliance, oxygenation, and plateau pressure.

APRV with Covid-19

Mechanically ventilated COVID-19 patients typically fall under the criteria of ARDS (Arentz et al., 2020; Bhatraju et al., 2020). Therefore, respiratory failure caused by COVID-19 can be treated with the ARDS treatments that have been established over many years (Lentz et al., 2020; Rice & Janz, 2020; Ziehr et al., 2020). Covid-19 cases who need invasive ventilation have a high mortality rate of 83% (Zorbas et al., 2021). There is limited data about the use of invasive ventilation for Covid-19 disease.

A study by (Mahmoud et al., 2021) was one of the first studies that investigated the effectiveness of using APRV with Covid-19 patients. A retrospective analysis of 60 patients diagnosed with Covid-19 who developed refractory hypoxemia and switched to APRV for a minimum of 8 hours. The study compares three major parameters before and after utilizing

APRV, oxygenation, ventilation, and dynamic compliance. The improvement in oxygenation was noticeable with an increase in the P/F, PaO2, and a decrease in FIO2. Also, ventilation has been improved after using APRV with a reduction in PaCO2 and minute ventilation. While TV was increased during APRV, the result showed no difference in dynamic compliance before and during the trial. Mahmoud et al (2021) study showed that APRV in Covid-19 patients may improve oxygenation and alveolar ventilation. This is because of the higher airway pressure provided by APRV resulting in a decrease in dead space ventilation and improved with alveolar recruitment. However, the implementation of APRV as a primary mode with Covid-19 is still unclear yet.

(Joseph et al., 2020) conducted a study using APRV on COVID-19 patients. The authors aimed to determine if APRV is beneficial for ARDS patients caused by COVID-19. In a surgical intensive care unit (SICU) they had 12 patients eligible based on the study's criteria. By observing the patients while using proper APRV based on settings, Joseph et al found that APRV improves oxygenation, reduces the need for sedation, and reduces the length of stay in ICU for COVID-19 patients.

A similar observational study by Zorbas et al (2021) was conducted to evaluate the clinical outcomes of Covid-19 patients who received APRV and compared it with other ventilator modes. Twenty-five confirmed Covid-19 patients, with eleven of whom received APRV, while the other 14 patients have received other modes of ventilation. The study results showed a significant reduction in 90-day survival with the APRV group compared to the conventional ventilator mode group. However, the APRV group was associated with significantly higher driving pressure, higher tidal volumes, and lower respiratory compliance than the conventional group.

A systematic review by (Roshdy et al., 2019) was conducted to investigate the use of APRV in patients who have Covid-19. Seven studies that evaluated the effectiveness of APRV in comparison to conventional mechanical ventilation (CMV) in COVID-19-related to acute hypoxemic respiratory failure in adults. These studies included 354 patients in their comparison. The review results showed that when compared with CMV, APRV improves gas exchange in adult patients who have COVID-19 and require mechanical ventilation; nevertheless, there was no difference in mortality or ventilator-free days between the two. However, the results were limited due to the poor quality of the available studies and the small number of patients who participated in the study.

APRV in Saudi Arabia

According to research, the participation of respiratory therapists (RT) in the care of patients suffering from respiratory problems leads to significant improvements in crucial outcome measures. More than three decades have passed since respiratory care services (RC) were first used by RTs in the Kingdom of Saudi Arabia (KSA)(Alotaibi, 2015). Based on a study describing how advanced mechanical ventilation is used among RTs in the critical care units (ICUs) of hospitals located in the Eastern Province of Saudi Arabia, only (19.83%) of a total of 83 participants reported that they use APRV in their practices(Aljuaid et al., 2019).

(Al Obead et al., 2021) conducted a cross-sectional study that examine the prevalence of utilizing APRV mode among RTs in the Eastern Province (EP) of Saudi Arabia, as well as their knowledge and perception of utilizing APRV on patients who have ARDS. Fifty two RTs respond to the survey from different 6 hospitals in the EP and showed a general level of knowledge about ARDS and APRV mode. However, the APRV was utilized by the majority of hospitals in the EP (96%) and by more than 80% of the respondants, of which 50% had positive results. Also, when APRV was used, the majority of patients (98%) were diagnosed

with acute respiratory distress syndrome. Al Obead et. al. study was the first study that investigated the prevalence of using APRV in SA. Additional research on RTs, involving APRV and ARDS in SA, is required, preferably with a bigger sample size and incorporating several parts of the country.

Summary

Covid-19 was a pandemic that overwhelmed hospitals and healthcare workers around the world due to the lack of resourses on how to treat affected patients. As many studies have discussed the difference between Covid-19-associated ARDS and non-Covid-19 ARDS, yet no study confirmed these phenomena. The clinical picture of ARDS caused by Covid-19 is most likely the same as Berlin's definition of ARDS. Therefore, Covid-19-associated ARDS should be treated and managed as regular ARDS. In patients diagnosed with ARDS, APRV was shown to enhance oxygenation, shorten the length of time patients spent in the ICUs and hospitals, lower mortality rates, and stable hemodynamic conditions. In clinical settings, advanced mechanical ventilation such as APRV were not utilized to their full potential, and their significance was likely underappreciated by those working in adult critical care. It is necessary to do more research to overcome the potential obstacles that may prevent the usage of more advanced ventilator modes, which may enhance the outcomes for patients.

Chapter III

Methodology

This study aims to evaluate the perception, prevalence, and utilization of APRV mode with Covid-19 patients among respiratory therapists in Saudi Arabia. Also, this study will show the prevalence rate of using APRV mode with Covid-19 cases in different regions of Saudi Arabia. In this chapter, we will describe how the designed methods will be applied in the following addressing questions:

1- What was the perception of utilizing APRV mode with Covid-19 patients among RTs in Saudi Arabia?

2- What was the prevalence of using APRV mode with Covid-19 patients between different regions in Saudi Arabia?

3- To what extent did education affect applying APRV mode among SA RTs?

Instrument

The survey instrument utilized was a self-administered questionnaire developed by Alobead et al (2021) based on current findings in the field (see appendix A). The survey was examined for face validity by five respiratory therapy educators from Georgia State University (GSU). The survey instrument included 29 validated questions and was divided into three sections to obtain information from respondents. These sections are demographic data, perceptions regarding APRV and ARDS, and the prevalence of utilizing APRV on patients with Covid-19 associated ARDS. The demographic information was collected to better understand the RT's knowledge of using APRV with Covid-19 associated ARDS among different regions in SA. Also, In the question "how do you rate the effectiveness of using APRV with Covid-19 associated ARDS", RTs were given a scale of 1-5 to rate the effectiveness of using APRV with Covid-19 cases during the pandemic. While 1 represents

"very poor", 5 means "strong". The online survey was sent to 13 respiratory therapy department directors in Saudi Arabia by email and they were asked to distribute it to their employees.

Sample

This research project used a sample population that was classified as a non-probability convenience sample. Because RTs have responsibility for ARDS patients and perform the APRV mode of ventilation, this study intended to include RTs in SA regardless of their positions or credentials. The inclusion criteria were all Registered RTs with Saudi Commission for Health Specialties working in clinical settings and who worked with Covid-19 patients, either in public or private hospitals, in SA. This included RTs with a diploma, bachelor, master, or Ph.D. in respiratory therapy. The Exclusion criteria was Non-RTs, RTs not practicing in Saudi Arabia, and RT students and interns who were volunteers during the pandemic.

Study design

The research consisted of an online questionnaire, which was made available via an online link. Qualtrics XM through the GSU website was used to administer the survey and collect the data. After receiving approval from the IRB, a link to an online survey was sent to the directors of the RT department's emails, and they were asked to send it to their staff. Reminder was sent to the same emails after two weeks. On the first page of the survey, the participants were asked to indicate whether or not they are willing to take part in the study. In addition, it was made clear in the survey that participation in this research project was voluntary, and that participants had the right to withdraw from the study at any time and without having to provide any explanations. The questionnaire had two different kinds of

questions: multiple-choice questions (also known as MCQs), and questions that needed a yes or no answer.

Data Analysis

Statistical Package for the Social Sciences SPSS (version 28) was used to analyze and evaluate the statistical studies that were included in the study. Calculation included the standard deviation, the mean, the frequency, and the total number of participants, in addition to determining the differences between the hospitals and the respondents regarding the use of APRV with Covid-19 in different regions in SA. Chi-square test was used to assess the prevalence about using APRV with Covid-19 cases among RTs. Also, the Kruskal-Wallis test was used to correlate between RTs' level of education and the utilizing APRV with covid-19.

Confidentiality

The study proposal was submitted to the Institutional Review Board (IRB) at GSU. Human subjects' protection measures were carefully enforced. When a participant returned a questionnaire for this study, they deemed to have given their permission. The survey's anonymity and confidentiality were ensured. Additionally, participants were not required to utilize email to submit their comments when the survey was conducted online, which eliminated any possibility of indirect identification. All surveys were removed once data analysis was completed.

Informed consent

Clicking the "agree" button resulted in the participants giving their consent to take part in the study. Participants were allowed to respond to the survey questions once they had provided their informed consent (see appendix B). However, if at any point during the research the participants felt that they could not safely continue with the study, they were given the option to quit on their own time.

Summary

This study utilized a self-administered questionnaire with 29 validated questions in three sections, including demographic data, perceptions regarding APRV and ARDS, and prevalence of utilizing APRV on Covid-19 associated ARDS patients. The online survey was sent to RT department directors, who distributed it to their employees. The sample population included registered RTs with Saudi Commission for Health Specialties working in clinical settings and who worked with Covid-19 patients in public or private hospitals in Saudi Arabia. Statistical Package for the Social Sciences SPSS was used for data analysis, and confidentiality and informed consent were ensured. The research design utilized a non-probability convenience sample, and the survey included multiple-choice and yes/no questions.

CHAPTER IV

Result

This study aims to evaluate the perception, prevalence, and utilization of APRV mode with Covid-19 patients among respiratory therapists in Saudi Arabia. Also, this study showed the prevalence rate of using APRV mode with Covid-19 cases in different regions of Saudi Arabia. The statistical analysis of the study and the participants' demographic information will be covered in this chapter. Statistical Package for the Social Sciences 28, also known as SPSS 28, was utilized in order to carry out the statistical analysis for this study. A separate analysis of the findings will be given in relation to the following study's questions:

1- What was the perception of utilizing APRV mode with Covid-19 patients among RTs in Saudi Arabia?

2- What was the prevalence of using APRV mode with Covid-19 patients between different regions in Saudi Arabia?

3- To what extent did education affect applying APRV mode among SA RTs?

Demographic Findings

The demographic data was collected in order to provide a description of the population. Eighty-six responses were obtained from the online survey that was sent to many respiratory therapy departments in different regions across SA. Two participants refused to participate, and n=47 (54.7%) of respondents did not complete the survey, and their answers were excluded. Therefore, there were n=37 (43%) respondents who completed the survey. The majority of respondents were male n=31 (83.8%), whereas the female accounted for n=6 (16.2%) of respondents. Most of the respondents held a bachelor's degree n=32 (86.5%), while five (13.5%) held a master's degree. There were no respondents who held associate or Ph.D. degrees. More than half of the RTs who participated in the survey graduated from

Saudi Arabia n=27 (73%). Others graduated from The United States, or the Philippines with n=7 (18.9%), and n=3 (8.1%) respectively. Most of the respondents had five or fewer years of experience n=27 (73%), and only n=10 (27%) had more than five years of experience. The west and the middle regions of SA had the highest responses with n=16 (43.2%), and n=12 (32.4%) respectively. The other responses were from the south and east regions of SA with n=6 (16.2%), and n=3 (8.1%) respectively. There were no responses from the northern region. In the table below, further demographics are broken down in greater detail (Table.1)

Table 1. Demographic Data among Respiratory Therapists in Saudi Arabia.

Demographics	N (%)
Gender	
- Male	31 (83.8%)
Female	6 (16.2%)
Level of education	
- Bachelor	32 (86.5%)
- Master	5 (13.5%)
Graduation country	
- Saudi Arabia	27 (73%)
- The United States	7 (18.9%)
- Philippines	3 (8.1%)
Years of experience	
- 0-5 years	27 (73%)
- 5< years	5 (13.5%)
- 10< years	5 (13.5%)

Working region	
- West	16 (43.2%)
- Middle	12 (32.4%)
- South	6 (16.2%)
- East	3 (8.1%)

Findings Related to Research Question 1

The first research question was, "What is the perception of utilizing APRV mode with Covid-19 patients among RTs in Saudi Arabia?" This question aimed to evaluate the understanding of the RTs, as well as their ability to identify and use APRV in patients with Covid-19. The results showed that RTs were comfortable using APRV with Covid-19 cases with a mean of (2.97± 0.763). RTs showed a moderate to a high level of knowledge about APRV and ARDS as seen in (figure.1). Respondents answer what does APRV refer to, and 88.5% (n=32) choose the correct answer which is Airway Pressure Released Ventilation. More than half of the respondents n=24 (54.1%) choose the accurate Berlin definition of ARDS. However, n=8 (21.6%) of respondents were close to the accurate answer (Table.2). Furthermore, the results showed that RTs believed that Covid-19 associated ARDS had a similar clinical picture of non-Covid-19 associated ARDS n=28 (75.7%) (Table.3). Although this question provides insights into the perception and knowledge of RTs in Saudi Arabia regarding the use of APRV with Covid-19 patients, the results cannot be generalized on all RTs across SA due to the small number of respondents.

Figure.1 What does APRV refer to?

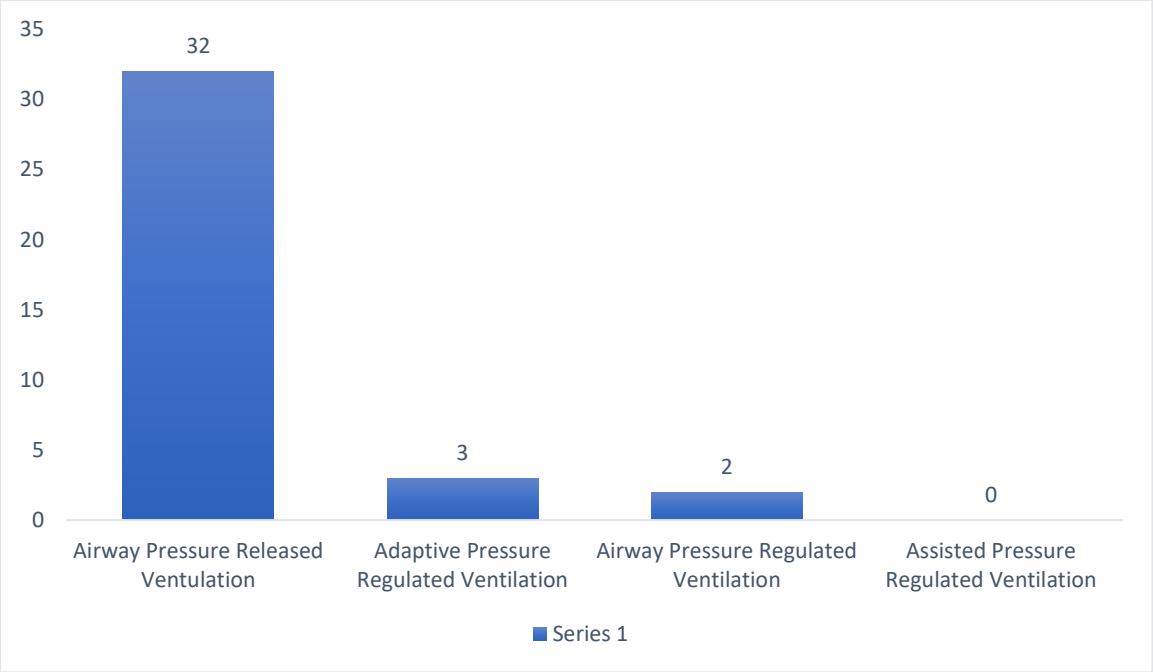

Table.2 The Berlin definition of ARDS

Question	N (%)
Acute onset, bilateral lung infiltration. P/F ratio ≤ 100 mm Hg on PEEP ≥ 5 cmH20	**20 (54.1%)**
Acute onset, bilateral lung infiltration, P/F ratio ≤ 200 mm Hg on PEEP ≥ 5 cmH2O	8 (21.6%)
Bilateral lung infiltration, SPO2 ≤ 90%, P/F ratio ≤ 100 mm Hg on PEEP ≤ 5 cmH2O	7 (18.9%)
Acute onset bilateral infiltration, SpO2 ≤ 90% on PEEP ≥ 5 cmH2O	2 (5.4%)

*Correct answer is bolded.

Table.3 Comparison between Covid-19 associated ARDS and non-Covid-19 associated ARDS

Based on your knowledge, do you believe that Covid-19 associated ARDS had the same clinical picture as the Berlin definition?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	28	75.7	75.7	75.7
	No	9	24.3	24.3	100.0
	Total	37	100.0	100.0	

Findings Related to Research Question 2

The second research question asked, " What is the prevalence of using APRV mode with Covid-19 patients between different regions in Saudi Arabia?" Most RTs confirmed that they use ARDS protocols in their hospital 86.5% (n=32). However, more than half of the respondents answered that their protocols do not include APRV with the ARDS protocols, 54.1% (n=20) (Table.4). When asked were RTs, " During the pandemic, have you ever used APRV mode on Covid-19 associated ARDS patients?", 51.4% (n=19) answered "Yes". A Kruskal-Wallis Test revealed no significant difference in using APRV with Covid-19 cases during the pandemic between the region of practice in Saudi Arabia; Kruskal-Wallis H=3.219, p=.395 (Table.5).

Table.4 Prevalence of using APRV with Covid-19 cases during the pandemic among SA RTs

Using APRV during the pandemic	N (%)
In your hospital, do you use ARDS protocols?	
- Yes	32 (86.5%)
- No	5 (13.5%)
Is APRV included in your ARDS protocols?	
- No	20 (54.1%)
- Yes	17 (45.9%)
During the pandemic, did you ever use APRV mode on Covid-19 associated ARDS patients?	
- Yes	19 (51.4%)
- No	18 (48.6%)

Table.5 Kruskal-Wallis Test comparing using APRV with Covid-19 cases during the pandemic in different regions across SA

Total N	37
Test Statistic	3.219
Degree Of Freedom	3[a]
Asymptotic Sig.(2-sided test)	.359

A Kruskal-Wallis test showed no significant difference, which is mean that the use of APRV mode is not influenced by the geographic location of the RTs in Saudi Arabia.

Findings Related to Research Question 3

The third research question asked, " To what extent does education affect applying APRV mode among SA RTs?". A Chi-square test was performed to show the correlation between participants' qualifications and the utilizing APRV with ARDS cases. The results showed that there was no significant difference among different qualifications (p=0.875). (Table.6). One possible explanation for this result is that RTs in Saudi Arabia, regardless of their education level, have a strong background knowledge about APRV. This means that they may be equally comfortable using APRV, regardless of their level of education.

Table.6 Correlation between participants' qualifications and utilizing APRV with ARDS.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.025[a]	1	.875		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.025	1	.875		
Fisher's Exact Test				1.000	.633
Linear-by-Linear Association	.024	1	.877		
N of Valid Cases	37				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.16.

b. Computed only for a 2x2 table

Summary

The chapter describes the findings related to the three research questions in the study. The results showed that the responders RTs had a good belief in the effectiveness of APRV mode with COVID-19 cases, as well as a moderate to high level of knowledge about APRV and acute respiratory distress syndrome (ARDS). Most of the RTs confirmed having an

ARDS protocol in their hospitals, but more than half did not include APRV with their protocol. Moreover, no significant difference was found in using APRV with COVID-19 cases during the pandemic between different regions of practice in Saudi Arabia. Education level did not affect the application of APRV among RTs in Saudi Arabia, which could be because of the strong background about APRV among RTs with different education levels. However, the results cannot be generalized on all RTs across Saudi Arabia due to the small number of respondents.

Chapter V

Discussion

This chapter provides a discussion of the results reported in the previous chapter. This chapter provides an overview of the study, a discussion of the findings, implications for research, limitations of the study, recommendations for future research, and a conclusion.

Overview of the Study

This study evaluated the perception, prevalence, and utilization of APRV mode with Covid-19 patients among respiratory therapists in Saudi Arabia. Also, the prevalence rate of using APRV mode with Covid-19 cases in different regions of Saudi Arabia were examined. The findings are in relation to the following study's questions:

1- What was the perception of utilizing APRV mode with Covid-19 patients among RTs in Saudi Arabia?

2- What was the prevalence of using APRV mode with Covid-19 patients between different regions in Saudi Arabia?

3- To what extent did education affect applying APRV mode among SA RTs?

Discussion of Findings

Findings Related to Research Question 1

The first research question was, "What is the perception of utilizing APRV mode with Covid-19 patients among RTs in Saudi Arabia?" The results of the study indicate that RTs in Saudi Arabia have a moderate to a high level of knowledge about APRV and ARDS. When asked to define APRV, the majority of respondents provided the correct answer, indicating a good understanding of the mode. In addition, over half of the participants chose the accurate Berlin definition of ARDS, which is "acute onset, bilateral lung infiltrates with P/F ratio ≤ 100 mm Hg on PEEP ≥ 5 cmH2O. However, many respondents were close to the Berlin definition which indicates they had a good background about ARDS, but they could not recall the accurate definition. These findings are supported by Al Obead et al (2021), who assert that most of the RTs had a level of adequate perception regarding APRV and ARDS in the Eastern Provine of Saudi Arabia. The findings are helpful because they indicate that RTs in SA have the necessary knowledge to provide appropriate care to patients with ARDS using APRV.

Mechanically ventilated COVID-19 patients typically fall under the criteria of ARDS (Arentz et al., 2020; Bhatraju et al., 2020). Similarly, the results of the study showed that RTs in SA believed that Covid-19 associated ARDS had a similar clinical picture of non-Covid-19 associated ARDS n=28 (75.7%). Therefore, respiratory failure caused by COVID-19 can be treated with the ARDS treatments that have been established over many years (Lentz et al., 2020; Rice & Janz, 2020; Ziehr et al., 2020).

Findings Related to Research Question 2

The survey found that most of the RT's n=32 (86.5%) reported having an ARDS protocol in their hospital, which suggests that these healthcare facilities are aware of the importance of having a standardized approach to managing patients with ARDS. However, only about half of them (54.1%) included APRV in their protocol, which highlights a potential gap in knowledge or training related to this mode of ventilation. Comparing with a study conducted in The Eastern province of Saudi Arabia by Aljuaid et al., (2019) mentioned that only (19.83%) of a total of 83 participants reported that they use APRV in their practices. However, the study involved all regions in SA. Moreover, findings found no significant difference in the use of APRV with COVID-19 cases during the pandemic between the regions of practice in Saudi Arabia. This suggests that the use of APRV mode is not influenced by the geographic location of the RTs in Saudi Arabia.

Compared to (Al Obead et al., 2021) study, this study had a fewer numbers of respondents in the eastern province n=3 compared to n=51. This might be because in their study they sent the survey to 6 hospitals in the eastern province, while this study was sent the survey to 2 hospitals. Moreover, the survey that was used in both studies was similar, therefore, survey fatigue could be another reason for the small number.

Overall, these findings suggest that while there is some knowledge and use of APRV among RTs in Saudi Arabia, there is still room for improvement in terms of incorporating APRV into ARDS protocols and increasing its use among COVID-19 patients who may benefit from this mode of ventilation.

Findings Related to Research Question 3

The third research question asked, " To what extent does education affect applying APRV mode among SA RTs?". The research question was investigating the relationship

between education level in respiratory therapy and utilizing the APRV mode of ventilation in patients with ARDS. The results showed there was no significant difference between the different qualifications.

This suggests that having a graduate degree in respiratory therapy may not significantly impact the use of APRV mode in ARDS cases among SA RTs. However, it is important to note that the results may be limited by the specific sample of participants and other factors that were not accounted for in the study. Further research may be needed to confirm these findings and to investigate other factors that may influence the use of APRV mode in clinical practice.

Implications for Research

The findings of this study have important implications for respiratory therapists, healthcare providers, and policymakers in Saudi Arabia and beyond. It suggests the need for ongoing education and training around the use of APRV mode and the importance of establishing standardized protocols and guidelines for its use in the treatment of COVID-19 and other respiratory illnesses. It is essential to have a protocol like a protective lung strategy, which is applying a high PEEP with a low tidal volume to enhance the oxygenation and reduce overdistention for minimizing mortality rates among patients with ARDS. The overall level of perception of APRV needs to be improved, which, in turn, can improve and strengthen the management of ARDS and respiratory disorders and increase the average survival rate in Saudi Arabia. More educational sessions and classes are required for this purpose. Additionally, the study highlights the need for further research into the factors that influence the use of APRV mode in clinical practice and the potential impact of different qualifications and levels of training on its utilization.

Limitations of the study

The current study has some limitations due to a variety of reasons. The major limitation of this study is the relatively small number of respondents who participated in the survey. Also, the findings of this study cannot be generalized to all RTs' perceptions due to the use of only one cultural background. There is a lack of studies that discuss the perception and prevalence of using APRV among respiratory therapists toward COVID-19 patients. As a result of this, it was difficult to compare the findings of this research to those of other studies linked with respiratory therapy due to the limited amount of research that had been conducted in this particular field.

Recommendation for future study

Due to the limited number of studies on this topic, further studies are recommended to examine respiratory therapists' perception toward APRV and its use with ARDS. In addition, replication of the study with a larger sample size is recommended to validate the findings presented in this study. Moreover, the study showed that many hospitals in SA do not include APRV in their ARDS protocol. Therefore, conducting studies that evaluate and show the benefits of using APRV with ARDS cases and how can APRV improve the use of protective lung strategy are needed.

Conclusion

This study was the first study to our knowledge that assessed the perception and prevalence of using APRV with COVID-19-associated ARDS among respiratory therapists in Saudi Arabia. The study found that RTs in Saudi Arabia have a good level of knowledge and a high level of confidence in using APRV mode. The study also found that there was no significant difference in the use of APRV mode among participants with different qualifications and that the use of APRV mode is not influenced by the geographic

location of the RTs in Saudi Arabia. The study suggests the need for ongoing education and training around the use of APRV mode, and the importance of establishing standardized protocols and guidelines for its use in the treatment of COVID-19 and other respiratory illnesses.

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Appendix A: Survey

Survey

I. Prevalence of using APRV on Covid-19 associated ARDS

1. Are you aware of the Berlin definition of ARDS? □ Yes □ No
2. In your hospital, do you have an 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 a 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. During the pandemic, have you ever used APRV mode on Covid-19 associated ARDS patients? □ Yes □ No

11. Which of the following is correct in regard 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

12. During the pandemic, had you considered using APRV in severe Covid-19 associated 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 _____

13. In the majority of times you have used APRV on Covid-19 associated 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 with Covid-19 associated ARDS
    e) Other _____

14. In your hospital, have you used or combined other management practices rather than APRV with Covid-19 associated ARDS patients? □Yes □No

15. If yes, which of the following you used?

a) Decrease neuromuscular blocker (to enhance spontaneous breathing).

b) Prone positioning.

c) Both

d) No, we only use 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

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

7. 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

8. Based on your knowledge, do you believe that Covid-19 associated ARDS had the same clinical picture as the Berlin definition? □Yes □No
9. If no, which of the following was different?

a) Covid-19 associated ARDS had different CXR interpretations compared with non-Covid-19 ARDS.
b) Covid-19 associated ARDS had different ABG interpretations compared with non-Covid-19 ARDS.
c) Both.

d) Other _____

10. On a scale of 1-5, how do you rate the effectiveness of using APRV with Covid-19 associated ARDS? 1□ Very poor 2 □ Poor 3 □ Good 4 □ Very good 5 □ Strong

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

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

III. Demographics

In which region of Saudi Arabia did you practice the Respiratory therapy profession during the Covid-19 pandemic? □ Middle □ East □ North □ West □ South

- 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:

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Research advisor Dr. Lynda Goodfellow: Ltgoodfellow@gsu.edu

Appendix B: Informed consent

Dear Respiratory Therapist, you are invited to a research study because you are taken part in a clinical setting as a registered respiratory therapist. This study aims to evaluate the perception, prevalence, and utilization of APRV mode with Covid-19 patients among respiratory therapists in Saudi Arabia. Also, this study will show the prevalence rate of using APRV mode with Covid-19 cases in different regions of Saudi Arabia.

Jihad Alrehaili is conducting this research study as part of the requirements for the master's degree in respiratory therapy from the Department of Respiratory Therapy at Georgia State University, under the guidance of Dr. Lynda T. Goodfellow, Professor and Senior Associate Dean for Academic Affairs.

Although there will be no direct benefit to you from participating in this study, the information gathered will improve healthcare quality for respiratory care services. If you choose to participate, you will be required to complete the following survey, which should take no more than 10 minutes.

Your participation is entirely voluntary, and you may refuse or discontinue taking the survey at any time without penalty or loss of benefits to which you are otherwise entitled. Please note that your responses are used exclusively and entirely confidential for research purposes. To protect your privacy, no names or codes will be used to identify you or your survey. Your completion and submission of the survey constitute your agreement to take part in the study.

We look forward to the completion of your survey. However, you may withhold at any time by not completing or sending a blank survey if you decide not to participate in this study. The information from this study may be published in journals and presented at professional meetings. This study does not cost the participant in any way, except for the time spent completing the survey.

If you have any questions about this research, now or in the future, don't hesitate to contact Jihad Alrehaili at jalrehaili2@student.gsu.edu or Dr. Lynda Goodfellow at ltgoodfellow@gsu.edu. The department's mailing address can be found at the bottom of this page. You may also contact the Georgia State University IRB at https://gsu.imedris.net/. Please note: Completion and submission of this survey imply that you have read this information and consent to participate in the research.

Your completion and submission of the survey imply 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.

Please note: If you agree to participate in this research, please continue with the survey.

o I Agree o I Disagree

Sincerely,

Jihad Alrehaili

Dept. of Respiratory Therapy

Georgia State University