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**A survey of prevalence and experience of the Adaptive Support  
Ventilation (ASV) mode among respiratory care practitioners in  
the Eastern Province of Saudi Arabia**

By

Zainab A. Alrastem

Presented in Partial Fulfillment of Requirements for the

Degree of

Master of Science

in

Health Sciences

in

the Department of Respiratory Therapy

Under the supervision of Dr. Lynda T. Goodfellow

in the

Byrdine F. Lewis College of Nursing and Health Professions

Georgia State University

Atlanta, Georgia

2021

## ACCEPTANCE

This thesis, A survey of prevalence and experience of the Adaptive Support Ventilation (ASV) mode among respiratory care practitioners in the Eastern Province of Saudi Arabia, by Zainab A. Alrastem, was prepared under the direction of the Master's Thesis Advisory Committee of the Respiratory Therapy department at Georgia State University. It is accepted by the committee in partial fulfillment of requirements for the Master's of Science degree in Respiratory Therapy at Byrdine F. Lewis School of Nursing and Health Professions, Georgia State University.

The Master's Thesis Advisory Committee, as representatives of the faculty, certifies 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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## **DEDICATION**

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

This thesis is dedicated to my beloved parents, who supported me with their endless love and encouragement throughout my life.

To my husband, I cannot express my heartfelt thanks for him. I am forever grateful for his endless love and inspiration. His tremendous support and encouragement helped me a lot to achieve one of my biggest accomplishments.

I would like to thank all my sisters and brothers who have shared their kind words and enormous support to finish this thesis.

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## ABSTRACT

**Background:** Adaptive support ventilation (ASV) is an improved ventilatory mode that uses a closed-loop controlled system between breaths using the least required setting for minimal breathing work based on patients' demands and lungs mechanics. ASV mode has significant outcomes when used with different lung conditions. Despite the known literature about the effectiveness of ASV mode, there is a lack of research that addresses RTs' practice regarding ASV mode.

**Purpose:** This study aimed to determine what is known about the ASV mode practice in the Eastern Province hospitals of Saudi Arabia among RTs and explore the potential reasons for not applying ASV mode.

**Methods:** A cross-sectional study was designed as a self-administered questionnaire developed from the literature review. The questionnaire was examined for validity by three experts of respiratory therapy educators from Georgia State University. The survey instrument includes two parts. The population was a convenience sample of RTs. An online link was distributed to 183 RTs from eight hospitals via their official e-mails. RT students, interns, and other healthcare providers were excluded.

**Results:** A total of 64 RTs responded. The majority of respondents were bachelor's degree holders (89.1%), and the mean of the respondents' experience years was  $7.4 \pm 5.12$  SD years. More than half of respondents used ASV mode (59.4%), whereas the remaining (40.6%) have never used the ASV mode before. For those who used ASV mode (n=38), only (42.1%) used the ASV mode protocol. Most RTs picked the correct answers regarding the initial parameters, essential features, and patient types (97.4%, 65.8%, and 60.5%, respectively). 58% of RTs do not prefer to use ASV mode as an initial mode, but 65.8% prefer to use ASV as a weaning mode and agreed that ASV mode could facilitate the weaning process and shorten mechanical ventilation duration 81.6% and 79%, respectively. 73.7% would suggest other RTs use ASV mode. There were no significant differences between the RTs' perceptions regarding ASV mode based on their current positions. Those who never used ASV mode (n=26) revealed their reasons as follows, lack of equipment (65.4%), lack of knowledge (38.5%), unfamiliar with ASV mode (38.5%), and the physicians are unfamiliar with ASV (38.5%).

**Conclusion:** The study showed that more than half of RTs from hospitals in the Eastern Province have used, were familiar with ASV mode, and have positive perceptions toward ASV mode. The most apparent reason for not applying ASV mode is the lack of equipment. Besides the known publications about the effectiveness of ASV mode, the present study adds to the limited body of knowledge to what extent RTs know and use the ASV mode. Further research is highly recommended with a larger number of participants from various regions of Saudi Arabia.



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## **List of Abbreviations**

A/C: ASSIST/CONTROL

APRV: AIRWAY PRESSURE RELEASE VENTILATION

ARDS: ACUTE RESPIRATORY DISTRESS SYNDROME

ASV: ADAPTIVE SUPPORT VENTILATION

CABG: CORONARY ARTERY BYPASS GRAFT

COPD: CHRONIC OBSTRUCTIVE PULMONARY DISEASE

FIO<sub>2</sub>: FRACTION OF INSPIRED OXYGEN

FRC: FUNCTIONAL RESIDUAL CAPACITY

ICU: INTENSIVE CARE UNIT

ILD: INTERSTITIAL LUNG DISEASE

MINVOL%: MINUTE VOLUME IN TERMS OF PERCENTAGE

MVs: MECHANICAL VENTILATORS

NAVA: NEURALLY ADJUSTED VENTILATORY ASSISTANCE

PACO<sub>2</sub>: PARTIAL PRESSURE OF CARBON DIOXIDE

PAO<sub>2</sub>: PARTIAL PRESSURE OF OXYGEN

PAV: PROPORTIONAL ASSIST VENTILATION

PCV: PRESSURE CONTROL VENTILATION

PEEP: POSITIVE END-EXPIRATORY PRESSURE

PRVC: PRESSURE REGULATED VOLUME CONTROL

PS: PRESSURE SUPPORT

PSV: PRESSURE SUPPORT VENTILATION

RT: RESPIRATORY THERAPIST

RTS: RESPIRATORY THERAPISTS

SBT: SPONTANEOUS BREATHING TRIAL

SIMV: SYNCHRONIZED INTERMITTENT MANDATORY VENTILATION

TV: TIDAL VOLUME

VAP: VENTILATOR-ASSOCIATED PNEUMONIA

VCV: VOLUME CONTROL VENTILATION

VE: MINUTE VENTILATION

WOB: WORK OF BREATHING

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# CHAPTER I

## Introduction

### Background

Mechanical ventilators (MVs) are life-sustaining machines that play an integral role in maintaining critically ill patients' ventilatory support (Spieth, Koch, & Gama de Abreu, 2014). MVs can support patients who have respiratory diseases by ventilating and oxygenating the lungs. (Spieth, Koch, & Gama de Abreu, 2014). However, although lifesaving in many patients, these machines can be associated with possible complications such as ventilator-associated pneumonia (VAP) and mechanical ventilator dependence if they are not discontinued as soon as the patient's condition is resolved (Nguile-Makao et al., 2010). VAP is associated with significant consequences, such as increasing the duration of mechanical ventilation, hospital costs, as well as morbidity and mortality rates (Nguile-Makao et al., 2010), (Warren et al., 2003); thus, health care professionals need to be aware in managing MV to deliver the optimal care of ventilated patients.

Many modern mechanical ventilators have various modalities (including conventional and advanced mechanical ventilation modalities) that provide full and/or partial ventilatory support. Conventional modes of mechanical ventilation are simplistic modes that depend on fundamental principles that deliver full or partial ventilatory support based on the operator's settings; that is, none of the ventilator settings is automatically adjusted. Conventional mechanical ventilation modes include volume/pressure assist/control(A/C), volume/pressure synchronized intermittent mandatory ventilation (SIMV), and pressure support ventilation (PSV) (Lei, 2017). Advanced mechanical ventilation, or adaptive ventilation modes, are designed in which one major controlled parameter is automatically regulated based on the patient's feedback and the particular

algorithms to provide target tidal volume (Lei, 2017), (van der Staay & Chatburn, 2018). These algorithms usually adapt to any change in the patient lungs' mechanics or the breathing pattern to assure an appropriate response (van der Staay & Chatburn, 2018). In the past decades, the most common advanced ventilation modes used are airway pressure release ventilation (APRV), pressure-regulated volume control (PRVC), proportional assist ventilation (PAV), adaptive support ventilation (ASV), neurally adjusted ventilatory assist (NAVA), and SmartCare (Lei, 2017).

More sophisticated advanced modes are closed-loop controlled ventilation modes that provide pressure-controlled with targeted volumes breath by breath based on the breathing pattern and the patients' lung mechanics (Lellouche & Brochard, 2009). Closed-loop controlled system is the use of a feedback signal to control overall ventilatory pattern (Chatburn & Mireles-Cabodevila, 2011); it was developed to provide automatic readjustment of tidal volume and respiratory rate according to the patient's needs to improve patient care outcomes such as adaptive support ventilation (ASV) (Lellouche & Brochard, 2009). ASV is an improved ventilatory mode that uses a closed-loop controlled system between breaths designed to provide minimum minute ventilation in mechanically ventilated patients using the least required setting for minimal work of breathing based on patients' demands and lungs mechanics (Iotti et al., 2010). In the early 1990, ASV mode was established as an intelligent ventilation mode that uses a microprocessor-controlled closed-loop system designed to adjust mechanical ventilation settings breath by breath automatically (Sviri et al., 2012). The principle of ASV working depends on the Otis Equation, which states that for a given level of alveolar ventilation, there is a particular respiratory rate that achieves a minimal work of breathing (Lellouche & Brochard, 2009) (Iotti et al., 2010) (Khamaiseh, 2016). ASV mode can automatically choose the target ventilatory pattern (the target respiratory rate and tidal volume)



inside safety limits to avoid any complications such as dead space ventilation, apnea, barotrauma, and volutrauma, after the setting of desired minute ventilation by the operator (Fernández, Miguelena, Mulett, Godoy, & Martínón-Torres, 2013). In ASV use, the operator needs to insert the exact height and gender to calculate the ideal body weight (IBW). Three main parameters are required to be set for ventilation and oxygenation based on the patient's condition, which are the target percent of minute volume (%MinVol), positive end-expiratory pressure (PEEP), and the fraction of inspired oxygen (FiO<sub>2</sub>) (Fernández, Miguelena, Mulett, Godoy, & Martínón-Torres, 2013). The minute ventilation (VE) is calculated based on the %MinVol and IBW settings (Sviri et al., 2012). ASV automatically adapts the respiratory rate and ventilatory pressure level to maintain a minimum VE in mechanically ventilated patients depending on patients' elastic and resistive compliance loads, either actively or passively breathing ventilated (Sviri et al., 2012), (Arnal et al., 2018).

Many published studies worldwide have clarified that the effectiveness of ASV and its clinical benefits. According to Yazdannik (2019), a study to compare the impacts of ASV and SIMV on intubation duration and hospital stay after coronary artery bypass graft surgery (CABG) found that the ASV mode had a significant positive effect on patients after CABG. ASV reduced the intubation duration and hospitalization days compared to the SIMV. Chen et al. (2011) tested the impact of implementing ASV in a medical intensive care unit and found that ASV helped shorten the intubation time to extubation readiness. Kirakli (2014) compared ASV with PSV in the weaning of COPD patients. This research illustrates similar results between these two modes, but ASV was slightly faster in the weaning of COPD patients to shorten weaning times compared to PSV. Furthermore, ASV mode requires few manipulations and alarms by healthcare professionals compared to other conventional ventilation modes (Petter et al., 2003), and ASV

could associate with reducing the health care team's workload by allowing few manipulations and decreasing the risk of health care team's mistakes (Arnal et al., 2018).

In the Middle East, especially in the Eastern province of Saudi Arabia, few published studies have been conducted on ASV mode. A review study was completed by Al-Marshad (2015) in Dammam city of Saudi Arabia that summarized the clinical implications, recommendations, and limitations of ASV mode. Al-Marshad mentioned that ASV is not recommended for certain types of patients, such as obese patients who underwent thoracic surgery due to their lower functional residual capacity, and also for patients who have an increase in the respiratory drive due to the following conditions: fever, sepsis, or burn; for these patients, the ASV may give less support or misinformation for weaning readiness. Al-Otaibi (2018) performed a study in King Faisal Specialist Hospital and Research Center in Riyadh city that provided various detailed aspects such as the history of dual modes and intelligent-ASV, computerized-base system, and safety applications. Al-Otaibi indicated that ASV is a promising modality for ventilation but suggested further studies to examine the ASV effectiveness.

### **Statement of the problem**

Despite the known literature about the effectiveness of ASV mode in mechanically ventilated patients in several clinical trials, there is a lack of research that addresses how respiratory therapists know, use, or not use the ASV mode. Additionally, it is unclear to what extent the ASV mode is actually used in daily clinical practice. Since RTs play a significant role in managing mechanically ventilated patients, they are expected to have sufficient information about the ASV mode and its use.

## **Significance of the Study**

More research is needed to provide information about the prevalence, familiarity, and perceptions of RTs regarding the ASV mode since no study thus far has looked at evaluating these aspects. This research is needed to advance respiratory therapists' practice in advanced mechanical ventilation management by contributing information about the beneficial features of ASV mode in the clinical practice and widening ASV mode availability.

## **Purpose of the study**

This study aimed to determine what is known about the ASV mode practice in the Eastern Province hospitals of Saudi Arabia among RTs and explore the potential reasons for not applying ASV mode.

## **Research Questions**

**The main questions for this study were:**

1. How widespread is the ASV mode use among RTs in Eastern Province hospitals of Saudi Arabia?
2. Do RTs in Eastern Province hospitals of Saudi Arabia familiar with ASV mode?
3. Are there differences in the perceptions of RTs in the Eastern Province hospitals in Saudi Arabia toward ASV mode based on their current position?

## **Summary**

This chapter presents an important background, the significance of this study, the study purpose, and the research questions. Adaptive support ventilation (ASV) was developed as a closed-loop ventilation mode that provides either pressure control or pressure support ventilation based on the patient's needs. Many published articles clarified that the ASV has significant features

such as fewer manipulations on the MV, facilitating the weaning process, and accelerating the extubation plan, thus shorting the duration of mechanical ventilation and reducing the health care provider's effort. However, there was a lack of information about how widespread the use of ASV was, and how familiar were RTs of ASV, and what perceptions of RTs toward ASV mode.

## **CHAPTER II**

### **REVIEW OF THE LITERATURE**

#### **Introduction**

This literature review explores the most relevant information about the current study and reveals what is known. The goals are to widen the clinical picture of ASV mode with various and similar viewpoints, trying to see it from different angles. The articles in this study were collected from the following databases: Science Direct, PubMed, EBSCO databases, and Google Scholar using a combination of the following key terms: “Advanced Mechanical ventilation modes”, “closed-loop ventilation”, “ASV prevalence”, “ASV knowledge”, “respiratory therapists’ perceptions”, “respiratory therapists in Saudi Arabia”, and “ASV in Saudi Arabia”. Also, this chapter is organized and divided into relevant articles into categories as follows:

1. The development of mechanical ventilation and ASV mode.
2. The effectiveness of ASV mode.
3. Prevalence and knowledge of ASV mode.
4. ASV mode in Saudi Arabia.

The findings showed a variety of publications that reviewed this newer approach in mechanical ventilation. However, there was insufficient research in measuring the prevalence of use, knowledge level, or perceptions among RTs to the ASV mode. The following research questions were used to guide the acquisition of information as follows:

1. How widespread is the ASV mode use among RTs in Eastern Province hospitals of Saudi Arabia?
2. Do RTs in Eastern Province hospitals of Saudi Arabia familiar with ASV mode?

3. Are there differences in the perceptions of RTs in the Eastern Province hospitals in Saudi Arabia toward ASV mode based on their current position?

### **The development of mechanical ventilation and ASV.**

Mechanical ventilators are a fundamental instrument that has become indispensable in all ICUs' hospitals worldwide. Many review studies have examined the historical development of ventilators and explained how valuable mechanical ventilation can be to sustaining patients' lives and how closed-loop controlled ventilation has been an integral part of ventilatory support in everyday practice.

A study was completed by Kacmarek (2011) to review the historical development of mechanical ventilation stated that mechanical ventilators have changed over the years as technology has changed. Today's ventilators are more intelligent and can increase the quality of ventilatory support. During the 1940s and 1960s, the first generation of positive-pressure ventilations became available with limited features that included only volume control, machine-triggered, inspiratory rates, and fixed (I:E) ratio at 1:2. These ventilators provided monitoring for tidal volume, airway pressure, and respiratory rate. In the 1970s to 1980s, the second generation of mechanical ventilators provided volume ventilation and had a patient-triggered inspiration with central alarms for high pressure, low volume, and high respiratory rate. Intermittent mandatory ventilation (IMV) was introduced by Downs et al. to ventilate adult patients during this period. Later, IMV was changed to synchronized intermittent mandatory ventilation (SIMV) by adding demand values. Pressure control ventilation (PCV) and pressure support (PS) were introduced, as was the concept of closed-loop ventilation. The third generation of mechanical ventilation was presented as microprocessor-controlled in which a breathing simulator was used to test each ventilator's triggering response to varying patient inspiratory efforts and control breath delivery.

In this era, most ventilators had new features from the previous generations' ventilators, including new types of modes such as SIMV-PC, flow-triggering, monitoring patient's status and functions of ventilator via different types of waveforms (including pressure, volume, and flow), and also via two types of loops ( including pressure-volume loop and volume and flow loop). Finally, Kacmarek explained that the fourth generation of mechanical ventilators appeared in the late 1990s and are still being developed until today. These ventilators are the most complex mechanical ventilators that have been changed dramatically with technology evolution. One of the most distinguishing features of microprocessor-controlled systems is closed-loop control ventilation in newer ventilation models such as ASV mode.

Branson (2000) conducted a study to address the automated feedback technique of mechanical ventilation. This study aimed to describe ventilators with dual control ventilation modes, such as ASV mode. The author indicated that dual control modes were considered modes that allow the ventilator to control pressure based on patient volume feedback. Dual controlled breath-to-breath strategies are divided into pressure-controlled breaths and pressure-supported breaths. ASV is a dual control breath-to-breath for pressure control modes. It is considered pressure-limited, time-cycled ventilation that uses tidal volume as feedback control for continuously adjusting the pressure limit. Branson mentioned that ASV was developed to incorporate several mechanical input parameters into a feedback system that provides a high degree of closed-loop ventilation, which uses the flow sensor at the airway and the inspiratory flow sensor to determine an average volume. Once a patient is placed to ASV, the ventilator provides test breaths and measures system compliance, airway resistance, and intrinsic PEEP. This system is essential for accurate measurement of variables uses the Otis Equation for minimal work of breathing. After the ideal body weight setting, the ventilator chooses a target minute volume, the

appropriate breathing pattern, inspiratory time, and I:E ratio to prevent air trapping for spontaneous and mandatory breaths. Branson stated that ASV could give either full or partial ventilatory support based on the patient's needs and lung mechanics changes.

Tehrani (2008) discussed the new automatic techniques of the mechanical ventilators' systems. The author addressed the development of adaptive support ventilation mode (ASV), which is one of the closed-loop ventilation modalities that provides both pressure control and support ventilation. Tehrani indicated that mechanical ventilation modes' development became useful to automatically monitor patient status by developing more advanced physiological monitors such as automatic ventilation modalities. This development is associated with decreasing the healthcare team's workload and improving the quality of care, reducing the length of ICU stay, reducing the rate of mortality and morbidity, and reducing healthcare costs. Similarly, Haas et al. (2012) examined advanced ventilation modes and their techniques., The authors stated that the newer ventilation modes such as ASV mode are theoretically attractive and had proven clinically to provide safe settings to reduce lung injury, improve patient comfort, and automatically make adjustments in the ventilatory support to shorten the mechanical ventilation and weaning duration.

### **The effectiveness of ASV.**

Many researchers have tried to investigate the effectiveness of using adaptive support ventilation in different patient groups by comparing its application with other modes.

### **ASV mode and post-cardiac patients.**

Yazdannik et al. (2016) compared ASV and SIMV on the length of the intubation period after coronary artery bypass graft surgery (CABG). This study included two groups of a total of



64 patients aged between 25 to 65 years (32 subjects in each group) who underwent CABG in Shahid Chamran Hospital of Isfahan University of Medical Sciences. These subjects had no chronic lung disease such as COPD or asthma, and they had no history of any cardiopulmonary surgery, brain stroke, liver disorders, or seizure. Additionally, patients were stable hemodynamically and no history of intra-aortic balloon pump use. The first group received ASV mode after CABG, while the control group received SIMV. The ASV group was placed on the following initial settings based on their IBW: 100% of MinVol%, 50 % of FiO<sub>2</sub>, ten cmH<sub>2</sub>O of PEEP, and then five cmH<sub>2</sub>O. The researchers explained the ASV was acting as PCV at the beginning of ventilation then acting as PSV when the patient was breathing spontaneously by adjusting the settings according to the patient's effort. Arterial blood gases were taken after 30 minutes of the ventilatory support to evaluate and ensure blood gases' stability. Spontaneous breathing trials (SBT) were considered if a patient's ventilatory condition was stable and the percentage of MinVol% reached 75% by reducing MinVol% to 35%. The same assessment was performed after placing a patient on the SIMV mode. Adjustments of the SIMV mode were made when the patient's respiration condition was needed; for example, reducing the set respiratory rate by two b/min if the patient began to breathe spontaneously. SIMV mode was shifted to PSV mode if the patient had reached breath 6 b/min with 10 cmH<sub>2</sub>O of PS. In case the patient did not tolerate with PS mode, SIMV had reset again, while if the patient did tolerate, the set PS decreased to 5 cmH<sub>2</sub>O. The authors founded significant differences in the intubation duration 4.83 h with the average time of the ASV group while 6.71 h in the SIMV group ( $p < 0.001$ ) and in the average time of the hospitalization 140.6 h in the ASV group while it was 145.1 in the SIMV group ( $p = 0.006$ ).

A randomized controlled study completed by Sulzer et al. (2001) tested ASV for rapid tracheal extubation after cardiac surgery. The researchers hypothesized that an ASV protocol to wean post-cardiac surgery patients could decrease the intubation duration. After surgery, 36 subjects were assigned randomly to two groups based on standard protocols: the ASV group (16) and the control group (20). All patients were assessed for their need for fluids, sedation, or painkillers based on standardized protocols. Both groups were placed on standard ventilator settings initially. Both groups were assessed for weaning readiness if any patient in the control group tolerated shifting to PS of 10cmH<sub>2</sub>O, followed by an ABG after 20 minutes. While in the ASV group, extubation was performed if 50% or less of MinVol% had been applied and 5 cmH<sub>2</sub>O in PS patients. The findings showed that the ASV group had a shorter MV duration than the control group ( $p=0.02$ ), and the total number of successful extubations was higher in the ASV group than the control mode ( $p<0.01$ ).

#### **ASV on Acute respiratory distress syndrome (ARDS)**

Agarwal et al. (2013) evaluated ASV for full ventilatory support in ARDS patients in a randomized controlled pilot trial. This study aimed to compare ASV's outcomes versus volume-cycled ventilation (VCV) in ARDS by assessing the MV duration and hospital stay. Forty-eight ARDS patients were randomly divided into two groups. After intubation, all patients were initially stabilized and ventilated passively with VCV for one hour, 4 to 6 ml/kg, to predict their estimated IBW and to determine the target minute volume and respiratory rate  $\geq 35$  b/min. The authors aimed to achieve acceptable oxygen saturation levels 88% to 92%, with the lowest FiO<sub>2</sub> at a plateau pressure of  $\leq 30-35$  cm H<sub>2</sub>O and pH  $>7.30$ . After one hour, patients were divided randomly into two groups; a VCV group continued with the same ventilation mode, including 25 patients. The other group switched to ACV mode that included 23 patients. All patients received a standard

medical protocol. Weaning trials were conducted in both groups; any patient in the VCV group was shifted to PSV once the FiO<sub>2</sub> and PEEP achieved acceptable levels <40% and <8 cmH<sub>2</sub>O. On the other hand, the weaning trial in the ASV group was initiated if any patient was on 70% or less of MinVol%, less than 8 cm of P<sub>insp</sub>, FiO<sub>2</sub>, and PEEP had acceptable levels ≤40% and ≤8 cmH<sub>2</sub>O. Both groups had SBT for one hour. The study's findings revealed no significant difference between these two groups in the MV duration ( $p=0.51$ ) and the hospital stay ( $p=0.97$ ). Agarwal et al. concluded that further studies are needed to clarify the application of ASV with ARDS patients.

### **ASV on COPD**

In a randomized controlled trial, Kirakli et al. (2011) evaluated ASV for faster weaning in COPD patients. The researchers hypothesized that ASV mode could decrease the weaning duration in COPD patients compared with PSV mode. This study was included COPD patients admitted due to acute respiratory failure and needed intubation. Patients were randomized into two groups for weaning, either PSV or ASV. All patients were placed on VCV mode with the following initial settings: 8 ml/kg of TV, 12 to 15 breaths/min, 3 to 5 cmH<sub>2</sub>O of PEEP, and FiO<sub>2</sub> gradually titrated to maintain acceptable oxygen saturations levels of COPD 88% to 92%. As Kirakli et al. mentioned, if there was any improvement in the ABG results (less than 40 % of FiO<sub>2</sub>), sedation was interrupted to assess patients for weaning readiness. Once patients could trigger spontaneous breaths, they were randomized to either the ASV group or the PSV group. Both groups had undergone SBT before the extubation procedure. However, for any development of respiratory distress in a patient, the weaning trial was discontinued and switched back to VCV to maintain the ventilatory support. Once extubated, patients were assessed for MV independence. This study showed similar outcomes in weaning failure in terms of percentage, 31% in the PSV group and 28% in the ASV group. However, a slight difference in the weaning duration in the ASV group

was shorter than in the PSV group ( $p=0.041$ ). Also, the ICU stay was shorter with the ASV group compared to the PSV group. The authors conclude that ASV might be beneficial to wean COPD patients.

Mohamed et al. (2014) evaluated the role of ASV to wean COPD patients. The purpose of this study was to compare the short-term effects between ASV mode to PSV mode in weaning ventilated COPD patients. 50 COPD patients admitted to the ICU over a twenty-two months period in Riyadh Care Hospital. After intubation, all the subjects were initially placed on A/C control mode with COPD's standard settings. The researchers assessed patients for weaning readiness and were randomly divided equally into an ASV group or PSV group. Both groups were observed for two hours and were extubated unless patients failed to wean. There were significant differences in the MV weaning duration between the two groups. Patients in the ASV group had a shorter need for MV ( $p=0.036$ ) and a shorter weaning duration ( $p=0.02$ ) than patients in the PSV group. Additionally, the total number of re-intubations through the 28 days follow-up was higher in the PSV group (16% in the PSV group and 12% in the ASV group). However, the findings revealed no significant differences in ABG results before extubation for both groups. The author concludes that ASV mode could simplify the weaning trial in COPD patients, reduce the length of MV duration, thus hospital stay.

Kirakli and colleagues (2015) conducted a randomized controlled trial comparing the ventilation duration between ASV and PCV modes. This study included 229 adult patients who needed ventilatory support and were randomized to be placed on ASV or PCV. Any ARDS, tracheostomized patients or home mechanical ventilators were excluded. Standardized protocols and treatments were provided for each group, such as sedation, COPD medications, fluids maintenance, enteral nutrition, etc. The ASV group included 114 patients who underwent the

following main settings: 100% of MinVol%, 3 to 5 cmH<sub>2</sub>O of PEEP, and 100% of FiO<sub>2</sub>. Conversely, the PCV group was 115 patients given the following settings: 30 cmH<sub>2</sub>O of pressure control, 3 to 5 cmH<sub>2</sub>O of PEEP, 12 to 15 breaths/min of respiratory rate, and 100% of FiO<sub>2</sub> initially. SBT was conducted once the patient was able to take consecutive spontaneous breaths via a mechanical ventilator. Furthermore, any patient in the PCV group who failed an SBT was switched to PSV. Whereas in the ASV group, MinVol % was gradually reduced to 30% as tolerated for two hours. The researchers reported that the MV weaning duration was shorter in the ASV group than the PCV group, even though the ASV group had more patients with COPD ( $p = .06$ ). Additionally, the ASV group needed fewer manipulations on the MV than the PCV group ( $p < 0.001$ ). The authors empathized that the use of ASV mode in various patient groups could lead to better outcomes by facilitating an early recognition of weaning readiness and thus shortening the duration of ventilatory support.

### **Other studies related to ASV mode**

Khamaiseh (2016) examined the early weaning of mechanical ventilation by using ASV mode. This Jordanian study included 126 subjects aged between 52 and 58 who were randomly chosen and divided into SIMV and ASV, with 64 patients in each. Khamaiseh explained how ASV acted by determining patient's compliance and resistance, delivering PCV or PSV depending on patient breathes, whether active or passive and using the Otis Equation. The results showed that the ASV group had a shorter duration (6 to 24 hours) for weaning trail until successful extubation than the SIMV group. The author emphasized that ASV mode could be used in all patient groups because the patient can be ventilated passively and actively and leads weaning the patient smoothly, reducing the care provider's effort, and reducing cost.

Chen et al. (2011) studied the impact of applying ASV in medical ICU ventilated patients. The study indicated that newer modern modes could continuously monitor patients' needs, such as ASV, which is considered is closed-loop ventilation that uses a specific algorithm that can monitor patient's effort and provide or act as PCV or PSV depending on the patient's needs. The researchers hypothesized that ASV could facilitate the ventilatory support liberation with patients who were recovered from acute respiratory failure in a medical ICU. The study included 600 patient groups were divided into two groups. The ASV group included 79 patients, and the non-ASV group included 70 patients. For the non-ASV group, patients were initially placed on VCV or PCV, with 5 to 7 ml/kg of Tidal Volume to maintain acceptable pH and PaCO<sub>2</sub> levels. FiO<sub>2</sub> and PEEP were adjusted to maintain acceptable oxygen saturation levels ( $\geq 96\%$ ). Patients were switched to either PSV or PSV/SIMV, based on their protocol; a daily SBT to assess extubation readiness for thirty minutes. If a patient tolerated SBT well with the ventilator and could trigger, the patient was ready to wean. Regarding the ASV group management, the initial settings were applied, and if patients were not able to take spontaneous breathes on 100% of MinVol%, the MinVol% was reduced to 80%. However, if patients developed respiratory distress with these ASV settings, the researchers switched back to the previous settings and excluded them from the study. Both groups received the same standard protocols (including sedation, lung-protective ventilation strategy, weaning criteria, and extubation criteria.). Overall, successful extubation attempts were 80% in the non-ASV group while 73% in the ASV group ( $p=0.45$ ). Also, in the non-ASV group, only 4% reached extubation readiness within 1 day of enrollment, whereas 20% in the ASV group ( $p<0.001$ ). The findings show similar percentages in the ASV group's re-intubation rates and the non-ASV group, 5%, and 7%, respectively. There were no significant differences between both

groups in the hospital stay. Chen et al. conclude that despite the positive outcomes of ASV in this pilot study, further randomized controlled trial studies are needed.

A prospective study completed by Iotti and colleagues (2010) evaluated the short-term impact of the full support of the ASV mode versus conventional ventilation modes in acute respiratory failure patients. The researchers aimed to clarify the unclear points: what was the effectiveness of ASV in terms of CO<sub>2</sub> elimination, oxygenation, and breathing energetics? The study was in six European medical ICUs and included 88 adult patients who were passively ventilated on PCV or VCV for 24 hours. These patients had stable hemodynamics and respiratory status. Patients were grouped into one of three main groups: restrictive, obstructive, and no specific lung disease. All patients had undergone the following three ventilatory conditions: PCV or VCV, then ASV with the same minute volume as the minute volume in PCV or VCV, and ASV set to get the same PaCO<sub>2</sub> as the value of PaCO<sub>2</sub> in PCV or VCV. The findings showed that the PaCO<sub>2</sub> level and the minute ventilation were slightly lower in ASV mode than in control ventilation modes ( $p < 0.01$ ). No differences were noted in oxygenation and hemodynamics. Additionally, the respiratory rate was marginally lower and TV slightly higher ( $p < 0.01$ ) during ASV mode, especially in obstructive lung patients.

Belliato et al. (2004) assessed the breathing pattern generated by ASV mode in a physical lung test model and ventilated patients with three different types of lung conditions: normal lungs, restrictive lungs, or obstructive lungs. Belliato et al. found that ASV mode chose a ventilatory strategy similar to the physiological one in patients with normal lungs. While in COPD patients, ASV mode chose a high expiratory time pattern, and in patients with restrictive lungs, ASV modes chose a low tidal volumes pattern. In the physical lung test model, ASV mode chose similar

ventilatory patterns for all three types of lungs. Belliato et al. emphasized that ASV mode can apply an appropriate breathing pattern for different lung conditions.

Arnal et al. (2007) conducted a prospective observational cohort study to assess the ventilatory pattern selected by ASV in different types of lung conditions. Among 243 patients who had: Normal lung, COPD, and restrictive lung disease. The daily assessment was applied to evaluate the breathing patterns and arterial blood gases. Arnal et al. emphasized that in patients with passive breathing, ASV mode can automatically adjust the delivered breathing pattern (tidal volume and respiratory rate combination) based on the lung condition, providing higher tidal volume and lower respiratory rate in patients COPD than in those with restrictive lung disease.

Tassaux et al. (2002) conducted a prospective interventional crossover study to assess ASV mode and SIMV mode in 10 patients with acute respiratory failure during an early weaning phase. The primary aim was to evaluate the patient-ventilator synchronization. The findings showed that for a given same level of minute ventilation, ASV patients had a better patient-ventilator synchronization and a lower WOB based on the electromyography that measures respiratory muscle efforts comparing to SIMV mode connected patients.

### **Prevalence and knowledge of ASV mode**

Overall, there is no known study found that addressed the perceptions of RTs toward ASV mode. However, few of the founded studies are known about knowledge or perceptions regarding mechanical ventilation in general. Tallo et al. (2017) tested the knowledge level of medical students, residents, and physicians taking qualifying courses at the Brazilian Society of Internal Medicine toward mechanical ventilation. A self-assessment questionnaire was distributed among 806 medical students, residents, and physicians in the medical schools in Brazil (Tallo et al., 2017). The study findings showed that most of the respondents (85%) had poor mechanical ventilation



knowledge during the medical institutions' training. (77%) respondents stated that they did not know when to begin noninvasive ventilation, more than 80% of respondents did not know when to initiate control modes or support modes in patients. More than 90% of respondents stated that they did not identify the basic mechanical ventilation principles, either with obstructive lung disease or restrictive lung disease (Tallo et al., 2017). Cox et al.( 2003) evaluated the knowledge and perceptions of 259 residents in mechanical ventilation management throughout a survey. The study findings showed, among the respondents, despite that the mean test of mechanical ventilation score was more than 70% correct, lack of knowledge in several aspects were found in identifying the weaning readiness (38%), in setting the appropriate tidal volume in the acute respiratory distress syndrome (48%) and determining when to start noninvasive ventilation (27%) (Cox et al., 2003). Thus, the residents did not have enough knowledge to apply mechanical ventilation.

Little is known about the prevalence and knowledge level of RTs in mechanical ventilation management, and no known studies found about the knowledge level of ASV among RTs. A recent study was conducted in Saudi Arabia (2020) to evaluate RTs' knowledge regarding ARDS management. This study aimed to assess the extent of understanding the importance of updated ARDS management among healthcare providers. The researchers indicated a variety of responses to the updated ARDS management in the Saudi Arabia hospitals' practice (Hadadi, Alamoudi, Aldaraweish, & Ghazwani, 2020). 83.5% of the respondents were practicing the updated management of ARDS. Whereas only half of these responders used the Berlin definition of ARDS as the diagnostic definition of ARDS. This study had concerns about the findings and the causes of the variations. For instance, the methodology was not clear enough to illustrate the types of survey questions and how many participants and hospitals were enrolled. Thus, mechanical ventilation management practice and RTs' knowledge are two concerns connected.

## **ASV mode in Saudi Arabia.**

Overall, few of the published studies are found in Saudi Arabia about ASV mode. Al-Marshad SA (2016) conducted a study to review ASV mode and its management in clinical implementation. In this study, Al-Marshad SA indicated when the ASV is recommended and when it is not. Also, the published studies about ASV mode used different protocols to apply ASV mode in ventilated patients. Al-Otaibi (2018) conducted a study to review the history of ASV mode and the computerized-based system to ventilate the patients. Al-Otaibi stated that ASV is a safe mode that has many clinical features. Aljuaid et al. (2019) evaluated the common advanced mechanical ventilation modalities in the Eastern Province in Saudi Arabia. Aljuaid, Sahari, Gazwani, and Alqahtani (2019) found that among 83 RTs, neurally-adjusted ventilatory assistance (NAVA) (35.34%), airway pressure release ventilation (APRV) (19.83%), proportional assist ventilation (PAV) (17.25%), and the INTELLiVENT-ASV mode was rarely used (<1%). Additionally, Aljuaid et al. stated the lack of knowledge about these new modalities (51%), suspicion in these modes (23%), lack of value (21%), and lack of equipment that operate these new modalities (5%) were the barriers of their respondents that impede them from using these modes frequently. Thus, based on the study findings, RTs in the Eastern Province in Saudi Arabia were not having enough knowledge to apply these new modalities of ventilation, resulting in malpractice that negatively impacts patient care quality.

## **Summary**

The development of mechanical ventilators continues with modern technology's advent to create new ventilation modalities to monitor and manage. Due to technology's convenience and

efficiency, computing artificial intelligence with complex closed-loop systems in ventilators will be manufactured to create intelligent modes that integrate physiological principles, such as ASV, to enhance critically ill patients' ventilation. Furthermore, many published studies investigated that the ASV mode has positive outcomes, especially in post-cardiac patients and COPD patients. The knowledge of RTs plays a vital role in mechanical ventilation management. However, few studies have examined the knowledge and perception regarding mechanical ventilation. Little studies available demonstrate how much RTs knowledgeable in mechanical ventilation in general and ASV mode in particular. Therefore, this present study is important to document the prevalence, the RTs' knowledge, and perceptions of ASV mode since no study has looked at the literature evaluating these aspects.

## **CHAPTER III**

### **Methods**

Documenting methods for any research study is important as replication is desirable. In this chapter, methods used to answer the following research questions are:

1. How widespread is the ASV mode use among RTs in Eastern Province hospitals of Saudi Arabia?
2. Do RTs in Eastern Province hospitals of Saudi Arabia familiar with ASV mode?
3. Are there differences in the perceptions of RTs in the Eastern Province hospitals in Saudi Arabia toward ASV mode based on their current position?

### **Research Design**

This study will use a descriptive research design to evaluate the prevalence, familiarity, and perceptions of ASV mode among RTs in the Eastern Province of Saudi Arabia. A cross-sectional self-administrated survey was used to collect data from respiratory care practitioners to report their use, familiarity, and perceptions about ASV mode. Survey studies have many advantages to using only one instrument, such as gathering a large amount of data from many participants. It can be cost-effective to use new technologies, such as e-mail, to reach a high number of participants with minimal costs, time, and effort are needed (Portney & Watkins, 2015).

### **Informed Consent**

Informed consent was obtained before the participants respond to the survey, as they were asked to agree to participate. By checking the agree button, “I agree to participate in this study”, they were allowed to proceed to answer the questionnaire. Participants were

also informed that they had the right to withdraw at any time without answering questions.

The informed consent for this study can be found in the appendix A.

### **Sample**

This study had a convenience sample that included respiratory therapists who work either at public or private hospitals located in the Eastern Province in Saudi Arabia (including Dammam Medical Complex in Dammam, Qatif Center Hospital in Al-Qatif, King Fahad University Hospital in Al-Khobar, King Fahad Hospital in Alhasa, Almoosa Specialist Hospital in Alhasa, Dr. Sulaiman Al-habib Hospital in Al-Khobar, Jubail General Hospital in Jubail, and Saudi German Hospital in Dammam). The target population was all the respiratory therapists who have any respiratory care certificate (including diploma, bachelor's, master's, or Ph.D. degree) and work in a hospital in the Eastern Province in Saudi Arabia. Participants were provided the survey with an invitation cover letter explaining the primary purpose of this study and assuring them of confidentiality. RT students, interns, and other healthcare providers were excluded.

### **Instrumentation**

Since no instrument was found to evaluate the prevalence, familiarity, and perceptions of the ASV mode, a self-administrated questionnaire was developed where the questions were from a literature review (Fernández, Miguelena, Mulett, Godoy, & Martínón-Torres, 2013), (Kacmarek, Stoller, Heuer, Chatburn, & Kallet, 2017) about the mechanical ventilation and ASV mode. The survey included two main parts; the first part contained multiple-choice, dichotomous, and Likert questions to assess RC practitioners' prevalence, knowledge, and perceptions in the Eastern Province in Saudi Arabia toward ASV mode. The second part of the survey included a demographic questionnaire consisted of fill-in-the-blank and multiple-choice questions such as

gender, age, hospital type, educational level, current position, and years of experience. The survey was examined for validity by three experts of respiratory therapy educators from Georgia State University. The final survey consisted of 24 items, and an online link was sent out and distributed to the participants via their official e-mails to have access to the survey. The instrument and the link for this study can be found in the appendix C.

### **Invitation Cover Letter**

An invitation cover letter was conducted based on a review of different previous styles of similar published surveys (Portney & Watkins, 2015). The cover letter for this study can be found in the appendix B.

### **Ethical consideration**

The researcher obtained approval from the Georgia State University Institutional Review Board (IRB) to distribute the survey and protect all subjects who participated in this study. The researcher maintained confidentiality within the data and ensuring that all the participant's rights were protected and anonymous. The survey was confidential and anonymous, and there were no names or personal information obtained from participation in this study.

### **Data Collection and Analysis**

The Statistical Package for the Social Science (SPSS) version 26 was used to analyze data. Exploratory analysis using descriptive statistics (including frequencies for categorical variables and means and standard deviations for continuous variables) was calculated for relevant questions. Moreover, the researcher used comparative analysis included the Chi-square test to determine if there is a difference in using ASV mode questions related to the participants' current position. The significance of this test was based on the Fisher's Exact test p-value  $\leq$  of 0.05.

## **Summary**

This chapter describes the main points regarding the methods, the chosen target population sample size, the instrument, and how it was developed and kept confidential. Also, descriptive statistics and comparative analysis of significance were described to analyze the collected data and measure the primary aims of this study, including the prevalence of use, familiarity, and perceptions of ASV among RTs.

## **Chapter IV**

### **Results**

This chapter's primary aim was to document the results of experience and prevalence of the ASV mode among respiratory care practitioners in the Eastern Province of Saudi Arabia. Respiratory therapies were surveyed to evaluate the prevalence, familiarity, and perceptions of ASV mode. All the RTs who participated were included in this study, and their demographic data were statistically analyzed and presented. The following research questions were answered in this study:

1. How widespread is the ASV mode use among RTs in Eastern Province hospitals of Saudi Arabia?
2. Do RTs in Eastern Province hospitals of Saudi Arabia familiar with ASV mode?
3. Are there differences in the perceptions of RTs in the Eastern Province hospitals in Saudi Arabia toward ASV mode based on their current position?

### **Description of Sample**

This study was performed in the Eastern Province in Saudi Arabia. The researcher included respiratory therapists who agreed to participate in this study from eight different hospitals to represent the Eastern region, either public or private hospitals. The questionnaire was sent to 183 participants via their official e-mails, and a total of 64 of them responded. The response rate of the survey was 35% (64 of 183). Statistical analysis describing the data was done using SPSS. More than half of the participants were male respondents accounted for 60.9% (n=39), whereas 39.1% (n=25) were female respondents. The respondent's educational level was majorly from bachelor's degree holders (n=57, 89.1%), and the remaining respondents were master's degree holders (n=7,



10.9%). The mean of the respondents' experience years was calculated, and the results showed that the respondents had a mean of  $7.4 \pm 5.12$  SD years. The mean of the respondents' age was calculated, and the results showed that the respondents had a mean of  $31.05 \pm 5.3$  SD years. Furthermore, most RTs were senior respiratory therapists (n=40, 62.5%). In terms of hospital types, most respondents were from governmental hospitals (n=48, 75%), and the remaining respondents from private hospitals (n=16, 25%). Interestingly, the findings showed that all the 64 respondents work primarily in adult critical care units. (See Tables 1 and 2 for further details).

**Table1: Demographic Data of The Sample**

<b>Characteristics</b>	<b>N, (%)</b>
<b>• Gender</b>	
- Male	39 (60.9%)
- Female	25 (39.1%)
<b>• Age</b>	
- 21- 25	15 (23.4%)
- 26-30	16 (25.1%)
- 31-39	31 (48.6%)
- $\geq 40$	2 (3.2%)
<b>• Educational level</b>	
- Diploma	0 (0.0%)
- Bachelor	57 (89.1%)
- Masters	7 (10.9%)
- Phd	0 (0.0%)
<b>• Current position</b>	
- Manager of respiratory therapy	1 (1.6%)
- Supervisor of respiratory therapy	9 (14.1%)
- Senior respiratory therapist	40 (62.5%)
- Junior respiratory therapist	14 (21.9%)
<b>• Age</b>	
- Government	40 (78.4%)
- Private	11 (21.6%)
<b>• Years of experience</b>	
- 0 – 3 years	19 (23.7%)
- 4 – 10 years	33 (57.2%)
- 11 – 15 years	10 (15.8%)
- $\geq 16$ years	2 (3.2%)
N= 64	

**Table (2): Demographic Data of The Sample**

<b>Characteristics</b>	<b>N, (%)</b>
• <b>Hospital type</b>	
- Government	48 (75%)
- Private	16 (25%)
• <b>Hospital Name</b>	
- Qatif Center Hospital (QCH)	22 (39.8%)
- Dammam Medical Complex (DMC)	15 (17.4%)
- Dr. Sulaiman Al-Habib Hospital (HMG)	8 (12.7%)
- Almoosa specialist hospital (ASH)	6 (9.5%)
- King Fahad University Hospital (KFUH)	6 (9.5%)
- King Fahad Hospital (KFH)	4 (6.3%)
- Saudi German Hospital (SGH)	
- Jubail General Hospital	
• <b>Facility unit type</b>	
- Adult critical care	64 (100%)
- Emergency	54 (84.4%)
- Ward care	48 (75%)
- Pediatric critical care	39 (60.9%)
- Neonate critical care	37 (57.8%)
- Long-term patients	24 (37.5%)
- Outpatient	7 (10.9%)
- Home care	4 (6.3%)
- Rehabilitation center	1 (1.6%)

N= 64

### **The prevalence of ASV mode**

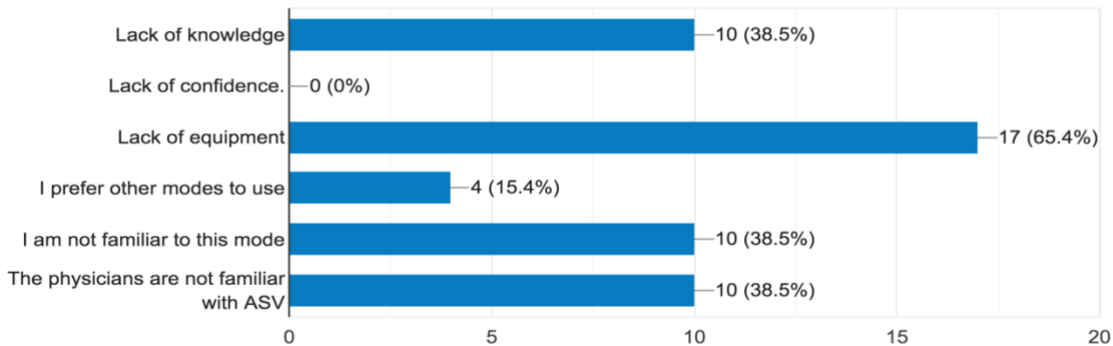
This section of the study is concerned with to what extent the ASV mode is used in the Eastern Province of Saudi Arabia. The respondents were asked if they have used ASV mode in their clinical practice or not, and the findings showed more than half of the total number of 64 respondents were using ASV mode (n=38, 59.4%), whereas the remaining respondents (n=26, 40.6%) have never used the ASV mode before. Moreover, those who never used ASV mode were asked a multiple-select question to reveal their reasons for not applying ASV. 17 RTs (65.4%) of 26 respondents answered that “lack of equipment that operated ASV mode”, followed by (n=10, 38.5%) answered “lack of knowledge”, (n=10, 38.5%) “not familiar with ASV mode”, and (n=10,

38.5%) “the physicians are not familiar with ASV”, and only 4 RTs (15.4%) out of 26 “prefer to use another mode rather than ASV”. (Figure 1).

Moreover, 38 responses to the question “In your practice, how often have you used the

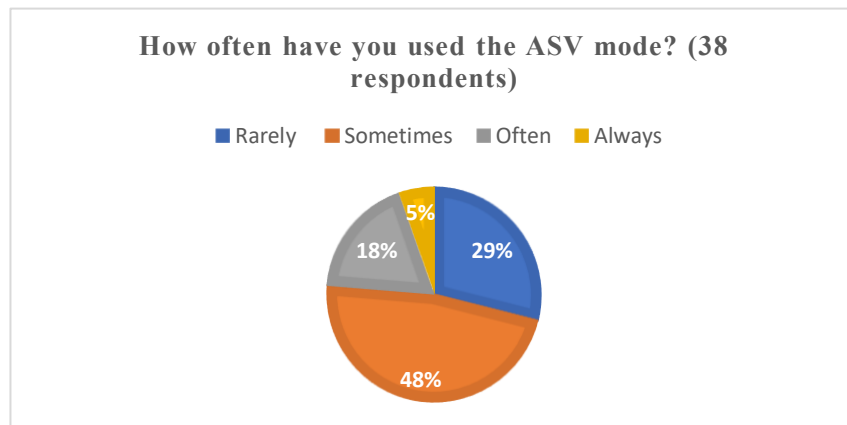
3. What are the reasons? (Please check all that apply):

26 responses



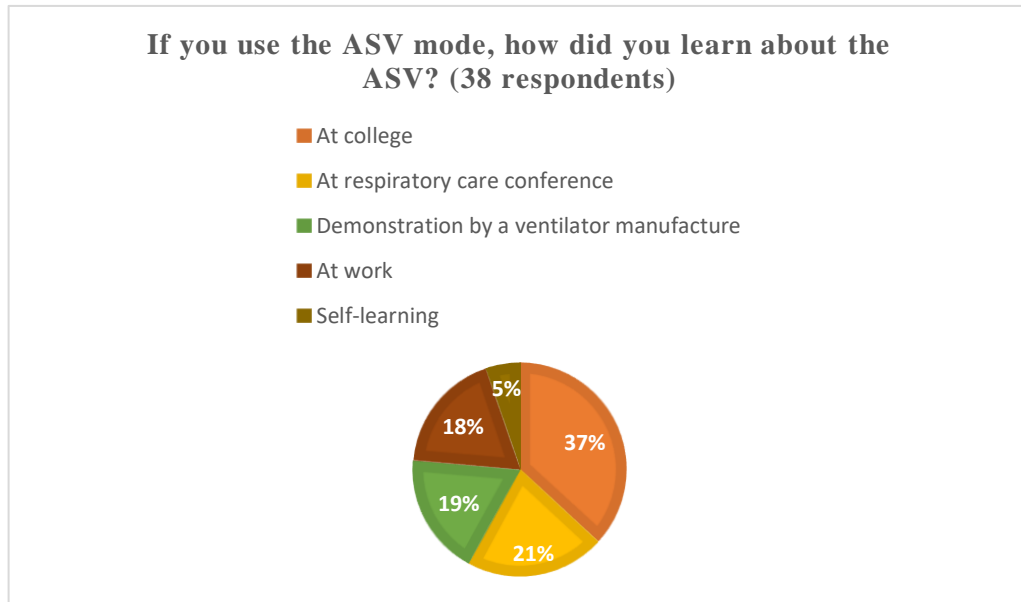
**Figure 1:** Twenty-six RTs of the total number of 64 respondents who have never used ASV mode revealed their reasons why ASV mode is not commonly used in the Eastern Province in Saudi Arabia.

ASV mode?” were varied. Only 18 RTs (47.4%) of the total number of 38 answered: “sometimes”, whereas the remaining respondents of 38 answered, “rarely” (n=11, 28.9%), “often” (n=7, 18.4%), and “always” (n=2, 5.3%). (Figure 2).



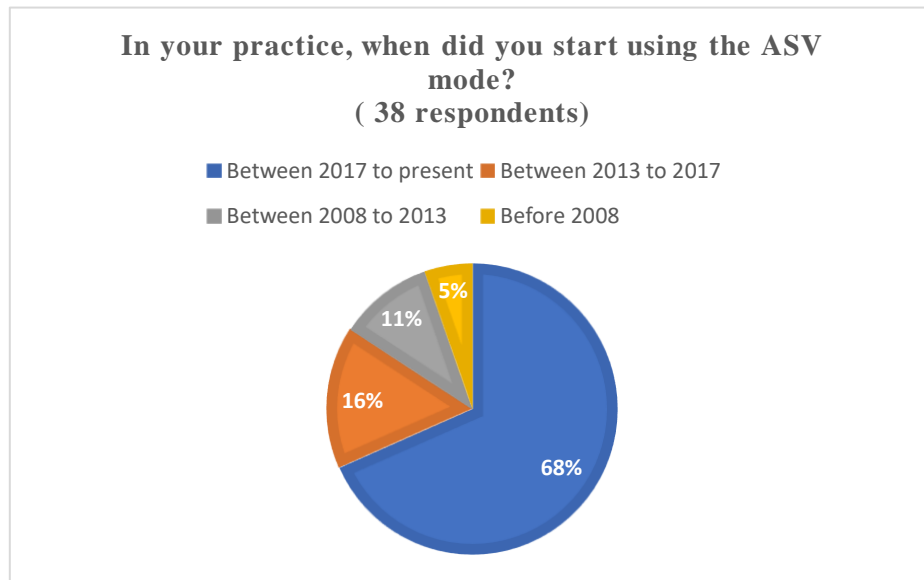
**Figure 2:** Thirty-eight RTs of the total number of 64 respondents who use ASV mode revealed their frequency in using ASV mode in the clinical practice.

Additionally, 38 RTs were asked about their ASV mode application, and results showed a total of 22 RTs (57.9%) out of 38 respondents did not follow the ASV mode protocol to use the mode. Surprisingly, only 16 RTs out of 38 respondents followed the ASV mode protocol to use the mode. The 38 RTs were also asked the following question: what patients' category do you prefer to use the ASV mode ?, the results showed that most respondents (n=25, 65.8%) RTs of the total 38 respondents preferred to use ASV mode on adult patients, and (n=11, 28.9%) of the total 38 respondents answered long-term, and only 2 RTs (5.3%) of the total 38 respondents answered post-operative patients. As shown in Figure 3, the 38 RTs were asked about their learning to use ASV mode in their clinical practice, (n=14, 37%) answered at college, (n=8, 21.1%) responded at respiratory care conference, (n=7, 18.4%) answered Demonstration by ventilator manufacture, (n=7, 18.4%) answered at work, and only 2 RTs (5.2%) answered by self-learning.



**Figure 3:** Thirty-eight RTs of the total number of 64 respondents who use ASV mode revealed their learning to use ASV mode in the clinical practice.

Furthermore, the 38 RTs were also asked the following question: In your practice, when did you start using the ASV mode? As shown in the Figure4, the majority of 38 respondents (n= 26, 68.4%) answered they began to use ASV mode between 2017 to present, whereas the remaining (n=6, 15.8%) of 38 respondents started to use ASV mode between 2013 to 2017, (n= 4, 10.5%) answered between 2008 to 2013, and only 2 RTs (5.3%) answered before 2008. (See Table 3 for further details).



**Figure 4:** Thirty-eight RTs of the total number of 64 respondents who use ASV mode revealed their beginning in using ASV mode in the clinical practice.

**Table(3): The prevalence of ASV mode among RTs in the Eastern Province in Saudi Arabia.**

Questions:	N, (%)
Have you ever used the ASV mode?	N=64, (100%)
- Yes	38 (59.4%)
- No	26 (40.6%)
If you answered no, what are the reasons? (please check all that apply):	N=26, (100%)
- Lack of equipment	17 (65.4%)
- Lack of knowledge	10 (38.5%)
- I am not familiar with this mode	10 (38.5%)
- The physicians are not familiar with ASV	10 (38.5%)
- I prefer other modes to use	4 (15.4%)

- Lack of confidence.	00 (00.0%)
If you use the ASV mode, how did you learn about the ASV?	N=38, (100%)
- At college	14 (36.8%)
- At respiratory care conference	8 (21.1%)
- Demonstration by a ventilator manufacture	7 (18.4%)
- At work	7 (18.4%)
- Self-learning	2 (5.2%)
In your practice, how often have you used the ASV mode?	N=38, (100%)
- Sometimes	18 (47.4%)
- Rarely	11 (28.9%)
- Often	7 (18.4%)
- Always	2 (5.3%)
In your practice, what patients' category do you prefer to use the ASV?	N=38, (100%)
- Adult patients	25 (65.8%)
- Long-term patients	11 (28.9%)
- Post-operative only	2 (5.3%)
- Pediatric patients	00 (00.0%)
In your practice, when did you start using the ASV mode?	N=38, (100%)
- Between 2017 to present	26 (68.4%)
- Between 2013 to 2017	6 (15.8%)
- Between 2008 to 2013	4 (10.5%)
- Before 2008	2 (5.3%)
In your practice, do you follow a protocol utilizing ASV mode at your working hospital?	N=38, (100%)
- Yes	16 (42.1%)
- No	22 (57.9%)

### **Familiarity with ASV mode.**

As shown in Table 4, some questions in this study aimed to evaluate the RTs' familiarity with ASV mode. All the 64 respondents were asked if they knew the ASV abbreviation. The findings showed that most of the respondents (n=63, 98.4%) were familiar with the ASV abbreviation as "Adaptive Support Ventilation", and only one respondent (1.6%) answered, "Assisted Synchronized Ventilation".

For those 38 RTs who use ASV mode, they were asked about the initial parameters to set ASV mode in the mechanical ventilator; 97.4% respondents of 38 RTs answered "Minvol%,

PEEP, and FiO2”; however, one respondent (2.6%) answered pressure support, “Minvol%, and FiO2”. Regarding the multiple-select question of the important features of the ASV mode, more than half of the 38 respondents identified the following features in nearly equal proportion: ASV decreases work of breathing (n=25, 65.8%), ASV can be used in passive or active patients (24, 63.2%), ASV needs only three parameters to be set to operate (n=23, 60.5%), and ASV improves patient-ventilator synchrony (n=23 60.5%). While less than half of 38 respondents answered that ASV decreases the weaning duration (n=17, 44.7%) and ASV applies lung-protective strategies (n=10, 26.3%).

We also asked them about the types of patients who are placed on the ASV mode; respondents were allowed to choose more than one type for this question. The results showed that most respondents of 38 RTs (n=23, 60.5%) were known that ASV mode is used for patients with no known lung disease such as post-operative patients, (n=17, 44.7%) answered for obstructive lung diseases (n=15, 39.5%) answered for any lung disease, and only a few RTs (n= 5, 13.2%) answered for restrictive lung diseases. (See Table 4).

**Table (4): The familiarity of ASV mode among RTs in the Eastern Province in Saudi Arabia.**

Questions:	N, (%)
ASV is an abbreviation referred to as:	N=64, (100%)
- <b>ADAPTIVE SUPPORT VENTILATION.</b>	63 (98.4%)
- Airway Support Ventilation.	1 (1.6%)
- Airway Synchronized Ventilation.	00 (00.0%)
- Assisted Synchronized Ventilation.	00 (00.0%)
In your practice, what are the parameters that you have used to initially set up the ASV mode?	N=38, (100%)
- MinVol%, PEEP, and Fio2.	37 (97.4%)
- Pressure Support, MinVol%, and Fio2.	1 (2.6%)
- Respiratory Rate, PEEP, and Fio2.	00 (00.0%)
- Pressure, PEEP, and MinVol%.	00 (00.0%)
- Tidal Volume, PEEP, and Fio2.	00 (00.0%)
In your practice, the important features of the ASV mode are? (you may choose more than one response if applicable):	N=38, (100%)
- ASV decreases work of breathing	25 (65.8%)

- ASV can be used in passive or active patients.	24 (63.2%)
- ASV improves patient-ventilator synchrony	23 (60.5%)
- ASV needs only three parameters to be set to operate.	23 (60.5%)
- ASV decreases the weaning duration.	17 (44.7%)
- ASV applies lung-protective strategies.	10 (26.8%)
In your practice, what types of patients are placed on the ASV mode? (you may choose more than one response if applicable):	N=38, (100%)
- No known lung disease (e.g., Postoperative).	23 (60.5%)
- Obstructive lung diseases (e.g., COPD and Asthma).	17 (44.7%)
- Any lung disease.	15 (39.5%)
- Restrictive lung diseases (e.g., ARDS and ILD).	5 (13.2%)

### Perceptions of ASV mode

This part of the study aimed to explore RTs' perceptions regarding the ASV mode and whether there are differences in their perceptions based on their current positions. For those 38 RTs who used ASV mode, they were asked further questions about ASV mode to identify their perceptions. These questions were yes/no questions or Likert questions. The 38 respondents have various perceptions of the ASV mode; for example, 84.2% RTs of the 38 RTs responded that they do not prefer to use ASV mode as an initial mode, and only 6 RTs (15.8%) preferred to use it as an initial mode. In contrast, most of these 38 respondents (n=25, 65.8%) prefer to use ASV as a weaning mode, and the remaining of them (n=13, 34.2%) do not prefer to use it as a weaning mode. Moreover, most 38 respondents (n=31, 81.6%) agreed that ASV mode could facilitate the weaning process. Additionally, most RTs of 38 respondents (n=30, 78.9%) agreed that ASV mode could shorten mechanical ventilation duration. However, few RTs of 38 respondents opposed that ASV mode could not facilitate the weaning process and shorten the mechanical ventilation duration (n=5, 13.2%), (n=7, 18.4%), respectively. Lastly, the 38 RTs were asked if they would suggest other respiratory therapists use the ASV mode, and more than half of them (n=28, 73.7%) answered yes. (See Table 5 for further details).



**Table (5): The perceptions of ASV mode among RTs in the Eastern Province in Saudi Arabia.**

<b>Questions:</b>	<b>N, (%)</b>
In your practice, do you prefer using ASV as an initial mode?	N=38, (100%)
- Yes	6 (15.8%)
- No	22 (57.9%)
In your practice, do you prefer ASV as a weaning mode?	N=38, (100%)
- Yes	25 (65.8%)
- No	13 (34.2%)
In your practice, how likely do you believe that the ASV mode could accelerate the weaning process?	N=38, (100%)
- Strongly agree	2 (5.3%)
- Agree	31 (81.6%)
- Disagree	5 (13.2%)
- Strongly disagree	00 (00.0%)
In your practice, how likely do you believe that the ASV mode could shorten the duration of mechanical ventilation?	N=38, (100%)
- Strongly agree	1 (2.6%)
- Agree	30 (78.9%)
- Disagree	7 (18.4%)
- Strongly disagree	00 (00.0%)
In your practice, would you suggest other respiratory therapists use the ASV mode?	N=38, (100%)
- Yes	28 (73.7%)
- No	10 (26.3%)

### **Relationships between variables**

Due to the small sample size, the Chi-square test of independence was performed in SPSS to examine if there was a relation between the RTs' perceptions (n=38) and their current positions, and we used the Fisher's Exact test p-values. Overall, our data analysis showed no significant differences between the 38 RT's perceptions regarding ASV mode based on their current positions. ( See Table 6 for further details).

**Table (6): The Fisher’s Exact test's statical findings to demonstrate the differences of RTs perceptions based on their current positions.**

Perceptions questions	Statistical tests
	<b>Fisher’s Exact test</b>
- Using ASV as an initial mode.	p=1.000
- Using ASV as a weaning mode.	p=0.222
- ASV could accelerate the weaning process.	p=0.568
- ASV could shorten the duration of mechanical ventilation.	p=0.307
- Suggesting other respiratory therapists use ASV mode.	p=0.82

N=38 , (\*) Significant difference (P value <0.05).

### Summary

This chapter presents the findings in this study from the collected data to answer the three research questions. Based on the statistical analysis, it appeared that there was more than half of 64 respondents (n=38, 59.4%) use ASV mode from 2017 until now. Also, most respondents of those who use ASV mode were familiar with the initial parameters, the essential features, and patients’ categories of ASV mode. Additionally, most RTs of 38 respondents agreed that ASV mode could the weaning process and shorten the mechanical ventilation duration, and (73.7%) would suggest other respiratory therapists use the ASV mode. Moreover, for those 26 RTs who never used ASV mode before, they revealed their reasons, and most of them answered lack of equipment. Overall, based on what we got in the results, there were no statistically significant differences between the following variables: the respondents’ current positions and their perceptions to apply ASV mode in the clinical practice.

## **Chapter V**

### **Discussion**

This chapter presents the interpretations of the study results, which were demonstrated in Chapter IV. The chapter is divided into five major sections: an overview of the study, discussion of findings, limitations of the study, implications for practice, recommendations, and conclusion.

#### **Overview of the Study**

The purpose of this study was to answer three questions regarding the prevalence, familiarity, and perceptions of ASV mode among RTs in Eastern Province hospitals of Saudi Arabia. Also, to explore the reasons for not applying ASV mode. The following research questions were addressed to guide the study:

1. How widespread is the ASV mode use among RTs in Eastern Province hospitals of Saudi Arabia?
2. Do RTs in Eastern Province hospitals of Saudi Arabia familiar with ASV mode?
3. Are there differences in the perceptions of RTs in the Eastern Province hospitals in Saudi Arabia toward ASV mode based on their current position?

#### **Discussion**

##### **Finding Related to Research Question 1**

The first research question was asked, "How widespread is the ASV mode use among RTs in Eastern Province hospitals of Saudi Arabia?". Based on the statistical analysis, the findings showed that, overall, more than half of RTs of the total 64 respondents used ASV mode in their daily clinical practice, but the data analysis revealed that less than half of these 38 respondents use ASV mode sometimes. Also, it is clear that the ASV mode is primarily used in adult patients by

RTs, and none of them reported that they use ASV mode with pediatric patients. Furthermore, more than half of the 38 respondents stated that they started to use ASV between 2017 until the present, and only two RTs started to use ASV mode before 2008, and this might be explained as observed in figure 4, the ASV mode's use was increasing over the years in the Eastern Province in Saudi Arabia. Additionally, among RTs who used ASV mode, a limited number reported having protocols to use ASV mode. This finding is needed to be investigated to explore the reasons behind this percentage. A study was conducted in (2017) stated that adherence to a protocol for weaning from mechanical ventilation is essential to minimize negative patient outcomes.

Moreover, the reasons for those RTs (n=26) who do not use ASV mode in their daily clinical practice were reported. The most reported reason for not applying ASV mode was the lack of equipment that operated ASV mode; this might be explained that the ASV mode is available only in Hamilton Galileo G5 Ventilator that not almost all the Eastern Province hospitals supplied this ventilator. The explanation of the most rated reason for not applying ASV mode, which is the lack of equipment, is that the ASV mode is exclusive on only one ventilator, which is Hamilton Galileo G5 Ventilator that not almost all the Eastern Province hospitals supplied this ventilator. A similar study was conducted in the Eastern Province of Saudi Arabia found that among 83 RTs, only a few RTs used advanced modes of ventilation. However, the lack of equipment was accounted for 5% of the measured barriers. This inconsistency because their study included many advanced modalities ( including NAVA, APRV, PAV, and ASV), which are available in various ventilators. In contrast, our study included only ASV mode, which is available on one ventilator. Interestingly, the lack of confidence was not a barrier to implementing ASV mode, which might be explained their willingness to apply new mechanical ventilation strategies. Furthermore, the remaining-most mentioned barriers with equal proportions (38.5% for each) were lack of knowledge, not familiar

with ASV mode, and the physicians are not familiar with ASV. This might be explained, at least in part, due to lack of experience or insufficient education, which are needed for acquiring proper knowledge and for successful implementation of ASV mode.

### **Finding Related to Research Question 2**

The second research question was “Do RTs in Eastern Province hospitals of Saudi Arabia familiar with ASV mode?”. According to our findings, overall, RTs of the Eastern province showed a fair amount of knowledge theoretically regarding the ASV mode. Almost all the respondents (98.4%) were able to pick the correct ASV abbreviation. Further, three questions were asked for those who apply ASV mode in their clinical practice related to familiarity (n=38). The findings showed that most of those who use the mode had a fair amount of knowledge (74.6%). To illustrate, most of the 38 RTs picked the best answers regarding the initial parameters, essential features, and patient types (97.4%, 65.8%, and 60.5%, respectively). Aljuaid et al. stated that more than half of the participants (51%) claimed not having enough knowledge to apply the advanced modes Aljuaid, Sahari, Gazwani, & Alqahtani, 2019). However, this is incompatible with our findings, their study assessed the knowledge of advanced modalities in general, which is a wide topic, but we assessed ASV specifically in our study. Since no more data was compared with our findings, we conclude that our results were inconsistent with Aljuaid et al. findings regarding the RTs knowledge in the Eastern Province of Saudi Arabia (74.6% compared to 51%).

### **Finding Related to Research Question 3**

The third research question was about the RTs' perceptions regarding the ASV mode, stating that, “Are there differences in the perceptions of RTs in the Eastern Province hospitals in Saudi Arabia toward ASV mode based on their current position?”. The study results showed diverse perceptions toward the ASV mode. More than half of 38 respondents who used ASV mode

in their daily clinical practice do not prefer ASV mode as an initial mode. In contrast, 65.8% of the 38 RTs prefer to use ASV as a weaning mode. Moreover, most of the 38 respondents agreed that ASV mode could facilitate the weaning process and shorten mechanical ventilation duration, 81.6%, and 78.9%, respectively. Also, 73.7% would suggest other RTs use ASV mode. The present results indicated that the respondents might not know that ASV mode can be used as an initial mode. According to a recent study was contacted by Titus, A., and colleges (2021), ASV mode can be used to start, maintain, or wean mechanical ventilation in both chronic and acute ventilated patients.

Regarding research question 3, overall, our data analysis showed no significant differences between the 38 RTs' perceptions regards their using of ASV mode based on their current positions. In other words, based on the statistical analysis, there were no significant differences found in preference to use ASV mode as an initial mode ( $p=1.000$ ) and as a weaning mode ( $p=0.222$ ) based on the current positions of RTs. Additionally, there were no significant differences in their beliefs in ASV mode that could accelerate the weaning process ( $p=0.568$ ) and shorten the MV duration ( $p=0.307$ ) based on the current position of RTs. These findings revealed that most of the 38 RTs who were ASV users had positive perceptions of ASV mode; however, no study examined RT's perceptions regarding ASV mode to compare our findings with. The insignificance can be attributed to the fact that ASV mode is a relatively new mode for RT supervisors and staff.

### **Limitations**

The present study has some limitations by several factors. The study's findings cannot be generalized due to a 35% response rate and its relatively small sample size ( $n=64$ ) drawn from a large population of RTs in the Eastern Province in Saudi Arabia. Also, since the survey was e-mailed to participants, it is limited by the participants' ability to check their e-mail. There was a

possibility that the survey was moved to the junk e-mail; therefore, the response rate might have been affected. What types of ventilators was another limitation because the survey did not ask this question. Moreover, despite the known literature about the effectiveness of ASV mode in mechanically ventilated patients in several clinical trials, there was a lack of research that evaluates ASV mode knowledge or perception among respiratory therapists globally and in Saudi Arabia.

### **Implication for Practice**

The study findings could help the respiratory therapy departments detect weak points they might not be aware of, such as having protocol. Having protocol is crucial in using ASV mode could improve the outcomes and reduce the probability of harm. Moreover, these findings may help fill the gap of ASV mode prevalence, knowledge, and perceptions among respiratory care practitioners. Furthermore, this study could be expanded, in the future, by modifying the survey to include more questions and alternative measures. Education and training sessions are the backbone in teaching respiratory care practitioners about advanced ventilation modalities. Overall, respondents give positive responses regarding ASV mode; therefore, this study will add to the literature some information on ASV mode among respiratory therapists in the Eastern Province of Saudi Arabia, and there will be various practices in terms of weaning from mechanical ventilation by respiratory therapists as they become more familiar with the ASV mode.

### **Recommendations**

Further research is highly recommended due to the lack of research that measures to what extent ASV mode use, how familiar RTs with ASV mode, and what RTs' perceptions of ASV mode. Also, to validate and generalize this study's findings, replication with a larger number of participants from various regions of Saudi Arabia is strongly recommended. Further education is

required to consider the updated publications of ASV mode by the respiratory therapy schools in Saudi Arabia by offering more courses specifically on ASV mode.

### **Conclusion**

Up to my knowledge, this seems to be the first attempt to investigate the extent of prevalence, familiarity, and perceptions of RTs regarding the ASV mode in Saudi Arabia by doing self-administrated survey research. Overall, the study findings revealed that more than half of RTs from eight hospitals in the Eastern Province in Saudi Arabia were familiar with ASV mode, and they have positive perceptions toward ASV mode. Also, the common reasons for not applying ASV mode were addressed, which is the most prominent is lack of equipment that operates ASV mode. Therefore, besides the known publications about the effectiveness of ASV mode in critically ill patients, the present study adds to the limited body of knowledge to what extent RTs know and use the ASV mode.



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## Appendix A: Informed Consent



**Title:** A survey of prevalence and experience of the Adaptive Support Ventilation (ASV) mode among respiratory care practitioners in the Eastern Province of Saudi Arabia.

**Principle Investigator:** Lynda T. Goodfellow, Ed.D, RRT AE-C.

**CO- PI:** Zainab A. Alrastem, MSc RC.

**Dear Respiratory Professional,**

You are cordially invited to participate in a research study. The purpose of this study is to address the prevalence, familiarity, and perceptions of ASV mode among RTs which is being conducted by Zainab Alrastem as a part of the requirements to fulfill the master's degree, from the Department of Respiratory Therapy at Georgia State University, under the advisement of Dr. Lynda Goodfellow, Professor of Respiratory Therapy and Senior Associate Dean for Academic Affairs.

The survey may take about eight to ten minutes to finish. Please note that your participation in this study is entirely voluntary. The subject may skip any question. If you refuse to take this survey or decide to withdraw, feel free to do so at any time; hence, you can complete the survey one time only at any time.

Your participation will not have any more risks and may not benefit you personally. To protect your confidentiality, the survey has no direct or personal information that will be used to identify you. Any information obtained from this survey will remain confidential and will be considered as results that will be used for the current research. The information you provide will be private to the extent allowed by Dr. Lynda will have access to reach them. Also, your information may be shared with (GSU Institutional Review Board (IRB) and the Office for Human Research Protection (OHRP).

Please note: If you thankfully agree to the participant, you will be asked to check the agree button:

I agree to participate in this study  I prefer not to participant in this study

The online survey link: <https://forms.gle/61BiKknWNro4BRb38>

If you have any questions or concerns about this study, please contact Dr. Lynda Goodfellow at [LtGoodfellow@gsu.edu](mailto:LtGoodfellow@gsu.edu) or 404-413-1223, or contact Zainab Alrastem at [Zalrastem1@student.gsu.edu](mailto:Zalrastem1@student.gsu.edu)

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Thank you for your cooperation and valued contribution.

## **Appendix B: Invitation Letter**

**Dear Respiratory Therapist,**

You are cordially invited to participate in a research study conducted by Zainab Alrastem, a master's degree candidate from the Department of Respiratory Therapy at Georgia State University. Kindly fill out the following survey, which aims to identify the extent of experience and prevalence of the ASV mode among respiratory care practitioners in the Eastern Province of Saudi Arabia. The survey has two main parts and includes multiple-choice questions. Please check the best choice in favor of each question. It may take about eight to ten minutes to finish. Please note that your participation in this study is entirely voluntary. If you refuse to take this survey or decide to withdraw, feel free to do so at any time; hence, you can complete the survey one time only at any time.

Your participation will not have any more risks and may not benefit you personally. To protect your confidentiality, the survey has no direct or personal information that will be used to identify you, and any information that is obtained from this survey will remain confidential and will be considered as results that will be used for the current research. If you thankfully agree to the participant, you will be asked to check the agree button.

I agree to participate in this study     I prefer not to participate in this study



## Appendix C

### Instrument Survey and Demographics

Thank you for agreeing to participate. It will only take a few minutes to complete. All of your answers are private and confidential. Please select the choice or choices that describe your experience. Your response is greatly appreciated.

#### Part 1:

**1. ASV is an abbreviation referred to as:**

- a) Airway Support Ventilation.
- b) Adaptive Support Ventilation.
- c) Airway Synchronized Ventilation.
- d) Assisted Synchronized Ventilation.

**2. Have you ever used the ASV mode?**

- a) Yes (please proceed to question #4)
- b) No (please answer question #3)

**3. If you answered no, what are the reasons? (Please check all that apply):**

- a) Lack of knowledge
- b) Lack of confidence.
- c) Lack of equipment
- d) I prefer other modes to use
- e) I am not familiar with this mode
- f) The physicians are not familiar with ASV
- g) Others

**4. If you use the ASV mode, how did you learn about the ASV?**

- a) At college
- b) At Respiratory care conference

- c) Demonstration by a ventilator manufacture
- d) Others

**5. In your practice, what are the parameters that you have used to initially set up the ASV mode?**

- a) Respiratory rate, PEEP, and FiO<sub>2</sub>.
- b) MinVol%, PEEP, and FiO<sub>2</sub>.
- c) Pressure, PEEP, and MinVol%.
- d) Tidal Volume, PEEP, and FiO<sub>2</sub>.
- e) Pressure support, MinVol%, and FiO<sub>2</sub>.

**6. In your practice, the important features of the ASV mode are? (You may choose more than one response if applicable):**

- a) ASV applies lung-protective strategies.
- b) ASV decreases work of breathing
- c) ASV improves patient-ventilator synchrony
- d) ASV decreases the weaning duration.
- e) ASV needs only three parameters to be set to operate.
- f) ASV can be used in passive or active patients.

**7. In your practice, what types of patients are placed on the ASV mode? (You may choose more than one response if applicable):**

- a) Obstructive lung diseases (e.g., COPD and Asthma)
- b) Restrictive lung diseases (e.g., ARDS and ILD)
- c) Any lung disease.
- d) No obvious lung disease (e.g., postoperative)

**8. In your practice, how often have you used the ASV mode?**

- a) Rarely
- b) Sometimes
- c) Often

d) Always

**9. In your practice, what patients' category do you prefer to use the ASV?**

a) Adult patients

b) Pediatric patients

c) Long-term patients

d) Post-operative only.

**10. In your practice, when did you start using the ASV mode?**

a) Before 2008

b) Between 2008 to 2013

c) Between 2013 to 2017

d) Between 2017 to present

**11. In your practice, do you follow a protocol utilizing ASV mode at your working hospital?**

a) Yes

b) No

**12. In your practice, do you prefer using ASV as an initial mode?**

a) Yes

b) No

**13. In your practice, do you prefer ASV as a weaning mode?**

a) Yes

b) No

**14. In your practice, how likely do you believe that the ASV mode could accelerate the weaning process?**

a) Strongly agree

b) Agree

c) Disagree

d) Strongly disagree

**15. In your practice, how likely do you believe that the ASV mode could shorten the duration of mechanical ventilation?**

- a) Strongly agree
- b) Agree
- c) Disagree
- d) Strongly disagree

**16. In your practice, would you suggest other respiratory therapists use the ASV mode?**

- a) Yes
- b) No

### **Part 2: Demographic Questionnaire**

**17. What is your gender?**

- a) Male
- b) Female

**18. What is your age?**

**19. What is your educational level?**

- a) Diploma
- b) Higher Diploma
- c) Bachelor
- d) Master
- e) PhD

**20. What is your current position?**

- a) Manager of respiratory therapy
- b) Supervisor of respiratory therapy
- c) Senior of respiratory therapy
- d) Junior of respiratory therapy

**21. How long have you been a respiratory therapist?**

### **Hospital Information.**

**22. What type of hospital in which you are working?**

- a) Ministry of Health (MOH) Governmental hospital
- b) Private hospital

**23. What is the name of the hospital?**

**24. Facility unit type in which you are working** (*You may choose more than one response if applicable*)

- a) Outpatient (such as diagnostics and pulmonary rehabilitation)
- b) Emergency
- c) Ward care
- d) Adult critical care
- e) Pediatric critical care
- f) Neonate critical care
- g) Long-term patients
- h) Home care
- i) Others

If you have any questions or concerns about this study, please contact Dr. Lynda Goodfellow at [LtGoodfellow@gsu.edu](mailto:LtGoodfellow@gsu.edu) or 404-413-1223, or contact Zainab Alrastem at [Zalrastem1@student.gsu.edu](mailto:Zalrastem1@student.gsu.edu).

Thank you for your cooperation and valued contribution.