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Effect of Non-Invasive Mechanical Ventilation with Average Volume Assured Pressure Support (AVAPS) in Patients with Chronic Obstructive Pulmonary Disease with Acute Exacerbation

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Abstract **Original Research Article**

***Background*:** Patients with acute respiratory failure have traditionally been evaluated for non-invasive mechanical ventilation (NIV) based on clinical evaluation and changes in blood gases, with NIV support pressures manually adjusted by an operator. Bilevel positive airway pressure-spontaneous/timed (BiPAP S/T) with average volume assured pressure support (AVAPS) uses a fixed tidal volume that automatically adapts to a patient's needs. ***Objective*:** To see the effective of non-invasive mechanical ventilation with average volume assured pressure support (AVAPS) in patients with chronic obstructive pulmonary disease with acute exacerbation. ***Materials and Methods*:** This single-center prospective study was carried out at the Gazi Medical College (GMC), Khulna, Bangladesh, in the department of medicine. The research's participants were all admitted between December 1, 2021, and January 1, 2023. The trial included all patients with acute exacerbations of chronic obstructive pulmonary disease. Age, gender, and disease severity were determined using the APACHE II scoring system. A structured proforma was used to collect data. The percentage and absolute number were used to express all category data. All numerical continuous data were reported as mean standard deviation. SPSS version 23 was used to analyze the data. All tests were evaluated using a 95% confidence interval, and a P value of 0.05 was deemed significant. ***Results*:** The mean MBS, NRS, dyspnea/comfort scale, respiration rates, systolic blood pressure, and diastolic blood pressure- post treatment were statistically significant ($p < 0.05$) when compared to pretreatment in the BiPAP S/T with AVAPS group. Mean PaCO2, MBS, NRS, dyspnea/comfort scale, heart rate, respiration rates, and systolic blood pressure- post treatment were statistically significant ($p < 0.05$) when compared to pretreatment in the BiPAP S/T group. ***Conclusion*:** BiPAP S/T with AVAPS promotes a quicker return to awareness in patients with chronic obstructive pulmonary disease and hypercapnic encephalopathy as compared to standard BiPAP S/T.

Keywords: Non-invasive mechanical ventilation, BiPAP S/T with AVAPS, Chronic obstructive pulmonary disease, AVAPS.

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INTRODUCTION

The prevalence of chronic obstructive pulmonary disease (COPD) is increasing worldwide due to tobacco usage [1]. Patients with acute exacerbations of chronic obstructive pulmonary disease (AECOPD) commonly present to emergency departments (ED) and often require hospital admissions. These patients may develop acute respiratory failure and require intubation and mechanical ventilation. However, these procedures are associated with high morbidity and possible difficulty in weaning these patients from ventilators [1].

Acute respiratory failure is a commonly encountered entity in the emergency department and intensive care unit. Non-invasive positive pressure ventilation (NIPPV) has dramatically changed the management of acute respiratory failure, particularly when chronic obstructive pulmonary disease (COPD) or congestive heart failure is the underlying etiology [2].

Non-invasive mechanical ventilation (NIV) in the management of acute respiratory failure are variable. This variability can be attributed to the heterogeneity of the different groups of subjects, in which greater success is demonstrated when NIV is

used in those with chronic obstructive pulmonary disease (COPD) and/or congestive heart failure exacerbated by infection [3].

Noninvasive ventilation (NIV) has gained increasing acceptance as a way to avoid intubation and improve outcomes in selected patients with acute respiratory insufficiency. Compared with optimum medical treatment plus oxygen therapy, NIV can reduce duration of intensive care unit stay and decrease complication in patients with chronic obstructive pulmonary disease (COPD) exacerbations [4].

The bilevel positive airway pressure-spontaneous/ timed (BiPAP S/T) with average volume-assured pressure support (AVAPS) ventilation strategy allows the use of a fixed preprogrammed volume, and this tidal volume remains fixed by specific changes in inspired pressures [5]. The ventilator approximates the volume delivered and adjusts its parameters in order to ensure the predetermined destination volume [5].

In bilevel positive airway pressure (BiPAP) ventilator, we set an inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP). Adjustments in the values of IPAP change the tidal volume delivered for a given breath. The difference between the levels of IPAP and EPAP dictates the pressure support which combines with respiratory rate to determine the patient's ventilation [6]. The disadvantage with BiPAP (S/T) mode is that it depends on the patient's level of consciousness, position, and underlying lung compliance to provide adequate tidal volume, if any of these factors change during a patient's hospital stay, it can reduce the tidal volume and thus ventilation, which can lead to patient's deterioration [7].

Non-invasive mechanical ventilation (NIV) in patients with acute respiratory failure has been traditionally determined based on clinical assessment and changes in blood gases, with NIV support pressures manually adjusted by an operator. Bilevel positive airway pressure-spontaneous/timed (BiPAP S/T) with average volume assured pressure support (AVAPS) uses a fixed tidal volume that automatically adjusts to a patient's needs.

MATERIALS AND METHODS

This is a single-centre prospective study was conducted in the Department of Medicine, Gazi Medical College (GMC), Khulna, Bangladesh. All subjects included in the study were admitted between December 1, 2021 and January 1, 2023. All patients with chronic obstructive pulmonary disease with acute exacerbation were enrolled in this study. The APACHE II score system was used to determine age, gender, and disease severity. The primary diagnosis that led to NIV, as well as the number of damaged lung quadrants as determined by a chest X-ray, were recorded. COPD, bronchial asthma, pneumonia, ARDS, congestive heart failure, and interstitial illness were used to categorize the participants. The patients were additionally classified based on the type of ARF: Obstructive disorders such as COPD and bronchial asthma are examples of hypercapnic ARF; pneumonia, ARDS, congestive heart failure, and interstitial lung disease are examples of de novo hypoxaemic ARF.

Inclusion Criteria

The subjects included were those who met the following criteria: (1) Age > 18 years, (2) admitted to an intensive care unit (ICU); (3) diagnosed with ARF due to exacerbation of asthma, exacerbation of COPD, pneumonia, interstitial lung disease, congestive heart failure, and/or acute respiratory distress syndrome (ARDS).

The defining criteria for ARF were as follows:

(a) Ventilatory failure secondary to hypercapnia ($PaCO_2$ > 45 mmHg, pH 7.35 or less); (b) inadequate oxygenation (PaO_2 < 60 mmHg) breathing ambient air (SaO_2 < 92%) with PaO_2/FiO_2 < 300 (mmHg) and severe dyspnoea (RR > 25 breaths per minute) with the use of accessory muscles.

Exclusion Criteria

Exclusion criteria were presented any of the following: (1) face deformities; (2) upper airway obstruction resulting from trauma and/or surgery; (3) central nervous system alterations unrelated to hypercapnic encephalopathy; (4) pneumothorax, embolism, septic shock, or haemoptysis; (5) urgent intubation due to cardiorespiratory arrest and haemodynamic instability with systolic pressure less than 80 mmHg; and (6) subjects with haemodynamic instability, excessive respiratory secretions, uncooperative or with agitated conduct, and recent upper airway surgery as well as those who were unable to use the interface device or who received NIV with do-not-resuscitate orders.

Clinical characteristics

The APACHE II score system was used to determine age, gender, and disease severity. The primary diagnosis that led to NIV, as well as the number of damaged lung quadrants as determined by a chest X-ray, were recorded.

COPD, bronchial asthma, pneumonia, ARDS, congestive heart failure, and interstitial illness were used to categorize the participants. The patients were additionally classified based on the type of ARF: Obstructive disorders such as COPD and bronchial asthma are examples of hypercapnic ARF; pneumonia, ARDS, congestive heart failure, and interstitial lung disease are examples of de novo hypoxaemic ARF.

Measurements

Arterial blood gases (ABG) were measured at baseline and then after 1 hour, 12 hours, and 24 hours of NIV use. The subjects were evaluated by a medical team with proper training and expertise in NIV. We reported data on systolic blood pressure (SBP, mmHg), heart rate (HR), diastolic blood pressure (DBP, mmHg), respiratory rate (RR), programmed tidal volume, maximum programmed inspired positive airway pressure (IPAP, cmH2O), IPAP level (cmH2O), inspiratory time (IT) (s), expired positive airway pressure (EPAP) level (cmH2O), exhaled tidal volume (VTE) (mL), minute volume (Vmin), leakage, FiO2 (%), and number of affected lung quadrants (according to patients' chest X-rays).

Programmed ventilator parameters

Initially programmed the ventilatory parameters in the BiPAP S/T mode with AVAPS, using a maximum programmed IPAP of 20 cm H2O, a minimum IPAP of 12 cm H2O, and an EPAP of 6–8 cm H2O. The researchers programmed the tidal volume considering 6–8 mL kg–1 of the ideal body weight (PBW) as follows: 55.5 ± 2.3 (height – 60 inches) = kg (PBW) for men and 45.5 ± 2.3 (height – 60 inches) = kg (PBW) for women. Additionally, the respiratory rate (RR) was 14–20 rpm, rise time was 300–400 ms, and inspiratory time (IT) was 0.8–1.2 s. Oxygen supplementation was added using a mask adapter to maintain the SaO2 above 90%. Vmin, VTE, maximum IPAP, and leaks were managed using the ventilator's software. We used BiPAP Synchrony with AVAPS, as well as the Autotrak (Respironics Inc., Murrysville, Pennsylvania, USA) and a Mirage IV series of facemasks. Decisions regarding adjustments of ventilator parameters were made at the discretion of the physician responsible for the patient and according to the degree of patient-ventilator asynchrony, respiratory frequency and comfort. The following were the criteria for failure of NIV and need for intubation: (a) persistence of hypercapnic ventilatory failure as evidenced by an increase in basal PaCO2 and persistence of low pH; (b) persistent hypoxaemia as evidenced by PaO2 < 70 mmHg with SaO2 < 90%; (c) severe dyspnoea with tachypnea (30–40 breaths per minute) and use of accessory respiratory muscles. Discontinuation of NIV therapy Ventilation was given continuously during the first 24 hours and in 3-hour periods afterwards, with periods without NIV depending on the tolerability of the patient. During these periods, the patient received therapy with an oxygen face mask. Subjects were weaned off NIV when they reached clinical stability, which our team defined as: respiratory rate of less than 24 rpm, HR of 90 bpm, and SaO2 > 90% with inspired FiO2 percentage less than 35–40%.

NIV withdrawal

Clinical stability was defined as: (1) RR < 25 rpm, (2) HR < 90 bpm, and (3) compensated arterial pH with SaO2 > 90% in ambient air or with a low flow of oxygen (< 3 L per minute). These parameters were measured during the periods without NIV and for a period of 24 hours.

Outcome Measures

The primary outcome, which was either the success or failure (defined as endotracheal intubation) in the usage of NIV, was expressed as a percentage. The secondary outcomes included length of hospitalization (days), need for endotracheal intubation (percentage), mortality (percentage), and predictors of success or failure.

Data were collected on a structured proforma. All categorical data were expressed in percentage and absolute number. All numerical continuous data were expressed in mean ±SD. The data analysis was done using SPSS version 23. All tests were analyzed with a 95% confidence interval and a P value of <0.05 was considered significant.

RESULTS

Almost three fourth (72.0%) patients were belonged to age ≤70 years in BiPAP S/T with AVAPS group and 19(76.0%) in BiPAP S/T group. Twenty three (92.0%) patients were male in BiPAP S/T with AVAPS group and 96.0% in BiPAP S/T group. More than half (52.0%) patients had hypertension in BiPAP S/T with AVAPS group and 11(44.0%) in BiPAP S/T group. Age, sex and co-morbidities were not statistically significant (p>0.05) between two groups (Table-1). Mean MBS, NRS, dyspnea/comfort scale, respiration rates, systolic blood pressure and diastolic blood pressure- post treatment were statistically significant (p<0.05) within the BiPAP S/T with AVAPS group compare with pretreatment. Mean $PaCO_2$, MBS, NRS, dyspnea/comfort scale, heart rate, respiration rates and systolic blood pressure- post treatment were statistically significant (p<0.05) within the BiPAP S/T group compare with pretreatment (Table-2). Mean change of MBS, NRS, dyspnea/comfort scale and satisfaction were not statistically significant (p>0.05) between two groups (Table-3). Mean change of pH, $PaCO_2$, SpO_2,, heart rate, respiration rates, systolic blood pressure and diastolic blood pressure were not statistically significant (p>0.05) between two groups**.** The mean duration of NIV was found 4.38±3.12 hours in BiPAP S/T with AVAPS group and 5.19±3.97 hours in BiPAP S/T group. The mean length of stay in ED was found 9.21±6.96 hours in BiPAP S/T with AVAPS group and 10.87±7.08 hours in BiPAP S/T group. Three (12.0%) patients were discharge in BiPAP S/T with AVAPS group and not found in BiPAP S/T group. The difference were not statistically significant (p>0.05) between two groups (Table-4).

Table 1: Baseline characteristics of the study patients (n=50)

	BiPAP S/T with AVAPS (n=25)		BiPAP S/T without AVAPS (n=25)		P value
	n	%	n	%	
Age (years)					
≤70	18	72.0	19	76.0	
71-80	6	24.0	6	24.0	0.598
>80	1	4.0	0	0.0	
Sex					
Male	23	92.0	24	96.0	0.552
Female	2	8.0	1	4.0	
Co-morbidities					
Asthma	2	8.0	1	4.0	0.552
Diabetes	1	4.0	3	12.0	0.297
Hypertension	13	52.0	11	44.0	0.571
Dyslipidemia	5	20.0	1	4.0	0.082
CKD	0	0.0	1	4.0	0.312
CAD	3	12.0	5	20.0	0.440

P value reached from chi square test

Table 2: ABGs, vital signs and symptoms in different follow-up (n=50)

	Pretreatment (n=25)		Post-treatment (n=25)		Difference	P value
	Mean	±SD	Mean	±SD		
BiPAP S/T with AVAPS						
pH	7.35	±0.08	7.36	±0.09	0.01	0.241
$PaCO_2$ (mmHg)	47.28	±19.21	45.81	±21.24	-1.47	0.296
SpO_2 (%)	94.20	±6.39	98.53	±1.72	4.33	0.589
MBS	8.25	±1.92	4.29	±1.74	-3.96	0.001
NRS	8.36	±1.66	4.43	±1.91	-3.93	0.001
Dyspnea/comfort scale	7.37	±2.18	4.12	±1.89	-3.25	0.001
Satisfaction	6.76	±2.34	8.41	±1.94	1.65	0.052
HR (beats/min)	115.8	±17.89	110.3	±19.58	-5.5	0.094
RR (breaths/min)	32.58	±6.44	26.48	±6.32	-6.1	0.002
SBP (mmHg)	165.5	±37.32	142.82	±19.86	-22.68	0.001
DBP (mmHg)	95.42	±18.63	82.33	±12.19	-13.09	0.047
BiPAP S/T without AVAPS						
pH	7.37	±0.6	7.38	±0.07	0.01	0.577
$PaCO_2$ (mmHg)	43.43	±7.19	41.2	±5.32	-2.23	0.045
SpO_2 (%)	96.51	±4.93	99.28	±1.11	2.77	0.056
MBS	7.58	±1.87	4.37	±1.64	-3.21	0.001
NRS	7.41	±1.79	4.38	±1.88	-3.03	0.001
Dyspnea/comfort scale	7.27	±1.9	4.32	±1.68	-2.95	0.001
Satisfaction	6.13	±2.15	7.10	±1.65	0.97	0.192
HR (beats/min)	114.56	±16.54	105.38	±15.02	-9.18	0.006
RR (breaths/min)	32.65	±6.32	25.63	±5.80	-7.02	0.001
SBP (mmHg)	144.63	±20.21	126.29	±13.62	-18.34	0.005
DBP (mmHg)	85.43	±19.14	78.98	±14.37	-6.45	0.090

P value reached from paired t-test

DBP= Diastolic blood pressure, HR= Heart rate, MBS= Modified Borg scale, NRS= Numeric rating scale, RR= Respiration rates, SBP= Systolic blood pressure

Table 3: Primary outcomes

	BiPAP S/T with AVAPS (n=25)		BiPAP S/T without AVAPS (n=25)		P value
	Mean	±SD	Mean	±SD	
MBS					
Pretreatment	8.25	±1.92	7.58	±1.87	
Post-treatment	4.29	±1.74	4.37	±1.64	
Difference (post vs pre treatment)	3.96	±1.83	3.21	±1.66	0.136
NRS					
Pretreatment	8.36	±1.66	7.41	±1.79	

Post-treatment	4.43	±1.91	4.38	±1.88	
Difference (post vs pre treatment)	3.93	±1.78	3.03	±1.93	0.093
Dyspnea/comfort scale					
Pretreatment	7.37	±2.18	7.27	±1.9	
Post-treatment	4.12	±1.89	4.32	±1.68	
Difference (post vs pre treatment)	3.25	±2.24	2.95	±1.96	0.617
Satisfaction					
Pretreatment	6.76	±2.34	6.13	±2.15	
Post-treatment	8.41	±1.94	7.10	±1.65	
Difference (pre vs post treatment	1.65	±2.53	0.97	±2.82	0.374

P value reached from unpaired t-test

Table 4: Secondary outcomes

	BiPAP S/T with AVAPS (n=25)		BiPAP S/T without AVAPS (n=25)		p value
	Mean	±SD	Mean	±SD	
pH					
Pretreatment	7.35	±0.08	7.37	±0.6	
Post-treatment	7.36	±0.09	7.38	±0.07	
Difference (pre vs post treatment	0.01	±0.04	0.01	±0.05	[a]1.00
$PaCO_2$ (mmHg)					
Pretreatment	47.28	±19.21	43.43	±7.19	
Post-treatment	45.81	±21.24	41.2	±5.32	
Difference (post vs pre treatment)	1.47	±4.38	2.23	±3.27	[a]0.490
SpO_2 (%)					
Pretreatment	94.20	±6.39	96.51	±4.93	
Post-treatment	98.53	±1.72	99.28	±1.11	
Difference (pre vs post treatment	4.33	±6.89	2.77	±4.23	[a]0.340
HR (beats/min)					
Pretreatment	115.8	±17.89	114.56	±16.54	
Post-treatment	110.3	±19.58	105.38	±15.02	
Difference (post vs pre treatment)	5.5	±13.07	9.18	±11.41	[a]0.294
RR (breaths/min)					
Pretreatment	32.58	±6.44	32.65	±6.32	
Post-treatment	26.48	±6.32	25.63	±5.80	
Difference (post vs pre treatment)	6.1	±6.13	7.02	±6.04	[a]0.595
SBP (mmHg)					
Pretreatment	165.5	±37.32	144.63	±20.21	
Post-treatment	142.82	±19.86	126.29	±13.62	
Difference (post vs pre treatment)	22.68	±23.29	18.34	±20.11	[a]0.511
DBP (mmHg)					
Pretreatment	95.42	±18.63	85.43	±19.14	
Post-treatment	82.33	±12.19	78.98	±14.37	
Difference (post vs pre treatment)	13.09	±17.97	6.45	±15.46	[a]0.168
Duration of NIV (hours)	4.38	±3.12	5.19	±3.97	[a]0.427
Length of stay in ED (hours)	**9.21**	±6.96	10.87	±7.08	[a]0.407
Disposition					
Discharge	3	12.0	0	0.0	
Admission	16	64.0	15	60.0	[b]0.256
Transfer to another facility	2	8.0	3	12.0	
Observation unit	4	16.0	7	28.0	

[a]P value reached from unpaired t-test
[b]P value reached from chi square test

DISCUSSION

In this study observed almost three fourth (72.0%) patients were belonged to age ≤70 years in BiPAP S/T with AVAPS group and 19(76.0%) in BiPAP S/T group. Twenty three (92.0%) patients were male in BiPAP S/T with AVAPS group and 96.0% in BiPAP S/T group. More than half (52.0%) patients had hypertension in BiPAP S/T with AVAPS group and 11(44.0%) in BiPAP S/T group. Age, sex and co-morbidities were not statistically significant (p>0.05) between two groups. Limsuwat *et al*., [1] reported the majority of the patients were male (10 [90.9%] in each group). The median (interquartile range [IQR]) age of the patients was 77 (64, 84) years in BiPAP S/T group

and 69 (49, 77) years in BiPAP S/T with AVAPS group. Briones Claudett *et al*., [5] reported the mean age was found 26.22±2.87 years in BiPAP S/T group and 24.23±2.62 years in BiPAP S/T with AVAPS group. The difference was not statistically significant (p>0.05) between two groups. Maheshwari *et al*., [8] observed the mean age was found 60.32±12.05 years in BiPAP S/T with AVAPS group and 57.5±10.59 years in BiPAP S/T group. 72.0% patients were male in BiPAP S/T with AVAPS group and 76.0% in BiPAP S/T group. The difference were not statistically significant (p>0.05) between two groups. Magdy *et al*., [9] reported 35.0% patients had diabetes in BiPAP S/T with AVAPS group and 25.0% in BiPAP S/T group. 30.0% patients had hypertension in BiPAP S/T with AVAPS group and 40.0% in BiPAP S/T group. 15.0% patients had dyslipidemia in BiPAP S/T with AVAPS group and 20.0% in BiPAP S/T group. The difference were not statistically significant (p>0.05) between two groups.

Present study observed the mean MBS, NRS, dyspnea/comfort scale, respiration rates, systolic blood pressure and diastolic blood pressure- post treatment were statistically significant (p<0.05) within the BiPAP S/T with AVAPS group compare with pretreatment. Mean $PaCO_2$, MBS, NRS, dyspnea/comfort scale, heart rate, respiration rates and systolic blood pressure- post treatment were statistically significant (p<0.05) within the BiPAP S/T group compare with pretreatment. Briones Claudett *et al*., [5] reported mean pCO^2 and respiratory rate - after 1 hour, 3 hours and 12 hours were statistically significant (p<0.05) within the BiPAP S/T group compare with initially. Mean pCO^2 and respiratory rate - after 1 hour, 3 hours and 12 hours were statistically significant (p<0.05) within the BiPAP S/T with AVAPS group compare with initially. Battisti *et al*., compared manually adjusted pressures with self-adjusting pressure support in patients with acute respiratory failure, which produced a decrease in pCO^2 levels in the latter group [10]. Limsuwat *et al*., [1] reported there were statistically significant decreases in both respiratory rate and systolic blood pressure in individuals in both groups.

In this study observed the mean change of MBS, NRS, dyspnea/comfort scale and satisfaction were not statistically significant (p>0.05) between two groups. Limsuwat *et al*., [1] reported the average decreases in MBS, NRS, and dyspnea and comfort were greater in the BiPAP S/T with AVAPS group than the BiPAP S/T group (4.09±1.81 vs. 2.91±1.64, *p*-value=0.125; 4.09±1.76 vs. 2.91±1.92, *p*-value=0.148; 3.27±2.45 vs. 3.00±1.90 *p*-value=0.774, respectively). However, these differences did not reach statistical significance. The patient satisfaction based on an overall comfort scale increased more in BiPAP S/T with AVAPS group then the BiPAP S/T group (1.64±2.77 vs. 1.09±3.02, *p*-value=0.663), but this was not statistically significant. This allows the ventilator to maintain a given tidal volume in an environment of deteriorating respiratory compliance. Its application was thought to be more tolerable and effective in these patients than with the BiPAP S/T mode because the fixed IPAP might deliver tidal volumes less than the patient needs during treatment of AECOPD as the result of dynamic changes in airway resistance and lungs mechanics [11]. Consequently, auto-adjusting IPAP with BiPAP S/T with AVAPS might improve the patient's comfort level and reduce dyspnea measured by MBS, NRS, and dyspnea and comfort scales better than BiPAP S/T.

Current study observed the mean change of pH, $PaCO_2$, SpO_2,, heart rate, respiration rates, systolic blood pressure and diastolic blood pressure were not statistically significant (p>0.05) between two groups. The mean duration of NIV was found 4.38±3.12 hours in BiPAP S/T with AVAPS group and 5.19±3.97 hours in BiPAP S/T group. The mean length of stay in ED was found 9.21±6.96 hours in BiPAP S/T with AVAPS group and 10.87±7.08 hours in BiPAP S/T group. Three (12.0%) patients were discharge in BiPAP S/T with AVAPS group and not found in BiPAP S/T group. The difference were not statistically significant (p>0.05) between two groups. Limsuwat *et al*., [1] reported vital signs, including systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), and respiratory rate (RR), decreased in both treatment groups after an hour of treatment. There was a trend for larger decreases in SBP, DBP, and RR at an hour after treatment (T1-T0) in BiPAP S/T with AVAPS group than in the BiPAP S/T group (31.45±26.25 vs. 18.18±21.15, *p*-value=0.206; 12.09± 18.96 vs.7.36±15.00, *p*-value=0.524; and 7.09±7.14 vs. 7.00±6.16, *p*-value=0.975, respectively), but these differences were not statistically significant. The physiologic changes during AECOPD include increases in heart rate, blood pressure, and sympathic nervous activity [12]. Decreases in sympathetic tone should happen when patients feel more comfortable, and this decreases the BP and heart rate.

The duration of NIV use and length of stay in the emergency department were similar in both group. The majority of patients were admitted by a medicine team: 7 (63.6%) in BiPAP S/T with AVAPS group and 6 (54.5%) in BiPAP S/T without AVAPS group. Previous randomized trials had a 26% intubation rate in the NIV groups but no patient required intubation during our study period [13]. Briones Claudett *et al*., [5] reported mean duration of NIV was found 5.81±1.83 days in BiPAP S/T group and 5.36±1.12 days in BiPAP S/T with AVAPS group. The difference was not statistically significant (p>0.05) between two groups. Some studies found favorable results in patients using NIV in hypercapnic encephalopathy reduction in days of mechanical ventilation [14] reduced risk of nosocomial infection [15, 16] and avoid intubation [17]. Maheshwari *et al*., [8] observed 8.0% patients were needed for invasive ventilation in BiPAP S/T with

AVAPS group and 14.0% in BiPAP S/T group. The difference were not statistically significant (p>0.05) between two groups.

CONCLUSION

BiPAP S/T with AVAPS promotes a quicker return to awareness in patients with chronic obstructive pulmonary disease as compared to standard BiPAP S/T. Recommend the use of BiPAP S/T with AVAPS as a safe noninvasive ventilatory therapy method in patients with COPD exacerbations, with the caveat that these patients be treated in units with plenty of experience and under strict supervision.

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