Section: Respiratory Medicine

Original Research Article

A HOSPITAL BASED PROSPECTIVE STUDY TO ASSESS THE EFFECTIVENESS OF S/T MODE BIPAP AND AVAPS MODE BY APPLYING THE CLINICAL ABG PARAMETERS AT ADMISSION AND AFTER 3 HOURS & 6 HOURS OF APPLYING NON-INVASIVE VENTILATION (NIV) IN MANAGEMENT OF TYPE II RESPIRATORY FAILURE IN AECOPD PATIENTS IN THE EMERGENCY DEPARTMENT AT TERTIARY CARE CENTER

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ABSTRACT

Background: Non-invasive mechanical ventilation (NIMV) can be applied with continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BPAP). The status of consciousness improved faster with AVAPS in patients with COPD who had hypercapnic respiratory failure, while improvements in arterial blood gas (ABG) parameters were similar to the S/T mode. This study aimed to compare the effects of AVAPS and routine S/T modes in NIMV patients admitted to the ED, on their ABG parameters and clinical status.

Materials & Methods: A hospital based prospective study done on 60 patients admitted in Respiratory ICU requiring NIV were recruited in the study. Patients were randomly distributed into the three groups of NIV. In group 1, patients were kept ST mode and iVAPS mode was used in group 2. Success rate of various modes applied (Time frame- 12 hours) success is considered when the patient is able to achieve: pH >7.35, decrease in partial pressure of carbon dioxide, PaCO2 (mmHg) by >15-20%, partial pressure of oxygen (PaO2) >60 mmHg, SpO2>90% on fraction of inspired oxygen (FiO2) < 24/minute, no signs of respiratory distress like agitation, diaphoresis or anxiety.

Results: The mean age of the 60 patients included in the study was 71.9 ± 12.3 years (age range: 21-92), and 50% (*n* = 30) were male. In the S/T group, the median GCS was 14 in the evaluation made after 6 hour; a significant difference was found in repeated measurements (*P=0.008*). In the AVAPS group, the median GCS was 15 (range: 13-15) in the evaluation made after 6 hour; a significant difference was found in repeated measurements (P<0.001). The blood gas parameters were compared and a significant improvement was observed in pH and $PaCO_2$ values in the follow- up (P>0.005 and P>0.05, respectively).

Conclusion: In this study, improvements in blood gas parameters in the AVAPS group were faster compared to the S/T group; however, we did not find any significant difference between the groups in terms of clinical parameters. The AVAPS mode is as effective and safe as BPAP S/T in treating patients with hypercapnic respiratory failure in the ED

Keywords: S/T mode, GCS, ABG, BiPAP, PaCO2, AVAPS.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) exacerbations are a very common reason for admission to hospital. 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.[1-3] Furthermore, complications can result in local tissue damage, nosocomial infections, and prolonged stays in intensive care.[4,5]

The standard treatment for patients with COPD exacerbations who come to the ED include conventional oxygen therapy via nasal cannula or facemask and pharmacologic therapy, such as inhaled bronchodilators and systemic corticosteroids. In addition, AECOPD patients with increased work of breathing or impaired gas exchange require consideration for non-invasive mechanical ventilation (NIV), according to the Global Initiative for Chronic Obstructive Lung Disease guidelines 2019 (GOLD 2019).[6]

Non-invasive mechanical ventilation (NIMV) can be applied with continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BPAP). CPAP aims at reducing the number of adverse respiratory events by providing constant positive pressure support throughout the breathing cycle, while BPAP provides different levels of positive airway pressure during inspiration and expiration. Bilevel pressure support is provided by setting constant expiratory positive airway pressure (EPAP) and inspiratory positive airway pressure (IPAP) values in the spontaneous/timed (S/T) mode.[7] Average volume-assured pressure support (AVAPS) is a different mode of NIMV. To achieve the target tidal volume (TV) with AVAPS, variable pressure support is applied during inspiration. The status of consciousness improved faster with AVAPS in patients with COPD who had hypercapnic respiratory failure, while improvements in arterial blood gas (ABG) parameters were similar to the S/T mode.[8] This study aimed to compare the effects of AVAPS and routine S/T modes in NIMV patients admitted to the ED, on their ABG parameters and clinical status.

MATERIALS AND METHODS

A hospital based prospective study done on 60 patients admitted in Respiratory ICU requiring NIV were recruited in the study in the Government Medical College & Bangur Hospital, Pali, Rajasthan, India. Patients were excluded if: not giving consent, patient requiring invasive ventilation, facial trauma, deformity and facial burns, COPD associated with carcinoma lung, agitated, uncooperative patient, recent upper airway or upper gastrointestinal surgery.

Methodology and intervention

Patients of AECOPD, a thorough history was taken and a detailed general and systemic examination was done and vital clinical parameters were recorded at the time of admission. Routine investigations were done at the time of admission of which an arterial blood gas (ABG) analysis was the primary investigation to be included in our study.

Patients were randomly distributed into the three groups of NIV. In group 1, patients were kept ST mode and iVAPS mode was used in group 2. Baseline clinical, biochemical and haematological parameters were recorded for each group. A proper NIV interface was chosen for each patient according to the size of their face and level of comfort. Identical NIV device was used to apply the two different modes in every patient. Each patient's vitals were recorded and ABG analysis was done and recorded after 3 hours and 6 hours of NIV. Final interpretation was done with the values achieved after 6 hours of NIV application and comparative evaluation was done. Patients of each group were followed up till the time they were admitted to analyse the success rate, intubation rate and length of ICU stay in each group.

Primary outcome measures: Success rate of various modes applied (Time frame- 12 hours) success is considered when the patient is able to achieve: pH >7.35, decrease in partial pressure of carbon dioxide, PaCO2 (mmHg) by >15-20%, partial pressure of oxygen (PaO2) >60 mmHg, SpO2>90% on fraction of inspired oxygen (FiO2) < 24/minute, no signs of respiratory distress like agitation, diaphoresis or anxiety.

Criteria for intubation: Respiratory arrest or a respiratory rate >35 breaths/min or higher than the value recorded on admission. Haemodynamic instability with systolic pressure less than 70 mmHg, and a heart rate of 60 beats/min or less. GCS- 3/15. Arterial pH of 7.30 and lower than the value recorded on admission even after the application of NIV mode. A PaO2/FiO2 less than 200 despite oxygen supplementation.

Statistical Analysis

The presentation of the categorical variables was done in the form of number and percentage (%). Paired t test was used for comparison across follow up. The qualitative variables were analyzed using Chi-square test. For statistical significance, p value of less than 0.05 was considered statistically significant.

RESULTS

The mean age of the 60 patients included in the study was 71.9 ± 12.3 years (age range: 21-92), and 50% (n = 30) were male. The median of pre-treatment of GCS values was 14 (9-15). The age, comorbid diseases, vital signs, and baseline blood

gas parameters of the AVAPS and S/T groups were compared, and no significant difference was found between the groups. [Table 1]

In the S/T group, the median GCS was 14 in the evaluation made after 6 hours; a significant difference was found in repeated measurements (P=0.008). In the AVAPS group, the median GCS was 15 (range: 13-15) in the evaluation made after 6 hours; a significant difference was found in repeated measurements (P<0.001).

The blood gas parameters were compared and a significant improvement was observed in pH and $PaCO_2$ values in the follow- up (P>0.005 and P>0.05, respectively). The comparison of ABG parameters during treatment also have been presented in Table 2.

Table 1: Comparison of Patient Characteristics, Initial Vital Parameters, and ABG Levels Between the Groups

Variables	S/T group	AVAPS group	*P*
Age*	68.27± 8.2	72.56±7.3	>0.05
Oxygen saturation*(%)	90.3±6.25	88±7.94	>0.05
Systolic blood pressure*(mmHg)	130±10.8	136±12.5	>0.05
Diastolic blood pressure*(mmHg)	76.8±7.2	82.5±8.5	>0.05
Heart rate*(min)	102±10.6	103±12.5	>0.05
pH	7.3 (7.20-7.36)	7.27 (7.18-7.28)	>0.05
$PaCO_2$*(mmHg)	64.6±3.6	65.4±4.5	>0.05
PaO_2*(mmHg)	65.6±2.8	62.9±3.1	>0.05
GCS**	13 (9-14)	14 (10-15)	>0.05

Table 2: Comparison of Vital Signs, ABG, and Ventilator Parameters During Treatment

	3 hours	6 hours	*P*
S/T group			
Heart rate (beats/min)	85.6±7.5	82.8±6.6	>0.05
Systolic blood pressure (mm/hg)	124±10	120±8	>0.05
Diastolic blood pressure (mm/hg)	74±4	72±6	>0.05
Oxygen saturation (%)	90.5±3.6	92.8±3.2	>0.05
GCS	14	14	0.008
pH	7.32	7.33	>0.05
$PaCO_2$ (mm/hg)	60.3±2.1	56.2±2.7	>0.05
PaO_2 (mm/hg) AVAPS group	83.32±1.6	80.4±1.4	>0.05
Heart rate (beats/min)	98±6.4	94±4.6	>0.05
Systolic blood pressure (mm/hg)	129±5.4	122±6.7	<0.001
Diastolic blood pressure (mm/hg)	76±6	73±5	0.002
Oxygen saturation (%)	93±2.4	94±2.6	<0.001
GCS	15	15	<0.001
pH	7.33	7.34	0.005
$PaCO_2$ (mm/hg)	57.4±1.8	54.3±1.2	<0.001
PaO_2 (mm/hg)	76.6±1.1	72.3±0.9	>0.05

DISCUSSIONS

The major theoretical advantage of BiPAP S/T with AVAPS is the auto-adjusting IPAP level to maintain targeted tidal volumes. 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.[9] 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. Our study did not show a statistically significant difference, but this may due to the small sample size of our study. A larger scale study is needed to better evaluate the effect of AVAPs in these patient.

In addition, this study found a decrease in BP and heart rate in both study groups after NIV application, but the trend toward greater decreases in SBP and DBP with BiPAP S/T with the AVAPS group compared with the BiPAP S/T group did not reach statistical significance. The physiologic changes during AECOPD include increases in heart rate, blood pressure, and sympathetic nervous activity.[10] Decreases in sympathetic tone should happen when patients feel more comfortable, and this decreases the BP and heart rate.

Ayman et al conducted a study on patients on NIV and divided them into 3 groups i.e. CPAP group; BIPAP group and standard group.[11] They observed that there was improvement in PaO2 in patients of group 2 (BiPAP group) during the follow up period after 1, 6, 12 h and on second day, with statistically significant improvement after 6 and 12 h and on second day with p=0.013, 0.001 and 0.012 respectively. In our study, significant increase was seen in SpO2 (%) after BiPAP as compared to that at admission in group 3 (p=0.012). This observation can be supported by a prospective observational study of 100 adult patients with hypercapnic RF done by Chawla et al.[12] Oxygen saturation was found to be significantly higher among patients

successfully managed with NIV (84.35±8.55 vs 76.87±7.33) as compared to patients who required intubation. Diaz et al prospectively examined patients with hypercapnic coma (GCS≤8) secondary to RF and treated with NIV.[13] At the beginning of ventilatory therapy, arterial pH was 7.13±0.06 and PaCO2 was 99±19 mm Hg. Improvements in pH, GCS, PaCO2, and PaO2/FiO2 within the first hour of NIV correlated with NIV success.

In a previous study, the use of AVAPS was evaluated in 81 patients with acute hypercapnic respiratory failure in the ICU, and it was reported to have been used effectively.[14] In a multicenter study by Briones Claudett et al., ST/T and AVAPS modes were compared in 22 patients with hypercapnic encephalopathy.[8] In this study, AVAPS was reported to provide better GCS improvements, but there was no significant difference in blood gases.8 In our study, significant decreases were observed even in the after 3 hours of blood gas control, in $PaCO_2$ of the AVAPS group. When partial carbon dioxide and pH levels, which are the study's primary objective, are considered, rapid and further improvement can be achieved with AVAPS. However, the comparison of both groups did not indicate a significant difference in terms of improvement in blood gas parameters similar to previous studies. NIMV treatment administered with both modes can effectively improve blood gas parameters.

CONCLUSION

In this study, improvements in blood gas parameters in the AVAPS group were faster compared to the S/T group; however, we did not find any significant difference between the groups in terms of clinical parameters. The AVAPS mode is as effective and safe as BPAP S/T in treating patients with hypercapnic respiratory failure in the ED.

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