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ORIGINAL RESEARCH

A Hospital Based Prospective Study to Assess the Effectiveness of S/T Mode BIPAP and AVAPS Mode by Applying the Clinical and ABG Parameters at Admission and After 3 Hours and 6 Hours of Applying Non-Invasive Ventilation (NIV) in Management of Type-2 Respiratory Failure in AECOPD Patients in the Emergency Department/ICU

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ABSTRACT

Background: Noninvasive ventilation (NIV) refers to the delivery of ventilatory support or positive pressure into the lungs without an invasive endotracheal airway, usually through a mask.The aim of this study to assess the effectiveness of S/T mode BIPAP and AVAPS mode by applying the clinical and ABG parameters at admission and after 3 hours and 6 hours of applying non- invasive ventilation (NIV) in management of type-2 respiratory failure in AECOPD patients in the emergency department/ICU.

Materials& Methods: A hospital based prospective study done on 50 patients with acute respiratory distress in ICU at SMS Medical College, Jaipur, Rajasthan, India during one year period. Patients were entered into the study if they were aged>18 yrs and had evidence of ARF as demonstrated by three of the following criteria: acute onset of moderate-to-severe dyspnoea as assessed by the ED physician who took care of the patient; a respiratory rate>30 (or<10) breaths/ min.; hypoxaemia (oxygen tension in arterial blood (Pa,O2) <7.3 kPa (55 mmHg) (on room air)) or need for O2 supplementation; respiratory acidosis (pH<7.33). 25 patients with acute exacerbations of COPD with GCS < 10 were designated to receive BiPAP S/T and 25 patients with acute exacerbations of COPD with GCS < 10 were designated to receive with AVAPS.Each patient was treated with NIV and was selected according to: APACHE II score within 4 points, age within 10 points, pH within 0.04, GCS within 2 points, and BMI within 2 points.

Results: The mean age of all patients was 78.72±11.43 years, mean APACHEII score was 18.47±2.55. There were no statistically significant differences between the two groups in terms of BMI, age, APACHEII score, or initial GCS score.The ANOVA analysis revealed statistically significant differences in favor of AVAPS for pCO2 (P <0.05*), respiratory rate (P<0.05*), maximum IPAP (P <0.05*), GCS score (P <0.001*) and ETV (P <0.05*). However,no significant differences were observed for length of stay (*P* >0.05) ordurationofNIV(*P*>0.05).

Conclusion: We propose the use of BiPAP S/T with AVAPS as a safestrategy of noninvasive ventilatory treatment in patientswith exacerbations of COPD (GCS < 10).

Keywords: BiPAP S/T, AVAPS, GCS, AECOPD, NIV.

INTRODUCTION

Patients with acute respiratory distress usually arrive at the hospital via the emergency department (ED), where the initial management leads quite rapidly either to improvement and subsequent transfer to a medical ward, or transfer into an intensive care unit (ICU). In extreme cases, patients unresponsive to medical therapy are submitted to mechanical ventilation. Until recently, mechanical ventilation required endotracheal intubation. Currently, several well-conducted studies have shown that noninvasive positive-pressure ventilation (NPPV) via a nasal or facial mask is at least as effective as invasive ventilation in several conditions, with less complications and better outcomes.[1-3]

Noninvasive ventilation (NIV) refers to the delivery of ventilatory support or positive pressure into the lungs without an invasive endotracheal airway,[4,5] usually through a mask. This technique has been demonstrated to efficiently improve acute respiratory failure (ARF), avoiding the complications associated with endotracheal intubation (EI) and conventional invasive mechanical ventilation (IMV), especially ventilator-associated pneumonia.[6,7]

However, NPPV, by its very nature, could imply a powerful placebo effect leading to clinical improvement, for instance in dyspnoea, tachypnoea, anxiety and agitation, independent of the improvement due to medical treatment. It is impossible to separate these possible effects, since in all studies performed to date NPPV plus medical therapy was compared to medical therapy alone or intubation and mechanical ventilation.The aim of this study to assess the effectiveness of S/T mode BIPAP and AVAPS mode by applying the clinical and ABG parameters at admission and after 3 hours and 6 hours of applying non- invasive ventilation (NIV) in management of type-2 respiratory failure in AECOPD patients in the emergency department/ICU.

MATERIAL & METHODS

A hospital based prospective study done on 50 patients with acute respiratory distress in ICU at SMS Medical College, Jaipur, Rajasthan, India during one year period. Patients were entered into the study if they were aged>18 yrs and had evidence of ARF as demonstrated by three of the following criteria: acute onset of moderate-to-severe dyspnoea as assessed by the ED physician who took care of the patient; a respiratory rate>30 (or<10) breaths/ min.; hypoxaemia (oxygen tension in arterial blood (Pa,O2) <7.3 kPa (55 mmHg) (on room air)) or need for O2 supplementation; respiratory acidosis (pH<7.33).

EXCLUSION CRITERIA

1. An immediate indication for endotracheal intubation (respiratory and/or cardiac arrest)
2. Haemodynamic instability despite a fluid challenge
3. Facial or thoracic trauma
4. Lack of cooperation
5. Difficult adaptation of a facial mask to a patient’s facial anatomy
6. Clinical suspicion of pulmonary embolism
7. Retrosternal pain suggestive of a myocardial ischaemia even with a normal admission electrocardiogram (ECG).

METHODS

TREATMENT GROUP ASSIGNMENTS

25 patients with acute exacerbations of COPD with GCS < 10 were designated to receive BiPAP S/T and 25 patients with acute exacerbations of COPD with GCS < 10 were designated to receive with AVAPS. Patients were treated immediately and referred to us by doctors who were unaware of the study. Each patient was treated with NIV and was selected according to: APACHE II score within 4 points, age within 10 points, pH within 0.04, GCS within 2 points, and BMI within 2 points.

NONINVASIVE MECHANICAL VENTILATION: BIPAP S/T WITH AVAPS

Ventilatory parameters were initially programmed in the BiPAP S/T mode and AVAPS with an inspiratory positive airway pressure (IPAP) maximum programmed into the device of 26 cmH2O, to IPAP minimum programmed value of 12 cmH2O and an expiratory positive airway pressure (EPAP) of 6 cmH2O. The programmed tidal volume was at 8 to 12 ml/kg of IBW, and once the patient reached clinical stability and sensory, the target Vt in our patients were reprogrammed to 6–8 ml/kg/ weight according to manufacturer's specifications, the decision was made by the expert physician in charge of patient case dependent, respiratory rate was 15 breaths/ min, rise time set at 300–400 ms and inspiratory time was at a minimum of 0.6 s. Were given supplements O2 via an adapter circuit close to the facemask in order to maintain SaO2 above 90%. Patients were maintained on continuous NIV initially. Maximum IPAP received delivered, exhaled tidal volume (EVT), Vmin, and leaks were monitored through the ventilator software.

MEASUREMENTS

Arterial blood gases were measured at initial values and after 3 hour and 6 hours during NIV; the patient was assessed by a respiratory therapist under close supervision of a physician trained in NIV. Mask use, complications, and tolerance were also assessed. Disease severity was assessed using the APACHE II score and GCS to determine the patient's level of consciousness. Maximum Vt, maximum IPAP, EVT, Vmin, leaks, respiratory rate, heart rate, systolic blood pressure, diastolic blood pressure, and IPAP were measured upon hospitalization, after 3 hours, and 6 hours during NIV.

DISCONTINUATION OF NIV

Treatment with NIV was initially used on a continuous regimen based on patient tolerance and after normalization of arterial pH > 7.35 ventilation was given in 3-hour blocks. The weaning process was initiated when clinical stability was achieved, which was defined as respiratory rate less than 24 breaths/min, a heart rate of 90 beats/min, and improved awareness and compensation from normalized pH values, with adequate SaO2 in ambient air and a low percentage of inspired O2 (3 liters). Once the patient remained stable, NIV was discontinued.

STATISTICAL ANALYSIS

Values are presented as mean±SD. T-tests for paired and unpaired samples were used to compare the variables. When more than two samples had to be compared, one-way analysis of variance (ANOVA) was used.

RESULTS

The mean age of all patientswas78.72±11.43years, mean APACHEII score was 18.47±2.55. There were no statistically significant differences between the two groups in terms of BMI, age, APACHEII score, or initial GCS score (Table1).

Table1: Initial patient assessment results NIV study groups in all patients.

Characteristics	BiPAP S/T	BiPAP S/T +AVAPS	P-value
BMI	26.23±2.89	24.56±2.76	>0.05
Age (years)	76.34±6.52	78.82±11.34	>0.05
APACHE II	18.43±2.46	18.54±2.66	>0.05
Initial GSC	8.36±1.44	8.37±1.58	1.00
Initial pH	7.28±0.02	7.29±0.04	>0.05

In patients undergoing NIV with BiPAP S/T and AVAPS, the programmed tidal volume on AVAPS was 621.95 ± 76.45 ml/kg (range: 500–700), with a programmed Vt/kg of 10.23 ± 2.21 ml (range 7.88- 11,84). The programmed maximum IPAP values (BiPAP S/T with AVAPS) were: 19.8 ± 2.2 cmH2O (initial), 18.3 ± 2.6 cmH2O (3 hours), and 17.4 ± 2.3 cmH2O (6 hours). The ANOVA analysis revealed statistically significant differences in favor of AVAPSfor pCO2 (P <0.05*), respiratory rate (P<0.05*), maximum IPAP (P <0.05*), GCS score (P <0.001*) and ETV (P <0.05*)(Table 2).

Table2: Evolution of blood gases, vitalsigns, and ventilator parameters (mean±SD)

Variables	Groups	Initial	3 hours	12 hours	P
GSC	**BiPAP S/T**	8.2 ± 1.39	11.78 ± 1.5	112.90 ± 1.23	<0.05 *
	BiPAP S/T + AVAPS	8.3 ± 1.56	13.8 ± 0.7	14.8 ± 0.6	
pH	**BiPAP S/T**	7.27 ± 0.02	7.32 ± 0.13	7.323 ± 0.11	>0.05
	BiPAP S/T + AVAPS	7.28 ± 0.03	7.37 ± 0.16	7.37 ± 0.087	
pCO2	**BiPAP S/T**	64.8 ± 9.3	53.24 ± 8.77	50.3 ± 6.4	<0.05 *
	BiPAP S/T + AVAPS	63.35± 15.3	45.4 ± 7.82	43.8 ± 6.5	
PO2	**BiPAP S/T**	66.56± 12.7	75.3 ± 26.7	79.7 ± 16.2	>0.05
	BiPAP S/T + AVAPS	71.5 ± 16.8	87.5 ± 11.45	87.4 ± 17.89	
HCO3	**BiPAP S/T**	26.9 ± 5.7	25.8 ± 4.6	27.1 ± 4.3	>0.05
	BiPAP S/T + AVAPS	24.4 ± 5	23.7 ± 5.2	24.6 ± 4.3	
Base excess	**BiPAP S/T**	3.32 ± 6.87	10.2 ± 31.5	3.56 ± 4.6	>0.05
	BiPAP S/T + AVAPS	−1.8 ± 5.67	5.68 ± 19.7	2.9 ± 8.72	
Systolic blood pressure	**BiPAP S/TS/T**	124.6 ± 10	130.3 ± 14.2	130.4 ± 13.7	>0.05
	BiPAP S/T + AVAPS	125.8± 17.2	128.8 ± 18.3	123.3 ± 15.88	
Diastolic blood pressure	**BiPAP S/T**	73.9 ± 9.7	71.8 ± 9.4	73.7 ± 10.7	>0.05
	BiPAP S/T + AVAPS	65.56 ± 11.5	70.3 ± 11.2	65.8 ± 8.3	
Heart rate	**BiPAP S/T**	86.7 ± 9.1	80.4 ± 5.8	79.1 ± 5.5	>0.05
	BiPAP S/T + AVAPS	82 ± 10.9	72.8 ± 14.1	72. ± 11.2	
Respiratory rate	**BiPAP S/T**	27.9 ± 5.6	21 ± 2.6	20 ± 1.61	<0.05

	BiPAP S/T + AVAPS	29 ± 6.9	18.5 ± 3.6	19.9 ± 5.1	*
Maximum delivered IPAP received	**BiPAP S/T**	12.3 ± 0.9	14.3 ± 0.8	14.7 ± 1	<.0.05 *
	BiPAP S/T + AVAPS	19.8 ± 2.2	18.3 ± 2.6	17.4 ± 2.3	
EPAP	**BiPAP S/T**	5.8 ± 0.3	6 .2± 0	6.1s ± 0	.32
	BiPAP S/T + AVAPS	5.34 ± 0	5.7 ± 0.4	5.8 ± 0.2	
Minute volume	**BiPAP S/T**	8.7 ± 3.1	10.8 ± 1.4	10.6 ± 1.3	>0.05
	BiPAP S/T + AVAPS	8.5 ± 2.3	11.5 ± 3.2	11.6 ± 1.7	
Exhaled tidal volume	**BiPAP S/T**	305 ± 60.5	521 ± 61.4	536.1± 63.6	<0.05 *
	BiPAP S/T + AVAPS	298.6 ± 55.3	626.3 ± 76.5	617.6 ± 76.4	
Leak	**BiPAP S/T**	9.4 ± 3.78	11.2 ± 3.12	11 ± 3.39	>0.05
	BiPAP S/T + AVAPS	14.2 ± 11.1	17.5 ± 16.4	17.5 ± 16.4	

However, no significant differences were observed for length of stay (*P* >0.05) or duration of NIV (*P*>0.05)(Table3).

Table3: Duration of hospital stay and time on NIV

Characteristics	**BiPAP S/T**	**BiPAP S/T +AVAPS**	**P-value**
Duration of hospital stay (Days)	7.29±2.28	7.08±1.38	>0.05
Duration of NIV (Days)	5.78±1.62	5.32±1.08	>0.05

DISCUSSION

The application of active NPPV in the emergency department shortly after the arrival of these patients avoided the programmed intubation in all patients, and resulted in a rapid improvement of the patient's condition. This improvement was due to the application of ventilatory support and not due to the conventional medical treatment already instituted.

Previous studies on the usefulness of noninvasive assisted ventilation in a number of conditions leading to ARF have shown that this form of therapy can result in the avoidance of endotracheal intubation, reduction in the number of complications such as nosocomial infections, reductions in the length of stay of the patients in the ICU and sometimes in the hospital, and in some studies decreases in mortality.[8-10] In the last few years, NPPV has been applied to patients with acute exacerbation of COPD[1,11], status asthmaticus[12,13], community acquired pneumonia[3], acute pulmonary oedema[14,15], ARF after solid-organ transplantation, and ARF in haematological malignancies or immunosuppressed patients.[16,17]

Our study demonstrates that the addition of AVAPS to BiPAP S/T in patients with acute exacerbations of COPD (AECOPD) produces a rapid recovery of consciousness (GCS), with early improvement of arterial blood gases as compared to conventional ventilation using solely BiPAP S/T. We observed significantly higher IPAP values in the BIPAP S/T + AVAPS group than in the group of patients treated solely with BIPAP S/T. Our study supported with Killen Harold Briones Claudett et al (2013)[18], they found that statistically significant differences in favor of the BiPAP S/T + AVAPS group in GCS (P = .00001), pCO2 (P = .03) and maximum inspiratory positive airway pressure (IPAP) (P = .005), among others. However, no significant differences in terms of length of stay or days on NIV were observed.

BIPAP mode S/T + AVAPS delivered pressure changesprogressively allowing the patient to conform much better to those pressures while the target tidal volume is

reached. Patients with the acute decompensation of COPD, ac-companied by an altered mental status require rapid correction of alveolar hypo ventilation which ensure an adequate tidal volume (minute volume) (volume settingsbetween 8–12 ml/kg/weight) for rapid dissemination or carbonmonoxide swept cerebr ospinal fluid and brain and its sensory recovery as early as possible.

Battistietal.[19]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.

In our study, initial GCS and pH values were virtually equal between groups. Secretions were properly managed, which is essential for preventing technique failure and the need for endotrachealin tubation. We observed a rapid and significant improvement in arterial blood gases and consciousness (GCS) in both groups; however, patients treated with BiPAPS/T+AVAPS improved much faster than patients treated with the conventional strategy, with a near-complete recovery within 3 hours.The improvement in the BiPAP S/T AVAPS group was probably linked to the rapid improvement in EVT andthe fact that, in these patients, IPAP quickly reached thelevels needed for maintaining appropriate tidal volume,and hypoventilation was corrected with consequent improvements in alveolar ventilation.

CONCLUSIONS

We propose the use of BiPAP S/T with AVAPS as a safestrategy of noninvasive ventilatory treatment in patientswith exacerbations of COPD (GCS < 10).

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