PILOT STUDY

Standard factors predicting success of Non-invasive ventilation are useful in treating Patients with POST Tuberculosis sequel

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Abstract

Objective: The aim was to access the effectiveness of Bilevel Positive Airway Pressure (BiPAP) in patients with type II respiratory failure secondary to Post Tuberculosis (TB) sequelae and determine the factors that can predict its success. PostTB pulmonary sequelae are complications after healing of TB and type II respiratory failure is frequently encountered in this group.

Methods: This prospective study was carried out in the department of Chest Medicine, Jinnah Postgraduate Medical Center Karachi. (JPMC) Total 78 patients, between 20-80 years of age having hypercapnic respiratory failure, were included. Patients were given BiPAP along with standard treatment

Results: Among 78 patients, 45 (56.3%) were males and 33 (43.7%) were females. Patients mean age was 50.6 ± 15.76 years. The BiPAP success rate was 70.5% (55/78). There is significant difference in age (p=0.008), duration of disease (p=0.021), baseline pH (p=0.00), PaCO2 (p=0.004), Glasgow Coma Score (p=0.031), Chest X-ray (p<0.05) and systolic blood pressure (p=0.007) between responders and non-responders. Improvement in Abgs and vitals was observed among responders following 3 hours of therapy while pH drops significantly at 3 hours in non-responders.

Conclusion: This study reveals that BiPAP is also efficacious method in patients with Type II respiratory failure post TB sequelae. Potential non responders can be identified relatively early in course of treatment and considered for ventilator

Keywords: Post Tuberculosis Sequelae, Type II (Hypercapnic) respiratory failure, Bi-level Positive Airway Pressure, Predictor, Noninvasive Positive Pressure Ventilation, Arterial Blood Gases (Abgs). (JPMA 69: 1146; 2019)

Introduction

Tuberculosis accounts for 9.6 million new cases and 1.5 million deaths annually.[1] The burden of tuberculosis is high in developing countries where Intensive Care Unit (ICU) facilities are limited.[2] Despite improvement in health care facilities and treatment of tuberculosis, a significant number of patients are left with residual sequelae, leading to significant morbidity and impaired quality of life.[3,4] Post tuberculosis (TB) pulmonary sequelae is defined as the state with different secondary lung parenchymal complications after healing of TB and includes; fibrothorax, pulmonary fibrosis, end stage destroyed lungs, bronchiectasis and obstructive airway disease.[5,6] The true prevalence of these complications are not known.[4] Most of the time, post TB sequelae patients show restrictive pulmonary disease or mixed ventilatory disorders and seldom show pure obstructive disorder but these patients are prone to exacerbations and develop acute Type II (hypercapnic) respiratory failure as their disease progresses.[7,8]

The Tertiary care hospitals in this part of World have limited ventilators and high flow of patients. Due to cost effectiveness and limited availability of mechanical ventilation, Bilevel Positive Airway Pressure (BiPAP) is widely used in treatment of type II respiratory failure.[2] The role of Non Invasive Positive Pressure Ventilation (NPPV) has been well established in Chronic Obstructive Pulmonary Disease (COPD)[9,10] but less work has been performed in post TB pulmonary sequel. Past studies focused mainly on management of chronic hypercapnic respiratory failure due to Post tuberculosis sequelae[11-13] but data focusing on acute exacerbation is less.[7,14] Success rate with BiPAP reported to be above 70%[2] but there is no defined criterion for selection of patients. Identifying the predictors associated with BiPAP success in post TB pulmonary sequelae can play an important role in selection of appropriate patients for NPPV, which will decrease the cost and also reduce the need for ventilator.

This study was performed to access the effectiveness of Bilevel Positive Airway Pressure (BiPAP) in patients with type II respiratory failure secondary to Post tuberculosis pulmonary sequelae and also to identify the factors that can predict the success rate with the hope that this will improve management of the disease.

Methodology

This prospective study on a cohort of patients with post-

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TB respiratory failure was carried out from January to July 2015 in the Chest Medicine department located in Jinnah Postgraduate Medical Center (JPMC), Karachi. This 330 bedded ward functions under supervision of qualified pulmonologists and run by postgraduate doctors concomitant with trained staff and chest physiotherapist. Total of five BiPAP machines and only one ventilator were available at time of study. Ethical approval was taken by the ethics committee JPMC and also consent was taken from closest family member accompanying each patient.

All patients between 20-70 years of age were eligible for the study if they had documented history of tuberculosis, regardless of treatment, in past and presented to hospital with acute hypercapnic respiratory failure. Patients were excluded from the study when they had (a) other causes of acute hypercapnic respiratory failure; patients on sedatives; known cases of COPD; history of significant exposure to smoking (>20 pack years) or biomass fuel (>2 years); Brainstem abnormalities, neuromuscular disorders, chest wall deformities,(b) unable to apply BiPAP due to facial deformity, burns, upper airway surgery in last six months, uncontrolled gastro intestinal haemorrhage (c) presented with cardiogenic or septic shock and systolic blood pressure less than 90 despite of vasopressor support. Acute hypercapnic respiratory failure was defined as arterial pH < 7.25 and/or PaCO2 > 45mm Hg.

These Patients were admitted in ICU and Bilevel Positive Airway Pressure (BiPAP) was applied via face mask within 1 hour of admission. Nasogastric tube was placed in all patients with head end raised at 45 degree to minimize the risk of aspiration. These patients were kept in recumbent position. BiPAP settings were initiated at Expiratory Positive Airway Pressure (EPAP) of 5 cm H_2O and Inspiratory Positive Airway Pressure (IPAP) of 10cmH_2O and increment in EPAP and IPAP was performed to maintain pH above 7.30. Supplement oxygen was provided to achieve SaO_2 above 85-90%. Patient comfort with the device was observed closely. If the patient became irritable reassurance by staff or doctor was given and short period of BiPAP free interval was also allowed. Sedation was never used. Routine blood test, ECG, Chest X-ray were performed along with standard treatment. Samples for Arterial blood gas (Abgs) were collected from each patient at admission before applying BiPAP and after 3 and 24 hours of BiPAP application. Also following parameters were observed at the same time while taking Abgs samples; Blood pressure, heart rate, respiratory rate, Glasgow Coma Scale (GCS). These patients were monitored in the ICU by the one of the researcher. Success of BiPAP was measured in terms of improvement in clinical parameters (consciousness, respiratory rate, blood pressure, heart rate and Abgs at 24 hours after application of BiPAP), avoidance of endotracheal intubation and live discharge. The total duration of BiPAP was determined by the Abgs and clinical parameters of patients.

SPSS v-21 was used to analyze the data. Independent T Test and Binary Logistic test were used to compare quantitative and qualitative variables respectively between patients who improved and those who did not improved with BiPAP therapy. Progressive change in variables with time was analyzed by Paired T test. Analysis of all variables was two tailed. P value less than 0.05 was considered significant.

Results

Total of 78 patients were recruited, among them 45 (57.7%) were males and 33 (42.3%) were females. Patients mean age was 50.6 ± 15.76 years. Total of 24 (30.3%) patients had bronchiectasis, 35 (44.7%) had fibrosis, and 19(25%) had destroyed lungs on Chest X-ray. The BiPAP success rate was 70.5% (55 out of 78 patients survived). Of the 23 patients who failed BiPAP, 8 patients were shifted to invasive mechanical ventilation, 6 left against medical advice, while 11 expired on NPPV. Among these 11,

Table-1: Characteristics and baseline physiological variables of two groups in patients with post TB sequelae.

	Not Responders	Responders	p-value
Mean Age (years)	58.739 ± 18.757	46.54 ± 17.65	0.008
Duration of disease (years)	23.26±17.73	15 ± 12.38	0.021
pH	7.18±0.072	7.25 ± 0.045	0.000
PaCO2	77±14.01	67.11 ± 8.70	0.004
PaO2	59.38±14.65	60.41 ± 6.90	0.749
Respiratory Rate (breath/min)	36.69±6.74	35.27 ± 6.39	0.381
Heart Rate (beats/min)	103.69±15.57	109.76 ± 19.44	0.188
GCS	8.39±2.14	9.44 ± 1.82	0.031
PaO2/FiO2 Ratio	234.75 ± 66.95	235.56 ± 31. 908	0.956
Systolic Blood Pressure	100 ± 21.10	112.96 ± 17.74	0.007

Abbreviations: GCS: Glasgow Come Score, M: male, F: Female, PaO2: Partial pressure of oxygen, PaCo2: Partial pressure of carbon dioxide, FiO2: Fractioned Oxygen concentration given.

Table-2: Comparison of gender and Chest-X-ray finding between responders and non-responders.

	Odd ratio	Sig (p <0.05)
Gender		
Female	1.204	0.714
Male		
Chest X-Ray Finding		
Bronchectasis		
Destroyed Lung	0.268	0.042
Lung Fibrosis	0.714	0.013

Among the responder group we compare the survival with gender and Chest X-ray findings. Lung fibrosis and Male gender were individual reference categories.

Table-3: Comparison of change in Abgs and physiological variables over progressive clinical course with BiPAP administration in two groups.

	Non-responders			Responders		
	Mean difference	S.D	p-vale (within the group)	Mean difference	S.D	p-value (within the group)
Baseline PH - 2nd PH	-0.04	0.03	0.000	-1.27	8.92	0.297
Baseline PH - 3rd PH	-0.07	0.04	0.000	-0.15	0.05	0.000
2nd PH - 3rd PH	-0.04	0.04	0.005	1.12	8.92	0.355
Baseline PCO2 - 2nd PaCO2	4.47	24.62	0.451	11.25	6.77	0.000
Baseline PCO2 - 3rd PaCO2	4.65	11.78	0.199	24.90	8.62	0.000
2nd PCO2 - 3rd PaCO2	-4.67	20.90	0.456	13.64	7.29	0.000
Baseline PO2 - 2nd PaO2	-2.08	9.81	0.382	-4.80	5.78	0.000
Baseline PO2 - 3rd PaO2	-1.44	13.18	0.712	-9.83	9.51	0.000
2nd PO2 - 3rd PaO2	0.67	6.12	0.713	-5.03	6.66	0.000
Baseline HR - 2nd HR	-3.33	17.31	0.425	3.95	11.87	0.017
Baseline HR - 3rd HR	-6.50	21.01	0.307	12.91	16.55	0.000
2nd HR - 3rd HR	-3.92	12.41	0.298	8.96	10.66	0.000
Baseline RR - 2nd RR	0.61	5.94	0.668	6.40	4.16	0.000
Baseline RR - 3rd RR	5.00	9.94	0.109	16.09	7.05	0.000
2nd RR - 3rd RR	4.58	5.85	0.020	9.69	5.01	0.000
Baseline GCS - 2nd GCS	-0.44	1.46	0.215	-3.06	1.47	0.000
Baseline GCS - 3rd GCS	0.08	2.47	0.909	-5.48	1.81	0.000
2nd GCS - 3rd GCS	0.42	2.23	0.532	-2.43	1.35	0.000
Baseline BP - 2nd BP	2.50	20.31	0.608	-5.31	11.77	0.002
Baseline BP - 3rd BP	0.00	21.32	1.000	-7.95	18.27	0.002
2nd BP - 3rd BP	4.58	19.00	0.42	-2.64	12.58	0.126

2nd and 3rd variable were collected after 3 and 24 hours of BiPAP application respectively

Abbreviation: HR: heart rate, RR: respiratory rate, PaO2: Partial pressure of oxygen, BP: blood pressure, GCS: Glasgow Come Score, PaCo2: Partial pressure of carbon dioxide.

Units for variables: Heart rate: beats per minute, Respiratory rate: breath per minute, PaO2: mmHg, PaCO2: mmHg.

nine(80%) patients died within 26 hours of presentation.

Characteristics and baseline physiological variables of two groups in patients with post TB sequelae (Table-1).

There is significant difference in age, duration of disease, GCS, baseline pH, PaCO2 and systolic blood pressure in two groups. Non-responders were older patients with prolong years of disease. This group has lower GCS, blood pressure and pH with higher PaCO2 level. ($p<0.05$)

Comparison of gender and C-X-ray finding between responders and non-responders (Table-2). (Reference Category; Lung Fibrosis and Male Gender)

The patients with lung fibrosis on C-Xray have 3.72 ($p= 0.042$) and 5.22 times ($p=0.013$) higher chances of survival than, patients with bronchiectasis and destroyed lungs respectively.

Comparison of change in Abgs and physiological variables over progressive clinical course with BiPAP administration in two groups is shown in (Table-3).

Analysis of progressive clinical course of patients demonstrated significant improvement in all clinical parameters among patients who responded to BiPAP therapy. Systolic blood pressure and pH remain the same at end of 3rd hour but significant improvement was noted at 24th hour. The positive change in rest of the variables seen at end of 3rd hour was maintained throughout the BiPAP treatment.

Among non-responder group there is significant drop in PH at 3 hours and it further drop at 24th hour. No significant improvement noticed in any variable in this group.

Moreover the mean IPAP applied to non-responders (13.56±1.99 cmH20) was higher when compared to responders (12.69±1.16 cmH20) ($p= 0.018$).

Among responder group median length of hospital stay was 7.09±2.27 days and no major complications were noted.

Discussion

According to World Health Organization (WHO) global report 2014, Pakistan bears the fifth highest disease incidence of TB in the World, with 500,000 new cases detected in 2014.[1] The acute exacerbation of post tuberculosis sequelae is also frequently encountered in clinical practice. Despite being a well-documented entity there is no defined line of management. There is a dire need for inexpensive but effective treatment option for these critically ill patients, in hospitals where facilities for invasive ventilation are not available.

Current study reported good success rate of NPPV in acute exacerbation of post tuberculosis pulmonary sequelae. Among the limited studies in this area, the one reported by Tsuboi et al demonstrated BiPAP success rate in post TB sequelae comparable to acute exacerbation of COPD.[7] AsoH et al also demonstrated effectiveness of NPPV in another study.[14] They found lower PH, BMI and serum potassium associated with weaning failure. NPPV was shown to be effective in correcting gas exchange abnormalities, avoiding endotracheal intubations and associated with a low rate of complications.[7,13]

The main safety concern in patients with low GCS Score was possibility of aspiration event; the risk was minimized by insertion of nasogastric tube.[15]

Several important conclusions can be drawn from this study; firstly baseline physiological parameters can be used to decide the care pathway of patients. In younger patients with shorter duration of disease, patients with baseline PH more then 7.25, PaCO2 of 67 or more, GCS of 9, non-invasive ventilatory therapy can be used as initial modality of treatment. Secondly identification of potential non responders relatively early in course of management is possible and, thus, this subset of patients can be considered for ventilator therapy, without delay. In current study poor response was observed in non-respondents after 3 hours of initiating BiPAP therapy and there is further progressive decline in clinical parameters in this group of patients. Thirdly mean stay of hospital in responder group was 7 days and suggests that the patients successfully weaned off from BiPAP did not require any further respiratory support.

This real-life study has important limitations; firstly it was a single centered study and reflects experience of only one group of professionals and therefore data from other centers is needed to validate our results. This was not a randomized controlled trial and BiPAP therapy results need to be compared with the outcome of invasive ventilator therapy. Although a concurrent control arm would have given more credence to the study, unavailability of ventilator reflects the real life scenario of our country and was the main incentive of doing this study. Moreover, notification of long-term mortality, morbidity was not performed.

Notwithstanding these limitations, present study opened up a new line of management for type II respiratory failure secondary to tuberculosis sequelae and has demonstrated role of NPPV as a feasible ventilatory modality. To the best of author's knowledge, this is the first study from South Asia that shows the potential factors that can predict the success of BiPAP in acute Type II failure in patients with Post Tb Sequelae.

Conclusions

In conclusion this study showed the successful treatment in patients with Type 2 respiratory failure post Tuberculosis sequelae in low resource countries with BiPAP. Appropriate selection of patients is paramount and continuous monitoring of patients and identification of clinical signs is essential. Change it.

Disclaimer: None

Conflict of Interest: None

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