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ORIGINAL ARTICLE

Non-Invasive Ventilation versus Invasive Mechanical Ventilation: Results from a Tertiary Care Hospital

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ABSTRACT

Objective: To compare the patient outcome in severe COVID-19 pneumonia between the non-invasive ventilation and invasive mechanical ventilation.

Study design: Prospective, observational study

Study Setting and Duration: Department of Pulmonology, Bahawal Victoria Hospital, Bahawalpur from January 2021 to June 2021.

Methodology: We analyzed 660 patients of severe covid pneumonia. Conscious proning was done in those requiring ≥ 21 L oxygen and oxygen saturation < 90%. We defined typical ARDS according to Berlin criteria. Atypical ARDS did not fulfill set criteria. We divided ARDS into 2 types i-e H and L type. We managed ARDS with either NIV, invasive mechanical ventilation or both. We used multiple regression analysis to predict ICU stay.

Results: Out of 660 patients, 285 (43.18%) developed biPAP failure and were subsequently intubated. We observed 273 (41.4%) overall mortality, 175 (64.1%) in IMV and 98 (35.9%) in the NIV group (p<0.0001). invasive mechanical ventilation had statistically significant correlation with mortality and also predicted ICU stay. (p=< 0.001, OR 3.2, p=0.001).

Conclusion: NIV therapy is superior to invasive mechanical ventilation in terms of ICU stay and outcome.

Keywords: ARDS, coronavirus, COVID-19, non-invasive ventilation, mechanical ventilation, pneumonia

INTRODUCTION

The total COVID-19 cases in Pakistan has surpassed over 800 thousand while the death toll has risen to nineteen thousand, nationally. [1-2] COVID-19 is a respiratory infection caused by the novel coronavirus. The majority of the patients who are infected by the virus, have mild to moderate symptoms and recover completely. However, a report from Chinese Center for Disease Control and Prevention revealed fourteen percent of patients suffer from severe disease with dyspnea, hypoxia, and lung involvement. [3]

Acute respiratory distress syndrome develops in 20 percent of the patients and 12.3 percent of these patients may require invasive mechanical ventilation (IMV). [4] Complications of COVID related ARDS in a retrospective study in China revealed AKI (29 percent; half of whom needed renal replacement therapy), liver dysfunction (29 percent), and cardiac injury (23 percent). The evidence of secondary bacterial pneumonia is inconclusive. In comparison to other causes of ARDS, COVID related ARDS had a higher lung compliance with a lower rate of barotrauma (pneumothorax in 2 percent as compared to 25 percent in other causes of ARDS).[5-6]

Oxygen requirements in hypoxemic COVID-19 patients may progress from nasal cannula to non-rebreather face mask to invasive mechanical ventilation. With the use of proper protective equipment in healthcare workers, 20-25% of patients may avoid IMV. (reintubation in a fraction), via high flow nasal cannula, non-invasive ventilation (NIV) and awake proning.[7] A prospective study revealed that prone positioning is feasible and effective in improving oxygenation in some patients regardless of whether they are on oxygen, high flow nasal cannula or NIV.[8] The decision to start NIV in patients who have acute hypoxemic respiratory failure and higher oxygen needs should be made while balancing the potential risk and benefits to the patient, exposure of healthcare workers and available resources. NIV might reduce the rate of intubation and mortality.[9] A systematic review and meta-analysis of observational studies revealed that in ICU mortality has decreased from 50% to 40% as the pandemic progresses. ICU mortality for patients who had completed ICU stay was 41.6%.[10] As clinicians we face this challenge frequently and the data to compare the outcome of NIV and IMV in COVID-19 is scarce. The present study aimed to determine the outcome of severe COVID-19 pneumonia patients and its association with the mode of ventilation and type of acute respiratory distress syndrome in the ICU population.

MATERIALS AND METHODS

It was a prospective observational study and approved by the institutional review board of Bahawal Victoria Hospital, Bahawalpur. Study was conducted in a Medical ICU dedicated for treatment of covid patients only. We recruited consecutively patients admitted from August to November 2020. Informed, written consent was taken from all patients.

All patients were admitted to ICU through the Emergency room (ER) or by the Rapid response team (RRT) due to increased oxygen requirement. As a prerequisite for admission to ICU, all patients admitted to covid ICU have code status order discussed with family and/or patient by ER physician or RRT and written upon admission orders. Full code status order was written for those who allowed all interventions including invasive mechanical ventilation (IMV) and medical code status order was written for those who did not allow IMV. We included all those patients who were 18 years or above, RT-PCR confirmed cases of covid pneumonia with full code or medical code status order, respiratory rate (RR) > 35/minute, PaO_2 /FiO_2 < 300 mmHg, oxygen requirement > 15 Liters per minute (LPM) and Ejection Fraction > 50%. Exclusion criteria included patients younger than 18 years, with DNR code status, negative RT-PCR results for covid pneumonia, respiratory rate of ≤ 35/minute, PaO_2 /FiO2 ≤ 300 mmHg, oxygen requirement ≤ 15 L/min and EF ≥ 50%.

After admission, history and physical examination was performed by a resident physician. Baseline investigations like blood chemistries, pan cultures, chest imaging and echocardiography were performed for all patients within the hospital. Antibiotics, steroids and multivitamins were given to all patients as standard protocol. Initially, all patients were offered NIV to maintain PaO_2 ≥60 and oxygen saturation ≥ 90%. IMV was initiated in patients with full code status when they had Respiratory rate >35/min, oxygen requirement > 15 L/min and PaO_2 < 60 mmHg while patients with medical code status were continued on NIV. Target of IMV was to maintain SpO_2 ≥ 90% or PaO_2 ≥ 60 mmHg. Proning was done in all patients with PaO_2/FiO_2 < 150.

Patients with typical ARDS were identified when they fully satisfied Berlin criteria and those who did not meet the criteria were identified as atypical ARDS. All patients were managed with low tidal volume ventilation (LTVV).

After enrollment, we recorded demographic parameters like age, gender, comorbid (0-1 or > 1) and duration of symptoms on a preformed structured questionnaire. We followed our patients till the time of death or discharge from ICU and recorded parameters like respiratory support devices (HFNC, BiPAP or CPAP), oxygen requirement, PEEP, PaO_2/FiO_2, driving pressures, need of proning and vasopressors and outcome in terms of mortality or survival.

The mortality or survival rates of patients according to mode of ventilation and type of ARDS were the primary outcomes of our study. All patients shifted from the intensive care unit to the general isolation ward were considered to have survived.

Data was analyzed using the statistical package for social sciences (SPSS version 25). Continuous variables were analyzed by using the chi-square test of independence. Multiple regression analysis was done to predict ICU stay from invasive mechanical ventilation.

RESULTS

We prospectively analyzed data of 660 patients with male dominance. Median age of the population was 61.5 years (IQR 54.2-69.1). 85 (12.8%) had ≥ 2 comorbidities. We offered NIV to all patients as an initial part of treatment. Out of 660 patients, 285 (43.2%) suffered from biPAP failure and eventually required invasive mechanical ventilation (IMV) (Figure 1).

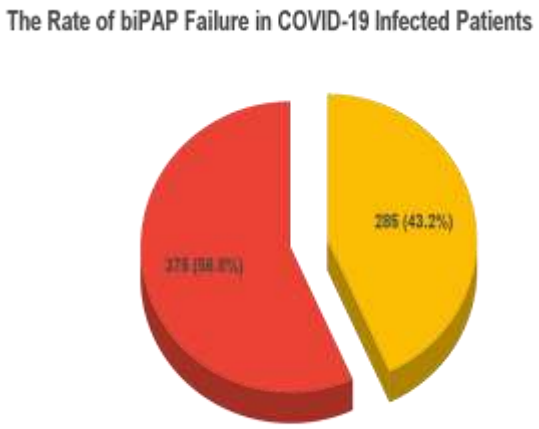

Figure 1. The Rate of biPAP Failure in COVID-19 Infected Patients (n=660)

biPAP failure was more common in > 60 years as compared to patients ≤ 60 years (61.75% vs 38.25%) (Fig.1). Median values of plateau pressure, driving pressure, PF, SF ration and PEEP are given in table 1. Median ICU stay and duration of IMV was 7 days (4-12) and 6 days (2-10) respectively (table 1).

Table 1. Median values of plateau pressure, driving pressure, PF, SF ration and PEEP

Parameters	Median	Percentile (25-75)
Plateau pressures	23.0 mmHg	18.5-29
Driving pressures	16.0 mmHg	12.8-19.3
PF ratio	126.2	99-177.8
SF ratio	123.3	92-240.3
PEEP	7.5 mmHg	5.6-6
Prone positioning	2.5 days	1-3.8
ICU days	7 days	4-12
Days on IMV	6 days	2-10
Days from NIV to IMV	2 days	0-7

Table 2. Distribution of Clinical Parameters with Respect to Age Group

Parameters	Total	≤60 years	>60 years	P value
BiPAP failure				
Yes	285 (43.18%)	109 (38.25%)	176 (61.75%)	< 0.001
no	375(54.82%)	241 (64.2%)	134 (35.8%)	
Type of ARDS				
H	193 (67.71%)	73 (66.97%)	120 (68.18%)	0.832
L	92 (32.28%)	36 (33.03%)	56 (31.82%)	
Outcome				
Non-survived	273 (41.4%)	145 (53.10%)	128 (46.9%)	0.97
Survived	387 (58.6%)	205 (53%)	182 (47%)	

Out of 285 ARDS patients who received IMV, 176 (61.75%) patients were older than 60 years (p<0.0001). Amongst them 120 (68.18%) were “H type” and 56 (31.82%) were “L type”. Interestingly, these types were not distinct entities and 74 (25.8%) patients transformed from one to another type during the course of their illness (Table 2).

Out of 285, 193 (67.72%) had typical ARDS while 92 (32.28%) had atypical ARDS (because they developed shortness of breath after 7 days). Type of ARDS did not show a statistically significant impact on mortality and need for vasopressors (p=0.35, 0.85 respectively).

We performed multiple regression analysis to predict ICU stay from IMV and NIV. IMV and NIV both significantly predicted ICU stay, F (2,69) = 8.20, F (1,70) = 13.3, p= .001, < 0.0005, R^2 = 0.192,0.16 respectively. Invasive mechanical ventilation was associated with more prolonged hospital stay as compared to those who received NIV (OR 3.2, p=.001). Out of 660 patients, 387 (58.6%) patients survived and 273 (41.4%) did not survive. There was no significant relationship between age and survival of patients (p=0.971) (Table 2).

There was a strong relationship between mortality and invasive mechanical ventilation p=< 0.001, as mortality was 175 (64.1%) in the IMV group and 98 (35.9%) in the NIV (Figure 2).

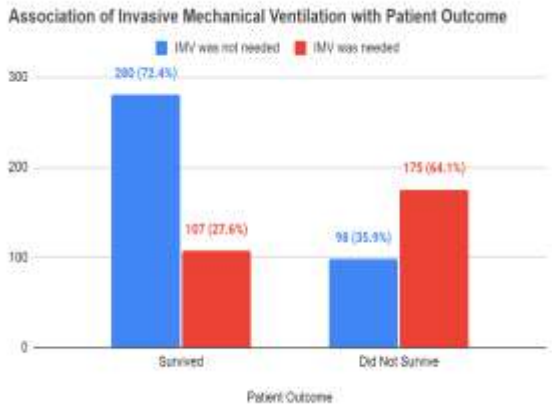

Figure 2. Association of Invasive Mechanical Ventilation with Patient Outcome (n=660)

Similarly, requirement of vasopressors was also high in those who received invasive mechanical ventilation as compared to those who were managed with non-invasive mechanical ventilation (91.3%vs 8.7%) and strong association was observed between vasopressors requirement and invasive mechanical ventilation (p=< 0.0001).

DISCUSSION

While the risk benefit ratio for NIV versus IMV must be evaluated for each patient, a study suggested that some patients with COVID-19 ARDS may benefit from NIV instead of IMV.[11] Studies have shown that mortality rate in patients on IMV is significantly higher than those on NIV. [12-13] In this study, we have reported the

outcomes in COVID-19 hospitalized patients who are intubated (IMV) versus those who are on non-invasive ventilation.

In our study, biPAP failure occurred in almost half the patients indicating the severity of the disease. The majority of them were above the age of sixty which reveals that older patients are more likely to have adverse outcomes.

We further revealed that the majority of the patients had acute respiratory distress syndrome (ARDS) which has been attributed to severe lung injury over time. [14] We further revealed a mortality rate of 71% in intubated patients which was almost similar to a study published in Lancet where a mortality rate of 57.7% was reported. [8] In another study from China, mortality was as high as 97% in patients who received invasive mechanical ventilation.[15]

According to the current study the mortality was higher in those > 60 years in contrast to the findings of a study from China with a mortality of 42.5% in the elderly group.[16] These differences in mortality may be attributed to differences in resources, practice, and severity of illness. Similarly, the requirement of vasopressors was higher in those who received invasive mechanical ventilation in comparison to those who received NIV. This finding is in line with a previous study in which 86.6% of ventilated patients required vasopressors.[17] In contrast to the current study, Grasselli et alo., reported a median ICU stay of 12 days which is higher than the present study. This could be explained by differences in the rate of intubation as Grasselli et al., intubated 87.3% of their population in comparison to 43% in our study. [17] Ferrando et al., claimed that the more severe ARDS, the higher the risk of mortality among ventilated patients that is the 28-day mortality was higher in severe ARDS as compared to mild ARDS [hazard ratio (RR) 0.56 (95% CI 0.33-0.93), p = 0.026].[18]

CONCLUSION

We concluded that NIV therapy is superior to invasive mechanical ventilation but in few cases invasive mechanical ventilation may become a necessary evil. Invasive mechanical ventilation is associated with increased mortality, ICU stay and requirement of vasopressors.

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