

Outcome of Non-Invasive Ventilation in Severe Corona Virus Disease of 2019 Patients; A Prospective Cohort Study

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ABSTRACT

Objective: To determine the Outcome of non-invasive ventilation in patients with severe COVID-19 pneumonia.

Methodology: A prospective cohort study was conducted at Pak Emirates Military Hospital, Rawalpindi, from 4th June to 30th Dec 2021. This study included 87 patients between the ages of 45 and 75 who were admitted due to severe acute respiratory syndrome coronavirus 2 (SARSCoV2) infection. Infection was confirmed by SARS-CoV-2 PCR (polymerase Chain reaction). These patients were symptomatic with radiological evidence consistent with COVID-19 pneumonia requiring non-invasive ventilation (NIV) trial. The primary outcome was to analyze the success and failure of using NIV, the need for invasive ventilation, as well as the mortality rate. SPSS 21 was used to enter and analyze the data.

Results: The mean age was 62.89 ± 7.55 years. There were 65 (74.7%) males and 22 (25.3%) females. NIV was successful in 33 (37.9%) patients, while 54 (62.1%) patients required endotracheal intubation (invasive ventilation). Out of these 54 patients, 44 (81.4%) died after intubation. The mean duration of NIV support was observed as 6.2 ± 3.9 days.

Conclusion: NIV can prevent intubation in less than half of the patients, according to our findings.

Keywords: Intubation, non-invasive ventilation, respiratory rate, SARS-CoV-2, severe COVID-19

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Introduction

Millions of people have been affected by SARS-CoV-2 pandemic, which has caused COVID-19 pneumonia. Roughly 73 million people worldwide have been infected with this disease, with 1.5 million deaths and 41 million recovered cases.¹ Recently, in Pakistan, there were 445,000 confirmed cases of COVID-19 with 9,000 deaths.² Severe cases of COVID-19 pneumonia leads to respiratory failure, hypercoagulability, septic shock and multi-organ failure leading to death.

To improve oxygenation in patients with increased severity of symptoms and lung involvement, treatment options like high-flow nasal cannulas, face masks, nebulizing masks & positive-airway pressure are usually suggested.³ Patients who require intubation & ventilator

support have a bad prognosis secondary to ventilator induced lung injury.⁴ Some researchers believe that NIV could be an alternative but are unsure about the success rate of NIV. In COVID-19 acute respiratory failure (ARF), data which favors early intubation is still missing as multiple studies have failed to find a meaningful difference in death rate based on the timing of intubation.^{5,6}

Literature showed that small-scale NIV trial could be helpful to manage COVID-19 patients for mild-to-moderate hypoxemic acute respiratory failure.⁷⁻¹⁰ Few trials showed success rate of 11-50%. Although, outcome of these patients and of those who were put on invasive ventilation due to severity of disease was still unexplained and further trials were required.^{11,12} Therefore, we conducted this trial to find the outcome of

NIV in severe COVID-19 pneumonia patients, to prevent intubation and achieve higher success rate in intensive care units.

Methodology

This prospective study was conducted from 4th June to 30th December 2022 at Pak Emirates Military hospital, Rawalpindi. Sample size of 87 cases was calculated with 95% confidence interval, 10.5% margin of error and percentage of success of noninvasive ventilation i.e. 48.1% patients.¹³ In accordance with hospital rules and regulations, written consent was taken before the enrollment of patients in the study. Ethical approval was obtained from the ethical committee of hospital via letter no A/28. Demographic data (age, gender), history of chronic diseases like diabetes, hypertension, ischemic heart disease (IHD) and duration of NIV were recorded. This study included patients irrespective of gender between age group of 45 to 75 years who were admitted with pO₂/FiO₂ (ratio of partial pressure of oxygen in blood to that in inspired air) 100 & 200 mmHg despite oxygen given through facemask and were SARS CoV-2 PCR positive. The reason for selection of this particular age group was that patients in this age group had better immunity with less comorbidities and more chances of survival compared to patients who were elder than 75 years. Patients with more than two comorbidities (diabetes, hypertension, IHD) were excluded from the study. The primary outcomes were success of NIV. The length of NIV was a secondary outcome. NIV was gradually weaned off and NRM (non rebreathable mask) oxygen mask was applied, depending on arterial blood gases level when the respiratory rate (RR) was 30 breaths per minute when FiO₂ was 50%, the expiratory tidal volume was more than 5 mL/kg and PEEP(positive end expiratory pressure) was less than 8 cmH₂O. NIV failure was classified as early (less than 48 hours) or late (more than 48 hours). The persistence of low oxygen saturation, a fast respiratory rate with pO₂/FiO₂ < 100mmHg was described as NIV failure. With the intention to avoid intubation, and to achieve an oxygen

saturation greater than 90%, NIV was titrated with IPAP 20-22 cmH₂O, PEEP 10-12 cmH₂O, and FiO₂ at 40%. The following criteria was used to decide whether or not to intubate a patient: Despite NIV, persistent acute respiratory failure (ARF), worsening (oxygen saturation 36/min), hemodynamic or electrocardiographic instability. Such situations required endotracheal intubation to protect airways or to control profuse tracheal and/or bronchial exudations.

Data was entered and analyzed in SPSS 2021. Age was calculated as mean \pm SD. Quantitative variables like gender, diabetes, hypertension & outcome were presented as frequency and percentage. Student's t test was used for comparison of two continuous variables. P value < 0.05 was considered as significant.

Results

A total of 87 patients were included. The mean age was 62.89 \pm 7.55 years. Most of the patients 44(55.5%) were between the age of 60-70 years. There were 65(74.7%) male and 22(25.3%) females. In our study, 56(64.4%) patients were diabetic, 45(51.7%) patients were hypertensive, and 7(8.0%) patients had ischemic heart disease (IHD).The mean duration of symptoms were 9.9 \pm 6.0 days. Of the 87 patients evaluated, mean arterial oxygen partial pressure (pO₂ in mmHg) to fractional inspired oxygen (FiO₂) ratio at baseline was 121.0 \pm 40.2, after 72 h of ventilation 154.2 \pm 77.9 and after 7 days was 190.1 \pm 85.2.

Arterial blood gases increased with gradual increase in time after admission and NIV application and this increase was statistically significant (p<0.05). (Table I)

Out of 87 patients, NIV was successful in 33 (37.9%) while failure was observed in 54 (62.1%) patients. Out of these 54 patients who underwent intubation, 44 (81.4%) died. The mean duration of NIV application was 6.2 \pm 3.9 days. The mean duration of NIV support was 7.9 \pm 2.8 days in cases who had successful treatment, 3.5 \pm 1.7 days in whom NIV failed and 6.8 \pm 3.4 days in patients who died. (Table II)

Table I: Lab Parameters.

ABG	Admission	72 hours	7 days	P value
pH	7.23 \pm 1.01	7.11 \pm 0.08	7.12 \pm 0.032	0.32
PCO ₂ (mmHg)	35.9 \pm 6.1	41.0 \pm 10.9	39.5 \pm 5.2	0.007
PO ₂	66.9 \pm 20.1	86.0 \pm 30.1	100.5 \pm 41.8	0.000
FiO ₂	121.0 \pm 40.2	154.2 \pm 77.9	190.1 \pm 85.2	0.000
Respiratory Rate	23.6 \pm 4.1	25.1 \pm 3.8	20.89 \pm 6.1	0.001

Table II: Findings of patients with NIV application (n = 87)

	N (%)
NIV success	33 (37.9%)
NIV failure	54 (62.1%)
Intubation required	54 (62.1%)
Death	44 (50.5%)
Duration of NIV (days)	
Overall	6.2 ± 3.9
NIV success cases	7.9 ± 2.8
NIV failure cases	3.5 ± 1.7
Death cases	6.8 ± 3.4

Discussion

NIV is a type of respiratory support in which the main interface is a mask that may be quickly applied and removed from the patient's respiratory system. The negative consequences of invasive ventilation in the treatment of respiratory distress syndrome have prompted a more thorough investigation of NIV. The right patient selection is very important to achieve success of NIV. It's vital to note that NIV requires a very tight patient selection process; the key criteria includes maintaining awareness, patient's consent as well as stable hemodynamics.¹⁴

We conducted this trial during the second wave of COVID-19 pandemic, which showed 50.5% in-hospital mortalities in patients who obtained endotracheal intubation after NIV failure. Moreover, length of NIV application outside the ICU exceeded 48 h i.e. 6.2 ± 3.9 days.

In this study, during the initial wave of the pandemic 87 patients were included in the study who underwent NIV support. CPAP was used as NIV support in other units. In limited resources, all patients were admitted to different departments of emergency and divided into three groups based on the degree of their respiratory failure. The 1st group was given only conventional oxygen, the 2nd was given CPAP & NIV and the 3rd was represented by the ICU, which provided ventilator support. It is significant to note that the majority of patients (about 80.5% of hospitalized cases) had a serious illness, with 38% requiring NIV in the emergency room to treat respiratory failure.¹⁵ NIV was previously used in patients with increasing respiratory failure, defined as a PaO₂/FiO₂ ratio of < 200 & a respiratory rate of more than 25 breaths per minute. As earlier mentioned, due to a lack of medical beds in 1st wave of pandemic, we were unable to treat patients with NIV early in the process of respiratory failure.

Several prior researchers proposed that the COVID-19 patients who received NIV, outside the intensive care unit, with NIV being used as a "ceiling" treatment in several cases.^{11, 16} Vaschetto et al, observed 49.6% 30-days death rate with NIV support, which is not similar with our findings, as they found the mortality in 30 days, while we only studied the mortality rate within hospital stay, which was just 5-7 days stay.¹⁷ Another study conducted in Pakistan found that NIV failed in 38% cases and was successful in 62% cases with mortality rate was of 56% which was very close to the rate as observed in our study.¹⁸ But Sadaf et al., found that 36.6% patients showed survival on NIV than on invasive ventilation (6.4%) $p=0.003$. They concluded that NIV should be prioritized in ICUs for early management of respiratory failure due to SARS-COV-2, as NIV has negligible adverse effects and showed better outcome.¹⁹ This value was also not in agreement with our study. Other studies reported the mortality rate from 26.5-26.7%. However, Jha et al. conducted a trial in India and discovered that approximately 70% of cases who received NIV treatment were successful, while 30% of cases required invasive mechanical ventilation, of which 26.7% died.²¹ Manzella et al., also found that the NIV was successful in 48.1% cases of SARS-CoV-2 infection, who were eligible for NIV treatment. Because of limited resources in hospitals of developing countries, using an escalation of care model. Patients were mostly present in emergency and divided into three groups based on the severity of their respiratory failure: the first group received only conventional oxygen therapy; the second group received CPAP and NIV therapy (the pulmonology unit represented this second group); and the third group received mechanical ventilation in the ICU.¹³

There are no recommendations for NIV in acute respiratory failure due to pandemic viral infection in clinical practice guidelines from the European Respiratory Society.²² Recent studies focused on NIV use in SARS-CoV-2 infection had comparable sample sizes, did not adjust for baseline characteristics, and did not compare effectiveness to traditional MV usage.²³

Conclusion

We concluded in this trial that NIV was successful in less than half of the patients suffering from severe COVID-19 disease. This information could be helpful for doctors who are considering using NIV in COVID-19 ARDS treatment. So further trials should be done with a larger sample size to confirm the evidence.

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