Original Article

Noninvasive ventilation (NIV) Vs High-flow nasal cannula (HFNC) which one is suitable for treating COVID-19 ICU Patients in a tertiary care Hospital, Dhaka, Bangladesh

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Abstract

Background: *The use of Noninvasive ventilation (NIV) and high-flow nasal cannula (HFNC) in patients with COVID-19 is debated.*

Objective: *Aim of this studywas to evaluate the usefulness of noninvasive ventilation (NIV) and high-flow nasal cannula (HFNC) for treating covid-19 positive critically ill patients in ICU.*

Methods: *This retrospective observational study was carried out at the department of Anesthesia, Analgesia and Intensive Care Medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka on 230 patients in the period between August 2020 to July 2021.*

Results: *study population was divided into two groups. 120 patients receive NIV and 110 patients were primarily treated with HNFC. In terms of baseline characteristics, laboratory tests, arterial blood gases, PaO2/FiO2 values, and vital signs, there was no significant difference between the two groups. The respiratory rate, heart rate, and oxygenation parameters were all significantly improved following 24 hours of therapy with either NIV or HFNC. The difference in the amount of improvement in vital signs and oxygenation between patients who used NIV and those who used HFNC was not significant. The NIV success rate was 40.4%, while the rate of invasive mechanical ventilation was 20.53% The success rate of HFNC was 38.62%, with 21.81%. of patients requiring invasive mechanical ventilation.*

Conclusion: COVID-19-related acute hypoxemic respiratory failure can be treated with NIV or high-flow nasal cannula (HFNC). We recommend NIV because it is more available in our country, less expensive and require less amount of oxygen to run the machine than HFNC.

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Introduction:

The COVID -19 pandemic in Bangladesh is part of the worldwide pandemic of coronavirus disease 2019 caused by severe acute respiratory syndrome coronavirus2 (SARS-CoV-2). The virus was confirmed to have spread to Bangladesh in march 2020. Since then, the pandemic has spread day by day over the whole nation and the number of affected people has been increasing.

As per worldometers September 2021 report, the world has already witnessed 4,684,149 deaths among 227,836,038 cases and Bangladesh has reported 1,538,203 confirmed cases among which 1,494,090 has recovered and 27,109 died[1]. The major symptoms for COVID-19 are fever, tiredness, breathing difficulties, and dry cough[2]. Among these symptoms, the respiration problem is more severe and acute. Some patients had rapid organ dysfunction, including acute respiratory distress syndrome leading to death[3]. Among critically ill patients, majority of the patient develop acute respiratory distress syndrome (ARDS), and most of them requiring mechanical ventilation (Noninvasive or invasive) with a very high mortality[4]. Oxygen therapy is the most important part of treatment for patients suffering from SARSCoV2 disease. So Oxygen delivery devices[5,6] are an appropriate solution for the COVID-19 patients. Nasal cannula, simple face mask, non-rebreathing mask, high flow nasal cannula, ventilators both invasive and non-invasive are mostly used oxygen delivery devices for Covid-19 patients[7,8].

Noninvasive Ventilation (NIV) and High-Flow Nasal Cannula (HFNC) constitute valuable tools to avert endotracheal intubation in patients with severe COVID-19 pneumonia who do not respond to conventional oxygen treatment. Sparing Intensive Care Unit beds and reducing intubation-related complications may save lives in the pandemic era. The main drawback of NIV and/or HFNC is intubation delay. Cautious selection of patients with severe hypoxemia due to COVID-19 disease, close monitoring and appropriate employment and titration of NIV and/or HFNC can increase the rate of success and eliminate the risk of intubation delay[9].

This study is designed to investigate the role of Noninvasive ventilation and the High Flow Nasal Cannula in the management of critically ill COVID - 19 patients. It is expected that this paper would be of great help to the experts who would like to contribute in this area.

Methodology

This was a retrospective observational study. The study was carried out at the department of Anesthesia, Analgesia and Intensive Care Medicine, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka.We analyzed all the files of the patients admitted to ICU in BSMMU with confirmed covid-19 associated with hypoxemic respiratory failure in the period between August 2020 to July 2021. The study population was Covid-19 positive patients admitted in the intensive care unit (ICU) of BSMMU. Total 230 patients were selected by using purposive sampling methods as per inclusion criteria. The inclusion criteria for this study considered age group over 18 years old, real-time PCR positive, CT findings suggestive of Covid-19, patients with acute hypoxemic respiratory failure who received NIV or HFNC as initial therapy. Patients who did not received NIV or HFNC, missing data on clinical and laboratory profile and not willing to participate in the study were excluded from this study.

Non-invasive ventilation was used as our ICU protocol.Oronasal face mask was used as interface in all cases with appropriate size according to each patient. Initial inspiratory pressure was set at 10 cm H_2O, and positive end expiratory pressure set at 5 cm H_2O; the pressures were gradually increased and continuously adjusted according to the clinical response of the patient. The fraction of inspired oxygen (FiO_2) was set and titrated to maintain SpO_2 above 92%. In case of patients don't tolerate NIV and failure in maintaining the oxygenation

at the desired level, we intubated the patient for mechanical ventilation.

The settings of HFNC were also used according to our ICU protocol. The flow was set from 30–70 l/min according to the patient's condition, and the temperature was set at 37°C. FiO_2 was adjusted to keep the SpO_2 above 92%. Close monitoring of the vital signs was done and if the management with HFNC was not successful or failed to maintain the oxygenation at the desired levels), then NIV was started as the rescue therapy. In case of no or poor response to NIV, endotracheal intubation and invasive mechanical ventilation was given. When the condition of the patients (symptoms, vital signs, hemodynamics, and SpO_2) showed signs of improvement, we used Non rebreathing mask intermittently with gradual increase in the duration of use of conventional oxygen therapy until complete weaning.

Data collection: Epidemiologic, demographic, clinical, laboratory, radiologic, treatment and outcome data were obtained from patient's electronic medical records. All information was collected and managed with a data collection form. To ensure the accuracy of the data, 2 researchers (YYL and ZSJ) checked the data independently.

Statistical analysis: All data were analyzed by SPSS (V.23.0) statistical tool and Microsoft excel.

Results:

Total 230 patients with acute hypoxemic respiratory failure who received NIV or HFNC as initial therapy were included in this study.

Table 1, demonstrate age distribution of 230 patients. In NIV Group out of 120 patients 19 (15.83%) were from 20 to 40 years of age, 33 (27.5%) were from 41 to 60 years, 58 (48.33%) were 61 to 80 years and only 10 (8.34%) were ≥81 years of age. In HFNC Group out of 110 patients 18 (16.25%) were from 20 to 40 years of age, 27 (24.55%) were from 41 to 60 years, 54 (49.09%) were 61 to 80 years and only 11 (10%) were ≥81 years of age.

Table 1: Age distribution

Age (years)	Group NIV (n=120)		Group HFNC (n=110)		MEAN± SD GROUP A	MEAN± SD GROUP B
	Frequency	Percentage (%)	Frequency	Percentage (%)		
20 to 40 years	19	15.83%	18	16.36	60.33± 18.31	61.03± 18.04
41 to 60 years	33	27.50%	27	24.55		
61 to 80 years	58	48.33%	54	49.09		
≥81 years	10	8.34%	11	10.00		
Total	120	100	110	100		

Figure 1 shows the gender distribution of the patients included in this study. Majority of the patients 125 (54.35%) were male and rest 105 (45.65%) were female.

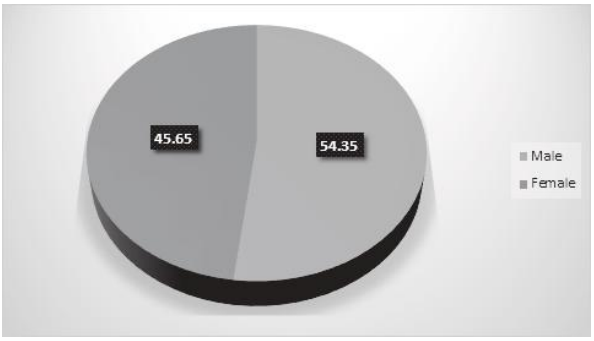

Figure 1 Gender distribution

Patients admitted with symptoms like shortness of breath (96%), persistent cough (60%), fatigue (55%), fever (40%), sore throat (35%), rhinorrhea (30%), diarrhea (5%) and chest pain (15%) as shown in table 2.

Table 2: Clinical symptoms of the patients

Symptoms	Frequency	Percentage (%)
Shortness of breath	192	96%
Persistent worsening cough	120	60%
Fatigue	110	55%
Fever	80	40%
Sore throat	70	35%
Rhinorrhea	60	30%
Diarrhea	10	5%
Chest pain	30	15%

Note: Most of the patients had Multiple symptoms

Diabetes, hypertension, chronic respiratory disease, chronic cardiac disease, and others were among the comorbidities as shown in table 3.

Table 3: Co-morbidities:

Parameters	Group NIV (n=120)	Group HFNC (n=110)
Diabetes Mellitus	58 (48.33%)	47 (42.73%)
Hypertension	40 (33.33%)	33 (30%)
Chronic cardiac disease	13 (10.83%)	16 (14.55%)
Chronic respiratory disease	7 (5.83%)	11 (10%)
Others	2 (1.66%)	3 (2.72%)

The results of laboratory tests showed there had nosignificant difference between 2 groups (table 4).

Table 4: Laboratory test result

Parameters	**Group : NIV (n=120)**	**Group : HFNC (n=110)**	**p-value Sig (2-tailed)**
Hemoglobin gm/dl	11.64±1.30	11.67±1.25	0.910
White blood cells × 10^9 /L	7.90±1.77	7.60±1.75	0.237
Neutrophils %	76.56±3.00	75.81±3.90	0.139
Lymphocyte's count × 10^9 /L	0.71±0.07	0.73±0.09	0.241
Platelet count × 10^9 /L	202.04±30.04	201.41±23.82	0.290
LDH	235.42±7.48	236.37±8.04	0.154
Ferritin ng/ml	839.57±10.28	839.21±9.18	0.482
Serum creatinine mg/dl	0.87±0.19	0.86±0.17	0.294
CRP mg/L	48.66±15.60	49.70±17.10	0.213
Procalcitonin ng/ml	0.07±0.016	0.07±0.024	0.109

When compared to baseline data, vital signs, arterial blood gases, and PaO2/FiO2 examined 24 hours after initiating either NIV or HFNC showed statistically significant differences (Tables 5). The use of either NIV or HFNC was linked to improvements in respiratory rate, heart rate, and PaO2/FiO2 (P<0.01). There was significant difference in respiratory rate, mean arterial blood pressure and PaO2/FiO2 after treatment in Group NIV and Group HFNC (Table 5).

Table 5: Comparison between vital signs and arterial blood gases before and after treatment of NIV and HFNC

Parameters	NIV (n=120) Before treatment	NIV (n=120) 24h after treatment	p-value NIV	HFNC (n=110) Before treatment	HFNC (n=110) 24h after treatment	p-value HFNC	p-value after treatment Group A and Group B
Heart rate (beats/minute)	105.10±7.30	90.49±5.11	0.01	105.10±6.08	90.01±7.16	0.01	0.183
Respiratory rate (beats/minute)	30.88±4.11	26.08±2.83	0.01	30.70±3.11	26.48±1.69	0.01	0.012
Mean arterial blood pressure (mmHg)	92.40±4.55	82.46±2.76	0.06	90.02±4.40	89.27±3.97	0.01	0.01
pH	7.42±0.03	7.40±0.02	0.02	7.42±0.04	7.40±0.03	0.10	0.16
PaCO2 (mmHg)	35.62±3.68	38.25±3.76	0.01	34.65±3.68	38.31±4.31	0.01	0.14
PaO2/FiO2	190.39±42.81	241.63±49.33	0.01	191.07±36.81	226.65±44.23	0.01	0.01

Among the 120 patients initially treated with NIV, 40.4% patients had a positive outcome, and the average treatment time was 11.53±1.12 days. 21.81% patients were intubated after failing to improve on NIV. And among the 110 patients who received HFNC as the primary therapy for hypoxemia, 38.62% patients showed good response with no need to further escalate the respiratory support, and the mean duration of treatment with HFNC was 12.86±1.10 days. 21.81% patients had progressive respiratory decompensation with failed therapy with HFNC, urgent endotracheal intubation was done for mechanical ventilation (Table 6).

Table 6: Outcome

Parameters	**NIV (n=120)**	**HFNC (n=110)**	**p-value**
Duration of treatment (days)	11.53±1.12	12.86±1.10	0.42
Success rate (%)	40.4%	38.62%	0.23
Intubation rate (%)	20.53%	21.81%	0.35

Discussion:

In our study total patients was 230 which was divided into two group. In Group NIV out of 120 patients highest 58 (48.33%) patients were from 61 to 80 years of ageand in Group HFNC out of 110 patients highest 54 (49.09%) patients were from 61 to 80 years of age. Mean and SD ingroup

NIVwas60.33±18.31 and in Group HFNC was 61.03±18.04. In our study majority of the patients 125 (54.35%) were male and rest 105 (45.65%) were female.

Patients was admitted in our ICU with the symptoms like shortness of breath (96%), persistent cough (60%), fatigue (55%), fever (40%), sore throat (35%), rhinorrhea (30%), chest pain (15%)and diarrhea (5%).Diabetes, hypertension, chronic respiratory disease and chronic cardiac disease were the important comorbidities of the admitted patients.

The results of laboratory tests showed between 2 groupswere not statistically significant.

When compared to baseline data, vital signs, arterial blood gases, and PaO2/FiO2 examined 24 hours after initiating either NIV or HFNC showed statistically significant differences . The use of either NIV or HFNC was linked to improvements in respiratory rate, heart rate, and PaO2/FiO2. There was significant difference in respiratory rate, mean arterial blood pressure and PaO2/FiO2 after treatment in both GroupNIV and HFNC.

COVID-19 was labeled a global pandemic by the World Health Organization in March 2020; the greatest concern is the percentage of individuals who suffer from severe disease with respiratory failure. Our study's major finding is that NIV & HFNC is effective in treating patients with acute hypoxemic respiratory failure caused by COVID-19. The rate of endotracheal intubation and length of therapy wasnot significantly different between the two groups.

In China, the use of HFNC ranged from 21% to 31% (pooled incidence: 26%) among critically sick patients, while the use of NIV ranged from 14 percent to 37 percent (pooled incidence: 28%)[10,11]. The utilization of HFNC and NIV, on the other hand, differed significantly between China and other countries. NIV was utilized in 11% of ICU patients in the Lombardy Region of Italy, while no patients used HFNC[12]. The HFNC was employed in 42 percent of critically ill patients in the Seattle Region of the United States, but no one used NIV[13].

Perhaps the availability of the HFNC and NIV, as well as expert views or recommendations or agreement, differed amongst countries.

Two meta-analyses of HFNC in hypoxemic respiratory failure patients[14,15] found no additional benefit over standard treatment, whereas a recent meta-analysis[16] found a beneficial effect of HFNC with a significant reduction in the rate of endotracheal intubation, and the benefits were comparable to NIV in terms of outcome. Both NIV and HFNC was found to be effective in managing patients with COVID-19 and acute hypoxemic respiratory failure in our trial. In terms of outcomes, there was no statistically significant difference between NIV and HFNC results.

The vital signs and PaO2/FiO2 levels improved significantly 24 hours after starting either NIV or HFNC, with no significant difference in magnitude of improvement between the two groups. These findings are consistent with those reported in another study comparing HFNC and NIV in hypoxemic respiratory failure patients[17], which found similar results. NIV has previously been shown to enhance gas exchange, lower the rate of endotracheal intubation, and lower mortality in patients with respiratory failure[18]. HFNC may have certain advantages than NIV, including as improved patient comfort, easier secretion clearance, and proper humidification[19].

In our study, the average length of treatment with NIV was 11.53±1.12 days, while the average length of treatment with HFNC was 12.86±1.10 days. For patients who underwent NIV and HFNC, the average rates of endotracheal intubation with invasive mechanical ventilation were 20.53% percent and 21.81% percent, respectively. Our findings are consistent with those of another study[20], which found a 17 percent average rate of endotracheal intubation for COVID-19 patients treated with HFNC and 15 percent for those treated with NIV; the average length of therapy in this study was 5.1 days for HFNC and 6.8 days for NIV.In our study, the average length of treatment is more than other study, endotracheal intubation rate is

a bit higher and success rate is low because critically ill patients were arriving late in our ICU. Oxygen therapy was provided through non-rebreathing mask and HFNC in covid-19 dedicated ward/cabin also. ICU bed availability was also a problem.

NIV and HFNC are both aerosol-producing methods. NIV, in theory, produces more aerosols than HFNC due to its higher pressures[21]. When dealing with COVID-19 patients, infection transmission is always a serious problem. In our study, very few of our ICU staff was infected during this period, all patients were admitted to room with Hepa filters, and all medical staff had used personal protective equipment during their duties.

In our study NIV used in more patients because of its availability and requirement of less amount of oxygen. NIV uses more positive pressure than HFNC. HFNC is costly and new in our country. Shortage of oxygen supply is also animportant factor in developing country like Bangladesh. So, we recommend NIV to manage critically ill covid-19 patients.

Conclusion:

Both NIV and High-flow nasal cannula oxygen (HFNC) is useful in the treatment of COVID-19-related acute hypoxemic respiratory failure. Both has equivalent efficacy with no differences in treatment duration or endotracheal intubation rate.

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