Effect of High Flow Nasal Cannula versus Non-invasive ventilation on critically ill patient Outcomes: Comparative study

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Abstract:

Background: High Flow Nasal Cannula appears to be a promising alternative to standard oxygen and non-invasive ventilation for treating patients with hypoxemic acute respiratory failure. Therefore, the present study **aimed** to evaluate the effect of high-flow nasal cannula versus non-invasive ventilation on critically ill patient outcomes. **Research hypotheses**: high-flow nasal cannula is expected to be more effective than non-invasive continuous positive airway pressure in reducing the length of stay, mortality rate, and post-extubation complications. A **comparative, Descriptive research design** was used. The study was conducted in ICUs of the anesthesia department at Assuit Main University Hospital. **A purposive sample** of 60 adult male and female patients who were aged (18-60 years) was included in the study and they were assigned into two groups (HFNC and NIV). **Five tools** were used to gather data, I: Patient assessment sheet, II: Glasgow coma scale (GCS), III: Dyspnea Visual Analogue Scale (D-VAS), IV: Device-related discomfort visual analogue scale and V: Clinical outcomes assessment sheet. **Results:** revealed that half of the patients in both the HFN and NIV (CPAP) groups stayed in the hospital for 6-10 days. Regarding patient progress, there is a statistically significant difference between both groups, with patients using the HFN protocol showing greater improvement than patients using the CPAP protocol. **Conclusion**: The patient in HFN protocol shows improvement in the level of progress than NIV (CPAP). **Recommendations:** High-Flow Nasal Cannula may serve as an alternative treatment for hypercapnic respiratory failure, particularly for patients who do not tolerate Non-Invasive Ventilation well.

Key words: High Flow Nasal Cannula, Non-invasive ventilation, patient Outcomes

Introduction:

Invasive mechanical ventilation can save lives, but it can be difficult to wean patients off ventilatory support. Complications often occur after the patient is taken off the ventilator, with reintubation being a common problem. Reintubation has been linked to higher mortality rates, longer hospital stays, and increased costs. A large study found that the rate of reintubation is around 10% in various ICUs, but other studies have reported rates as high as 20 % (**Granton. et al, 2020**).

Multiple strategies to prevent the development of respiratory failure in the post-extubation setting have been attempted. Preventative strategies, applied immediately after extubation, include conventional oxygen therapy (COT) (nasal prongs or Venturi mask), NIV (continuous positive airway pressure or bi-level positive airway pressure), or high-flow nasal cannula (HFNC). COT is typically limited to oxygen flow less than or equal to 15 L/min, while HFNC can deliver flow up to 50–60 L/min of heated and humidified oxygen (**Cortegiani, et al 2018**). HFNC can washout pharyngeal dead space, reduce respiratory resistance, provide some positive end-expiratory pressure (2–8 cm H2O), and may facilitate mucus clearance (**Cortegiani, et al, 2019**) Once post-extubation respiratory failure develops, treatment with noninvasive ventilation (NIV) has been associated with worse outcomes compared with reintubation (**Granton. et al, 2020**).

Several oxygenation therapies have been proposed to prevent reintubation in ARF due to several causes, including hypoxia, ventilatory insufficiency, and increased respiratory workload. Conventional oxygen therapy (COT) and noninvasive positive-pressure ventilation (NPPV) have been recommended as post-extubation respiratory support devices recently, high-flow nasal cannula oxygenation (HFNC) has also been used as a prophylactic post-extubation respiratory support device to avoid reintubation **(Yasuda et al, 2021).**

Non-Invasive Ventilation (NIV) recently becomes the treatment of choice in patients with respiratory diseases. Several diseases can be treated by NIV, such as restrictive lung disease (on the neuromuscular disorder), obstructive sleep apnea, pneumonia, lower respiratory tract obstruction (e.g asthma and bronchiolitis), respiratory failure and acute respiratory distress syndrome. One of the NIV methods commonly used in ICU is Continuous Positive Airway Pressure (CPAP) (**Kadafi et al., 2022**).

Continuous positive airway pressure (CPAP) application has a weakness, which requires additional tools, such as a mask or nasal prong, to prevent the air leak from the ventilator circuit. That may cause discomfort or even injury with prolonged use for the patient, which potentially induces treatment failure. CPAP also has some complications, such as pneumothorax or pneumomediastinum Another NIV modality for ARDS in children is High Flow Nasal Cannula (HFNC) (**Kadafi et al., 2022**).

High-flow nasal cannula oxygen therapy (HFNC) is currently spreading in adult intensive care unit (ICU) after first being used in pre-term neonates and pediatric care, as a first-line treatment for respiratory distress syndrome, and apnea of prematurity. More recently, physiological, pilot studies and controlled trials have drawn attention to HFNC's potential role in adults. HFNC is a strategy providing good comfort through warmed and humidified gas flow delivered via nasal prongs. It preserves high FiO2 and generates a low level of positive pressure in the upper airways due to a high flow of gas, which also provides washout of dead space in the upper airways. In this review we will focus on HFNC's physiological effects, provide clinical evidence during ARF and discuss its differences with NIV (**Cortegiani, et al, 2019)**

High flow nasal cannula has many Benefits as it can prevent deterioration of lung function and endotracheal intubation. However, there is limited evidence on the most appropriate form of non-invasive respiratory support in the different ARF scenarios. While HFNC is more comfortable and tolerated when compared to COT and to NIV, its ability to unload respiratory muscles in ARF may be lower than that provided by NIV **(Oczkowski et al., 2022).**

The benefits of HFNC over conventional oxygen devices (low-flow systems and noninvasive ventilation), (NIV; continuous or bi-level positive airway pressure ventilation) are improved patient comfort and physiologic advantages. The latter include improved oxygenation and ventilation, better pulmonary compliance, reduced anatomical dead space, modest positive end-expiratory pressure, more efficient respiratory effort, reduced work of breathing, and improved secretion clearance. unique feature of NHF is its ability to comfortably deliver high flows of warmed humidified gas, 20–70 L/ min, with a FiO2 range of 0.21–1.0 **(Park, 2021)**.

Significance of the study

The decision of extubation is a critical moment in the ICU because mortality is particularly high in case of extubation failure leading to reintubation. The overall rate of reintubation after planned extubation is around 10% but may exceed 20% in some subsets of patients. The most recent international clinical practice guidelines recommend the use of non-invasive ventilation immediately after extubation to prevent respiratory failure in patients at high risk of reintubation **(Thille et al., 2020)**

Guidelines recommend that preventive non-invasive ventilation should be applied in patients who are considered to be at high risk of extubation failure, with moderate-grade

evidence, HFNC and NIV can provide adequate respiratory support after extubation However, only two randomized controlled trials (RCTs) and one retrospective study directly compared the effectiveness of these two strategies. Both of these trials showed that HFNC was not inferior to NIV in the selected populations. Therefore, the optimal respiratory support strategy after extubation remains controversial. (**Sang** L et al ,**2020**)

About 1300 patients were admitted to general and trauma ICUs at Assuit University Hospital in the previous year and most of them often needed to be mechanically ventilated, (**Assiut University Hospital ICU records, 2022**) and hence the probability of reintubation may be considered to be increased. Therefore this study could be beneficial in many ways. First, it will provide a database that can be utilized by health team members to raise stuff awareness about the importance of high-flow nasal cannula and non-invasive positive airway pressure. Second, Health professionals can apply these modalities for better management after extubation, and prevention of reintubation and its complications. It is also hoped that this effort will generate attention and motivation for further research into this area.

Aim of the study

This study aimed to evaluate the effect of high-flow nasal cannula versus non-invasive ventilation on critically ill patient outcomes

To fulfill this, aim the following research hypotheses were formulated:

Research hypotheses:

- High flow nasal cannula is expected to be more effective than non-invasive continuous positive airway pressure in reducing the length of stay, mortality rate, and post-extubation complications

Patients and methods

Research Design

A Comparative, Descriptive research design was used to conduct this study.

Study Setting:

The study was conducted at the Critical care, anesthesia, trauma, and general intensive care units in Assiut Main University Hospital. The critical care unit is prepared and equipped with 6 beds, the general ICU has 3 sectors two sectors are equipped with 6 beds and one sector contains 2 beds, trauma ICU is equipped with 6 beds, and anesthesia ICU is equipped with two sectors each containing two beds. The total number of beds is 24

Study Sample:

A purposive sample of 60 adult male and female patients met the following inclusion criteria adult patients (≥18 years old) who were diagnosed with respiratory failure on admission and weaned to either NIV or HFNC were assigned into two groups 30 patients in each group and if a patient who had complicated congenital heart disease, with severe malnutrition, neuromuscular disease, Glasgow coma scale < 13, those who had facial anatomy contraindicating helmet or nasal cannula application, tracheostomies patients or weren't weaned and underwent unplanned extubation, a patient need oxygen therapy due to chronic respiratory failure, Hemodynamic instability (systolic blood pressure < 90 mm Hg or mean arterial pressure < 65 mm Hg) or shock and Metabolic acidosis (pH < 7.30 with normal- or hypocapnia) were excluded from this study

The sample size was calculated using the Epi Info software statistical package.

Calculation of sample size:

n= np (1 -P)

n-1(d2÷z2) +p (1-p)

n= sample size

z= level of confidence according to the standard normal distribution

P= proportion of population that meet the characteristics (when unknown=0.5)

D= tolerated margin of error

According to an analysis of statistical data from Assuit Heart University Hospital records, there were a total of 1300 patients were admitted to these units in 2021–2022. The

confidence level is 99.9%, with an expected frequency of 50%, an accepted error of 5%, and a confidence coefficient of 95%. The accepted sample size was 60 patients.

Study tools:

Five tools were used for gathering data by reviewing the relevant literature as follows:

Tool I: Patient assessment sheet:

This tool was developed by the researcher after reviewing the related literature (Grieco et al., 2020) & (Peng et al., 2022). It was used to assess the personal and clinical data of patients; it consists of three main parts as follows:

Part I: **Personal characteristics and clinical data** which include age, sex, medical diagnosis, APACHE II, history of diseases, length of stay, type of ICU**,** arterial blood gases (PH, PaO2 in mmHg, Paco2 in mm Hg, and Fraction of inspired oxygen (Fio2)%), weaning outcome (success or failure), number of reintubation, and patient's vital signs.

Part II: Causes of acute respiratory failure as **Pulmonary causes** such as acute asthma attack, acute respiratory distress syndrome, carbon dioxide poisoning, lung contusion (bruising), and pneumonia and **extrapulmonary causes** such as near drowning, drug or alcohol overdose, and smoke or toxin inhalation

Tool II: **Glasgow coma scale (GCS)** is adopted from (**Green, S, et al, 2011**).

This tool aimed to assess LOC and the scale provides a structure for the assessment of a patient's neurological status according to three sensory responses including visual, verbal, and motor responses. The total score is out of 15 points. The Scoring system for GCS is.

- Severe= GCS ≤ 8
-Moderate= GCS 9 - 12
- Mild = GCS ≥ 13.

Tool III: Dyspnea Visual Analogue Scale (D-VAS):

this scale was adopted after reviewing the related literature **(Grieco et al., 2020) (Gift A. 1989**) and used for conscious patients to assess the level of dyspnea which consists of a horizontal line of 10 cm, Patient is requested to draw a vertical line on it Distance (in mm) from the left side of the horizontal line to the right, the vertical line represents extent of dyspnea. This scale ranges from 0 (complete absence of breathing discomfort) to 10 (maximal imaginable breathing discomfort

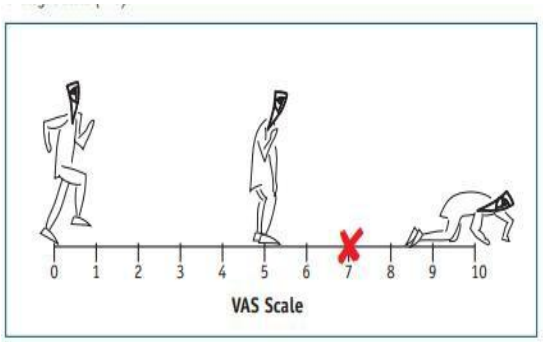

Figure (1): The patient is asked to evaluate his/her dyspnea on a visual analogue scale (VAS).

Tool IV: Device-related discomfort visual analogue scale:

It was adopted by **(Grieco et al., 2020)** and aims to measure the level of discomfort for patients who were critically ill when using the HFNC or non-invasive CPAP mask. It is a scale that ranges from 0 to 10, representing no discomfort to a high level of discomfort.

Tool V: Clinical outcomes assessment sheet:

The researcher developed this tool after reviewing the related literature **(Grieco et al., 2020) & (Peng et al., 2022)**, and used it to assess patient outcomes, it consists of length of stay in ICU, type of discharge, and number of times of reintubation occurrence.

Methods:-

The study was conducted through three main phases: preparatory, implementation, and evaluation.

l-Preparatory phase

- **An official Permission** was taken from the hospital's responsible authorities (head of anesthesia department and head of each ICI) to facilitate the study's implementation after explaining the aim of the study.
- **Approval** was obtained from the local ethical committee of the faculty of nursing affiliated with Assuit University emphasizing that there was no hazard to the study participants and that the study followed the ethical principles in the clinical research **(The ethical code was 1120230570)**.
- **Tools development:** The researchers developed the study tool depending on a review of the relevant literature. **(Grieco et al., 2020) & (Peng et al., 2022)**
- **Content validity:** The study tool was evaluated for content validity by a jury of five specialists two medical staff and three critical care nursing staff affiliated with Assiut University. The validity index was 0.87, and no modifications were reported.
- The reliability of the study tool was assessed using Cronbach's Alpha test, which turned out to be 0.969 to assess the consistency and stability of the tools.
- **A Pilot Study:** A pilot study was performed before the beginning of data collection on 10% (6 patients) of the sample size who were admitted to the previously mentioned units at Assuit Main University Hospital and who met the determined selection criteria to assess the applicability, clarity of the tools, and necessary modification was done, the six patients of the pilot study were excluded from the study.
- **Ethical considerations:** Each patient/patient relative was informed about the aim of the study before starting, and was informed that participation in the study is voluntary and that they had the right to withdraw from the study at any time with no consequences, without giving any reason and that their responses would be held confidentially. The Anonymity of the collected data has been ensured for the participants.
- **Data collection:** - Data collection was started from the end of February to the end of October 2023

ll- Implementation phase

- The researcher introduced herself to the staff and patients, explaining the process of data collection.
- The researchers assessed the personal and clinical data of patients in both groups, including age, sex, diagnosis, past medical history, length of stay, type of ICU, and the number of time the patient required reintubation. This baseline data was obtained from the patients' profiles.
- Enrollment criteria involved considering adult patients with acute respiratory failure. Acute respiratory failure was defined by criteria including a respiratory rate greater than 25 breaths per minute, acute-onset respiratory distress (less than 1 week), the need for supplemental oxygen to maintain an oxygen saturation of over 90%, evidence of pulmonary infiltrates in chest X-rays or CT scans, and an absence of a history of chronic respiratory failure or moderate-to-severe cardiac insufficiency.
- Patients in the study either received HFNC according to the HFNC protocol or received NIV according to the NIV protocol in the above-mentioned setting.
- HFNC Protocol: HFNC was used with a heated humidifier. The gas flow was set at 50 L/min, and the humidification chamber was set at 37°C. The flow rate was adjusted based on the patient's respiratory distress symptoms such as retraction, nasal flaring, thoracoabdominal asynchrony, and tachypnea. The humidification level was reduced if the patient experienced discomfort.
- NIV Protocol: NIV was administered using the ICU ventilation device in NIMV mode with a CPAP facemask. Under the CPAP mode, the initial pressure was set at 7 cm H2O. The pressure and FiO2 adjustments were made based on the patient's blood gas levels, oxygen saturation, and respiratory distress symptoms.
- After the patient has undergone 60 minutes of oxygenation, arterial blood gases,

heart rate, arterial blood pressure, and SpO2 will be measured. Patients will then be asked to rate the severity of their breathing difficulties and any discomfort related to the device using 0–10 visual analog scales designed for critically ill patients.

III. Evaluation phase

Both groups were assessed once daily for five consecutive days to compare the effects of the HFNC protocol versus the NIV protocol. This assessment included vital signs, arterial blood gases, weaning success or failure, occurrence of re-intubation, level of discomfort with the device, and incidence of dyspnea. Additionally, the outcome will be assessed, including length of stay in the ICU, mortality rate, and occurrence of complications.

Statistical analysis:

The statistical package for the social science (SPSS) version 26 was used for data entry and analysis. Numbers, percentage means, and standard deviation were used to present the data. The chi-square test was used to show a relation between variables. A T-test was used to compare the mean. The P-value is considered statistically significant when $p < 0.05$.

Result

Table (1): Shows that more than one-thir of the patients in both groups (HFN and CPAP) fe into the 30<40 age range (43.3% and 40.0 respectively). In terms of gender, the majority the HFN group and about two-thirds of the NI group were male (96.7% and 63.3% respectively).

Table (2): Illustrates that about one-third of the studied patients in both groups were admitted to the General ICU (36.7% and 30.0%). Also, more than one-third of both groups had respiratory disease on admission (40.0% and 40.0%). Regarding body mass index, more than one-third of the HFN group (40.0%) and one-third of the NIV group (30.0%) were underweight with the mean number of days on a mechanical ventilator being 3.47±1.33 for the HFN group and 3.77±1.55 for the NIV group, respectively. In addition, the mean number of reintubations was 1.93±0.63 for the HFN group and 1.3±0.47 for the NIV group.

Table (3): Shows that Regarding temperature, there were highly statistically significant differences between both groups after the 3rd and 5th day of connection of HFNC and NIV (p-value **0.001****), Regarding respiration there was a highly significant difference between both groups in the 1st and 3rd day after connection of HFNC and NIV (p-value 0.002** & **0.001**** respectively). Also, there was no significant difference between both groups before and on the 1st and 3rd day of the connection of HFNC and NIV. Highly significant difference on the 5th day (p value **0.001****) regarding pulse rate. Furthermore, illustrates no significant difference regarding BP on all days except 1st day a significant difference (p-value **0.021***)

Table (4): Presents that regards Pulse**,** Diastolic Blood pressure**,** mean blood pressure, Temperature, Spo2, and CVP there was no statistically significant difference observed, while shows statistically significant difference in Systolic Blood pressure p-value (**0.067***)

Table (5): Shows that there was no statistically significant difference between the two groups in terms of PO2, PaCO2, and HCO3 of arterial blood gas parameters. However, a statistically significant difference was observed in pH (p-value of 0.034*). Furthermore, a statistically significant difference in the Pao2/FIO2 ratio was observed from the 1st to the 3rd day with p values of 0.022*, 0.038*, and 0.045*, respectively.

Table (6): Demonstrate that the most common causes of ARF in the HFNC group were Pneumonia, Smoke, Acute asthma, ARDS, and Lung contusion (76.7%, 53.3%, 33.3%, 23.3% & 23.3% respectively), while for NIV group Pneumonia and Acute asthma were the common cause (43.3% & 26.7% respectively), Also table show a statistically significant difference between both groups regard Lung contusion, Pneumonia and Smoke with p-value (0.005**, 0.008** & 0.007** respectively).

Table (7): Present frequency distribution of Glasgow coma scale (GCS) related to both

groups Indicates significant decrease in GCS score in the HFNC group from 1st to the 5th day, while a significant increase was observed in NIV group with a statistically significant difference between both group in 1st and 5th-day p-value (0.049* & 0.010* respectively)

Table (8): Shows a statistically significant difference between both groups on the 1st, 3rd, and 5th day regarding device-related discomfort visual analogue score with p-value (0.042*, 0.031* & 0.030* respectively).

Table (9): Regarding length of stay the table shows that half of the studied patients in both the HFN and CPAP groups stayed in the hospital for 6-10 days. In terms of patient progress, there is a statistically significant difference between both groups, with patients using the HFN protocol showing greater improvement compared to patients using the CPAP protocol, as indicated by a p-value of 0.007*.

Table (10):- Describe that there was a statistically significant difference in dyspnea scale scores on the 1st, 3rd, and 5th days, with p values of 0.048*, 0.031*, and 0.027* respectively. Additionally, the NIV group showed moderate dyspnea on the dyspnea scale severity from the 1st to the 5th day.

Table (11):- Illustrate that there were statistically significant differences between both groups regarding the occurrence of pneumonia, barotrauma, and nasal trauma, where the p-values were 0.010*, 0.001**, and 0.006* respectively. However, no statistically significant differences were observed between both groups. Concerning the occurrence of epistaxis and drying mucous membrane, where the p-values were 0.222 and 0.136 respectively.

Table (1): **Percentage distribution of the studied patients in both groups according to their demographic data (no=60)**

Variables	HFN (n=30)		NIV (n=30)		X^2	P. value
	No.	%	No.	%		
Age						
18 <30 year	5	16.7	6	20.0		
30<40 year	13	43.3	12	40.0	1.33	0.722
40<50 year	9	30.0	11	36.7		
50-60 year	3	10.0	1	3.3		
Patients gender						
Male	29	96.7	19	63.3	10.42	0.001**
Female	1	3.3	11	36.7		

Chi-square test,

*** Statistically significant difference (p<0.05), ** highly statistically significant difference (p<0.01).**

- **High flow nasal cannula (HFN)**
- **Non-invasive ventilation (NIV)**

Table (2): Percentage distribution of the studied patients in both groups according to their Clinical data (no =60)

	HFN (n=30)		NIV (n=30)		X^2	P. value
	No.	%	No.	%		
Types of ICU						
General	11	36.7	9	30.0	0.68	0.878
Trauma	10	33.3	9	30.0		
Critical care	6	20.0	8	26.7		
Anesthesia ICU	3	10.0	4	13.3		
Medical diagnoses						
Traumatic	8	26.7	7	23.3	0.64	0.886
Respiratory disease	12	40.0	12	40.0		
Medical disease	7	23.3	6	20.0		
Other	3	10.0	5	16.7		
Body mass index						
Normal	4	13.3	7	23.3	2.59	0.458
Underweight	12	40.0	9	30.0		
Overweight	10	33.3	7	23.3		
Obese class I	4	13.3	7	23.3		
Past medical history						
Hypertension (HTN)	2	6.7	5	16.7	5.06	0.281
Diabetes (DM)	11	36.7	8	26.7		
DM&HTN	8	26.7	10	33.3		
Heart Failure	6	20.0	7	23.3		
DM& ischemic heart disease (IHD)	3	10.0	0	0.0		
Number of days on a mechanical ventilator	3.47±1.33		3.77±1.55		-0.805	0.424
Number of reintubations	1.93±0.63		1.3±0.47		1.166	**0.044***

Independent samples Chi-square test,
*** Statistically significant difference (p<0.05), ** highly statistically significant difference (p<0.01).**

Table (3): **Frequency distribution of the studied patients in both groups according to their Vital signs (no=60)**

Vital signs	HFN (n=30)		NIV (n=30)		X^2	P. value
	No.	%	No.	%		
Temperature						
before connection						
Normal	30	100.0	30	100.0		
after 1 day						
Normal	30	100.0	30	100.0	.	
after 3 days					.	
Normal	30	100.0	21	70.0	10.59	**0.001****
High	0	0.0	9	30.0		
after 5 days						
Normal	27	90.0	15	50.0	11.43	**0.001****
High	3	10.0	15	50.0		
Respiration						
before connection						
Normal	30	100.0	30	100.0		
after 1 day						
Normal	17	56.7	4	13.3		
High	7	23.3	17	56.7	12.81	**0.002****
Low	6	20.0	9	30.0		
after 3 days						
Normal	23	76.7	7	23.3		
High	5	16.7	15	50.0	17.13	**0.001***
Low	2	6.7	8	26.7		
after 5 days						
Normal	20	66.7	12	40.0		
High	9	30.0	13	43.3	5.39	0.067
Low	1	3.3	5	16.7		
Pulse						
before connection						
Normal	6	20.0	12	40.0		
High	18	60.0	14	46.7	2.90	0.235
Low	6	20.0	4	13.3		
after 1 day						
Normal	15	50.0	14	46.7		
High	13	43.3	11	36.7	1.49	0.475
Low	2	6.7	5	16.7		
after 3 days						
Normal	15	50.0	19	63.3		
High	10	33.3	8	26.7	1.19	0.551
Low	5	16.7	3	10.0		
after 5 days						
Normal	24	80.0	9	30.0		
High	4	13.3	15	50.0	15.19	**0.001****
Low	2	6.7	6	20.0		
Blood. Pressure						
before connection						
Normal	12	40.0	18	60.0		
High	10	33.3	8	26.7	2.76	0.252
Low	8	26.7	4	13.3		
after 1 day						
normal	21	70.0	16	53.3		
High	8	26.7	5	16.7	7.77	**0.021***
Low	1	3.3	9	30.0		
after 3 days						
Normal	16	53.3	11	36.7		
High	9	30.0	11	36.7	1.82	0.403
Low	5	16.7	8	26.7		
after 5 days						
Normal	13	43.3	15	50.0		
High	11	36.7	10	33.3	0.28	0.869
Low	6	20.0	5	16.7		

Chi-square test, *** Statistically significant difference (p<0.05), ** highly statistically significant difference (p<0.01).**

Table (4): Mean scores of hemodynamic parameters of the studied patients in both groups

Vital signs & hemodynamic	HFN (No=30)	NIV (No=30)	P. Value
Pulse	85.35±6.49	99.58±5.28	0.142
Systolic Blood pressure	130.78±10	117.07±10.10	**0.067***
Diastolic Blood pressure	75.35±9.49	69.58±7.28	0.403
Mean blood pressure	75.32±6.04	73.43±6.55	0.869
Temperature	36.83±0.34	36.837±0.42	0.325
Spo2	98.7±2.0%	99.16±4.5	0.761
C.V.P	3.92±1.23	4.00±1.7	0.526

Means, and Standard Deviation* Statistically significant difference (p<0.05), ** Highly statistically significant difference (p<0.01).

Table (5): Mean and standard deviation of arterial blood gas parameters' between both groups (n=60)

Arterial Blood Gas	HFN (No = 30)	NIV (No = 30)	P. Value
- PH	7.17 ± 0.8	7.42 ± 1.2	**0.034***
- PO2	96.47± 8.0	94.01± 2.0	0.652
- PaCO2	34.93±6.4	36.93±3.7	0.741
- HCO3	23.84±5.0	25.32±2.0	0.342
- Pao2/FIO2			
1 st day	228.17±104.05	290.3±100.64	**0.022***
2nd day	302.87±105.08	245.47±104.25	**0.038***
3rd day	240.43±92.59	292.93±105.26	**0.045***

Means, and Standard Deviation
*** Statistically significant difference (p<0.05), ** Highly statistically significant difference (p<0.01).**

Table (6): Frequency distribution for Causes of acute respiratory failure related to both groups (no =60)

	HFN (n=30)		NIV (n=30)		X^2	P. value
	No.	%	No.	%		
Acute asthma						
Yes	10	33.3	8	26.7	0.32	0.573
No	20	66.7	22	73.3		
ARDS						
Yes	7	23.3	4	13.3	1.00	0.317
No	23	76.7	26	86.7		
Pulmonary embolism						
Yes	3	10.0	2	6.7	0.22	0.640
No	27	90.0	28	93.3		
Lung contusion						
Yes	7	23.3	0	0.0	7.93	**0.005****
No	23	76.7	30	100.0		
Pneumonia						
Yes	23	76.7	13	43.3	6.94	**0.008****
No	7	23.3	17	56.7		
Near drowning						
Yes	3	10.0	0	0.0	3.16	0.076
No	27	90.0	30	100.0		
drug overdose						
Yes	1	3.3	2	6.7	0.35	0.554
No	29	96.7	28	93.3		
Smoke						
Yes	16	53.3	6	20.0	7.18	**0.007****
No	14	46.7	24	80.0		

Chi-square test,
*** Statistically significant difference (p<0.05), ** Highly statistically significant difference (p<0.01).**

Table (7): Frequency distribution of Glasgow coma scale (GCS) related to both groups (n=60)

Glasgow coma scale	HFN (n=30)		NIV (n=30)		X^2	P. value
	No.	%	No.	%		
1st day						
Mild coma (3-8)	7	23.3	3	10.0		
Moderate (9-12)	16	53.3	11	36.7	6.05	**0.049***
Sever coma (13-15)	7	23.3	16	53.3		
3rd day						
Mild coma (3-8)	2	6.7	2	6.7		
Moderate (9-12)	14	46.7	17	56.7	0.65	0.722
Sever coma (13-15)	14	46.7	11	36.7		
5th day						
Mild coma (3-8)	0	0.0	6	20.0		
Moderate (9-12)	11	36.7	14	46.7	9.15	**0.010***
Sever coma (13-15)	19	63.3	10	33.3		

Chi-square test,
*** Statistically significant difference (p<0.05), ** Highly statistically significant difference (p<0.01).**

Table (8): Frequency distribution of Device-related discomfort visual analogue scale related to both groups (no =60)

visual analogue scale	HFN (n=30)		NIV (n=30)		X^2	P. value
	No.	%	No.	%		
1st day						
None	4	13.3	1	3.3		
Mild	16	53.3	26	86.7	8.181	0.042*
Moderate	9	30.0	3	10.0		
Severe	1	3.3	0	0.0		
3rd day						
None	1	3.3	0	0.0		
Mild	10	33.3	20	66.7	8.905	0.031*
Moderate	19	63.3	9	30.0		
Severe	0	0.0	1	3.3		
5th day						
None	1	3.3	0	0.0		
Mild	18	60.0	8	26.7	8.971	0.030*
Moderate	11	36.7	21	70.0		
Severe	0	0.0	1	3.3		

Chi-square test,
*** Statistically significant difference (p<0.05), ** Highly statistically significant difference (p<0.01).**

Table (9): Relation between hospital stay and progress levels in both groups

Progress levels	Died (15)		Unimproved (4)		Improved (1)	
Length of stay						
	HFN	**NIV**	**HFN**	**NIV**	**HFN**	**NIV**
<5 day	12	4	12	4	4	12
6-10 days	15	16	15	16	16	15
>10 days	3	10	3	10	10	3
P. value	**0.005****	**0.011***	**0.012***	**0.109**	**0.007****	**0.655**

Table (10):- Frequency distribution of dyspnea Scale related to the both groups (no=60)

	HFN (n=30)		NIV (n=30)		X^2	P. value
	No.	%	No.	%		
1st day						
No	19	63.3	11	36.7		
Moderate	11	36.7	16	53.3	6.059	**0.048***
Maximum	0	0.0	3	10.0		
3rd day						
No	17	56.7	7	23.3		
Moderate	11	36.7	20	66.7	6.980	**0.031***
Maximum	2	6.7	3	10.0		
5th day						
No	16	53.3	6	20.0		
Moderate	12	40.0	21	70.0	7.20	**0.027***
Maximum	2	6.7	3	10.0		

Chi-square test,
*** Statistically significant difference (p<0.05), ** Highly statistically significant difference (p<0.01).**

Table (11):-Frequency distribution of Complications related to both groups (no =60)

Complications	HFN (n=30)		NIV (n=30)		X^2	P. value
	No.	%	No.	%		
Pneumonia						
Present	9	30.0	19	63.3	6.70	**0.010***
Absent	21	70.0	11	36.7		
Epistaxis						
Present	5	16.7	9	30.0	1.49	0.222
Absent	25	83.3	21	70.0		
Barotrauma						
Present	0	0.0	15	50.0	20.00	**0.001****
Absent	30	100.0	15	50.0		
drying mucous membrane						
Present	5	16.7	10	33.3	2.22	0.136
Absent	25	83.3	20	66.7		
nasal trauma						
Present	1	3.3	9	30.0	7.68	**0.006***
Absent	29	96.7	21	70.0		

Chi-square test,

*** Statistically significant difference (p<0.05), ** Highly statistically significant difference (p<0.01).**

Discussion:

Supplemental oxygen is vital for patients, especially those in the intensive care unit who are critically ill or at risk of impaired pulmonary gas exchange. These patients always receive oxygen therapy to prevent hypoxemia. Recent technological advancements have improved conventional oxygen therapy through the use of high-flow oxygen therapy delivered via a nasal cannula. The high-flow nasal cannula (HFNC) is a device used to deliver humidified and heated oxygen at a flow rate of up to 80 L/min. HFNC is recommended for patients with hypoxemic respiratory failure, for selected patients after extubation, and for high-risk patients following cardiac or thoracic surgery (**High-flow nasal cannula oxygen therapy devices. Nishimura M 2019**). While most research on HFNC focuses on its use in acute hypoxemic respiratory failure, it is increasingly considered an alternative to non-invasive ventilation (NIV) for hypercapnic respiratory failure. Physiological studies suggest that the high gas flows of HFNC may enhance ventilation by increasing mean airway pressure and clearing dead space, and patients find it more comfortable and tolerable (**High-flow oxygen through nasal cannula in acute hypoxemic respiratory failure. Frat J et al 2021**). Initial observational studies have shown that the use of HFNC can improve hypercapnia (**Can high-flow nasal cannula reduce the rate of endotracheal intubation in adult patients with acute respiratory failure compared with conventional oxygen therapy and non-invasive positive pressure ventilation?: a systematic review and meta-analysis. Ni Y, Luo J, et al 2017**). Therefore, the study was conducted to evaluate the effect of high-flow nasal cannula and non-invasive continuous positive airway pressure on critically ill patient outcomes

Regarding patient clinical data, the present study revealed that more than one-third of patients in both groups had respiratory diseases and were underweight upon admission. This is consistent with a study (**Comparison of high-flow nasal cannula oxygen therapy and non-invasive ventilation as first-line therapy in respiratory failure: a multicenter retrospective study**. **Koga Y, et al 2020**), which reported that acute respiratory failure is a common reason for admission of critically ill patients and a common complication in hospitalized patients. Although oxygen therapy using conventional devices is usually prescribed for patients with acute respiratory failure, many patients require advanced respiratory support such as High Flow Nasal Cannula (HFNC) and Non-Invasive Ventilation (NIV).

The study showed significant differences in the number of reintubations between the two groups. Patients using HFNC had fewer reintubations than those using NIV,

which is consistent with a study by (**The utility of HACOR score in predicting failure of high-flow nasal oxygen in acute hypoxemic respiratory failure**. **Magdy D and Metwaly A 2021**). The study found that within 72 hours after extubation, the re-intubation rate was lower in the high-flow group (6.6%) compared to the NIV group (20.9%), with an absolute difference of 14.3% and a statistically significant P-value of 0.001.

In a recent study, a highly significant difference in patient temperature was found between the HFNC (high-flow nasal cannula) group and the NIV (non-invasive ventilation) group. The majority of the HFNC group had a normal temperature after the 3rd and 5th day of device connection, with a p-value of (0.001**) when compared to the NIV group. Regarding respiration, there was also a highly significant difference between both groups on the 1st and 3rd day after the device connection, with p-values of (0.002** and 0.001**) respectively. More than half of the HFNC group had a normal respiratory rate after one day of device connection, and the majority had a normal respiratory rate after the third day. As for patient heart rate and blood pressure, the study found a high statistically significant difference between both groups after 5 days of device connection (P = 0.001**). In terms of blood pressure, there was a statistically significant difference between both groups after one day (p= 0.021*). These findings contradict the results of a study (**High-flow nasal cannula versus noninvasive ventilation in the prevention of escalation to invasive mechanical ventilation in patients with acute hypoxemic respiratory failure**,.**Agmy G, et al, 2022**), which reported no significant differences in baseline vital sign parameters between both groups. However, after 48 hours of intervention, all parameters showed significant differences between both groups.

In the current study, there was no statistically significant difference in all ABG parameters after the first day of device connection. However, there was a statistically significant difference in Pao2 and Sao2 after the second and third day, with more than two-thirds of HFNC patients showing improvement in oxygen saturation. Additionally, there was a decrease in $Paco_2$ observed in patients with HFNC on the third day of device connection. This aligns with the findings of (**Agmy G, et al, 2022**) where baseline arterial blood gas parameters did not differ significantly between the two studies groups at admission. However, one hour later, the PaCO2 was significantly lower in the HFNC group (P=0.020). Follow-up parameters after 6 hours showed significantly higher values for PaO2 and SaO2, and lower values for PaCO2 in the HFNC group also (**Koga Y, et al 2020**), reported that the P/F ratio was lower in the HFNC group and that PaCO2 levels were significantly higher in the NIV group.

The predominant cause of acute respiratory failure (ARF) in our study was pneumonia in both groups followed by smoking and acute asthma. This is in line with (**Koga Y, et al 2020**) reported that the most common cause of ARF in the HFNC group was pneumonia followed by intestinal lung disease. The NIV group's most common cause of ARF is intestinal lung disease followed by pneumonia

In our study, we found a statistically significant difference in the visual analogue scale and dyspnea scale in both groups from the first to 5 days of device connection, indicating device-related discomfort and patient dyspnea decrease with patients with HFNC. This is consistent with the findings of (**Agmy G, et al, 2022**), who discovered that HFNC achieved the best subjective scores for dyspnea, discomfort, and patient preferences. However, these findings are in contrast with those of (**High-flow nasal oxygen vs non-invasive positive airway pressure in hypoxemic patients after cardiothoracic surgery: a randomized clinical trial. Stéphan F, et al 2015**), who studied HFNC versus NIV in patients who developed hypoxemia post cardiothoracic surgery and found that the differences in comfort and dyspnea scores were insignificant between the NIV and HFNC groups.

The study results revealed that patients using non-invasive ventilation (NIV) experienced more complications such as pneumonia, epistaxis, barotrauma, drying of mucous membranes, and nasal trauma compared to patients using a high-flow nasal

cannula (HFNC). There were statistically significant differences between the two groups in terms of pneumonia, barotrauma, and nasal trauma, with p-values of (0.010, 0.001, and 0.006) respectively. However, no statistically significant differences were observed between the two groups regarding the occurrence of epistaxis and drying of mucous membranes, with p-values of 0.222 and 0.136, respectively. This contrasts with the findings of (**The Safety of a High-Flow Nasal Cannula in Neuromuscular Disease Patients with Acute Respiratory Failure. Lionello F, et al 2023**), who reported adverse events (AEs) related to HFNC use, including treatment failure leading to endotracheal intubation or death, barotrauma, epistaxis, and/or nose irritation.

The current study indicates that half of the patients in both the High-Flow Nasal (HFN) and Continuous Positive Airway Pressure (CPAP) groups were hospitalized for 6 to 10 days. In terms of patient progress, there is a statistically significant difference between the two groups. Patients using the HFN protocol showed greater improvement compared to those using the NIV protocol, as evidenced by a p-value of 0.007. This finding contrasts with the report by (**Use of helmet CPAP in COVID-19 a practical review**. **Amirfarzan et al. 2021**), which stated that although both CPAP and High-Flow Nasal Cannula (HFNC) generate positive end-expiratory pressure (PEEP) and aids in oxygenation, the positive pressure produced by HFNC is lower and varies compared to CPAP. This explains the better oxygenation demonstrated by the higher PaO2/FiO2 ratio observed in the CPAP group, which may reduce the need for invasive ventilation, decrease the length of hospital stay, and improve patient outcomes. NIV and HFNC operate through different mechanisms, resulting in distinct benefits and risks. NIV enhances oxygenation by increasing mean airway pressure, but it can also deliver harmful lung volumes, putting patients at risk for self-induced lung injury. In contrast, HFNC offers less positive pressure support than NIV, potentially reducing the risk of self-induced lung injury and improving patient comfort.

Conclusion:

There is a statistically significant difference between NIV and HFNC, with patients using the HFN protocol showing greater improvement than patients using the NIV protocol, as indicated by a p-value of 0.007*.

Recommendations:

Based on the findings of this study, the following recommendations are made:

High-Flow Nasal Cannula (HFNC) may serve as an alternative treatment for hypercapnic respiratory failure, particularly for patients who do not tolerate Non-Invasive Ventilation (NIV) well.

Additionally, further multicenter and randomized controlled studies are needed to determine the optimal use of HFNC in Type II respiratory failure compared to NIV.

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