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RESEARCH

EFFICACY OF NON-INVASIVE CONTINUOUS POSITIVE AIRWAY PRESSURE AND HI-FLOW NASAL CANNULA OXYGEN THERAPY IN GERIATRIC PATIENTS WITH COVID-19 PNEUMONIA ADMITTED TO INTENSIVE CARE UNIT

Abstract

Background: There is insufficient evidence regarding the effectiveness of non-invasive continuous positive airway pressure and high-flow nasal cannula oxygen therapy to reduce the requirement of invasive mechanical ventilation in geriatric patients with coronavirus disease-2019 pneumonia. This study aimed to compare the efficacy of two oxygenation therapies in geriatric patients with coronavirus disease-2019 pneumonia.

Material and Methods: Data from 141 geriatric patients who underwent continuous positive airway pressure or high-flow nasal cannula oxygen therapies at the intensive care unit of the Anesthesiology and Reanimation Department, Elazıg Fethi Sekin City Hospital, between 1 April 2020 and 1 March 2021 were retrospectively investigated. The primary outcome of interest in our study was to compare patient mortality, patient characteristics and the effectiveness of two accepted respiratory support modalities.

Results: A total of 141 patients, 57 female (40.42%) and 84 male (59.58%), aged 65-99 years met the inclusion criteria. Baseline demographic data and pre-existing comorbidities of geriatric patients with coronavirus disease-2019 pneumonia were recorded. The most common comorbidity was hypertension (69.7%). Of the 65 patients treated with high-flow nasal cannula oxygen, 36 were intubated; 18 of these intubated patients died (27%). Of the 76 patients who were treated with continuous positive airway pressure,28 were intubated;19 of these intubated patients died (25%).

Conclusion: In this retrospective observational study, continuous-positive airway pressure or high-flow nasal cannula oxygen therapy in geriatric patients with coronavirus disease-2019 was associated with a lower risk of invasive mechanical ventilation and no significant difference was found in patient mortality due to either treatment modality.

Key words: Continuous Positive Airway Pressure, Geriatrics, COVID-19.

INTRODUCTION

After the coronavirus disease (COVID-19) was first reported in December 2019 in China, it began to rapidly spread globally. Consequently, the World Health Organization (WHO) announced that the disease had become a pandemic in March 2020. COVID-19 has a broad clinical spectrum and can occur in clinical conditions ranging from asymptomatic cases to cases with severe respiratory failure requiring intensive care. COVID-19 continues to affect millions of individuals worldwide. From the first week to November 7, 2021, a slight upward trend (1% increase) was noted in the number of new weekly cases, with more than 3.1 million new cases reported. The WHO European Region reported an increase in the case and death incidences, while other regions reported declining or stable trends. As of 7 November 2021, over 249 million confirmed cases and over 5 million deaths had been reported (1). The clinical course of COVID-19, a global problem, varies. Although approximately 80% of COVID-19 cases are asymptomatic to mild, approximately 15% of patients show severe symptoms and approximately 5% exhibit a critical course, which frequently includes lung involvement with respiratory failure (2). The patients necessitating hospitalisation for COVID-19 predominantly present with acute hypoxaemic respiratory failure (AHRF)(3). The conventional low-flow oxygen therapy is hold out for patients with mild to moderate disease however patients with severe or critical illness are require more improved support. Endotracheal intubation and mechanical ventilation constitute the highest level of care for patients with AHRF but beds and ventilators in the intensive care unit (ICU) are limited. High-flow oxygen therapy through a nasal cannula (HFNO) or continue positive airway pressure (CPAP) are an important part of the treatment in patients with COVID-19 failing on conventional oxygen therapy in our ICU and has recently been endorsed in the surviving sepsis campaign (SSC) guidelines on COVID-19 (4).

Advanced age, hypertension, diabetes, chronic lung disease, asthma, chronic kidney disease, liver disease, cancer, obesity, and smoking are the risk factors of COVID-19. Age is a well-established risk factor for severe COVID-19 outcomes, with over 90% of deaths in the United Kingdom being reported in people over 60 years of age. Although individuals of all ages are at risk, the risk of severe disease is greater in people aged ≥60 years with chronic medical conditions. Regardless of the chronic condition, the mortality rate is the highest among those aged above 70 years (5).

According to the WHO, people aged 18-65 years are considered young adults, those aged 66–79 years are considered elderly, and those aged ≥80 years are considered very old (1,6). Various risk factors, including old age, male sex, hypertension, diabetes, obesity, chronic pulmonary diseases, and heart, liver, and kidney diseases, play a role in the development of severe COVID-19. Severe hypoxaemic respiratory failure may develop in patients infected with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and these patients require respiratory support (7).

COVID-19 patients who develop hypoxaemia despite conventional low-flow oxygen therapy are often treated with HFNO and CPAP therapies, according to international guidelines (4). Non-invasive ventilation (NIV) refers to mechanical ventilatory support using a full-face mask, nasal, oronasal, or helmet (8). CPAP is one of the most commonly used NIV modalities (4,8). The mortality rate of patients who require invasive mechanical ventilation (IMV) due to severe COVID-19 pneumonia is approximately 40%. Thus, non-invasive respiratory treatment modalities, such as HFNO and CPAP, have been widely adopted for patients with hypoxaemic respiratory failure secondary to COVID-19 (6,8).

The use of CPAP for patients with COVID-19 was first suggested based on experience in Italy (9). Similarly, CPAP and HFNO treatments are recommended by Perkins et al. as the basis of non-invasive respiratory support for COVID-19, and they have reported that they are suitable for use in patients with severe hypoxaemic respiratory failure due to COVID-19 who are not eligible for IMV treatment. HFNO is a non-invasive respiratory support modality that delivers warm, humidified oxygen at a maximum flow rate of 60 L/min and up to 100% of the inspired oxygen fraction (FiO_2) through the nasal cannula (10,11). CPAP treatment aims to increase functional residual capacity (FRC), remedy oxygenation, enhance lung compliance, and delay or avoid intubation (11,12). Endotracheal intubation and mechanical ventilation comprise the highest level of care for patients with AHRF; however, ventilators, healthcare professionals, and beds in the ICUs are limited (4).

Due to the concern about the use of HFNO and CPAP due to viral load in epidemics, we found a limited number of studies in the COVID-19 pandemic, and we aimed to examine the effectiveness of non-invasive methods and contribute to the literature by sharing our experiences, since the need for mechanical ventilators in intensive care units has increased excessively and they are not enough for patients (13).

In this retrospective study, we aimed to examine the effectiveness of oxygen therapy with HFNO and CPAP, length of hospital stay, and mortality rates in geriatric patients diagnosed with COVID-19 who were admitted to the ICU.

MATERIALS AND METHODS

After approval by the Ethics Committee of Elazig Fırat University Faculty of Medicine (number 2021/04-39), data from 141 geriatric patients who underwent CPAP or HFNO therapy in the ICU of the Anaesthesiology and Reanimation Department, Elazıg Fethi Sekin City Hospital, between 1 April 2020 and 1 March 2021 were retrospectively investigated. Data were collected from the hospital electronic record systems and patient charts. Patients' demographic data, including age, gender, preexisting chronic diseases such as hypertension, diabetes mellitus, chronic pulmonary diseases, malignancy, chronic kidney disease, coronary artery disease, cerebral infarction and admission comorbidities were collected. Data analysis was performed for geriatric patients who tested positive for SARS-CoV-2 following the polymerase chain reaction (PCR) test, had typical anamnesis, symptoms, and pulmonary infiltrates on conventional chest radiography or computed tomography scan (CT) and oxygen saturation <92% treated with HFNO or CPAP where CPAP was considered a more advanced modality of respiratory support. All patients included in the study, according to Infectious Disease Society of America (IDSA) and American Thoracic Society (ATS) ICU admission criteria (14), radiological (posterior/anterior) X-ray or CT infiltration > 50%, tachypnea (respiratory rate > 30 breath/min), a ratio of the partial pressure of arterial oxygen (PaO_2) to the fraction of inspired oxygen (FiO_2) (PaO_2/FiO_2) < 300 mm Hg. The clinical data, including admission disease severity scores [Sequential Organ Failure Assessment (SOFA) score and Acute Physiology and Chronic Health Assessment-II (APACHE-II)] and Glasgow Coma Scale (GCS) scores were recorded. APACHE II score and SOFA score were used for predicting ICU mortality and prognosis (15). The patients had partial pressure of arterial carbon dioxide ($PaCO_2$) not higher than 45 mm Hg. The most common types of respiratory failure were patients with COVID-19 in general units, with type 1 and, to a lesser extent, type 2 or a combination. Those with type 1 AHRF were included in the study. The patients were identified as requiring non invasive respiratory support on clinical grounds and supported using a management algorithm based on current SSC and other guidline recommendations (4,16). The patients with geratric COVID-19 pneumonia who had peripheral oxygen saturation (SpO_2) < 92% despite conventional low-flow oxygen therapy of at least 6 L/min for at least 15 minutes received either CPAP or HFNO therapy (Figure 1). All physiological parameters and labora-

Figure 1. Flowchart for the treatment of type 1 respiratory failure

Type1 respiratory failure. Target: All patients without chronic lung disease and COPD patients with PCO_2 < 6.0 kPa: SpO2 92-96%. Patients with COPD and PCO_2 > 6.0 kPa: SpO_2 88-92%	
Oxygen supply	
Mild to moderate COVID-19: Target SpO_2 obtainable with ≤ 5 L O_2/min (FiO_2 0.4), delivered by bi-nasal cannula	
↑ **Target SpO_2 obtained**	**Target SpO_2 not obtained** ↓
Severe COVID-19: Target SpO_2 obtainable with 6-15 L O2/min (FiO_2 0.4-0.6). Consider advising ICU-personnel about the patient's condition. Use:	
cCPAP, initially 10-12 cm H_2O, may be increased	
OR	
HFNO with Optiflow™: Initial flow 45 L/min + oxygen to meet SpO_2 requirements.	
OR	
Oxygen by reservoir mask	
↑ **Target SpO_2 obtained**	**Target SpO_2 not obtained** ↓
Very severe COVID-19: Target SpO_2 obtainable with > 15 L O_2/min (FiO_2 > 0.6):	
DI:	**DNI:**
Consult ICU consultant: Continue HFNO at higher flow/higher FiO_2 at IMU or ICU	Continue HFNO at higher flow/higher FiO_2 at IMU
OR	**Target SpO_2 not obtained** ↓
Intubate	NIV, closed system, e.g. 6/16 cm H20. Effect should be evaluated after i.e. 2 hours

DI; Do Intubate, DNI; Do Not Intubate, *CPAP;* continuous positive airway pressure, *COPD;* chronic occlusive pulmonary disease, *FiO_2;* inspiratory oxygen fraction, *PaO_2;* arterial oxygen tension, *ICU;* Intensive Care Unit, *NIV;* non-invasive ventilation, *IMU;* Intermediate Care Unit, *HFNO;* High Flow Nasal Cannula Oxygen. *Adapted from Jeschke KN et al. 2020 (16).*

tory markers of the patients included in the study were analyzed from the records shortly before the initiation of CPAP/HFNO therapy. Laboratory tests including white blood cell counts (WCC), C-reactive protein (CRP), D-Dimer, urea, creatinine and arterial blood gas analysis were also recorded.

The patients receiving <10 L/min standard oxygen therapy on the first day, incomplete results, receiving IMV or bi-level positive pressure (BiPAP) ventilation support, carbon dioxide pressure in venous blood gas (pCO2) > 6 kPa (VBG), a GCS score of 13 points or less, chronic obstructive pulmonary disease stage III-IV and those who decided not to participate were excluded from the study.

The primary outcomes of interest were patient mortality, patient characteristics, length of stay in the ICU, modality of respiratory support, admission, and outcome data. Treatment tolerance was authenticated on a post-hoc basis through a review of patients' adherence to therapies, as documented in their clinical case records.

HFNO treatment strategy

HFNO (Optiflow™ nasal high-flow interface) driven by AIRVO 2 humidification system (Fisher and Paykel Auckland, New Zealand) were used. The initial airflow was set at 45 L/min and adjusted according to patient tolerance. The HFNO was set to a certain humidity of 44 mg H_2O/L, temperature was set to 37 °C, and FiO_2 (between 0.21 and 1.0) was adjusted to maintain an SpO2 of 88-92% (Figure1).

CPAP treatment strategy

The face mask CPAP was started at a flow of 40 L/min and a PEEP of 10 cmH_2O which can be increased to a maximum of 20 cmH_2O at the at the discretion of the physician's. We suspect that the PEEP had normally been used at around 8–10 (−12) cmH_2O (Figure 1). The CPAP machines were Hamilton C3 (Hamilton Medical AG Via Crusch 8, Switzerland) devices.

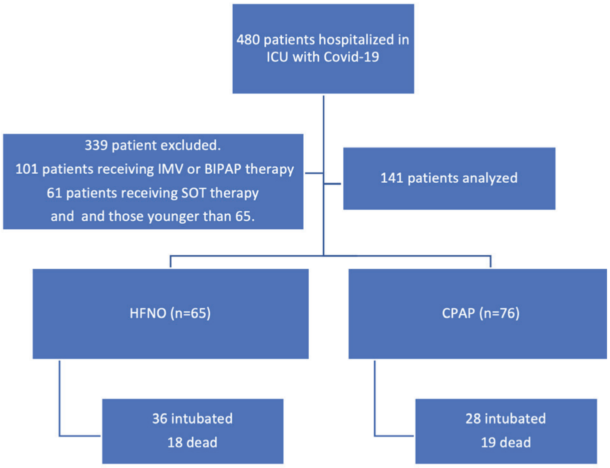
Patients with facial anomalies and tracheostomy, as well as those who were evaluated by the treating clinician as requiring urgent intubation and invasive ventilation due to severe hypoxia, acidosis and/or respiratory distress, upper airway obstruction, inability to manage airway secretions, or recurrent apneas, were excluded from the study. Patients who were transferred from other hospitals where they were previously treated were excluded.

All laboratory markers and physiological parameters included in the study were measured before and after the initiation of CPAP or HFNO treatment. The patients diagnosed with COVID-19 underwent face mask CPAP or HFNO therapy if they had hypoxaemia with an oxygen supply of >10 L/min to maintain $SpO_2 \geq 92\%$. The CPAP and HFNO treatments were handled by trained nurses in close collaboration with ICU anaesthesiologists and intensivists. Patients were closely monitored using non-invasive blood pressure (BP) measurements and pulse oximetry during treatment. Contraindications for starting CPAP included pneumothorax, systolic BP < 90 mmHg or diastolic BP < 50 mmHg, nausea/vomiting, or coma. The treatment was stopped if the patient did not tolerate the CPAP mask. The aim of CPAP treatment was to increase FRC, improve oxygenation, increase lung compliance, and conceivably delay or avoid intubation. The intubation rates and mortality rates of the patients who were treated with HFNO or CPAP were recorded (Figure 2).

Statistical Analysis

In the statistical analysis, continuous variables were presented as mean ± standard deviation (SD), and categorical variables were presented as numbers and frequencies (percentages). Continuous variables were expressed as mean ± SD or median with interquartile range (IQR) and were compared between the two groups using the Mann-Whitney U test. All data were exported to SPSS (version 27; IBM, Armonk, NY, USA) for further analysis. Multiple comparisons of continuous variables were per-

Figure 2. Flow chart. *NIV;* Non-invasive Ventilation, *CPAP;* Continuous Positive Airway Pressure, *ICU;* Intensive Care Unit, *HFNO;* High Flow Nasal Canula Oxygen



formed using ANOVA. For the post-hoc analysis, we used a Bonferroni-adjusted *t-test* for multiple comparisons. The significance threshold was set at $P < 0.05$.

RESULTS

A total of 141 patients, 57 women (40.42%) and 84 men (59.58%) aged 65-99 years met the inclusion criteria. Basic demographic data and preexisting comorbidities are shown in Table 1. The most common comorbidity detected in geriatric patients with COVID-19 was hypertension (69.7%). In addition, diabetes mellitus (21.9%) was frequently observed in these patients, and its association with hypertension and ischaemic heart disease is common. Prior to starting CPAP or HFNO, all patients had some level of respiratory distress. Of the 65 patients treated with HFNO, 36 were intubated and 18 of the intubated patients died (27%). Of the 76 patients who were treated with CPAP, 28 were intubated and 19 of the intubated patients died (25%) (*Fig 2).*

Table 1. Basic demographic data and pre-existing comorbidities

Patients (n%)	141
Female	57 (40.42)
Male	84 (59.58)
Age (years)	79±14
Body mass index (kg/m^2)	27.3±3.7
Hypertension	98 (69.7)
Subsistence of two or overage comorbidities	61 (43.26)
Diabetes mellitus	31 (21.9)
Coronary artery disease	30 (21.27)
Malignancy	29 (20.56)
Asthma	26 (18.43)
COPD	16 (11.34)
Cerebrovascular disease	6 (4.25)
Chronic renal disease	3 (2.41)

Data are presented as % or mean ± SD, unless otherwise defined. COPD: Chronic obstructive pulmonary disease

No significant difference was observed between the mortality rates of both groups ($p > 0.05$) (Table 2). Overall, 47 (72%) patients treated with HFNO and 57 (75%) patients treated with CPAP were discharged from the hospital in good health, without any significant difference ($p > 0.05$) (Table 2). The CPAP group tolerated oxygen therapy better than the HFNO group and had a reduced need for IMV ($p < 0.001$). No significant difference was observed between the mean length of hospital stay in either group ($p > 0.05$). When the laboratory test results of patients in the CPAP and HFNO groups were analysed, creatinine values were found to be higher in the CPAP group ($p = 0.016$). There was no significant difference in the length of (hospital) stay in the ICU between the two groups ($p > 0.05$) (Table 2).

Table 2. Characteristics of the study population and comparison between COVID-19 HFNO therapy and CPAP therapy

	HFNO (n=65)	CPAP (n=76)	P *value*
APACHE II scores	13 (5-17)	12 (6-17)	0.541
SOFA scores	3 (3-6)	3 (3-5)	0.872
GCS scores	15 (14-15)	15 (14-15)	0.962
Observations of the two group patients pre-HFNO/CPAP, mean±SD			
Arterial pH	7.46 (7.41-7.50)	7.43 (7.38-7.47)	0.103
FiO_2	82.7±19.5	81.3±21.5	0.891
PaO_2/FiO_2 ratio	229 (201–276)	227 (214–287)	0.671
Oxygen saturations	88.1±15.0	87.6±18.7	0.651
PaO_2, mmHg	57.3 ± 7.7	51.1 ± 9.3	0.583
Respiratory rate	25.2±6.9	27.4±6.3	0.058
Heart rate	87.6±15.3	91.7±17.7	0.073
Outcomes of the two group patients after HFNO/CPAP treatment, mean±SD			
Arterial pH	7.38 (7.35-7.43)	7.37 (7.36-7.45)	0.987
FiO_2	70.4±15.9	70.0±14.6	0.971
PaO_2/FiO_2 ratio	227 (196–292)	247 (224–304)	0.578
Oxygen saturations	91.6±7.9	93.3±6.8	0.048
PaO_2, mmHg	86.87±9.73	89.11±13.89	0.429
Respiratory rate	24.6±4.7	27.9±6.5	0.143
Heart rate	85.6±14.1	87.9±18.3	0.079
Laboratory results, mean±SD			
WBC $\times 10^9 \cdot L^{-1}$	11.6±5.3	12.6±4.1	0.897
D-Dimer ng mL^{-1}	2398±2154	2476±2259	0.351
C-Reactive protein mg.L^{-1}	147±116	163±102	0.161
Lymphocyte count $\times 10^9 \cdot L^{-1}$	1.02±0.63	1.01±0.66	0.635
Creatinine μmol.L^{-1}	98.1±57.3	109.1±79.7	0.016
Urea mmol.L^{-1}	12.1±10.3	13.8±10.7	0.052

Outcomes *n (%)*			
HFNO/CPAP duration days, median range†	3 (1-14)	5 (1-25)	0.062
HFNO/CPAP tolereted	29 (44%)	40 (52%)	0.001
Discharged from hospital	47 (72%)	57 (75%)	0.057
Mean Length of (hospital) stay*(IQR)	10 (4-19)	11,5 (3-23)	0.77
Death	18 (27%)	19 (25%)	0.873

CPAP: continuous positive airway pressure; HFNO: high-flow nasal oxygen; SOFA:Sequential Organ Failure Assessment Score; APACHE-II: Acute Physiology and Chronic Health Assessment-II;GCS: Glasgow Coma Scale; WCC: White blood cell; PaO_2:arterial oxygen tension; FiO_2: inspiratory oxygen fraction.†;n(%) and median range,*IQR:interquartile

DISCUSSION

Ageing, which is characterised by increased mortality and morbidity, is a universal process. Physiological, cellular, and molecular variations also affect the definition of ageing. Ageing affects the gas exchange properties. Arterial oxygenation gradually declines with age, likely secondary to an increase in ventilation/perfusion heterogeneity caused by a decrease in alveolar surface area and premature closure of small airways (4,17). Among the risk factors facilitating the development of pneumonia in elderly individuals are comorbidities, the negative effects of their treatments on the lungs, and changes in physiological parameters, such as the elastic retraction pressure of the lung, respiratory muscle strength, cough reflex with age, and the associated decrease in the defence capacity. In elderly patients, increased colonisation of microorganisms in the throat flora, microaspiration of these microorganisms, and the amount and virulence of the microorganism are factors that facilitate the development of pneumonia (17). In geriatric patients, diabetes, hypertension, chronic lung, kidney, cardiovascular, and cerebrovascular diseases, malignancies, and obesity (body mass index ≥ 40 kg/m²) increase the risk of mortality. In a study conducted in Italy, the data of the first 3200 patients who died due to COVID-19 were examined, and the average age of the expired patients was found to be 78.5 years. Only 481 patients had data on their underlying diseases. Of the 481 individuals, six (1.2%) had an underlying disease, 113 (23.5%) had two diseases, 128 (26.6%) had three diseases, and 234 (48.6%) had four or more diseases. Additional underlying diseases, in order of frequency, were as follows: hypertension (355, 73.8%), diabetes (163, 33.9%), ischaemic heart disease (145, 30.1%), atrial fibrillation (106, 22.0%), chronic kidney failure (97, 20.2%), cancer (94, 19.5%), chronic obstructive pulmonary disease (66, 13.7%), dementia (57, 11.9%), stroke (54, 11.2%), and chronic liver disease (18, 3.7%). The rate of comorbid diseases in patients hospitalised in the ICU is high (72.2%) (18). Similarly, in our study, we observed that the prevalence of hypertension, a comorbid disease, was higher than that of other comorbid diseases.

The patients with COVID-19 pneumonia may develop AHRF. Various indices have been used to define pneumonia. The clinical respiratory symptoms of SARS-CoV-2 infection frequently do not correlated to the severity of lung damage; thence, to correctly stratify COVID-19 patients, it is important to measure the acute lung injury based on well-acknowledged test for acute lung injury such as the partial pressure of arterial oxygen (PaO_2) to fraction of inspired oxygen (FiO_2) ratio (PaO_2/FiO_2). There are studies stating that the PaO_2/FiO_2 ratio can be seriously considered by healthcare professionals due to its accuracy and primitiveness (13,16). In our study, we used this index to detect early progression to acute respiratory failure in patients who underwent HFNO or CPAP. The HFNO or CPAP therapy is frequently used in hypoxaemic respiratory failure and decreases the need for intubation without affecting the mortality rates (16). Early in the COVID-19 pandemic, these modalities were assumed to be controversial, owing to the lack of quality evidence for their use in the treatment of bacterial pneumonia. CPAP is a non-invasive method for positive airway pressure ventilation (13). In contrast, HFNO is an oxygen supplementation method that provides humidified oxygen at a flow rate of up to 100 L/min and FiO_2 between 21% and 100%. It is assumed that these modalities offer respiratory support by decreasing the work of breathing, providing a low level of positive end-expiratory pressure (PEEP), and improving mucociliary clearance through humidification of oxygen (4,16). First-line options for supporting patients with respiratory failure and hypoxaemia are oxygen with a simple nasal cannula, Venturi masks, and a high-flow nasal cannula. Its heating and humidification properties make HFNO more tolerable. In addition, the soft and loose nasal interface makes it more comfortable to use and does not prevent the patient from speaking and eating. Some indicators are useful in monitoring oxygenation status and predicting outcome in patients with HFNO. If gas exchange worsens and oxygen demand increases despite these treatments, CPAP therapy, NIV, or IMV should be considered. In this study, we observed that the treatment was successful and the need for IMV was reduced by regular monitoring of the PaO_2/FiO_2 ratios of the patients and by increasing the oxygen support with noninvasive methods, HFNO or CPAP instead of considering the presence of hypoxemia according to the clinical situation. We did not find a statistical difference in the need for IMV between the two groups. However, we found that the tolerance to treatment of the patients in the HFNO group was better than in the CPAP group. The overall goal is to provide adequate oxygenation. A target of $SpO_2 \geq 90\%$ or $PaO_2 > 55$ mmHg is recommended (4,10,16).

NIV application in patients with moderate and severe acute respiratory distress syndrome (ARDS) has a failure rate of up to 50% but is associated with a mortality rate of up to 50% in severe ARDS cases (19,20). In several studies, HFNO and CPAP therapies have been limited because of respiratory failure due to COVID-19 pneumonia. Early intubation and IMV are recommended in cases of severe hypoxaemia (PaO2/FiO2 ≤ 200 mm Hg). In our study, early intubation and IMV were used in patients with severe hypoxaemia. We believe that a delay in intubation adversely affects the recovery process in patients with failed NIV, and the risk of transmission to healthcare professionals working in the ICU is higher in cases in which urgent intubation is required (16). $PaO_2/FiO_2 \leq 150$ mmHg indicates hypoxaemic failure and is the threshold value that determines the increased mortality risk (20,21). NIV should be avoided in patients with uncontrolled secretions, risk of aspiration, haemodynamic disorders, multiorgan failure, or impaired mental status (6). The CPAP device consists of an airflow generating unit that is delivered to the airway through a helmet or face mask, and the effects of CPAP have been studied in more than 1100 patients with ARF due to COVID-19 pneumonia (21). The continue CPAP therapy may be considered for a patient with ARF associated with COVID-19 in the following situations. The patients with hypoxic respiratory failure require 6-15 L/min of oxygen (ie, fraction of inspired oxygen (FiO_2, 0.4-0.6) to achieve an acceptable level of oxygen saturation, and clinicians agree that an increase to IMV is an option, but not immediately necessary. An initial pressure of 10–12 cm H_2O may be applied when starting CPAP therapy because, as in other severe ARF cases, the positive end-expiratory pressure must be high (4,16). Generally, CPAP therapy has an almost immediate effect in improving the condition of patients with COVID-19-related ARF; however, intubation and IMV may be required if more oxygen is required**.** We applied CPAP with a face mask to patients who developed respiratory failure due to COVID-19.

Many international guidelines state that healthcare workers using devices that generate bioaerosols have a high risk of contracting the infection and suggest taking care and even contradicting the use of these devices (4,21,22). However, the WHO advocates that health workers can use CPAP, HFNO, or NIV treatment in patients with COVID-19 and respiratory failure, provided they wear appropriate PPE (22,23). In line with the recommendations of the international guidelines at the start of the COVID-19 pandemic, most clinicians prefer standard oxygen therapy or early IMV support for acute respiratory failure caused by COVID-19. They preferred the use of IMV to protect hospital personnel from aerosols formed during treatments, such as CPAP and HFNO. Despite this, the inadequacy of mechanical ventilators in ICUs at some centres and the inadequacy of personnel with sufficient training and experience have forced clinicians to use non-invasive techniques. In our COVID-19 ICUs, we used HFNO and CPAP treatments in accordance with the literature published in the later stages of the epidemic and the recommendations of international guidelines (4,22). We used oxygen support treatments with CPAP or HFNO for patients with COVID-19 after wearing the necessary PPE following the WHO recommendations. In addition, all patient rooms in our ICU had negative pressure and were single rooms. We believe that this significantly reduces bioaerosol exposure among healthcare workers.

A recent study argued for "permissible hypoxemia" and did not impose a target for oxygen saturation, which reduced the number of intubated patients. This was associated with an 83% treatment success rate for CPAP in patients deemed fit for IMV. This suggests that more patients should be treated with non-invasive methods of respiratory support. However, after this report was published, many opposing opinions have been suggested (24).

Geriatric patients have higher mortality rates than the general population. In a study investigating the clinical features of patients with SARS-CoV-2 pneumonia, the mortality rate of patients aged >80 years was 18.8% (25). In this study, the clinical parameters of the 60 geriatric patients were divided into two groups: 65-79 years and >80 years. We included 141 geriatric patients aged ≥65 years who were administered either of two oxygen therapy strategies in the ICU, CPAP or HFNO. The mortality rate was 25% in the CPAP group and 27% in the HFNO group, and no statistical difference was found between these rates ($p > 0.05$).

A multicentre observational study conducted to understand the global impact of severe acute respiratory failure showed no significant difference in the severity of ARDS and ICU and hospital death rates of patients with ARDS treated with NIV or mechanical ventilation. Associated comorbidities and demographic characteristics were examined in both the treatment groups. This study showed that mortality and failure rates in the NIV group were related to the severity of respiratory failure. Compared with HFNO, NIV does not significantly reduce the intubation rate and mortality of COVID-19 patients with ARDS (26). In our study, there was no statistically significant difference between intubation and mortality rates in geriatric patients who developed acute hypoxemic respiratory failure due to COVID-19 pneumonia, who were treated with HFNO or CPAP. We attribute this result to our early application of HFNO or CPAP. In two recent cohort studies, they were able to determine the cut-off value of the PaO_2/FiO_2 ratio as 274 mmHg in patients who developed ARF due to COVID-19 pneumonia (27,28). We also obtained similar findings in our study. In order to achieve successful results in HFNO or CPAP treatment, we believe that the PaO_2/FiO_2 ratio of patients should be followed regularly and correlated with laboratory parameters.

The CPAP and HFNO are appropriate treatment options for patients with hypoxemic respiratory failure due to COVID-19 pneumonia, including those deemed unsuitable for invasive ventilation. With respect to the therapeutic mechanism, HFNO involves low PEEP (3 cmH_2O, on average). Nevertheless, this pressure level is uncontrollable, unstable, and is affected by many factors. In contrast, CPAP can ensure stable and adjustable airway pressure (8,19). In our study, we observed that patients treated with CPAP responded better to treatment and tolerated the treatment better than those treated with HFNO.

Few studies have compared the effectiveness of CPAP and HFNO treatments for acute respiratory failure due to COVID-19 pneumonia. Geriatric patients have several comorbidities, which affect the effectiveness and success of oxygen therapy modalities. This study aimed to contribute to the literature by examining the clinical parameters of geriatric patients with COVID-19.

This study had several limitations. First, only 141 geriatric patients with COVID-19 were included. Although the number of geriatric patients with COVID-19 treated in our ICU was much higher, those treated with IMV, standard oxygen therapy, or BiPAP were excluded from the study. Second, specific information, such as CPAP settings from the ICU data was missing. However, the data on clinical examination, supportive treatment of oxygen, living status, and the duration from ICU admission to death are indisputable. Third, this is a retrospective study. This study was a preliminary assessment of the clinical course and outcomes of geriatric patients with SARS-CoV-2 pneumonia. Further studies are needed to confirm this hypothesis.

CONCLUSION

In this retrospective observational study, the administration of HFNO or CPAP to geriatric patients with COVID-19 was associated with a lower risk of IMV. There was no significant difference in patient mortality according to the treatment modality. However, future multicentre studies with larger sample sizes are needed for more credible evaluation.

Conflicts of Interest

The authors of this article state that they have no conflict of interest.

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Statement of Ethics

The study protocol was approved by the Research Ethics Committee of the Elazıg Fırat University of Medicine Faculty (ethical code 2021/04-39). The study was administrated in agreement with the Declaration of Helsinki.

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