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RESEARCH

COMPARISON OF HIGH FLOW NASAL OXYGEN AND MASK OXYGEN IN THE WEANING PROCESS OF GERIATRIC INTENSIVE CARE PATIENTS

Abstract

Introduction: Geriatric patients under mechanical ventilation in the intensive care setting can have a prolonged weaning process and face respiratory failure requiring reintubation. High flow nasal oxygen therapy can be used to improve oxygenation after extubation. In this study, we aimed to compare high flow nasal oxygen therapy with simple oxygen face mask treatment in the weaning process of geriatric intensive care unit patients.

Materials and Method: Fifty-three patients above the age of 65 were retrospectively included in the study. High flow nasal oxygen therapy was initiated to patients with partial pressure of oxygen/fraction of inhaled oxygen<150 within 48 hours of extubation. Patients with partial pressure of oxygen/fraction of inhaled oxygen ≥150 were treated with oxygen masks with 10-15L/min flow. The two groups were compared for reintubation and mortality. A cut-off partial pressure of oxygen/fraction of inspired oxygen value for reintubation requirement was calculated.

Results: Reintubation rates were 51.6% in Group-HFNOT and 54.5% in Group-Mask. Mortality rates of reentubated patients; Group-HFNOT 38.7%, Group-Mask 40.9%. There was no significant difference between the groups. The mean baseline partial pressure of oxygen/fraction of inspired oxygen value was 119.7±18.4 for Group-HFNOT, and a cut-off value of 107 for predicting reintubation was calculated.

Conclusion: High flow nasal oxygen treatment can be preferred for geriatric patients with respiratory failure during the weaning process with appropriate patient selection.

Keywords: Geriatrics; Oxygen inhalation therapy; Ventilator weaning; Respiratory insufficiency; Critical care

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INTRODUCTION

An increasing number of geriatric patients in intensive care units (ICUs) is expected with the expanding geriatric population worldwide (1). Mechanical ventilation (MV) is necessary for 38-51% of geriatric ICU patients and weaning from MV is a challenge in this patient population (2). Respiratory failure requiring reintubation is associated with increased ICU length of stay and higher mortality for all age groups (3,4). Acute respiratory failure can arise after weaning from MV due to dysfunction of the medullary respiratory centre or respiratory muscles, impaired lung mechanics, or impaired gas exchange (4). The rate of acute respiratory failure, which necessitates reinitiating MV within 48 hours, following successful, planned extubations is 10-15% among all ICU patients and can surpass 20% in high risk populations such as geriatric patients (3,5,6).

High flow nasal oxygen treatment (HFNOT) has emerged as an alternative to traditional oxygen support. These devices supply heated, humidified oxygen at flows as high as 60 L/min through nasal cannulae (7,8). HFNOT is beneficial in protecting mucociliary functions, preventing lung collapse, providing a constant inspiratory oxygen fraction (FiO2), and clearing carbondioxide in dead spaces (9). With better gas exchange and oxygenation, HFNOT reduces the work of breathing. HFNOT may be preferred over traditional oxygen treatments following planned extubations (10,11). Improvement of dyspnoea and oxygenation parameters, better tolerance, and increased survival have been reported with the use of HFNOT to prevent respiratory failure after extubation (12,13).

In our retrospective study, we aimed to compare HFNOT with oxygen mask treatment in the weaning process of geriatric ICU patients.

Table 1. Comparison of demographic variables between the HFNOT and Mask groups

	HFNOT (n=31)	**Mask (n=22)**	**p**
Age	79±7.8	82.2±8.3	0.157 a
Sex (Male/Female); n (%)	19 (61.3%)/12 (38.7%)	10 (45.5%)/12 (54.5%)	0.254 b
GCS	14 (10-15)	12.5 (10-15)	0.216 c
Apache II	19.5±6.9	19.5±8.1	0.999 a
SAPS II	44.8±14	45±16.3	0.589 a
Cause of MV; n (%) Primary respiratory / Secondary	25 (80.6%)/6 (19.4%)	16 (72.7%)/6 (27.3%)	0.524 d
Basal PaO2/FiO2 ratio*	119.74 ±18.43	211±77.36	<0,001a
MV duration before extubation (days)	5 (1-15)	3.5 (1-24)	0.339 c
NIMV support; Yes/No, n (%)	5 (16.1%)/26 (83.9%)	8 (36.4%)/14 (63.6%)	0.092 b
Reintubation; Yes/No, n (%)	16 (51.6%)/15 (48.4%)	12 (54.5%)/10 (45.5%)	0.833 b
Discharge from the ICU; n (%) Discharged alive Mortality	 19 (61.3%) 12 (38.7%)	 13 (59.1%) 9 (40.9%)	0.872 b

Descriptive statistics are expressed as the mean±standard deviation, median (min-max) or frequency and percentages. a Independent samples t-test b Pearson chi-square test c Mann-Whitney U test d Fisher's exact test * Average PaO2 / FiO2 ratio from blood gas results before HFNOT in Group-HFNOT and after extubation in Group-Mask. GCS: Glasgow Coma Score, Apache II: Acute Physiologic Assessment and Chronic Health Evaluation II scoring system, SAPS II: the Simplified Acute Physiology Score II, MV: mechanical ventilation, NIMV: noninvasive mechanical ventilation, ICU: intensive care unit

Table 2. Distribution of diagnoses underlying the need for mechanical ventilation

Diagnosis	HFNOT (n: 31)	Mask (n: 22)
Primary Respiratory Causes: n (%)	25 (80.6%)	16 (72.7%)
Pneumonia	21 (67.7%)	14 (63.6%)
Pulmonary oedema	2 (6.5%)	2 (9.1%)
Pulmonary embolism	1 (3.2%)	-
Lung cancer	1 (3.2%)	-
Secondary Causes: n (%)	6 (19.4%)	6 (27.3%)
Postoperative	2 (6.5%)	3 (13.6%)
Intracranial haemorrhage / CVD	2 (6.5%)	2 (9.1%)
Encephalitis	1 (3.2%)	-
Multi-trauma	1 (3.2%)	-
Urosepsis	-	1 (4.5%)

Descriptive statistics are expressed as frequencies and percentages. CVD: cerebrovascular diseases

METHODS

The study was conducted retrospectively on patients aged ≥65 who received HFNOT or oxygen support through face masks after planned extubation following more than 24 hours of MV in the ICU at the University of Health Sciences Fatih Sultan Mehmet Health Research and Application Center between January 2016 and January 2019. Patients with MV under 24 hours, an unplanned extubation, Glasgow Coma Scale (GCS) score ≤ 8, or a tracheotomy were excluded. Approval for this study was obtained from the University of Health Sciences Fatih Sultan Mehmet Health Research and Application Center Scientific Studies Board (27/02/2019, 17073117-050.06-E.41).

All 53 included patients were started on 6-8 L/min of oxygen via standard face masks after their extubation. At the time of the study period, HFNOT was a new treatment modality in our clinic and the decision to switch to HFNOT was made by the patient's clinician. HFNOT was initiated if partial pressure of oxygen/fraction of inhaled oxygen (PaO2/FiO2) was < 150 within 48 hours of extubation. Patients with PaO2/FiO2 ≥ 150 were treated with oxygen masks with flows increased to 10-15L/min. The patients were thereby placed in different groups. Patients who were on HFNOT had continued their treatment for at least 24 hours and until supplemental oxygen was no longer necessary or reintubation was required. Patients who were continued on standard oxygen support via face masks made up the Mask group and patients who were started on HFNOT within 48 hours of extubation made up the HFNOT group. HFNOT was delivered with the AIRVO 2 OptiFLOW ™ (Fisher & Paykel, New Zealand) device.

Data on age, sex, diagnoses, GCS score at the time of extubation, Acute Physiologic Assessment and Chronic Health Evaluation II scoring system (APACHE II) and the Simplified Acute Physiology Score II (SAPS II) scores, days on MV and, for reintubated patients, days free of MV were recorded.

Arterial blood gases immediately after extubation for the Mask group and before HFNOT for the HFNOT group were used for baseline measurements of partial pressure of oxygen / fraction of inspired oxygen (PaO2/FiO2), partial pressure of oxygen (PaO2), partial pressure of carbon dioxide (PaCO2), and oxygen saturation (SaO2). Baseline heart rate (HR), mean arterial pressure (MAP), ini-

Table 3. Comparison of reintubated and non-reintubated patients in the HFNOT group

HFNOT Group	Non Reintubated n=15	Reintubated n=16	p
Age	77±7.3	80.8±8.1	0.681a
Sex (Male/Female); n (%)	10 (66.7%)/5 (33.3%)	9 (56.3%)/7 (43.8%)	0.552b
GCS	14 (10-15)	14 (10-15)	0.129c
APACHE II	19.4±7.7	19.6±6.2	0.528a
SAPS II	49±9.5	41.4±16.3	0.724a
Cause of MV; n (%) Primary respiratory / Secondary	9 (60%)/6 (40%)	16 (100%)/0 (0%)	0.007d
MV duration before extubation (days)	6 (1-12)	5 (1-15)	0.257c
Basal PaO2/FiO2 ratio	127±19.9	112.8±14.3	<0.001a
Basal PaO2 (mmHg)	60.8±8.9	54.1±5.2	<0.001a
Basal PaCO2 (mmHg)	38.8±6.6	36.3±5.3	0.146a
PH	7.50±0.04	7.46±0.06	0.723 a
SaO2	90.6±6.3	88±3.2	<0.001a
HR (beats/min)	96.4±16.3	91.7±14	0.476a
MAP (mmHg)	92.9±12.1	87.7±14	0.981a
HFNO initial flow (lt/min)	40 (30-60)	37.5 (30-60)	0.830c
Initial FiO2 (%)	50 (40-60)	55 (40-80)	0.281c
NIMV support; n (%) Yes / No	4 (26.7%)/11 (73.3%)	1 (6.3%)/15 (93.8%)	0.172d
NIMV support; n (%) Yes / No	15 (100%) 0 (0%)	4 (25%) 12 (75%)	<0.001b

Descriptive statistics are expressed as the mean±standard deviation, median (min-max) or frequency and percentages.a Independent samples t-test. b Pearson chi-square test. c Mann-Whitney U test. d Fisher's exact test. GCS: Glasgow coma score, Apache II: Acute Physiologic Assessment and Chronic Health Evaluation II scoring system, SAPS II: the Simplified Acute Physiology Score II, MV: mechanical ventilation, ICU: intensive care unit, HR: heart rate, MAP: mean arterial pressure, HFNO: high flow nasal oxygen, NIMV: noninvasive mechanical ventilation

tial flow rates and oxygen concentrations for the HFNOT group, need for noninvasive mechanical ventilation (NIMV), need for reintubation within 10 days of extubation, successful discharge from the ICU, and mortality were also recorded.

Age, sex, APACHE II scores, SAPS II scores, mechanical ventilation time, need for reintubation, ICU discharge rate, and mortality were compared between the two groups. Within-group comparisons were carried out for reintubation requirements. Reintubated patients in both groups were further analysed for age, sex, GCS, APACHE II, SAPS II scores, diagnoses, MV time, freedom from MV, ICU discharge rate, and mortality. PaO2/FiO2 measurements were analysed for their association with reintubation, and a cut-off PaO2/FiO2 value for reintubation was calculated.

Statistical Method

The results are presented as the mean ± standard deviation or median (minimum-maximum) for continuous variables. Categorical variables are described as frequencies and percentages. The

Shapiro Wilk test was used to test normality. Continuous variables were compared using Student's t-test and the Mann-Whitney U test. Pearson's chi-squared test and Fisher's exact test were applied for categorical variables. The cut-off value for PaO2/FiO2 was determined with an ROC analysis according to reintubation for patients in the HFNOT group. A p-value <0.05 was considered significant. All statistical analyses were performed with IBM SPSS v.23.0 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.).

2; there was no significant difference between the groups (p=0.524).

When reintubated and non-reintubated patients within the HFNOT group were compared, there were significant differences in the cause of MV, baseline PaO2/FiO2, PaO2, SaO2, and ICU discharge rates. The HFNOT group patients who required reintubation had lower baseline PaO2/FiO2, PaO2, and SaO2 values. Primary respiratory causes were more frequent in HFNOT patients requiring reintubation (p=0.007) (Table 3).

Table 4. Comparison of reintubated patients in the HFNOT and Mask groups

Reintubated Patients	**HFNOT n=16**	**Mask n=12**	**p**
Age	80.8±8.1	82.9±8.2	0.507 a
Sex (Male/Female); n(%)	9 (56.3%)/7 (43.8%)	4 (33.3%)/8 (66.7%)	0.229 b
GCS	14 (10-15)	12 (10-15)	0.110 c
Apache II	19.6±6.2	20.5±5.3	0.694 a
SAPS II	41.4±16.3	43.9±10.1	0.645 a
Cause of MV; n (%) Primary respiratory / Secondary	16 (100%)/0 (0%))	10 (83.3%)/2 (16.7%)	0.175 d
MV duration before extubation (days)	5 (1-15)	6.5 (2-24)	0.189 c
Day without mechanical ventilation	5 (1-10)	2.5 (1-10)	0.423 c
NIMV support; n(%) Yes/No	1 (6.3%)/15 (93.8%)	7 (58.3%)/5 (41.7%)	0.004 d
Discharge from the ICU; n(%) Discharged alive Mortality	 4 (25%) 12 (75%)	 3 (25%) 9 (75%)	 1.000 d

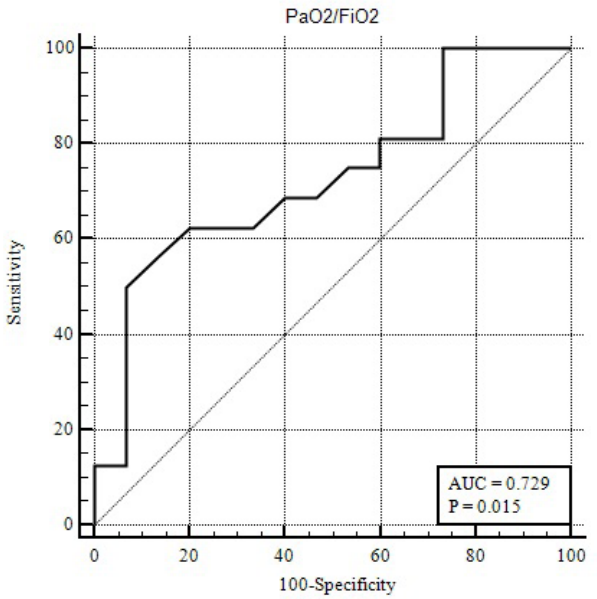
Descriptive statistics are expressed as the mean±standard deviation, median (min-max), or frequency and percentages. a Independent samples t-test. b Pearson chi-square test. c Mann-Whitney U test. d Fisher's exact test. GCS: Glasgow coma score, Apache II: Acute Physiologic Assessment and Chronic Health Evaluation II scoring system, SAPS II: the Simplified Acute Physiology Score II, MV: mechanical ventilation, NIMV: noninvasive mechanical ventilation, ICU: intensive care unit

RESULTS

A total of 53 patients who received MV in the ICU and underwent planned weaning were included in our study. Thirty-one patients were in the HFNOT group, and 22 patients were in the Mask group. Groups were not different in terms of demographic or ICU parameters (Table 1). Details on the causes of MV by study group are given in Table

Of the 22 patients in the Mask group, 12 (54.5%) required reintubation. Age, sex, GCS, APACHE II, SAPS II, MV time, and NIMV requirement were not different between the reintubated and non-reintubated patients. Ten (83.3%) reintubated patients and 6 (60.0%) non-reintubated patients in this group had primary respiratory causes for MV, and this difference was not significant (p=0.348). PaO2

Figure 1. Figure 1: ROC curve for PaO2/FiO2 in predicting the reintubation of HFNOT patients



ROC analysis was used for diagnostic valuation.

and SaO2 values measured under spontaneous respiration immediately after extubation were lower ($p<0.001$) in patients who needed reintubation, while PH and PaCO2 levels were within normal limits and with no significant difference (p=0,723, p=0,080). The mean PaO2/FiO2 was lower for reintubated patients (156.7±33.1), than non-reintubated patients (278.1±60.8) ($p<0.001$). The mortality rate was higher, with 75% mortality in reintubated patients ($p<0.001$). Of the reintubated patients, 2 were discharged without the need for a tracheotomy, while 1 patient was discharged with a tracheotomy.

Reintubated patients in the HFNOT and Mask groups were not different in terms of age, sex, GCS, APACHE II, SAPS II scores, cause of MV, MT time, or days free of MV. NIMV requirements were more frequent in the mask group. Mortality rates were not significantly different between two groups (Table 4).

A cut-off of PaO2/FiO2 ≤107 for reintubation was significant in the HFNOT group with AUC = 0.729 and p=0.015. For this cut-off, the sensitivity was 50%, and the specificity was 93.33% (Figure 1).

DISCUSSION

Since its introduction to our clinic, HFNOT has been increasingly used in to avoid reintubation of geriatric patients. Considering this growing interest in HFNOT in our clinic, we intended to guide our practice through our retrospective evaluation of patient data. We aimed to evaluate the effects of HFNOT on the weaning process and reintubation requirement of geriatric patients mechanically ventilated in our ICU. NIMV requirement was more frequent in the mask group than in the HFNOT group, which emphasizes HFNOT as a decent alternative to NIMV with its disadvantages (facial pressure, patient discomfort, hindrance to oral feeding). The reintubated patients in the HFNOT group had primary respiratory causes and lower PaO2/FiO2 ratios, which signify the need to better standardize the indications for HFNOT and

increase its appropriate use.

Lower reintubation rates in ICU patients who received HFNOT compared to standard oxygen support via face masks have been reported (7,14,15,16). Maggiore et al. showed that patients on HFNOT within the first 48 hours after extubation had lower rates of desaturation and reintubation (3.8%) in their study on ICU patients with PaO2/FiO2 of 200-300 (14). Hernández et al. studied patients under 65 years old with planned extubation and found a lower rate of reintubation (4.9%) among patients receiving HFNOT within 72 hours of extubation (15). In both studies, reintubation rates were lower than in our study. The two studies have accepted PaO2/FiO2 < 300 for HFNOT initiation, while in our study the accepted rate was <150 which explains our higher reintubation rate. Also, our patients were all in the geriatric age group and were high risk patients, which may have resulted in a higher rate of reintubation. Fernandez et al. reported better results with HFNOT than standard oxygen therapy in patients with high risk for post-extubation respiratory failure, with 11% of HFNOT patients requiring reintubation (16). In contrast to these studies, Futier et al. reported no benefit of prophylactic HFNOT over standard oxygen therapy for abdominal surgery patients with regard to long-term (>7 days) hypoxia or pulmonary complications in the postoperative period (17).

In both groups, some patients required intermittent NIMV to increase oxygenation. The NIMV requirement was not different between the groups. When only reintubated patients in the two groups were compared, we observed a higher rate of NIMV use in the Mask group. Hernández et al. reported similar rates of respiratory failure and reintubation when HFNOT alone was compared against intermittent NIMV in addition to oxygen support with a face mask (12).

HFNOT is beneficial in reducing intubation for acute respiratory failure or reintubation after extubation; however, it can cause a delay in the decision to intubate, thereby increasing mortality (18). In our study, nearly all our patients had primary respiratory causes for MV. In the HFNOT group, the last arterial blood gas results under spontaneous respiration yielded a base PaO2/FiO2 mean of 119.7±18.4.

In light of patients who do not require reintubation after HFNOT despite low PaO2/FiO2 values, we postulated that HFNOT is beneficial in preventing reintubation for patients with critical status. The PaO2/FiO2 cut-off we determined for reintubation in HFNOT patients was 107. Therefore, we believe that close monitoring of patients is crucial in not delaying the decision to intubate. We have taken the resulting PaO2/FiO2 cut-off of 107 into account when initiating HFNOT for geriatric patients in our clinic and accept a threshold up to 20% above this value when necessary, depending on the clinical findings associated with our patients.

Kang et al. found lower rates of successful weaning and extubation, more days on MV, and increased mortality (66.7%) in patients who were reintubated after longer than 48 hours of HFNOT (mean PaO2/FiO2=165.6) than in patients reintubated after shorter HFNOT durations (19). Ni et al observed fewer intubations with HFNOT compared to oxygen via face mask in patients with acute respiratory failure, with no difference in ICU length of stay or mortality (20). Brotfain et al. noted better oxygenation and fewer reintubations with HFNOT after extubation than with oxygen via face mask, without a difference in ICU length of stay or mortality (21). In our study, mortality was 38.7% in the HFNOT group and 40.9% in the Mask group, with no significant difference. Reintubation was associated with higher mortality in both groups.

Our study is retrospectively designed, however, we believe that HFNOT is significant in the intensive care setting, especially for geriatric patients. To reduce the rate of reintubation after weaning, HFNOT can be beneficial in clinical practice with close patient monitoring and selecting for patients

with appropriate PaO2/FiO2 ratios. Prospective studies that group patients according to their PaO2/FiO2 ratios can guide future practice. Our study has certain limitations. In addition to blood gas results, patients were evaluated for their respiratory patterns when assessing respiratory failure after extubation and making a decision regarding reintubation. However, this assessment was not recorded in a standard, numerical fashion and was not included in our statistical analysis. Future prospective studies on this topic can benefit from the standardized recording of respiratory parameters. Serial blood gas results are more important than a single result. We could not obtain serial results due to the retrospective nature of our study. Another limitation is the limited number of included patients. While a large number of patients received HFNOT in our ICU, only the specific group of geriatric patients was included in our study, limiting our patient size.

We conclude that, geriatric patients with post-extubation respiratory failure after the weaning process can benefit from HFNOT. In clinical practice, with appropriate patient selection, reintubation rates and noninvasive mechanical ventilation requirements can be reduced.

Conflict of Interest

The authors declare that there is no conflict of interest regarding this article.

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