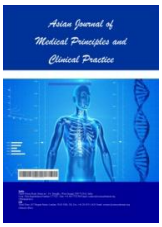

Asian Journal of Medical Principles and Clinical Practice

4(1): 28-33, 2021; Article no.AJMPCP.64150

High Flow Oxygen Therapy. Application in an Adult Intensive Care Unit

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Authors' contributions

This work was carried out in collaboration among all authors. Author CF conception of the study, data collection, interpretation of results and final approval of the version presented. Author GS study design, data analysis and draft the article. Author CG data collection and critical review of intellectual content. Author LP interpretation of results and critical review of intellectual content. Author LF critical review of the intellectual content and final approval of the version presented. All authors read and approved the final manuscript.

Article Information

Editor(s):
(1) Dr. Viduranga Y. Waisundara, Rajarata University of Sri Lanka, Sri Lanka.
Reviewers:
(1) Rohmah Ninda Arofah, University of Muhammadiyah Surakarta, Indonesia.
(2) Hagiu Bogdan-Alexandru, Alexandru Ioan Cuza University, Romania.
Complete Peer review History: http://www.sdiarticle4.com/review-history/64150

Original Research Article

Received 01 November 2020
Accepted 06 January 2021
Published 27 January 2021

ABSTRACT

Introduction: The main objective of supplemental oxygen supply is to reverse hypoxemia, as well as to treat and prevent its symptoms and complications, however, it is necessary that oxygen therapy is complemented with additional strategies, since low oxygen availability to the tissues can have different etiologies, since this does not depend solely on the supplementary supply of oxygen, it also depends on ventilation, the concentration and saturation of hemoglobin and cardiac output.
Objective: To analyze the incidence of the use of high-flow oxygen therapy (HFOT) in intensive care and assess the procedure.
Methodology: A prospective observational study was carried out in which patients with moderate respiratory failure, cardiac surgeries, pneumonia with high oxygen needs admitted to the intensive care unit (ICU) of a private medical center in the city of Asunción during the months of January to November 2018 who received treatment with high-flow oxygen therapy.

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Results: A total of 32 cases were obtained, of which 50% were men, with a mean age of 75 ± 11 years. The incidence of HFOT was 0.95%. The indication for HFOT was: 47% moderate respiratory failure or need for oxygen supply. In meeting the HFOT objectives, oxygen therapy was improved in 91.7%.
Conclusions: There is a low incidence of the use of HFOT in the unit. Although most patients have improved with oxygen therapy, intubation could not be avoided in them.

Keywords: Hypoxemia; TAFO; epidemiology; adults patients.

1. INTRODUCTION

Oxygen is considered a drug since it has precise indications, must be used in appropriate doses and times, has adverse effects and requires clinical and laboratory criteria for its preparation [1] that is why its use in medicine should be prescribed based on a valid reason and administered correctly and safely.

Oxygen therapy is the administration of oxygen (O_2) for therapeutic purposes, in concentrations higher than that existing in the ambient gas mixture [1].

The main objective of supplemental oxygen supply is to reverse hypoxemia, as well as to treat and prevent symptoms (increased cardiorespiratory work, irritability and depression of the Central Nervous System (CNS), cyanosis) and its complications (hypoxia, metabolic acidosis, etc.), however, it is necessary that oxygen therapy be complemented with additional strategies, since a low availability of oxygen to the tissues can have different etiologies, since this does not depend solely on the supplementary supply of oxygen, it also depends on the ventilation, hemoglobin concentration and saturation, and cardiac output [2].

The choice of the type of device to be used in oxygen therapy will depend on the needs of the patient and the availability in relation to flow and concentration, as well as adaptation and comfort, in order to alleviate hypoxemia. Usually, nasal cannulas and inhalation masks are used, which provide a limited flow of oxygen and are usually not heated and do not reach adequate humidity [3].

In high-flow oxygen therapy, oxygen flow is provided alone or mixed with air, above the maximum inspiratory flow of the patient, through a nasal cannula, this serves to maintain adequate patient oxygenation levels and avoid tissue hypoxia . This is achieved when the partial pressure of O_2 in arterial blood reaches values higher than 60 mmHg, which corresponds to a hemoglobin saturation of 90%, approximately [1].

Recently it has been incorporated, an alternative that would solve these limitations of conventional oxygen therapy is the use of devices that provide oxygen at high flow. High flow oxygen therapies (HFOT) seek to exceed the inspiratory flow demand of patients, while minimizing or preventing air dilution [2], based on the above, the aim of this research was to analyze the use of oxygen therapy high-flow (HFOT) in intensive care in adult patients.

2. MATERIALS AND METHODS

A prospective observational non probabilistic study was carried out in which all patients with moderate respiratory failure, cardiac surgeries, pneumonia with oxygen needs admitted to the intensive care unit during the months of January to November 2018 who received treatment with high-flow oxygen therapy were included.

All patients were consecutively included, without ruling out anyone, who were admitted to the ICU with pneumonia, postoperative, sepsis, among others. Were considering only one hospitalization per patient, none had two admissions to the ICU.

Pneumonia was diagnosed according to the guidelines of the Infectious Diseases Society of America / American Thoracic Society 2007 [4]. Exclusion criteria were age under 18 years, indication for immediate mechanical ventilation on admission, and lack of commitment to full life support.

Patients electively intubated for diagnostic or therapeutic procedures (fiberoptic bronchoscopy and surgery) were also not included. The patients were followed up to death or discharge from hospital.

Demographic variables and severity scores were recorded at the time of inclusion.

The High Flow Nasal Cannula Device (Aquaven System, Heated Humidified MR850 RT202 Delivery Tube and RT050 / 051 Nasal Cannula; Fisher and Paykel Healthcare, Ltd) consists of a low resistance nasal cannula that can deliver up to 60 L / min of air conditioning (37 °C and 100% relative humidity) gas mixture. It was started with a minimum flow of 30 l / min with a FIO_2 of 1. Then, the FIO_2 was adjusted to maintain a pulse oximetry (SpO_2) greater than 92%, and the flow rate was established according to the criteria.

The parameters used to assess the level of respiratory support provided were FIO_2 and the total flow administered, adjusted to the needs of the individual patient.

The parameters used to assess respiratory failure were respiratory rate (RR), SpO_2 / FIO_2 ratio, and arterial carbon dioxide ($PaCO_2$).

The criteria for intubation and mechanical ventilation [5] were decreased level of consciousness (Glasgow Coma Scale score, b12), cardiac arrest / arrhythmias and severe hemodynamic instability (norepinephrine N0.1 µg / kg per minute) or persistent or respiratory deterioration Condition defined as at least 2 of the following criteria: failure to achieve correct oxygenation (PaO_2 b60 mm Hg despite HFOT flow ≥30 L / min and FIO2 of 1), respiratory acidosis ($PaCO_2$ N50 mm Hg with pH b7. 25), RR greater than 30 beats per minute, or inability to clear secretions.

The Rox index that predicts the need for mechanical ventilation was calculated from the measured respiratory variables that assessed respiratory failure, which differed significantly between the groups (success versus failure). Their objective was to obtain an additive effect, increasing their ability to discriminate between patients who would succeed in High Flow Nasal Cannula (HFNC) and those who would fail.

Variables with a positive association with HFNC success, such as oxygenation, evaluated by the SpO_2 / FIO_2 ratio, were placed in the numerator. In contrast, RR was placed in the denominator as it has an inverse association with the success of HFNC. We use the name ROX (Respiratory rate Oxygenation) for the index, as the ratio of SpO_2 / FIO_2 to RR6.

3. RESULTS

Thirty-two patients who were administered oxygen through the high-flow Aquaven circuit (Armstrong) with nasal cannulas, 16 women (50%), aged between 49 to 94 years (75 ± 11 years), were studied. Table 1 lists the characteristics of the patients and previous treatment.

The average days of hospitalization was 5 ± 2 days, all patients were discharged in good condition, no deaths were recorded.

The mean values and standard deviation of the analyzed variables are described in Table 2.

The observed parameters reveal an average flow of around 50 L / m, in patients frequent use is 30 to 40 L / m, the average respiratory rate is above normal values, as is the heart rate.

Among the admission diagnoses, pneumonia and respiratory diseases predominated (Fig. 1).

The initial FiO2 was 0.25 in all cases.

When reviewing the correlation between PaO_2 / FiO_2 and SO_2 / FiO_2, it was found that the use of a mechanical ventilator has a moderate correlation with r = 0.92 *P* = 0.001 (Table 3)

When analyzing the Rox index in relation to the respiratory rate, as expected, as the respiratory rate increases, the Rox index value is lower in patients admitted to the ICU (Fig. 2).

Table 1. Demographic characteristics of patients with high-flow oxygen therapy in an adult Intensive Care Unit (N = 32)

Demographic characteristics	N=32	%
Age (X + SD)	75 + 11	
49 a 59 years	4	12.5
60 a 69 years	6	18.7
70 a 79 years	6	18.7
> 80 years	14	43.7
Sex		
Feminine	16	50
Masculine	16	50

Table 2. Mean respiratory parameters at the time of measurement of the ROX index in patients with high-flow oxygen therapy in an adult Intensive Care Unit. (N = 32)

Respiratory parameters	Mean ± SD
Flow L / m	48.75 ± 9.4
FiO2 (%)	0.45 ± 0.17
Breathing frequency	24 ± 5
Heart rate	88 ± 16
Saturation O_2	70 ± 30
Rox index	8.3 ± 2.9

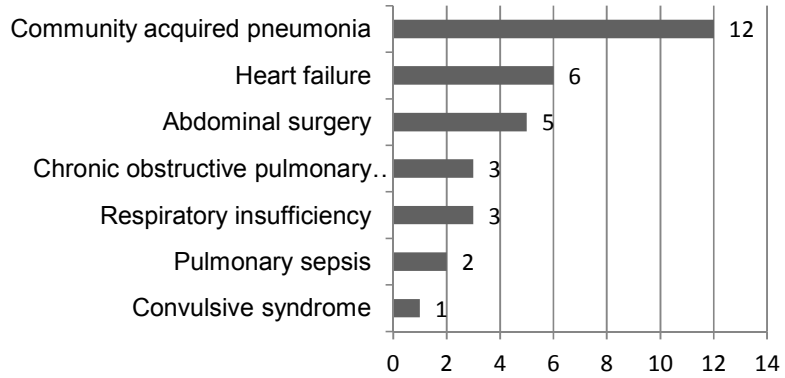

Fig. 1. ICU admission diagnoses in patients with high-flow oxygen therapy in an adult Intensive Care Unit. (N= 32)

Table 3. Relationship between the use of oxygen and FiO2 in patients with high-flow oxygen therapy in an adult Intensive Care Unit (N = 32)

	Mean	SD	r	*P*
PaO_2/FiO_2	180.70	92.11	0.92	0.001
SO_2/FiO_2	225.62	64.03		

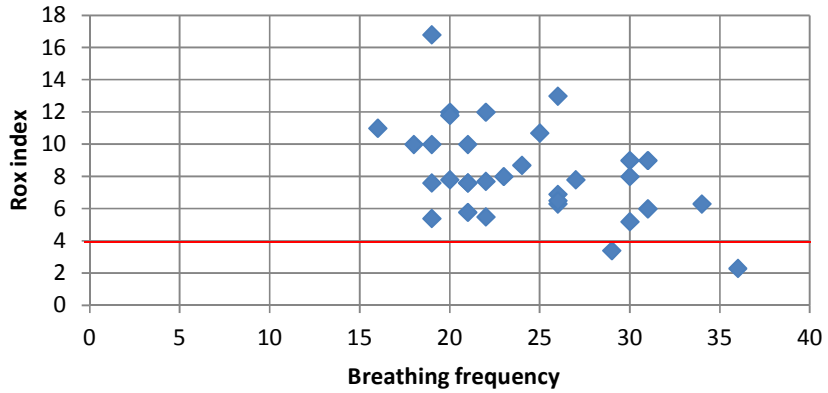

Fig. 2. Rox index in relation to the respiratory rate of patients in an intensive care unit (N = 32)

4. DISCUSSION

A high percentage of patients admitted to the Intensive Care Unit require oxygen therapy as therapeutic support. Oxygen therapy continues to be a first-line therapy in the management of these patients, high-flow oxygen therapy has been described as a useful alternative to conventional oxygen therapy in patients with acute respiratory failure.

It is common to find patients who, after being stabilized, maintain a degree of dyspnea and hypoxemia that does not improve with conventional oxygenation systems and is not attributable to a worsening of their functional level or lack of medical treatment. The application of the high-flow system was effective in all patients.

There is little experience in the use of adult high-flow therapy. Roca et al [5] published in 2010 a study that compares the comfort and degree of efficacy of a HFOT system versus the conventional Venturi mask in the treatment of 20 patients with ARF of different etiology in an intensive care unit, and obtained significant positive results in favor of the HFOT system with few side effects. The data agree with those of our patients.

The good respiratory parameters obtained with this system are mainly due to two causes; First, HFOT systems provide a more constant FiO_2 and, second, the use of nasal cannulas as an interface reduces dead space and generates a constant positive pressure directly proportional to the flow used and the resistance created on expiration that contributes to increasing the oxygenation [6].

Sztrymf et al. In a study carried out, considered that SO_2 / FiO_2 can be an adequate substitute for PaO_2 / FiO_2, as an automated tool for screening for acute respiratory distress syndrome, therefore, the SO_2 / FiO_2 index can be used in place of the PaO_2 / FiO_2 index for the early detection of pulmonary dysfunction with a non-invasive monitoring method [7]

In our series, pneumonia was the most frequent cause of hospitalization and use of HFOT. Acute respiratory failure is a frequent reason for admission to Intensive Care Units, in which 55% of patients admitted in some series even require ventilatory support. High-flow oxygen therapy improves the ventilatory pattern, decreases the respiratory and heart rate, and the oxygen needs (O_2), increases O_2 saturation and arterial oxygen pressure (PaO_2), without influencing CO_2 and pH10 values [8].

A study carried out by Demoule et al. [9] collected data from 70 French ICUs and showed a gradual increase in their use, with significant differences.

It is possible that high-flow oxygen therapy, by itself, reduces mortality, as has been described in the literature; in our series we have not recorded any deaths [10,11].

It is important to highlight the directly proportional correlation between SO_2 / FiO_2 and PaO_2 / FiO_2, found in our study, results similar to those found by Rice et al, although this study was carried out for the diagnosis and follow-up of patients with ALI and ARDS.

The study has the limitation of being retrospective observational. Furthermore, only patients using high-flow oxygen therapy have been studied, without comparing them with a control group. On the other hand, it has the advantage of having a large sample size and being consistent with the published bibliography [7].

5. CONCLUSION

The use of high-flow oxygen therapy (OAF) in intensive care is a growing procedure. The patients admitted to ICU-A are older adults with a similar sex distribution with frequent respiratory disorders.

The SO_2 / FiO_2 index can be used as an alternative for monitoring non-invasive ventilatory function, since it is a cheap technique and there are portable devices that are very manageable versus arterial blood gas, which is a bloody and invasive technique that produces pain and nervousness during extraction, leading to hyperventilation, which can lead to overestimation of oxygenation.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for

any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT AND ETHICAL APPROVAL

The research has received an ethical clearance from the Tropical Medicine Institute in Asuncion – Paraguay number: 032/ 2019. As per international standard or university standard, patient's written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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