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Clinical Outcomes of High-Flow Nasal Oxygen Therapy in Acute Respiratory Failure in the Emergency Setting.

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ABSTRACT

Background: The Emergency Department (ED) Now Uses High-Flow Nasal Oxygen (HFNO) Treatment as an Advanced Approach to Treating Patients Experiencing Acute Respiratory Failure. HFNO Provides Warm Humidified Oxygen Through Nasal Channels with High Flow Rates Which Builds Oxygenation While Decreasing Respiratory Work and Providing Better Comfort to The Patient.

Objectives: To determine both the effectiveness and various clinical outcomes achieved through high-flow nasal oxygen therapy when treating patients with acute respiratory failure in emergency departments.

Methods: Adults aged ≥18 years who received high-flow nasal oxygen (HFNO) for acute respiratory failure were eligible. Investigators abstracted demographics, baseline clinical measures (vital signs, arterial blood gas, SpO_2/FiO_2), HFNO settings, and clinical response, and recorded outcomes of endotracheal intubation, ICU admission, and in-hospital mortality.

Results: Among 100 patients, the mean (SD) age was 64.7 (13.2) years, and 58% were male (n=58). Pneumonia was the leading etiology of acute respiratory failure (34%), followed by COPD exacerbation (22%) and pulmonary edema (19%). Within 2 hours of HFNO initiation, oxygenation and respiratory rate improved (SpO_2 85.2% ± 5.4 to 94.7% ± 3.8; $p<0.001$). During hospitalization, 18.2% required endotracheal intubation and 36.5% were admitted to the ICU; overall in-hospital mortality was 12.8%.

Conclusion: High-flow nasal oxygen therapy is a safe and effective treatment modality for acute respiratory failure in the emergency department to treat acute respiratory failure inside emergency departments. Hospital patients receive better oxygenation through this therapy while clinicians need less invasive ventilation and may reduce the need for escalation to intensive care in selected patients. Better clinical results accompany rapid patient reactions to HFNO therapy.

Keywords: High-Flow Nasal Oxygen, Acute Respiratory Failure, Emergency Department, Clinical Outcomes

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INTRODUCTION

The emergency department (ED) frequently manages acute respiratory failure (ARF), a life-threatening condition that requires rapid recognition and timely initiation of oxygen therapy to stabilize patients and prevent progression to respiratory arrest or the need for invasive mechanical ventilation [1]. ARF is associated with high morbidity and mortality, particularly when there is a delay in appropriate respiratory support. Conventional oxygen delivery systems, including nasal cannulas and non-rebreather masks, are commonly used as first-line therapies; however, they often prove inadequate in patients with moderate-to-severe hypoxemia due to limited oxygen flow rates, inconsistent FiO_2 delivery, and insufficient humidification [2].High-flow nasal oxygen (HFNO) therapy has emerged as an effective alternative for managing ARF. It delivers heated and humidified oxygen at high flow rates of up to 60 L/min, allowing for better oxygen delivery and improved patient tolerance [3]. The physiological benefits of HFNO include improved oxygenation, reduction in anatomical dead space, and generation of a low level of positive airway pressure, which together contribute to decreased work of breathing [4]. Additionally, HFNO enhances mucociliary clearance and maintains airway hydration, which further supports respiratory function.Multiple clinical studies have demonstrated that HFNO improves gas exchange and reduces the need for endotracheal intubation in patients with both hypoxemic and hypercapnic respiratory failure [5]. It has also been associated with improved patient comfort compared to conventional oxygen therapy and non-invasive ventilation, leading to better compliance and tolerance [6]. Furthermore, HFNO facilitates carbon dioxide washout from the upper airway, thereby contributing to improved ventilatory efficiency.Despite these advantages, most of the existing literature evaluating HFNO has been conducted in intensive care units (ICUs) or inpatient settings. There remains a paucity of real-world data assessing its early initiation and effectiveness in the ED environment, where clinical decisions must often be made rapidly and resources may be limited [7]. The ED presents unique challenges, including high patient turnover, time constraints, and variability in disease severity, making it essential to evaluate interventions that are both effective and easy to implement. Given these considerations, HFNO represents a promising frontline therapy for ARF in emergency settings. Early application of HFNO may improve oxygenation, reduce the need for invasive ventilation, and potentially decrease ICU admissions [8]. Identifying patient characteristics and early clinical indicators associated with HFNO success or failure is crucial to guide timely escalation of care and optimize patient outcomes [9].This study aims to evaluate the clinical outcomes associated with the use of HFNO therapy in the ED among patients presenting with ARF. Specifically, we assess its impact on oxygenation parameters, respiratory rate, intubation rates, ICU admission, and in-hospital mortality, thereby contributing to the growing evidence base for HFNO use in emergency medicine [10].

MATERIALS AND METHODS

This retrospective study was conducted at Department of Diabetes, Endocrinology & Metabolic diseases, Hayat Abad Medical Complex, Peshawar, Pakistan from January 2023 to January 2024.Adult patients receiving HFNO therapy for managing acute respiratory failure formed the study sample in the emergency department. Patients received treatment through an HFNO system which delivered heated humidity and adjusted both airflow up to 60 L/min and FiO_2 levels to maintain Spo_2 above 92%. The investigators obtained demographic and clinical data through a review of the electronic medical record system. The institutional review board provided its ethical approval before the studiers extracted data for the study.

INCLUSION CRITERIA

Adult patients aged ≥18 years who received high-flow nasal oxygen (HFNO) therapy for acute respiratory failure (ARF) as the primary diagnosis in the emergency department were included in the study.

EXCLUSION CRITERIA

Patients with do-not-intubate (DNI) orders, those requiring immediate invasive mechanical ventilation at presentation, and patients with incomplete clinical records were excluded.

ETHICAL APPROVAL STATEMENT

Ethical approval was obtained from the Hospital Ethics Committee and the Postgraduate Studies Committee, Hayatabad Medical Complex.Written informed consent was obtained from all participants. All procedures were conducted in accordance with the Declaration of Helsinki. Patient confidentiality was strictly maintained, and all data were de-identified prior to analysis.

DATA COLLECTION

Data were collected from the hospital's electronic health

record system. Variables included demographic characteristics, primary diagnosis, comorbidities, baseline vital signs, arterial blood gas (ABG) parameters, and HFNO settings. Clinical outcomes such as duration of stay in the emergency department, need for endotracheal intubation, intensive care unit (ICU) admission, and in-hospital mortality were also recorded.

STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS version 24.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize baseline characteristics. Continuous variables were analyzed using the independent samples t-test, while categorical variables were compared using the chi-square test. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 100 patients were included in the study, with a mean age of 64.7 ± 13.2 years; 58% were male. The most common causes of acute respiratory failure were pneumonia (34%), chronic obstructive pulmonary disease (22%), and cardiogenic pulmonary edema (19%).Following initiation of HFNO therapy, significant clinical improvement was observed. The mean respiratory rate decreased from 28.6 ± 6.1 to 22.3 ± 4.9 breaths per minute ($p < 0.001$), while oxygen saturation improved from 85.2% ± 5.4% to 94.7% ± 3.8% within the first two hours ($p < 0.001$).Endotracheal intubation was required in 18.2% of patients, and 36.5% required ICU admission. The mean duration of stay in the emergency department was 6.2 ± 3.4 hours. The overall in-hospital mortality rate was 12.8%.Patients who demonstrated early improvement in oxygen saturation had significantly lower rates of intubation and ICU admission. No significant differences in outcomes were observed based on gender or across different age groups.

Figure 1: Etiology of Acute Respiratory Failure Among Study Participants

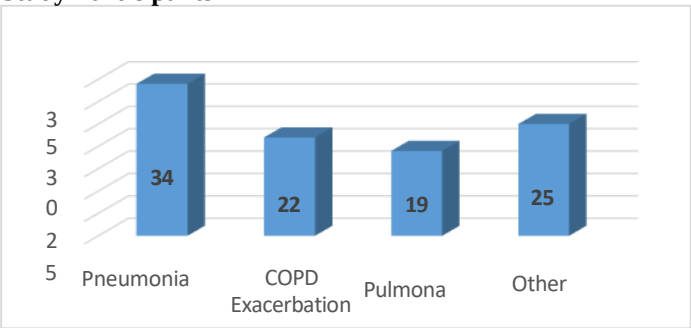

Figure 1 illustrating the distribution of underlying causes of acute respiratory failure in the study population. Pneumonia was the most common etiology, followed by chronic obstructive pulmonary disease (COPD), cardiogenic pulmonary edema, and other causes. The values represent the number (or percentage) of patients in each category.

Table 1. Baseline Characteristics of Patients (n = 100)

Total Patients	**100**
Mean Age (years)	**64.7 ± 13.2**
Male	**58(58%)**
Female	**42(42%)**

Table 2. Etiology of Acute Respiratory Failure

Pneumonia	**34%**
COPD Exacerbation	**22%**
Pulmonary Edema	**19%**
Others	**25%**

Table 3. Clinical Outcomes of HFNO Therapy

Intubation	**18.2%**
ICU Admission	**36.5%**
In-Hospital Mortality	**12.8%**

DISCUSSION

This study demonstrates that high-flow nasal oxygen (HFNO) therapy is an effective intervention for patients presenting with acute respiratory failure (ARF) in the emergency department (ED), leading to significant improvements in oxygenation and respiratory parameters while reducing the need for invasive ventilation [11,12]. The observed early improvements in oxygen saturation and respiratory rate within the first two hours are consistent with previous studies highlighting the physiological benefits of HFNO in enhancing gas exchange and reducing work of breathing [13].The intubation rate of 18.2% in our cohort is comparable to findings reported in previous studies. For example, Jean-Pierre Frat et al. demonstrated lower intubation rates with HFNO compared to conventional oxygen therapy and non-invasive ventilation in patients with ARF [14]. Although most studies have been conducted in ICU settings, our findings confirm that similar benefits can be achieved in the ED, supporting HFNO as a frontline therapy across

different clinical environments [11]. The in-hospital mortality rate of 12.8% observed in our study is relatively favorable and may reflect early intervention and close monitoring in the ED setting [15,16]. Previous studies, including those by Katsunori Nagata et al., have also demonstrated improved patient outcomes and better tolerance with HFNO compared to non-invasive ventilation [17,18,19].HFNO was well tolerated across a wide range of ARF etiologies, including both hypoxemic and hypercapnia respiratory failure. Studies by Jean-Damien Ricard et al. have shown improved secretion clearance, enhanced comfort, and better tolerance with HFNO compared to conventional oxygen therapy [20]. The increased use of HFNO during the COVID-19 pandemic further supports its safety and effectiveness when appropriate infection control measures are applied [21]. Additionally, studies by Gonzalo Hernández et al. demonstrated that HFNO reduces reintubation rates in critically ill patients, highlighting its role in preventing respiratory deterioration [22,23].These findings align with our results and reinforce the potential of HFNO as a non-invasive strategy to reduce disease progression.However, this study has limitations. It was conducted as a retrospective analysis in a single center, which may limit generalizability. Larger, multicenter prospective studies are needed to validate these findings and to identify predictors of HFNO success in the ED setting.

LIMITATIONS

This study is limited by its retrospective design, single-center setting, and relatively small sample size. Potential confounding factors and missing data may have influenced outcomes. Additionally, the absence of a control group limits direct comparison with other oxygen delivery modalities

CONCLUSION

HFNO therapy is an effective and safe modality for managing acute respiratory failure in the emergency department. It significantly improves oxygenation, reduces respiratory distress, and may decrease the need for invasive mechanical ventilation. HFNO should be considered a first-line non-invasive respiratory support strategy in acute care settings.

FUTURE DIRECTIONS

Future multicenter prospective studies are required to identify predictors of HFNO success in emergency settings. Comparative trials with other non-invasive modalities and integration of predictive models may further optimize individualized respiratory care.

AUTHORS' CONTRIBUTION

Concept & Design: Ziaullah Khan

Data Collection: Aftab Khattak

Data Analysis: Khalid Usman

Critical Review: Khalid Usman

Final Approval: All authors

CONFLICT OF INTEREST: Not applicable.

FUNDING DISCLOSURE: No external funding was received for this study.

ETHICAL STATEMENT

Ref.No.812/ HEC/B&PSC/04/2022.

AI USAGE STATEMENT

AI tools (**e.g., ChatGPT**) were used for language editing and structuring of the manuscript. The authors take full responsibility for the content and accuracy of the manuscript.

COPYRIGHT STATEMENT

DATA AVAILABILITY STATEMENT

All data generated or analyzed during this study are available from the corresponding author upon reasonable request.

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