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EFFECTIVENESS OF NON-INVASIVE VENTILATION IN PATIENTS WITH ACUTE RESPIRATORY FAILURE ADMITTED IN INTENSIVE CARE UNIT; A CROSS SECTIONAL STUDY

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Abstract

Background: *Acute respiratory failure (ARF) is a critical condition requiring timely intervention. Non-invasive ventilation (NIV) has gained prominence as a treatment modality, reducing the need for invasive mechanical ventilation and improving clinical outcomes.*

Objective: *To evaluate the effectiveness of non-invasive ventilation in improving oxygenation and ventilation in patients with acute respiratory failure (ARF).*

Methods: *This analytical cross-sectional study was conducted at the ICU of Integrated Medical Care Hospital over four months. A total of 140 patients aged 20-90 years, diagnosed with either Type I or Type II respiratory failure, requiring NIV assistance, were included. Patients with severe neurological impairment, facial trauma, or progressive neuromuscular diseases were excluded. Arterial blood gas (ABG) analysis, respiratory rate, and NIV success rates were assessed. Data were analyzed using SPSS 22.0.*

Results: *The study included 140 patients (52.14% males, 47.86% females) with a mean age of 64.78 ± 8.98 years. COPD was the most prevalent diagnosis (49.3%), followed by pneumonia (21.4%), ARDS (15.7%), and acute cardiogenic pulmonary edema (13.6%). NIV was successful in 77.14% of cases, with a 40% overall mortality rate. Intubation was required in 25% of cases. NIV resulted in statistically significant improvements in respiratory rate, PaO2, pH, and PCO_2 ($p < 0.05$).*

Conclusion: *This study concluded that, NIV demonstrated significant efficacy in improving oxygenation, ventilation, and acid-base balance in ARF patients, reducing the need for invasive mechanical ventilation. The findings underscore its role as a preferred intervention in critically ill patients.*

INTRODUCTION

Acute respiratory failure (ARF) is a life-threatening condition that results in the failure of the respiratory system to maintain adequate gas exchange, leading to severe hypoxemia or hypercapnia (1). It remains one

of the leading causes of ICU admissions worldwide and is associated with significant morbidity and mortality. Patients with ARF often experience severe dyspnea, tachypnea, and respiratory distress, necessitating immediate medical intervention (2).

The underlying causes of ARF are diverse and include respiratory infections such as pneumonia, chronic obstructive pulmonary disease (COPD), acute respiratory distress syndrome (ARDS), and acute cardiogenic pulmonary edema (3). Other contributing factors include neurological disorders, trauma, metabolic imbalances, and systemic infections. These conditions compromise the lungs' ability to facilitate oxygen transport and carbon dioxide elimination, leading to life-threatening complications (4).

Traditionally, invasive mechanical ventilation (IMV) has been the standard of care for ARF patients requiring ventilatory support. However, IMV is associated with a high risk of complications, including ventilator-associated pneumonia, barotrauma, and airway injuries (5). In contrast, non-invasive ventilation (NIV) has emerged as a preferred alternative, offering effective respiratory support without the need for endotracheal intubation. NIV is delivered via a nasal or facial mask and works by providing continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BiPAP), thereby improving oxygenation and ventilation (6).

This study aims to evaluate the effectiveness of NIV in patients with ARF admitted to the ICU by analyzing clinical outcomes such as respiratory rate, arterial blood gas (ABG) parameters, NIV success rate, and mortality rate. Understanding the impact of NIV on these parameters will help optimize its use in clinical practice.

Methods

This analytical cross-sectional study was conducted at the ICU of Integrated Medical Care Hospital, DHA Phase 5, Lahore, over four months. A total of 140 patients with ARF were enrolled using a non-probability convenient sampling technique. Inclusion criteria included patients aged 20-90 years diagnosed with Type I or Type II respiratory failure who required NIV assistance. Exclusion criteria included patients with severe neurological impairment (GCS < 8), facial trauma, progressive neuromuscular disease, or those requiring immediate intubation. Ethical approval for the study was obtained from the Institutional Review Board of The Superior University. Written informed consent was obtained from all participants or their legal representatives before enrollment. Clinical data, including demographic characteristics, disease etiology, duration of NIV, and ICU stay, were recorded. Arterial blood gas (ABG) values, respiratory rate, and oxygen saturation were measured before and after NIV initiation. NIV success was defined as improvement in oxygenation, avoidance of intubation, and clinical stability. NIV failure was defined as the need for intubation due to worsening respiratory status.

Statistical analysis was performed using IBM SPSS 22.0. Descriptive statistics were presented as mean ± standard deviation for continuous variables and as frequencies and percentages for categorical variables. Independent t-tests and chi-square tests were used to compare pre- and post-NIV parameters. A p-value of <0.05 was considered statistically significant.

Results

The study included 140 patients, with a mean age of 64.78 ± 8.98 years. Gender distribution was nearly equal, with 52.14% males and 47.86% females. The most common diagnosis was COPD (49.3%), followed by pneumonia (21.4%), ARDS (15.7%), and acute cardiogenic pulmonary edema (13.6%).

Table 1: Demographics of patients

Variable	Mean±SD
Mean ±Age (years)	64.78 ± 8.98
Gender Distribution	52.14% Male, 47.86% Female
COPD	49.3%
Pneumonia	21.4%

ARDS	15.7%
Acute Cardiogenic Pulmonary Edema	13.6%

NIV was successful in 77.14% of cases, while 25% of patients required intubation due to respiratory deterioration. The highest NIV success rate was observed in COPD patients (60 out of 69 cases), while ARDS patients exhibited the highest failure rate (10 out of 32 cases, p = 0.01).

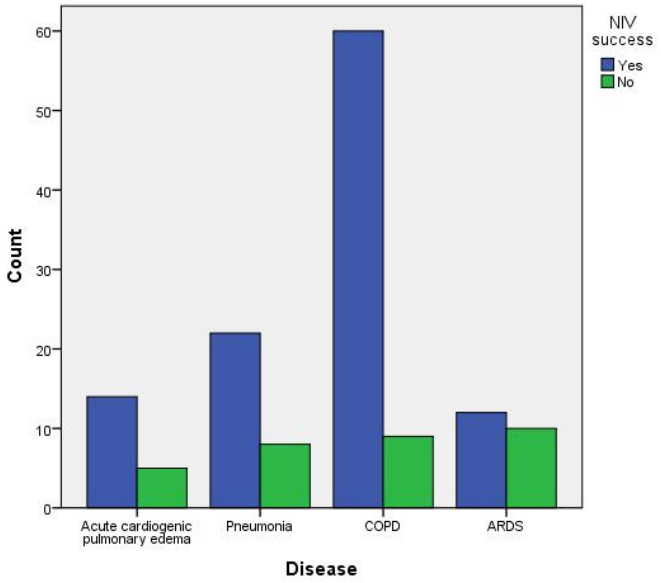

Figure 1: NIV success and disease of patients

Physiological improvements were statistically significant. Respiratory rate decreased from 30.79 ± 5.35 to 24.19 ± 5.45 breaths/min ($p < 0.05$), while PaO2 increased from 64.75 ± 18.84 to 72.52 ± 18.57 mmHg ($p < 0.05$). Similarly, pH improved from 7.2185 ± 0.141 to 7.3474 ± 0.170 ($p < 0.05$), and PCO2 decreased from 65.10 ± 16.51 to 47.00 ± 8.90 mmHg ($p < 0.05$). Blood pressure remained stable throughout the study.

Table 1: Physiological Improvements with NIV

Parameter	Pre-NIV Mean ± SD	Post-NIV Mean ± SD	p-value
Respiratory Rate (breaths/min)	30.79 ± 5.35	24.19 ± 5.45	< 0.05
PaO2 (mmHg)	64.75 ± 18.84	72.52 ± 18.57	< 0.05
pH	7.2185 ± 0.141	7.3474 ± 0.170	< 0.05
PCO2 (mmHg)	65.10 ± 16.51	47.00 ± 8.90	< 0.05

Discussion

The findings reinforce the efficacy of NIV as a first-line intervention in ARF patients. Our study demonstrated significant improvements in respiratory rate, oxygenation, and acid-base balance. These findings align with prior studies that have reported high success rates of NIV in patients with COPD and pneumonia (7,8).

Compared to previous studies, our NIV success rate of 77.14% is within the reported range of 69-84%. Agarwal et al. (2021) similarly reported improvements in PaO2 and pH following NIV therapy, consistent with our findings. However, our study's mortality rate (40%) was slightly higher than those reported in previous research, indicating the

potential influence of disease severity and delayed NIV initiation. Early application of NIV has been associated with improved survival and reduced ICU mortality (9).

NIV failure remains a concern, particularly among ARDS patients, who exhibited the highest failure rate (31.2%). Identifying early predictors of NIV failure, such as persistently high respiratory rate (> 30 breaths/min) and worsening ABG values, is essential for timely intervention and improved outcomes (10). Further studies are needed to refine NIV protocols for different patient subgroups.

This study was limited to a single ICU setting, reducing its generalizability. Additionally, long-term patient outcomes were not assessed. Future research should include multi-center trials and long-term follow-up to evaluate the sustained benefits of NIV. Standardized protocols for early NIV initiation should be developed to optimize clinical outcomes and reduce NIV failure rates.

Conclusion

NIV significantly improved respiratory parameters, oxygenation, and acid-base balance in ARF patients. It reduced the need for intubation and improved clinical outcomes in ICU settings. The study highlights the role of NIV as an effective alternative to invasive ventilation, particularly in COPD and pneumonia patients.

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