

Non-Invasive Ventilation in Onco-Critical Care: Safety, Efficacy, and Clinical Outcomes

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ABSTRACT

Objective: To evaluate the safety, efficacy, and outcomes of non-invasive ventilation (NIV) in a predominantly oncology intensive care unit (ICU) population and identify factors associated with NIV success and failure.

Study Design: This study is a retrospective observational cohort.

Place and Duration of Study: Oncology Critical Care Unit, Shaukat Khanum Memorial Cancer Hospital and Research Centre, Lahore, from February to December 2025.

Methodology: Using purposive sampling, 100 ICU patients with acute respiratory failure requiring NIV were included. Data on demographics, indications, ventilatory parameters, complications, arterial blood gas (ABG) response, and outcomes were collected.

Results: The cohort comprised 80% oncology and 20% non-oncology patients. Mean age was 46.3 ± 20.7 years, and 56% were male. The most common indications for NIV were hypoxemic respiratory failure related to oncological conditions and acute exacerbation of chronic obstructive pulmonary disease, followed by pneumonia and pulmonary oedema. NIV intolerance occurred in 22% of patients and complications in 15%. ABG improvement was observed in 78%, while NIV successfully avoided intubation in 64% of cases. Intubation was required in 36% and was associated with higher mortality than successful NIV use (63.9% vs. 12.5%). Overall, ICU mortality was 28%.

Conclusion: NIV is a safe and effective treatment for acute respiratory failure in a predominantly oncology ICU population. Early initiation, favorable ABG response, and good tolerance were associated with NIV success, whereas severe hypoxemia and intolerance were linked to NIV failure.

Keywords: Non-invasive ventilation, acute respiratory failure, oncology ICU, intensive care outcomes.

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1. INTRODUCTION

An established technique for treating acute respiratory failure (ARF) in intensive care units is non-invasive ventilation (NIV), which reduces complications like ventilator-associated pneumonia, airway trauma, and sedation-related side effects while providing ventilatory support without endotracheal intubation [1]. NIV has proven to be beneficial in acute exacerbations of cardiogenic pulmonary oedema and chronic obstructive pulmonary disease (COPD), where it lowers intubation rates and increases survival [2].

However, in hypoxemic respiratory failure, where results vary based on patient selection, commencement timing, and underlying disease, its efficacy is less reliable [3]. Increased ICU mortality and poorer clinical outcomes have been

repeatedly linked to NIV failure requiring delayed intubation [4, 5].

Due to the high risk of infection and low intubation tolerance, NIV is being utilized more frequently as an alternative to invasive ventilation in immunocompromised and cancer patients [6]. Evidence, however, indicates that results in this category are still inconsistent, especially for individuals with severe hypoxemia or multi-organ dysfunction [7].

ARF continues to be a major cause of ICU admission worldwide, but its prevalence is rising in South Asia as a result of bacterial pneumonia, complications from cancer, and a lack of critical care resources [8, 9]. Respiratory failure accounts for a significant percentage of ICU admissions in Pakistan, and patients requiring invasive mechanical ventilation have a high fatality rate, especially in tertiary oncology settings [10]. Local data on NIV outcomes is still scarce. Therefore, there is a need to evaluate real-world outcomes of NIV in mixed oncology ICU populations and to identify factors associated with success and failure.

2. METHODOLOGY

This was a retrospective observational cohort, consisting of a retrospective observational cohort study of adult ICU patients receiving NIV for acute respiratory failure. The study was conducted from February 2025 to December 2025 in the oncology intensive care unit of Shaukat Khanum Memorial Cancer Hospital and Research Centre, Lahore, where approximately 80% of admissions involved patients with underlying malignancy and 20% comprised non-oncological critical illness.

After purposive sampling, 100 adult patients aged ≥ 18 years who received NIV for acute respiratory failure during the study period were included. Inclusion criteria comprised patients with malignancy-related hypoxemic respiratory failure, acute exacerbation of chronic obstructive pulmonary disease, pneumonia, or cardiogenic pulmonary oedema requiring NIV support. Patients were excluded if they had facial trauma, upper airway obstruction, or required immediate endotracheal intubation at presentation. NIV failure was defined as the need for endotracheal intubation despite optimized NIV support for at least 1–2 hours, with persistent or worsening hypoxemia ($\text{PaO}_2/\text{FiO}_2 < 100$ mmHg or $\text{SpO}_2 < 90\%$), respiratory acidosis ($\text{pH} < 7.25$), or clinical deterioration including increased work of breathing, hemodynamic instability requiring vasopressors, reduced consciousness, or inability to protect the airway.

Clinical data were extracted from electronic ICU records at the time of NIV initiation and included demographics, comorbidities, indications for NIV, ventilatory parameters, duration of support, tolerance, complications, arterial blood gas (ABG) values, and $\text{PaO}_2/\text{FiO}_2$ ratios. Severity of illness scores such as APACHE II and SOFA were not consistently available; therefore, baseline severity was assessed using physiological parameters including respiratory rate, FiO_2 requirement, pH, and oxygenation indices as surrogate markers. Outcomes assessed included NIV success or failure, need for intubation, ICU length of stay, and mortality.

NIV was delivered using standard ICU ventilators in pressure support ventilation mode or BiPAP, with initial inspiratory pressure support of 8–14 cmH₂O and positive end-expiratory pressure (PEEP) of 5–10 cmH₂O. FiO_2 was titrated to maintain oxygen saturation targets based on ABG and clinical response. Oronasal masks were the primary interface, while nasal masks were used selectively; helmet NIV was not routinely available during the study period. The mean NIV duration was 12 ± 4 hours per day.

Ethical approval was obtained from the Institutional Ethics Committee and Review Board of Shaukat Khanum Memorial Cancer Hospital and Research Centre (Approval No: EX-29-01-25-01) on March 06, 2025. The study used anonymized data and was granted a waiver of informed consent. The study was conducted in accordance with the Declaration of Helsinki.

Data were analyzed using SPSS software and descriptive statistics, with continuous variables expressed as mean $\pm$ standard deviation and categorical variables as frequencies and percentages. Normality was assessed using the Shapiro–Wilk test. Group comparisons between NIV success and failure were performed using independent t-test or Mann–Whitney U test for continuous variables and Chi-square or Fisher's exact test for categorical variables. A p-value < 0.05 was considered statistically significant. Given sample size limitations, multivariable regression analysis was not performed, and results were reported as unadjusted comparisons.

3. RESULTS

The study population represented a heterogeneous ICU cohort including both oncology and non-oncology patients. A total of 100 patients receiving NIV for acute respiratory failure were analyzed. The study population included 80 patients (80%) with malignancy-related illnesses and 20 patients (20%) with non-oncological diagnoses. The mean age was 46.3 ± 20.7 years (range: 18–75), and 56 (56%) were male patients. Comorbidities were present in 64 (64%) patients. Hypoxemic

respiratory failure secondary to oncological causes (including documented advanced lung malignancy, metastatic disease, or chemotherapy-related pulmonary toxicity), COPD exacerbation, pneumonia, and pulmonary oedema were the main indications for NIV. Hypoxemic respiratory failure due to oncological causes was the most common category (42 [42%]), followed by COPD exacerbation (28 [28%]), pneumonia (12 [12%]) and pulmonary oedema (18 [18%]). Indications were based on documented primary clinical diagnosis recorded in ICU charts at the time of NIV initiation. A history of smoking was present in 48 (48%) patients (Table I).

Table I: Baseline Characteristics and Indications for NIV

Variable	Value
Total patients	100
Age (mean $\pm$ SD)	43.14 $\pm$ 16.07 years
Males	56 (56%)
Comorbidities present	64 (64%)
Smoking history	48 (48%)
Hypoxemic respiratory failure secondary to malignancy-related pulmonary complications	42 (42%)
COPD exacerbation	28 (28%)
Pneumonia	12 (12%)

Type 2 respiratory failure predominated among COPD exacerbations, whereas hypoxemic respiratory failure was more common in patients with malignancy-related pulmonary complications and pneumonia. NIV tolerance was generally favorable; however, 22 (22%) patients experienced intolerance due to anxiety, mask discomfort, or poor interface fit. Complications occurred in 15 (15%) patients, most commonly minor facial skin breakdown (10 [10%]) and aspiration events (2 [2%]). ABG improvement within two hours of NIV initiation was observed in 78 (78%) patients, with mean $\text{PaO}_2/\text{FiO}_2$ improving from 140 to 220. (Figure1).

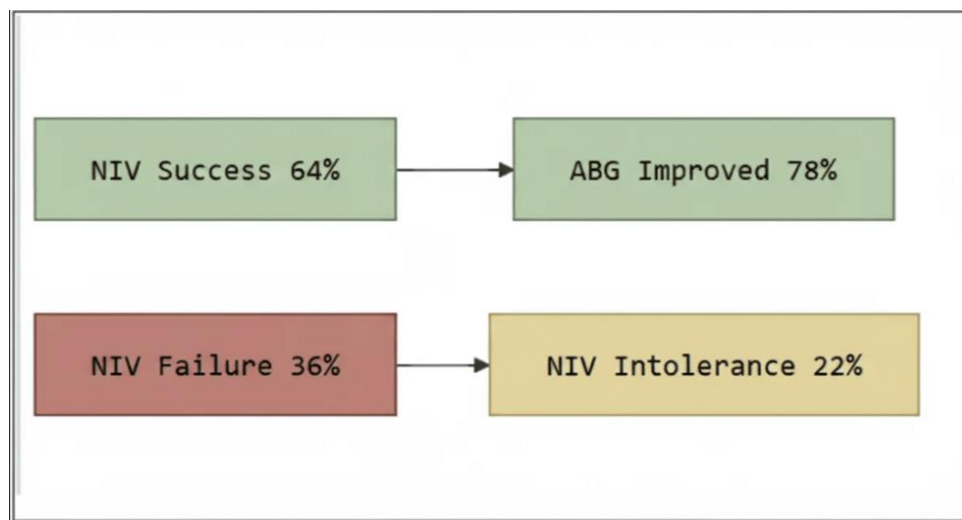


Figure 1: Major clinical outcomes following non-invasive ventilation

NIV avoided intubation in 64 (64%) patients, while 36 (36%) required invasive mechanical ventilation. Patients requiring intubation had significantly worse outcomes, with mortality of 23/36 (63.9%) compared to 8/64 (12.5%) among those successfully managed with NIV. The overall ICU mortality rate was 28 (28%). The mean ICU length of stay was 6.4 ± 2.8 days. Thirty-day readmission occurred in 14 (14%) patients, and 18 (18%) were discharged with continued NIV support (Table II) (Figure 2).

Table II: Clinical Outcomes and Complications

NIV success (no intubation)	64 (64%)
Intubation required	36 (36%)
ICU mortality	28 (28%)
Mortality in intubated patients	23/36 (63.9%)
Mortality in NIV success group	8/64 (12.5%)
NIV intolerance	22 (22%)
Complications (overall)	15 (15%)
Skin breakdown	10 (10%)

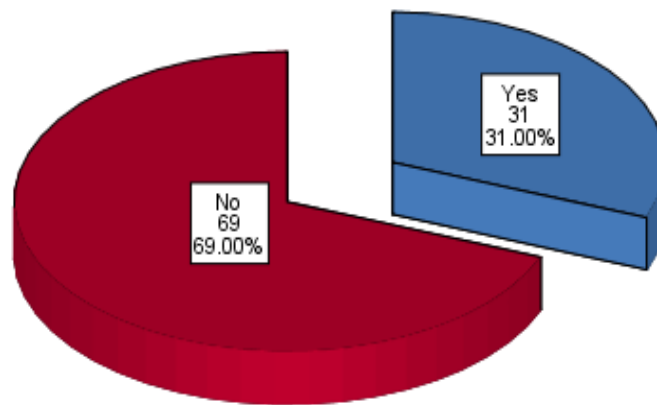


Figure 2: ICU mortality among NIV success and intubation groups

Patients requiring intubation demonstrated more severe baseline respiratory compromise, characterized by higher respiratory rates, lower pH values, greater FiO₂ requirements, and markedly reduced PaO₂/FiO₂ ratios compared with patients successfully managed with NIV (Table III).

Table III: Mean Baseline Respiratory Parameters in NIV Success and NIV Failure Groups

Variables	NIV Success (n = 64)	NIV Failure (n = 36)	p-value
Respiratory rate (breaths/min)	24.89 ± 3.10	37.58 ± 4.12	<0.001
pH	7.55 ± 0.24	7.38 ± .20	<0.001
PaCO ₂ (mmHg)	47.20 ± 7.02	57.86 ± 9.74	<0.001
FiO ₂ (%)	68 ± 9	90 ± 6	<0.001
PaO ₂ /FiO ₂ ratio	255.78 ± 27.68	174.78 ± 30.10	<0.001

Early ABG improvement and good NIV tolerance were associated with successful NIV outcomes, whereas severe baseline hypoxemia and higher oxygen requirements were more frequently observed in patients requiring intubation. Clinicians emphasized early initiation, frequent monitoring, and standardized protocols as key facilitators of successful NIV use.

4. DISCUSSION

The results of NIV were assessed in a real-world intensive care unit population that was primarily made up of cancer patients experiencing acute respiratory failure. The group illustrates the difficulty of modern intensive care unit practice, where respiratory failure is often complicated, with overlapping contributions from pneumonia, chronic obstructive pulmonary disease, malignancy-related lung sequelae, and fluid overload.

NIV continues to be an effective initial ventilatory approach in properly chosen patients, as evidenced by the 64% avoidance of intubation in this diverse sample [11, 12]. This success rate is in line with research on acute respiratory failure, which shows that results vary greatly according on the underlying cause, the severity of the sickness, and the timing of intervention. Crucially, early physiological response during the first few hours of starting NIV seemed to distinguish patients who later avoided invasive ventilation from those who did not respond to treatment [13, 14].

Higher respiratory rates, higher oxygen requirements, worse acid-base status, and lower PaO₂/FiO₂ ratios were among the more severe baseline physiological impairment seen in patients who needed intubation. These results suggest that baseline respiratory impairment and subsequent NIV outcome are related [15, 16]. However, these data should be considered as associations rather than independent effects due to the lack of explicit multivariable adjustment.

One noteworthy conclusion was that patients who advanced to invasive mechanical ventilation had a considerably greater mortality rate than those who were successfully managed with NIV. This is consistent with the evidence that shows delayed intubation after NIV failure is linked to worse outcomes, which may be more indicative of the severity of the underlying disease than of NIV failure [17, 18, 19]. These results highlight the significance of prompt respiratory support escalation and early detection of NIV failure.

The safety profile of NIV when used in a monitored intensive care unit setting is further supported by the low number of problems seen [20]. The majority of adverse events were mild and linked to skin-related issues or interface intolerance, both of which may be prevented with proper patient selection, nursing assistance, and interface optimization. Successful outcomes were consistently shown to be facilitated by early NIV introduction and organized monitoring methods. On the

other hand, NIV failure was thought to be significantly influenced by interface intolerance and delayed detection of clinical deterioration [21]. These findings highlight the fact that system-level variables and clinical decision-making procedures have a significant impact on NIV efficacy in addition to patient physiology [22].

In certain ICU patients with acute respiratory failure, these results support the use of NIV as an initial ventilatory technique. These results should be considered as associations that generate hypotheses and offer a foundation for future prospective research that include multivariable modeling and formal severity ratings.

Limitations:

Although the cohort was predominantly oncology-related (80%), a minority of non-oncology patients were included, which may introduce heterogeneity in outcomes. The inclusion of multiple etiologies of acute respiratory failure, particularly COPD exacerbations, may influence overall observed NIV success rates, given the known favorable response of hypercapnic respiratory failure to NIV. Therefore, findings should be interpreted as reflecting real-world ICU practice rather than disease-specific outcomes. Severity scoring systems such as APACHE II or SOFA were not consistently available and therefore were not included in the analysis. Additionally, retrospective data collection may introduce selection and documentation bias, and variability in underlying disease processes may limit subgroup-specific inference. Although oncological variables such as cancer stage, histological subtype, and treatment status were available in the electronic medical record system, they were not extracted for analysis in this study.

5. CONCLUSIONS

NIV is effective in appropriately selected patients with acute respiratory failure in a predominantly oncology intensive care unit population. NIV was most commonly used for hypoxemic respiratory failure secondary to oncological causes, followed by COPD exacerbation, pneumonia, and pulmonary oedema. Early ABG improvement and good tolerance were observed in patients with successful NIV outcomes, while severe hypoxemia and intolerance were more common in NIV failure. Clear failure criteria, timely escalation to invasive ventilation, and trained healthcare staff are essential to optimize outcomes and reduce mortality in the high-risk population.

Declarations

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