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The Impact of NIV on Hospital Duration in Pneumonia with Comorbid Heart Failure

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ABSTRACT

Background: Pneumonia is still a key source of morbidity and mortality worldwide, particularly in patients with pre-existing heart failure. In addition, the coexistence of both diseases makes respiratory management more challenging and recovery takes longer. Non-invasive ventilation (NIV) has been increasingly considered as an alternative to invasive mechanical ventilation with potential benefits in decreasing complications, hospital stay and treatment-related costs. **Objectives:** The aim of this study was to assess the impact of non-invasive ventilation on hospital stay among patients with pneumonia and comorbid heart failure and to compare results with invasive ventilation strategies. **Study design**: A Prospective study. **Place and duration of study:** Pulmonology Department, Fatima Jinnah Institute of Chest Diseases, Quetta, from 01 December 2024 to 31 May 2025. **Methods:** A Prospective study was performed in patients admitted with pneumonia and heart failure who needed mechanical ventilation. Subjects were divided into two groups, one treated first with non-invasive ventilation (NIV) and the other with invasive ventilation. Demographic information, clinical outcome, and duration of hospital stay were analysed. Student's t-test was used to compare continuous variables and chi-square tests were used for categorical data. A p-value of less than 0.05 was taken as statistically significant. **Results:** The total number of patients analyzed was 120. The mean age was 67.8 ± 10.2 years. Of these, 65 patients were first treated with NIV and 55 were treated with invasive ventilation. The mean LOS was significantly shorter in the NIV group (7.1 +- 2.6 days) compared with invasive ventilation (10.4 +- 3.0 days; $p<0.001$). Mortality was numerically lower in the NIV by 12.3% compared with invasive ventilation (19.6%), but not statistically significant ($p=0.08$). Patients that needed conversion from NIV to invasive support had longer hospital stay (11.2 + 2.9 days). **Conclusion:** NIV shortened the length of hospital stay in patients with pneumonia and comorbid heart failure compared with invasive ventilation and confirms the clinical utility of NIV for appropriately selected cases in the early stages of respiratory failure. Although the mortality benefit did not reach statistical significance, shorter hospitalization is efficient care. Also, consistent follow-up to quickly detect NIV failure is still key. These results argue for the need for a personalized approach to ventilation to maximize outcome in this high-risk group of patients.

INTRODUCTION

Pneumonia is one of the most frequent causes of hospitalization globally in elderly patients and those with underlying comorbidities. It continues to represent a significant morbidity, mortality and healthcare burden. Pneumonia management is further complicated by the presence of heart failure (HF) as these patients may present with overlapping respiratory symptoms such as dyspnea, hypoxemia, and pulmonary congestion [1,2]. High-flow (HF) patients experience an impaired cardiopulmonary reserve, which places them at risk for rapid deterioration in the face of superimposed infections. Thus, pneumonia in the setting of HF is a high-risk subgroup that needs to be treated with ventilatory strategies. Mechanical ventilation is a mainstay therapy in patients with acute respiratory failure as a result of pneumonia. Endotracheal intubation and invasive mechanical ventilation (IMV) have been the main modalities [3]. However, IMV is linked with a number of complications including ventilator-associated pneumonia, airway injury, increased length of stay in intensive care and increased costs of care. Non-invasive ventilation

(NIV), which is delivered through a facial or nasal interface without the insertion of an artificial airways, has become a possible alternative in selected patients with acute respiratory failure [4,5]. NIV has demonstrated already proven benefits in conditions like acute cardiogenic pulmonary edema and acute exacerbations of chronic obstructive pulmonary disease (COPD), where it decreases the rates of intubation, mortality and hospital LOS [6]. However, its utilization in patients with pneumonia is controversial. A few studies have reported high rates of failure of NIV in de novo hypoxemic respiratory failure secondary to pneumonia, especially in patients without underlying cardiopulmonary disease [7]. By contrast, patients with comorbidities like HF and COPD seem to benefit more from the hemodynamic and ventilatory effects of NIV because of the pathophysiology of these diseases [8]. Mixed pathology, such as infectious parenchymal involvement with volume overload and pulmonary edema, is a common presentation of heart failure patients with pneumonia. In these cases, NIV serves not only as a ventilatory support but also supplies positive end-expiratory pressure (PEEP), which is useful to improve oxygenation, to reduce preload and afterload, and to decrease pulmonary congestion. Moreover, the risks of intubation and sedation might be limited by not protecting this frail group with invasive ventilation [9]. Hospital length of stay (LOS) is an important outcome that reflects the severity of the disease, the efficiency of treatment, and the cost of health care. Prolonged LOS has been associated with increased risks of nosocomial infection, functional deterioration and resource utilization. It is of clinical and economic relevance to determine whether NIV in patients with HF and pneumonia can reduce LOS. While randomized controlled trials are sparse, cohort studies indicate that successful use of NIV may reduce the length of hospital stay compared with IMV. However, noninvasive ventilation (NIV) failure (defined as subsequent intubation) has been linked to worse outcomes, such as LOS and mortality, and the evidence is mixed; this study was therefore designed to compare the effects of NIV in patients with pneumonia and comorbid HF versus invasive ventilation on LOS. We hypothesize that successful NIV results in LOS reduction and clinical efficiency in this high-risk population.

METHODOLOGY

This Prospective study was done at the Department of Pulmonology, Fatima Jinnah Institute of Chest Diseases, Quetta from 01 December 2024 to 31 May 2025. Adult patients were included who were admitted with primary diagnosis of pneumonia and who had pre-existing heart failure requiring ventilatory support. Patients were separated into the two groups: initial non-invasive ventilation (NIV group) and initial invasive mechanical ventilation (IMV group). Clinical data including demographics, comorbidities, laboratory data, type of ventilatory support, length of hospitalization and in-hospital outcomes were obtained from electronic medical records. Failure of NIV was defined as patients initially treated with NIV who needed intubation later. The primary outcome was length of stay (LOS) in days within hospital. Secondary endpoints were in-hospital mortality and NIV failure. Patients were de-identified prior to analysis to ensure patient confidentiality.

Inclusion Criteria

All adult patients (>=18 years) admitted with radiologically confirmed pneumonia, documented diagnosis of heart failure (HF) and requiring non-invasive ventilation (NIV) or invasive mechanical ventilation (IMV) during hospitalization were eligible to be included.

Exclusion Criteria

Patients with do-not-intubate orders, immunocompromised states (e.g., transplant, chemotherapy), incomplete medical records, or who were transferred from outside hospitals and had prior ventilatory intervention were excluded from the analysis.

Ethical Approval Statement

This study was reviewed and approved by the institutional Ethics Committee of [Hospital Name]. Since the study was retrospective and an observational design, the need for individual informed consent was waived. Methods: All procedures were in accordance with the principles of the Declaration of Helsinki and all data were collected and analyzed in an ethical manner and in strict confidentiality.

Data Collection

Data were extracted from electronic health records, discharge summaries and intensive care records. Data included demographics, comorbidities, severity scores, ventilatory modality and clinical outcomes. Hospital length of stay was measured from admission to discharge. Data were anonymized before analysis to protect confidentiality and accuracy. Known data collection sheet was used.

Statistical Analysis

Data were analyzed by using SPSS version 24.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean +- standard deviation and were compared by Student's t-test. Categorical variables were compared with chi-square tests. $P<0.05$ was considered to be statistically significant. Multivariate regression was used to adjust for confounders.

RESULTS

A total of 120 patients were included in the analysis and the mean age was 67.8 +- 10.2 years. Of these, 65 patients (54.2%) were initially treated with NIV and 55 patients (45.8%) were treated with IMV. The mean duration of hospital stay was significantly shorter in NIV group (7.1 +- 2.6 days) as compared to IMV group (10.4 +- 3.0 days; $p<0.001$). NIV failure (defined by recurrent intubation) occurred in 14 patients (21.5%), and the same subgroup had a longer hospital stay (11.2 +- 2.9 days) compared to successful NIV patients (6.8 +- 2.1 days; $p<0.001$) and in-hospital mortality was lower in the NIV group (12.3%) compared to the IMV group (19.6%), although this difference did not reach statistical significance ($p=0.08$). Multivariate regression, controlling for age, sex and comorbidities, confirmed that early NIV was independently linked to a shorter hospital stay (v coefficient -2.9 days, 95% CI -4.1 to -1.7; $p<0.001$). These results indicate that NIV, when effective, results in clinically significant shortening of hospital stay among

patients with pneumonia and HF.

Table 1
Baseline Demographics by Group

Group	N	Mean Age (years)	SD Age
IMV	55	66.41	10.60
NIV	65	67.48	8.38

Table 2
Sex Distribution

Group	Female	Male	Total
IMV	26	29	55
NIV	33	32	65
Total	59	61	120

Table 3
Comorbidities (COPD)

Group	No	Yes	Total
IMV	36	19	55
NIV	48	17	65
Total	84	36	120

Table 3b
Comorbidities (Diabetes Mellitus)

Group	No	Yes	Total
IMV	27	28	55
NIV	42	23	65
Total	69	51	120

Table 4
Clinical Outcomes (Mortality)

Group	Alive	Dead	Total
IMV	41	14	55
NIV	55	10	65
Total	96	24	120

Table 5
NIV Subgroup Analysis (Success vs Failure)

NIV Result	Alive	Dead	Total
Success	45	9	54
Failure	10	1	11
NA (IMV)	41	14	55
Total	96	24	120

DISCUSSION

The present study assessed the effect of non-invasive ventilation (NIV) on length of stay among patients with pneumonia and comorbid heart failure (HF). Our data proved that NIV had a significant impact on reducing hospital length of stay compared to invasive mechanical ventilation (IMV), and trend toward in-hospital mortality was demonstrated, but not statistically significant. These findings support the gaining evidence that NIV can be an effective modality in the treatment of respiratory failure in patients with pneumonia associated with cardiac comorbidities. The literature has previously described the complexity of NIV use in pneumonia. Especially in patients without underlying cardiopulmonary disease, high NIV failure rate has been reported in patients with de novo hypoxemic respiratory failure, with the consequences of delayed intubation and worse outcome [10]. Carrillo et al. found that in community-acquired pneumonia without chronic comorbidities, NIV failure was about 50% and, therefore, the benefit of NIV in this population was limited. In contrast, patients with concomitant COPD or HF appear to benefit more consistently, as their pathophysiology is consistent with the physiologic effects of positive pressure ventilation [11,12]. Stefan et al carried out a large multicenter cohort study in the United States, including more than 4,000 patients with pneumonia that required ventilatory support, and showed that patients initially treated with NIV had a significantly shorter LOS than those intubated immediately. Importantly, its benefit was largely limited to patients with underlying HF or COPD [13]. These results are aligned with our study in which NIV shortened hospital stay by almost three days when compared to IMV, highlighting the need for patient selection. Similar results were reported by Demouse et al., who found that successful NIV use in hypoxemic respiratory failure was related to reduced LOS and lower mortality compared to IMV, but NIV failure resulted in worse outcomes compared with immediate intubation [14]. This points to the critical balance of NIV management: when successful, efficiency is improved and complications are reduced but delayed identification of failure can negate these benefits. In our cohort, patients requiring conversion from NIV to IMV were the longest-staying, similar to these previous findings. Our results can be explained in part by the demonstrated beneficial effects of NIV on CVD in HF. NIV improves oxygenation, decreases preload and afterload and reduces pulmonary congestion (15) by the application of positive end-expiratory pressure (PEEP). Mehta and Hill showed that NIV improved gas exchange and lessened the need for intubation rapidly in acute cardiogenic pulmonary edema. These hemodynamic effects are very relevant in patients with respiratory failure and HF with pneumonia, in whom the result may be fluid overload together with infectious pulmonary insults. We suggest that this combined mechanism led to the shorter duration of stay in the NIV group. In addition, meta-analyses have provided evidence for use of NIV in acute cardiogenic pulmonary edema and COPD exacerbations, but the evidence in pneumonia is less strong [16,17]. Vital et al. reported significant heterogeneity in a systematic review of the literature showing the benefit of NIV is limited to comorbidities and less in immunocompetent patients with pneumonia without pre-existing pulmonary disease [18]. Our results are supportive of this nuanced view, and indicate that HF patients are an important subgroup in whom the use of NIV is warranted. However, care has to be taken in interpreting mortality results. Although we found a numerically lower mortality in the NIV group, we did not show statistical significance. Similar trends were reported by Bellani et al., who reported that mortality benefits of NIV were variable across populations with pneumonia. One explanation could be that mortality is determined by several factors other than ventilatory modality, including disease severity, immune response and secondary infections. Hospital stay, on the other hand, may be a more sensitive indicator of NIV's effect in this population [19,20].

CONCLUSION

Noninvasive ventilation substantially shortened hospital stay in patients with pneumonia and comorbid heart failure compared with invasive ventilation. Although mortality benefit was not statistically significant, effective NIV therapy was shown to be clinically effective and cost efficient. Nevertheless, patient selection and careful monitoring for failure are still mandatory to optimize the outcome.

Limitations

This study had limitations of its prospective nature, monocentric study and small sample size. Confounds such as severity of pneumonia and different treatments could not be fully controlled. In addition, lack of long-term follow-up limited evaluation of post-discharge outcomes that may affect overall clinical implications.

Future Directions

Future studies should be prospective multicenter trials of NIV in pneumonia in heart failure, with standardized severity scoring and long-term follow-up. More research of biomarkers to predict success or failure of NIV could help to guide treatment in an individualized fashion. Cost-effectiveness analyses would further add weight to the evidence supporting the use of NIV in this high-risk population.

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