Original Article

Indications and Outcomes of Non-Invasive Ventilation in Patients Presenting with Acute Respiratory Distress to The Emergency Department of A Tertiary Care Hospital: A Prospective Observational Study

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Abstract

Background: Non-invasive ventilation (NIV) provides an effective bridge between supplemental oxygen and invasive ventilation in selected patients with acute respiratory failure, but its early use in the Emergency Department (ED) – particularly outside critical care settings in India – remains underutilised and understudied. The objective is to study the use of NIV in the ED of a tertiary care hospital, identify the conditions in which it is effective, determine causes of NIV failure leading to intubation, assess effectiveness by clinical and arterial blood gas (ABG) parameters, and describe patient disposition. **Material and Methods:** This prospective observational study enrolled 111 consenting adults presenting to the ED with acute respiratory distress and initiated on NIV between December 2017 and June 2019. Demographic data, comorbidities, provisional diagnosis, and clinical/ABG parameters at hour 0 and hour 1 of NIV were recorded on a structured proforma. Statistical analysis was performed using Stata version 14.2; chi-square or Fisher's exact tests were used for categorical comparisons, with significance set at $p<0.05$. **Results:** Of 111 patients, 63 (56.8%) were male and the majority (54.0%) were aged 51–70 years. A pre-existing comorbidity was present in 72 (64.9%), most commonly COPD (32.4%). The leading ED diagnoses were acute exacerbation of COPD (27.0%), community-acquired pneumonia (CAP, 26.1%), and pulmonary edema due to congestive cardiac failure (CCF, 20.7%). Pulmonary edema (cardiogenic and renal) was the most common diagnosis leading to NIV initiation. Clinical improvement at 1 hour was observed in 89 patients (80.2%), while ABG improvement was seen in 63 (56.8%); this difference was statistically significant ($\chi^2=20.79$, $p<0.001$). Eighteen patients (16.2%) failed NIV and required intubation, most commonly due to worsening respiratory failure. Of the 93 patients successfully managed without intubation, 71 (76.3%) were nonetheless transferred to the High Dependency Unit (HDU) or Intensive Care Unit (ICU) for continued monitoring. **Conclusion:** NIV was effective in the majority of ED patients with acute respiratory failure, particularly those with COPD exacerbation, cardiogenic pulmonary edema, pulmonary edema due to CKD, and CAP. Clinical assessment, rather than ABG values alone, was the more sensitive early indicator of response. Even successfully managed patients frequently required intensive-care-level monitoring, underscoring that NIV success in the ED does not eliminate the need for vigilant downstream care.

Keywords: Non-invasive ventilation; Emergency department; Acute respiratory failure; COPD; Pulmonary edema; Intubation.

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Introduction

Emergency medicine in India remains a developing speciality, with increasing emphasis on early identification and prompt treatment of acute illness. Patients presenting in acute respiratory failure are common in the Emergency Department (ED), where a critical decisional point often lies between intubation and non-invasive support.

Non-invasive ventilation (NIV) – the delivery of ventilatory support through a face mask to a spontaneously breathing patient – has well-established clinical effectiveness in acute exacerbations of chronic obstructive pulmonary disease (COPD) and acute cardiogenic pulmonary oedema.[1-4] Evidence for its use in other conditions such as pneumonia and asthma is more limited. Beyond respiratory benefits, NIV can improve cardiac output by reducing left ventricular preload and afterload in heart failure.[5-9]

Objective indicators for NIV initiation include oxygen saturation below 90%, use of accessory respiratory muscles, inability to speak in full sentences, respiratory rate above 24/min, and altered

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mental status. Barriers to its use include unfamiliarity with the technique, lack of equipment or respiratory therapist support in the ED, and the time required for initiation and monitoring.[10] A pH below 7.25 predicts a greater than 70% risk of NIV failure.[11] Despite its established benefits – reduced technical complexity, avoidance of sedation and intubation-related complications, and lower cost – NIV remains underutilised by clinicians.[12-15]

There is a paucity of Indian data on the use of NIV specifically in the ED setting, as distinct from the intensive care unit. In a resource-limited setting where invasive ventilation substantially increases cost and burden of care, early identification of appropriate candidates for NIV – including in primary and community health centres – may meaningfully reduce morbidity, mortality, and the financial burden on patients and their families.

This study was undertaken to characterise the use of NIV in the ED of a tertiary care hospital: the conditions in which it proved effective, the causes of its failure, its effectiveness by clinical and arterial blood gas (ABG) parameters, and the disposition of patients from the ED.

Materials and Methods

Study Design and Setting: This was a single-centre, prospective observational study conducted in the Department of Emergency Medicine, St. John's Medical College Hospital, Bengaluru, a tertiary care teaching hospital.

Study Period and Ethical Approval: Consecutive eligible patients presenting from December 2017 to June 2019 were enrolled, until the calculated sample size was achieved. This study was approved by the Institutional Ethics Committee, St. John's Medical College Hospital, Bengaluru (IEC No. IEC/1/1036/2017; IEC Study Ref No. 327/2017; approved 18 December 2017). Written informed consent was obtained from all participants prior to enrolment.

Participants: Inclusion criteria were: age above 18 years; presentation to the ED with acute respiratory distress meeting clinical criteria for acute respiratory failure (respiratory rate >25/min, SpO_2 <90%, and use of accessory muscles of respiration); and initiation of NIV at the treating clinician's discretion. Patients were excluded if they required immediate intubation, had an ABG pH ≤7.10, Glasgow Coma Scale ≤14/15, were in shock (systolic blood pressure ≤90 mmHg), or were unable to cooperate with NIV.

Data Collection: Demographic data, presenting symptoms, comorbidities, and provisional ED diagnosis were recorded on a structured proforma. Clinical parameters and ABG values were recorded at hour 0 (prior to NIV initiation) and at hour 1 of therapy. Outcomes recorded included clinical improvement, ABG improvement, need for intubation and its indication, and final ED disposition (discharge, ward admission, HDU/ICU admission, dialysis, or mortality).

Sample Size: Sample size was estimated using proportion data from a prior ED-based NIV study from Italy, in which COPD exacerbation accounted for 45.2% of patients managed with NIV.[12] With this as the estimated proportion, a 5% significance level, and 10% precision, the minimum required sample size was 95, inflated to 105 to allow for a 10% non-response rate. A total of 111 patients were ultimately enrolled.

Statistical Analysis: Statistical analysis was performed using Stata version 14.2 (StataCorp, College Station, TX). Categorical variables were summarised as frequencies and percentages with 95% confidence intervals; age was the only continuous variable and was categorised into six groups for analysis. Cross-tabulations were performed between diagnosis and other study variables, and between ABG improvement, clinical improvement, and intubation status. The chi-square test (or Fisher's exact test where expected cell counts were small) was used to assess statistical significance, with $p<0.05$ considered significant.

Results

A total of 111 patients presenting to the ED with acute respiratory distress and initiated on NIV were included in the study.

Demographic and Clinical Characteristics: Of the 111 patients, 63 (56.8%) were male and 48 (43.2%) were female. The majority were aged 51–70 years (54.0% combined; Table 1). A pre-existing comorbidity was present in 72 patients (64.9%); among individual comorbidities, COPD was most common (32.4%), followed by chronic kidney disease (CKD, 24.3%), congestive cardiac failure (CCF, 22.5%), obstructive sleep apnoea (6.3%), and asthma (5.4%). Thirty-three patients (29.7%) had a history of prior ventilatory support – 30 (27.0%) with NIV and 3 (2.7%) with invasive ventilation – while 17 (15.3%) were on domiciliary respiratory support (home oxygen or CPAP) prior to admission.

Table 1: Demographic and Clinical Characteristics of the Study Population (N=111)

Characteristic	n	%
Sex – Male	63	56.8
Sex – Female	48	43.2
Age <30 years	6	5.4
Age 31–40 years	12	10.8
Age 41–50 years	17	15.3
Age 51–60 years	29	26.1
Age 61–70 years	31	27.9
Age >70 years	16	14.4
Any pre-existing comorbidity	72	64.9
– COPD	36	32.4
– Chronic kidney disease	27	24.3
– Congestive cardiac failure	25	22.5
– Obstructive sleep apnoea	7	6.3
– Asthma	6	5.4
Prior ventilatory support (NIV or invasive)	33	29.7

Domiciliary respiratory support (O_2/CPAP)	17	15.3

Individual comorbidity categories are not mutually exclusive and do not sum to the "any comorbidity" total, as patients could have more than one pre-existing condition.

Diagnosis and Indication for NIV: Acute exacerbation of COPD was the most common ED diagnosis (27.0%), followed by CAP (26.1%), pulmonary edema due to CCF (20.7%), pulmonary edema due to CKD (18.0%), asthma exacerbation (4.5%), and sepsis (3.6%). Physiologically, type 2 (hypercapnic) respiratory failure was the primary mechanism in 35 patients (31.5%), predominantly those with COPD exacerbation and asthma, while type 1 (hypoxemic) respiratory failure accounted for the majority, including patients with pulmonary edema (cardiogenic and renal combined) and CAP [Table 2].

Table 2: ED Diagnosis (N=111)

Variable	n	%
COPD exacerbation	30	27.0
Community-acquired pneumonia	29	26.1
CCF (cardiogenic pulmonary edema)	23	20.7
Pulmonary edema due to CKD	20	18.0
Asthma exacerbation	5	4.5
Sepsis	4	3.6

Clinical and ABG Response, and NIV Failure: At 1 hour of therapy, clinical improvement was observed in 89 patients (80.2%) and ABG improvement in 63 (56.8%) – a statistically significant difference (χ^2=20.79, p<0.001), indicating that ABG normalisation lagged behind clinical response. ABG improvement varied significantly by diagnosis (χ^2=18.73, p=0.002), being lowest in CKD-related pulmonary edema (15.0%) and highest in COPD exacerbation (73.3%); clinical improvement did not differ significantly by diagnosis (χ^2=3.29, p=0.656).

Eighteen patients (16.2%) failed NIV and required intubation, most commonly due to worsening respiratory failure (15/18, 83.3%), with hypotension, cardiac arrest, and GCS drop each accounting for one case. Intubation rates did not differ significantly by diagnosis (χ^2=5.08, p=0.406), though numerically highest in asthma exacerbation (40.0%) and CKD-related pulmonary edema (25.0%). Both ABG non-improvement and absence of clinical improvement were strongly associated with subsequent intubation (χ^2=18.24 and 75.28 respectively, both p<0.001).

Table 3: Clinical Improvement, ABG Improvement, and Intubation by Diagnosis

Diagnosis (n)	ABG improved, n (%)	Clinical improved, n (%)	Intubated, n (%)
COPD exacerbation (30)	22 (73.3)	24 (80.0)	5 (16.7)
Asthma exacerbation (5)	3 (60.0)	3 (60.0)	2 (40.0)
Pulmonary edema due to CKD (20)	3 (15.0)	15 (75.0)	5 (25.0)
Community-acquired pneumonia (29)	19 (65.5)	23 (79.3)	4 (13.8)
CCF (cardiogenic pulmonary edema) (23)	14 (60.8)	20 (87.0)	2 (8.7)
Sepsis (4)	2 (50.0)	4 (100.0)	0 (0.0)
Overall (111)	63 (56.8)	89 (80.2)	18 (16.2)

ABG improvement by diagnosis: χ^2=18.73, p=0.002. Clinical improvement by diagnosis: χ^2=3.29, p=0.656. Intubation by diagnosis: χ^2=5.08, p=0.406.

Overall, 89 patients (80.2%) were transferred to the HDU/ICU, 15 (13.5%) were discharged, 4 (3.6%) required dialysis, and 3 (2.7%) were admitted to the general ward (Table 4). Of the 93 patients successfully managed without intubation, 71 (76.3%) were nonetheless transferred to the HDU/ICU for continued monitoring – in addition to the 18 patients who were intubated and transferred following NIV failure. Disposition varied significantly by diagnosis (χ^2=29.0, p=0.016), with the highest HDU/ICU transfer rates seen in CCF (87.0%) and COPD exacerbation (83.3%).

Table 4: Disposition by Diagnosis (N=111)

Diagnosis	HDU/ICU, n (%)	Dialysis, n (%)	Ward, n (%)	Discharged/DAMA, n (%)
COPD exacerbation (30)	25 (83.3)	0 (0.0)	3 (10.0)	2 (6.7)
Asthma exacerbation (5)	4 (80.0)	0 (0.0)	0 (0.0)	1 (20.0)
Pulmonary edema due to CKD (20)	13 (65.0)	4 (20.0)	0 (0.0)	3 (15.0)
Community-acquired pneumonia (29)	24 (82.8)	0 (0.0)	0 (0.0)	5 (17.2)
CCF (cardiogenic pulmonary edema) (23)	20 (87.0)	0 (0.0)	0 (0.0)	3 (13.0)
Sepsis (4)	3 (75.0)	0 (0.0)	0 (0.0)	1 (25.0)
Overall (111)	89 (80.2)	4 (3.6)	3 (2.7)	15 (13.5)

χ^2=29.0, p=0.016 (Fisher's exact recommended for cells with small expected counts, e.g. dialysis and ward categories).

Discussion

Demographics and Comorbidity Profile: Male preponderance (56.8%) and a predominance of patients aged 51–70 years (54.0%) reflect the typical age and sex distribution of acute respiratory failure reported in other ED-based NIV cohorts. Almost two-thirds of patients had a pre-existing

comorbidity, most commonly COPD, CKD, or CCF, suggesting that the majority of ED presentations with acute respiratory failure represent acute decompensation of known chronic disease rather than de novo respiratory illness.

Diagnosis and Indications for NIV: COPD exacerbation, CAP, and cardiogenic pulmonary edema together accounted for almost three-quarters of diagnoses, consistent with the established evidence base for NIV in these conditions.[1-4,13,14] Pulmonary edema (cardiogenic and renal combined) was the most common diagnosis leading to NIV initiation in our cohort, in keeping with prior literature on the prominent role of NIV in both cardiogenic and renal fluid overload states.[15]

ABG versus Clinical Improvement: A key finding was the discordance between clinical improvement (80.2%) and ABG improvement (56.8%) at 1 hour. This suggests that early clinical response – work of breathing, respiratory rate, sensorium – may be a more sensitive indicator of NIV response than ABG normalisation alone within the first hour of therapy, and that the two should be interpreted in conjunction rather than relying on ABG trends in isolation when deciding whether to continue or escalate therapy.

NIV Failure and Invasive Ventilation: Sixteen percent of patients failed NIV and required intubation, most commonly due to worsening respiratory failure – consistent with previously reported NIV failure rates and predictors in the literature.[16,17] This reinforces that NIV functions as a bridge rather than a substitute for invasive ventilation in a subset of patients, and that close monitoring with a low threshold for escalation is essential to its safe use in the ED.[18]

Disposition: That over three-quarters of patients successfully managed with NIV alone were nonetheless transferred to the HDU/ICU highlights an important practical point: NIV success in the ED does not equate to clinical stability sufficient for ward-level care. Continued close monitoring after apparent initial improvement is warranted, given the potential for later deterioration.

Comparison with Existing Literature: Our findings are broadly consistent with international and Indian data on NIV use in acute respiratory failure.[19,20] Notably, although community-acquired pneumonia does not carry a high level of evidence for NIV use compared with COPD or cardiogenic pulmonary edema, our cohort showed a favourable clinical and ABG response in this subgroup, consistent with a growing body of literature suggesting a role for NIV as an adjunct in selected pneumonia patients, while underscoring the need for cautious patient selection and close monitoring rather than routine use.

Limitations

This was a single-centre, prospective observational study without a comparator arm, which limits causal inference about NIV's effect relative to standard oxygen therapy alone. Severity scoring (e.g. for pneumonia) was not performed, limiting risk-stratified conclusions within diagnostic subgroups. Outcomes were assessed only up to ED disposition; subsequent in-hospital course, length of stay, and mortality beyond the ED were not captured. Comorbidities were recorded as present/absent without severity grading, and the influence of multiple concurrent comorbidities was not adjusted for in the analysis. Finally, the decision to initiate NIV was at the treating clinician's discretion rather than by a standardised protocol, which may introduce selection bias.

Conclusion

NIV was an effective tool in the management of ED patients with acute respiratory failure in this cohort, particularly in COPD exacerbation, cardiogenic pulmonary edema, pulmonary edema due to CKD, and CAP. Clinical assessment proved a more sensitive early marker of response than ABG values alone, and even patients successfully managed with NIV frequently required HDU/ICU-level monitoring. Worsening respiratory failure remained the leading cause of NIV failure. Given the paucity of Indian ED-based data on NIV, further multicentre studies are warranted to refine patient selection criteria and define the role of NIV in resource-limited Emergency Department settings.

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Conflicts of interest

There are no conflicts of interest.

References

1. British Thoracic Society Standards of Care Committee. Non-invasive ventilation in acute respiratory failure. Thorax. 2002;57:192–211.
2. Purwar S, Venkataraman R, Senthilkumar R, Ramakrishnan N, Abraham BK. Non-invasive ventilation – are we overdoing it? Indian J Crit Care Med. 2014;18:502–6.
3. Carron M, Freo U, BaHammam AS, Dellweg D, Guarracino F, Cosentini R, et al. Complications of non-invasive ventilation techniques: a comprehensive qualitative review of randomized trials. Br J Anaesth. 2013;110:896–914.
4. Aboussouan LS, Ricaurte B. Noninvasive positive pressure ventilation: increasing use in acute care. Cleve Clin J Med. 2010;77:307–16.
5. Nava S, Hill N. Non-invasive ventilation in acute respiratory failure. Lancet. 2009;374:250–9.
6. Ozyilmaz E, Ugurlu AO, Nava S. Timing of noninvasive ventilation failure: causes, risk factors, and potential remedies. BMC Pulm Med. 2014;14:19.
7. Esteban A, Ferguson ND, Meade MO, Frutos-Vivar F, Apezteguia C, Brochard L, et al. Evolution of mechanical ventilation in response to clinical research. Am J Respir Crit Care Med. 2008;177:170–7.
8. Del Sorbo L, Ranieri VM. We do not need mechanical ventilation any more. Crit Care Med. 2010;38:S555–8.
9. PausJenssen ES, Reid JK, Cockcroft DW, Laframboise K, Ward HA. The use of noninvasive ventilation in acute respiratory failure at a tertiary care centre. Chest. 2004;126:165–72.
10. Patel SP, Pena ME, Babcock CI. Cost-effectiveness of noninvasive ventilation for chronic obstructive pulmonary disease-related respiratory failure in Indian hospitals without ICU facilities. Lung India. 2015;32:549–56.
11. Rose L, Gray S, Atzema C, et al. Mechanical ventilation in the emergency department: a prospective observational pilot study. Acad Emerg Med. 2011;18:S208.
12. Groff P, Giostra F, Ansaloni S, Piccari L, Miglio F, Pratesi M, et al. Use of non-invasive mechanical ventilation in the Emergency Department, clinical outcomes and correlates of failure. Ital J Public

Health. 2008;5:198–211.
13. Winck JC, Azevedo LF, Costa-Pereira A, Antonelli M, Wyatt JC. Efficacy and safety of non-invasive ventilation in the treatment of acute cardiogenic pulmonary edema – a systematic review and meta-analysis. Crit Care. 2006;10:R69.
14. Naughton M, Rahman M, Hara K, Floras J, Bradley T. Effect of continuous positive airway pressure on intrathoracic and left ventricular transmural pressures in patients with congestive heart failure. Circulation. 1995;91:1725–31.
15. Penuelas O, Frutos-Vivar F, Esteban A. Noninvasive positive-pressure ventilation in acute respiratory failure. CMAJ. 2007;177:1211–8.
16. Confalonieri M, Garuti G, Cattaruzza M, et al. A chart of failure risk for noninvasive ventilation in patients with COPD exacerbation. Eur Respir J. 2005;25:348–55.
17. Mehta S, Hill N. Noninvasive ventilation: state of the art. Am J Respir Crit Care Med. 2001;163:540–77.
18. Keenan SP, Sinuff T, Burns KEA, Muscedere J, Kutsogiannis J, Mehta S, et al. Clinical practice guidelines for the use of noninvasive positive-pressure ventilation and noninvasive continuous positive airway pressure in the acute care setting. CMAJ. 2011;183:E195–214.
19. George IA, John G, John P, Peter JV, Christopher S. An evaluation of the role of noninvasive positive pressure ventilation in the management of acute respiratory failure in a developing country. Indian J Med Sci. 2007;61:495–504.
20. Antro C, Merico F, Urbino R, Gai V. Non-invasive ventilation as a first-line treatment for acute respiratory failure: “real life” experience in the emergency department. Emerg Med J. 2005;22:772–7.