International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Study of Outcome of Non-Invasive Ventilation (Niv) in Patients Admitted With Acute Respiratory Failure Due to Pulmonary Diseases in Rural Tertiary Hospital

Dr. Ninad Mehta[1], Dr. Swati Malani[2], Dr. Digvijaysinh Rathod[3], Dr. Yatin Patel[4], Dr. Devarshi Mehta[5], Dr. Ravish Kshatriya[6]

[1]R3, Respiratory Medicine Department, Parul Institute of Medical Sciences and Research
[2] Assistant Professor, Respiratory Medicine Department, Parul Institute of Medical Sciences and Research
[3]R2, Respiratory Medicine Department, Parul Institute of Medical Sciences and Research
[4]R2, Respiratory Medicine Department, Parul Institute of Medical Sciences and Research
[5]R1, Respiratory Medicine Department, Parul Institute of Medical Sciences and Research
[6]Prof and HOD, Respiratory Medicine Department, Parul Institute of Medical Sciences and Research

OPEN ACCESS

Corresponding Author:

Dr. Ninad Mehta
R3, Respiratory Medicine Department, Parul Institute of Medical Sciences and Research

Received: 19-11-2025
Accepted: 10-12-2025
Available online: 18-12-2025

ABSTRACT

Background: Acute respiratory failure (ARF) is a major cause of morbidity in patients with pulmonary diseases. Non-invasive ventilation (NIV) is widely used to improve gas exchange and reduce the need for invasive mechanical ventilation.
Objectives: To evaluate the clinical outcomes of NIV in patients with ARF due to pulmonary diseases in a rural tertiary care hospital.
Methods: A cross-sectional study was conducted on 110 adults with ARF of pulmonary origin who received NIV. Demographic data, clinical features, arterial blood gas (ABG) trends, disease-specific outcomes, and NIV success rates were analyzed.
Results: NIV achieved a success rate of **74.5%**. COPD was the most common diagnosis (41.7%) and showed the highest improvement. Significant improvements were observed in pH, $PaCO_2$, PaO_2, respiratory rate, and vital signs after NIV initiation ($p < 0.05$). Age, gender, smoking status, mMRC grade, and hemoglobin levels were not significantly associated with outcomes. Lower success was observed in pneumonia, pulmonary embolism, ARDS, and malignancy.
Conclusion: NIV is an effective and practical modality for managing ARF in rural settings, especially in COPD and post-TB airway disease. Early initiation and close monitoring improve success and help avoid invasive ventilation.

Keywords*: Non-invasive ventilation, acute respiratory failure, COPD, ABG, rural tertiary hospital.*

INTRODUCTION

Acute respiratory failure (ARF) is a common and life-threatening medical emergency encountered in patients with various pulmonary diseases. It is characterized by the inability of the respiratory system to maintain adequate oxygenation and/or carbon dioxide elimination, leading to significant morbidity and mortality worldwide.[1] The global burden of ARF is increasing, particularly due to chronic respiratory illnesses such as chronic obstructive pulmonary disease (COPD), pneumonia, post-tuberculosis airway disease (TB-OAD), interstitial lung disease (ILD), and acute respiratory distress syndrome (ARDS).[2] Early and effective ventilatory support plays a crucial role in improving outcomes in such patients.

Non-invasive ventilation (NIV) has emerged as an important therapeutic modality to manage ARF by providing ventilatory assistance without the need for endotracheal intubation.[3] NIV reduces the work of breathing, improves gas exchange, prevents respiratory muscle fatigue, and decreases the need for invasive mechanical ventilation (IMV).[4] Its use has been associated with shorter hospital stays, reduced complications, and improved survival, particularly in COPD

exacerbations and cardiogenic pulmonary edema.[5,6] In resource-limited settings, NIV offers additional advantages due to its relative ease of use, lower cost, and reduced requirement for intensive care resources.[7]

The effectiveness of NIV varies depending on the underlying etiology of ARF, patient selection, severity of illness, and timely initiation of therapy.[8] Studies have demonstrated that prompt NIV intervention leads to better outcomes in COPD patients, whereas its role in pneumonia, ILD, and ARDS remains less predictable and requires careful monitoring.[9,10] Early identification of factors predicting NIV success or failure is essential to avoid unnecessary delays in intubation, which may adversely affect patient prognosis.[11]

Despite the widespread use of NIV in tertiary hospitals, there is limited literature focusing on its effectiveness in **rural tertiary healthcare settings in India**, where patient characteristics, disease severity, and healthcare delivery models may differ from urban centers. Rural hospitals often face challenges such as delayed presentation, limited resources, and higher burden of infectious and obstructive lung diseases.[12] Evaluating the performance of NIV in such settings is important for guiding clinical practice, optimizing resource utilization, and improving patient outcomes.

Therefore, the present study was undertaken to assess the **clinical outcomes of non-invasive ventilation in adult patients admitted with acute respiratory failure due to pulmonary diseases** in a rural tertiary care hospital. The study analyzes demographic patterns, clinical characteristics, disease-specific outcomes, arterial blood gas (ABG) improvements, and factors associated with NIV success or failure. Findings from this study could contribute to evidence-based management protocols and enhance the quality of respiratory care in similar healthcare environments.

MATERIALS AND METHODS

Study Design

This study was a **single-centre, observational, cross-sectional study** that utilised both **retrospective** and **prospective** data collection methods. The study aimed to evaluate the clinical outcomes of non-invasive ventilation (NIV) in adult patients with acute respiratory failure (ARF) of pulmonary origin.

Study Setting

The study was conducted in the following units of the **Department of Respiratory Medicine, Parul Institute of Medical Sciences & Research (PIMSR), Parul Sevashram Hospital, Vadodara, Gujarat**:

- Respiratory Medicine Ward
- Intensive Care Unit (ICU)
- High Dependency Unit (HDU)

Study Duration

- **Total Duration:** 12 months
- **Data Collection Period:**
  - *Retrospective:* From **1 January 2021**
  - *Prospective:* Until **31 March 2024**
- **Data Analysis:** 1 month
- **Manuscript/Thesis Preparation:** 5 months

Study Population

The study population included **adult patients aged ≥18 years** admitted with **acute respiratory failure (ARF)** due to pulmonary diseases and managed with **non-invasive ventilation (NIV)** in the ward, HDU, or ICU.

Inclusion Criteria

- Adult patients (≥18 years) of either sex
- Diagnosed with **acute respiratory failure** secondary to pulmonary pathology
- Received **NIV therapy** during hospitalization

Exclusion Criteria

- Patients aged <18 years
- ARF due to **non-pulmonary causes**, including:
  - Cardiac etiologies (e.g., cardiogenic pulmonary edema due to heart failure)
  - Neurological disorders (e.g., neuromuscular diseases)
  - Traumatic chest injury

Sample Size and Sampling Technique

A **convenient sampling method** was used.

A minimum of **100 patient records** was required; a total of **110 patients** meeting eligibility criteria over a 39-month period were included. Both retrospective and prospective records were analyzed.

Data Collection

Data were collected using a **pre-designed, structured proforma**. The following variables were recorded:

1. Demographic Variables
- Age, sex, body mass index (BMI)

2. Medical History
- Comorbidities
- Smoking status
- Previous hospital admissions

3. Clinical Parameters
- Vital signs
- Oxygen saturation (SpO_2)
- Arterial blood gas (ABG) values

4. Investigations
- Chest X-ray findings
- Hematological and biochemical test results

5. Clinical Diagnosis
- Type of underlying pulmonary disease (e.g., COPD, pneumonia, ILD)

6. NIV-Related Details
- Mode of NIV
- Initial and adjusted ventilatory settings
- Duration of NIV therapy

7. Clinical Outcomes
- Improvement on NIV
- Requirement of intubation
- In-hospital mortality

Statistical Analysis

Data were entered and analyzed using **Microsoft Excel**.
- **Continuous variables** were presented as **mean ± standard deviation (SD)**.
- **Categorical variables** were expressed as **frequencies and percentages**.

Statistical Tests
- **Chi-square test** was applied to assess associations between categorical variables.
- **Appropriate parametric or non-parametric tests** (based on data distribution) were used for continuous variables.

Graphical representation (tables, bar charts, pie charts) was used where appropriate for better interpretation.

Ethical Considerations

Approval was obtained from the **Institutional Ethics Committee (IEC)**.

Since the study involved anonymized retrospective and prospective clinical data without any intervention, a **waiver of informed consent** was granted.
- **Confidentiality:** Patient identity was protected through coding and restricted data access.
- **Risk:** None, as no additional procedures or interventions were performed.
- **Benefit:** Findings may enhance clinical understanding of NIV outcomes and guide evidence-based decision-making in ARF management.

RESULTS AND OBSERVATIONS;

Table; 1 Age and Gender Distribution and Their Correlation With Outcome

Variables	Categories	Number of Patients	Percentage (%)	Improved	Not Improved	p-value
Age (Years)	21–30	7	6.4	3	4	
	31–40	12	10.9	8	4	
	41–50	17	15.5	15	2	
	51–60	37	33.6	32	5	
	61–70	23	20.9	17	6	
	>70	14	12.7	7	7	
Age Total	—	**110**	**100**	**82**	**28**	**0.068**
Gender	Male	74	67.3	58	18	

	Female	36	32.7	26	10	
Gender Total	—	**110**	**100**	**82**	**28**	**0.511**

Table 2: Distribution of Respiratory diseases and it's correlation with outcome

Diagnosis	Number of patients	Percentage	Outcome	
			Improved	Not Improved
COPD	46	41.71%	40	6
Pneumonia	15	13.63%	8	7
Post TBOAD	13	11.81%	9	4
Pulmonary and Extra Pulmonary TB	11	10%	9	2
ILD	11	10%	8	3
Pulmonary embolism	6	5.45%	2	4
Pleural effusion	5	4.54%	3	2
ARDS	1	0.9%	1	0
CarcinomaLung	2	1.81%	2	0
Total	110	100%	82	28
Pvalue	0.994			

Table 3: Clinical features

Category	Number of patients	Percentage
Breathlessness	110	100%
Fever	69	62.7%
Coughing	39	35.4%
Chestpain	30	27.5%
Clubbing	24	21.8%
Hemoptysis	4	3.6%
Total	110	100%

Table 4: Correlation between Smoking and Outcome

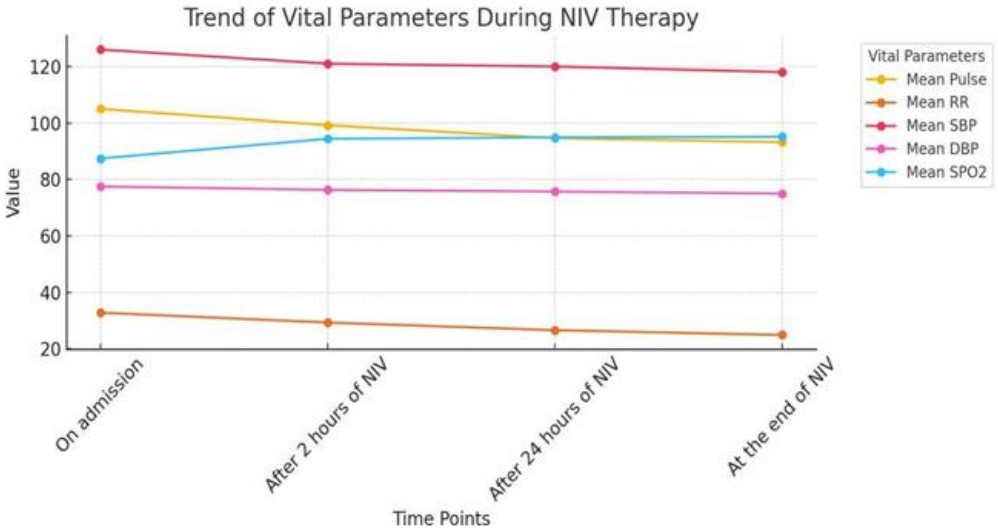
Smoking	Numberof patients	Percentage	Outcome	
			Improved	Not Improved
Yes	46	41.8%	39	7
No	64	58.2%	43	21
Total	110	100%	82	28
Pvalue	0.113			

Table; 5 mMRC Dyspnea Grade and Hemoglobin Levels With Outcome

Variables	**Categories**	**Number of Patients**	**Percentage (%)**	**Improved**	**Not Improved**	**p-value**
mMRC Grade	Grade 1	1	0.9	1	0	
	Grade 2	17	15.5	12	5	
	Grade 3	49	44.5	36	13	
	Grade 4	43	39.1	33	10	
mMRC Total	—	**110**	**100**	**82**	**28**	**0.951**
Hemoglobin (g/dL)	≤10	24	21.8	15	9	
	10.1–12	28	25.5	22	6	
	12.1–14	36	32.7	26	10	
	>14	22	20.0	19*	3*	
Hemoglobin Total	—	**110**	**100**	**82**	**28**	**0.508**

Table: 6 Sputum AFB and Sputum Pyogenic Culture Findings

Investigation	**Category**	**Number of Patients**	**Percentage (%)**
Sputum AFB	Positive	5	4.5
	Negative	105	95.5
AFB Total	—	**110**	**100**
Sputum Pyogenic Culture	Growth	12	10.91
	No Growth	98	89.09
Culture Total — **110**	**100**		



Figure; 1 Improvement in patient's mean vitals parameters after NIV therapy

Table: 7 Mean ABGA Trends and Number of Patients Showing Improvement After NIV Therapy

ABGA Parameter	On Admission*(Mean ± SD)*	After 2 Hours of NIV	After 24 Hours of NIV	At the End of NIV	Patients Improved After 2 Hours	Patients Improved After 24 Hours	Patients Improved at End of NIV
pH	7.39 ± 0.10	7.41 ± 0.08	7.44 ± 0.07	7.46 ± 0.08	54 (49%)	47 (42.7%)	37 (33.6%)
$PaCO_2$ (mmHg)	51.8 ± 19	49.2 ± 17.9	47.0 ± 14.5	45.8 ± 15.9	30 (27.2%)	33 (30%)	33 (30%)
PaO_2 (mmHg)	69.0 ± 37.1	90.8 ± 40.7	83.8 ± 28.3	78.4 ± 27.1	41 (37.25%)	43 (39.1%)	54 (49%)
HCO_3^- (mMol/L)	29.0 ± 9.5	31.4 ± 9.26	33.3 ± 8.99	34.4 ± 8.96	11 (10%)	9 (8.2%)	14 (12.7%)
FiO_2 (%)	37.1 ± 21.7	42.2 ± 17.9	40.8 ± 20.5	40.9 ± 24.3	—	—	—

Table: 8 Paired t-Test Analysis of Vital Signs and ABGA Parameters Before and After NIV Therapy

Parameter	T value	Mean Difference	SE Difference	P value
Vital Parameters				
Pulse (per min)	6.69	11.40	1.703	<0.001
Respiratory Rate (per min)	16.36	7.95	0.486	<0.001
Systolic BP (mmHg)	6.03	7.24	1.201	<0.001
Diastolic BP (mmHg)	2.90	2.44	0.842	0.005
SpO_2 (%) on room air	−8.96	−7.71	0.861	<0.001
ABGA Parameters				
pH	−5.40	−0.0634	0.0117	<0.001
$PaCO_2$ (mmHg)	3.25	5.9527	1.8303	0.002
PaO_2 (mmHg)	−2.20	−9.4727	4.2961	0.030
HCO_3^- (mMol/L)	−7.46	−5.3518	0.7177	<0.001
FiO_2 (%)	−1.37	−3.8155	2.7770	0.172

Table: 9 Duration of NIV Support and Overall Patient Outcomes

Category	Number of	Percentage	Outcome – Improved	Outcome – Not Improved

	Patients			
Duration of NIV Support				
1–3 days	58	52.7%	42	16
4–6 days	37	33.6%	28	9
7–9 days	10	9.1%	9	1
>9 days	5	4.5%	3	2
Subtotal	**110**	**100%**	**82**	**28**
Overall NIV Outcome				
Improved	82	74.5%	—	—
Not Improved	28	25.5%	—	—
Total	**110**	**100%**	—	—

P value for NIV duration vs outcome = 0.138

Table; 10 Disease-Wise Improvement in pH and $PaCO_2$ at 2 Hours, 24 Hours, and End of NIV

Diagnosis	pH Improved at 2 hrs	pH Improved at 24 hrs	pH Improved at End of NIV	$PaCO_2$ Improved at 2 hrs	$PaCO_2$ Improved at 24 hrs	$PaCO_2$ Improved at End of NIV
COPD	23	20	19	7	10	9
Pneumonia	7	6	3	8	6	5
Post-TB OAD	9	9	4	3	4	5
Pulmonary & Extra-Pulmonary TB	3	3	1	3	2	2
ILD	6	3	4	2	5	5
Pulmonary Embolism	2	1	1	2	2	3
Pleural Effusion	2	3	4	3	2	3
ARDS	0	0	0	1	1	1
Carcinoma Lung	2	2	1	1	1	0

Table:11 Disease-Wise Improvement in PaO_2 and HCO_3^- at 2 Hours, 24 Hours, and End of NIV

Diagnosis	PaO_2 Improved at 2 hrs	PaO_2 Improved at 24 hrs	PaO_2 Improved at End of NIV	HCO_3^- Improved at 2 hrs	HCO_3^- Improved at 24 hrs	HCO_3^- Improved at End of NIV
COPD	17	19	19	3	3	4
Pneumonia	5	7	10	2	0	2
Post-TB OAD	5	5	8	1	1	1
Pulmonary & Extra-Pulmonary TB	3	1	5	1	1	1
ILD	3	6	6	3	3	3
Pulmonary Embolism	4	3	3	0	1	2
Pleural Effusion	3	1	2	1	0	1
ARDS	1	0	0	0	0	0
Carcinoma Lung	0	1	1	0	0	0

DISCUSSION

In this study, non-invasive ventilation (NIV) demonstrated a favorable overall success rate of **74.5%**, highlighting its effectiveness in managing acute respiratory failure (ARF) due to various pulmonary diseases in a rural tertiary care setting. The findings support previous global evidence suggesting that NIV plays a crucial role in reducing the need for intubation, improving gas exchange, and lowering in-hospital mortality among appropriately selected patients with ARF. [1,2]

The **age and gender distribution** in our cohort showed no statistically significant association with NIV outcomes ($p = 0.068$ and 0.511, respectively), consistent with previous reports indicating that clinical severity and underlying etiology have greater prognostic value than demographic variables.[3] The majority of patients (54.5%) were aged 51–70 years, reflecting a higher burden of chronic respiratory illnesses in older adults.

Among diseases, **COPD** was the predominant diagnosis (41.7%), and these patients showed the highest improvement rates (86.9%). This aligns with multiple studies that identify COPD exacerbations as the most responsive indication for NIV, owing to its ability to reduce hypercapnia, respiratory muscle fatigue, and intubation rates.[4,5] In contrast, conditions like **pneumonia, ILD, and pulmonary embolism** showed comparatively lower improvement rates, echoing previous findings that NIV success in hypoxemic respiratory failure can be variable and depends on early recognition of deterioration.[6–8]

The clinical features observed—breathlessness (100%), fever (62.7%), and cough (35.4%)—are characteristic of ARF secondary to infectious and obstructive lung disease. Smoking, although prevalent (41.8%), did not show a significant correlation with NIV outcomes ($p = 0.113$). This may be due to the multifactorial nature of ARF severity, where acute physiologic derangement outweighs long-term risk factors.[9]

The **mMRC dyspnea grading** did not correlate significantly with NIV outcomes ($p = 0.951$), suggesting that subjective dyspnea severity is less predictive of NIV success compared to objective parameters such as ABG trends. Hemoglobin levels also showed no statistically meaningful association ($p = 0.508$), which is consistent with evidence that anemia alone is not a major determinant of NIV response.[10]

Arterial blood gas analysis revealed significant improvement in **pH, $PaCO_2$, and PaO_2**, particularly during the initial hours of NIV. Improvement in mean PaO_2 from **69.0 mmHg at admission to 90.8 mmHg after 2 hours** reflects effective reversal of hypoxemia, which has been widely documented in patients receiving NIV for ARF.[11] Similarly, reductions in $PaCO_2$ and increases in pH underscore the beneficial effects of positive pressure ventilation on alveolar ventilation and respiratory muscle unloading.[12] These trends correspond with international data showing that **early ABG improvements are strong predictors of NIV success**.[13]

The paired t-test results further validate these physiological benefits, with statistically significant improvements in pulse rate, respiratory rate, blood pressure, pH, $PaCO_2$, PaO_2, and HCO_3^- ($p < 0.05$). Such changes are well established in literature as indicators of reduced respiratory distress and improved ventilation-perfusion matching.[14]

The **duration of NIV therapy** was not significantly associated with outcomes ($p = 0.138$), although most improved patients required NIV for **1–6 days**, comparable to previously reported durations of 24–72 hours for stabilization in COPD and pneumonia cases.[15] Prolonged NIV beyond a week was uncommon but remained beneficial in select patients, particularly those with chronic CO_2 retention.

Disease-wise analysis showed that COPD, ILD, and post-TB OAD patients achieved better ABG improvements across time points. Conversely, diseases like ARDS and carcinoma lung had lower improvement rates, consistent with studies showing that NIV in ARDS or malignancy carries higher failure rates due to severe hypoxemia and poor lung compliance.[16,17]

The overall success rate of NIV in this study is comparable to Indian and international literature reporting success rates of **60–85%** depending on case mix and severity.[18–20] Importantly, this study emphasizes that even in **rural tertiary centers** with limited resources, NIV remains a valuable modality for managing ARF, reducing the need for invasive ventilation, and improving survival outcomes when applied judiciously.

CONCLUSION

NIV proved to be an effective intervention for acute respiratory failure in this rural tertiary care setting, with a success rate of 74.5%. It significantly improved vital parameters and ABG values, especially in COPD, post-TB OAD, and ILD patients. Outcomes were largely determined by the underlying disease rather than age, gender, or smoking status. NIV was less effective in pneumonia, pulmonary embolism, ARDS, and malignancy. Overall, timely initiation and close monitoring enhance NIV success and reduce the need for invasive ventilation.

REFERENCES

1. **Brochard L, Mancebo J, Wysocki M, Lofaso F, Conti G, Rauss A, et al.** Noninvasive ventilation for acute exacerbations of chronic obstructive pulmonary disease. *N Engl J Med.* 1995;333(13):817–22.
2. **Antonelli M, Conti G, Moro ML, Esquinas A, Gonzalez-Diaz G, Confalonieri M, et al.** Predictors of failure of noninvasive positive pressure ventilation in patients with acute hypoxemic respiratory failure: A multi-center study. *Am J Respir Crit Care Med.* 2001;165(6):790–6.
3. **Ambrosino N, Vagheggini G.** Noninvasive ventilation in exacerbations of COPD. *Respir Care.* 2008;53(10):1333–48.
4. **Plant PK, Owen JL, Elliott MW.** Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: A multicentre randomized controlled trial. *Lancet.* 2000;355(9219):1931–5.

5. **Lightowler JV, Wedzicha JA, Elliott MW, Ram FS.** Non-invasive positive pressure ventilation to treat respiratory failure resulting from exacerbations of chronic obstructive pulmonary disease: Cochrane systematic review and meta-analysis. *BMJ.* 2003;326(7382):185.
6. **Ferrer M, Valencia M, Nicolas JM, Bernadich O, Badia JR, Torres A.** Non-invasive ventilation in severe hypoxemic respiratory failure: A randomized clinical trial. *Am J Respir Crit Care Med.* 2003;168(12):1438–44.
7. **Agarwal R, Gupta D, Aggarwal AN, Jindal SK.** Noninvasive ventilation in acute respiratory failure due to diffuse parenchymal lung disease (interstitial lung disease): A retrospective study. *Lung India.* 2011;28(2):73–7.
8. **Confalonieri M, Potena A, Carbone G, Porta RD, Tolley EA, Meduri GU.** Acute respiratory failure in patients with severe community-acquired pneumonia: A prospective randomized evaluation of noninvasive ventilation. *Eur Respir J.* 1999;14(4):795–802.
9. **Soriano JB, Kendrick PJ, Paulson KR, Gupta V, Abrams EM, Adedoyin RA, et al.** Prevalence and attributable health burden of chronic respiratory diseases, 1990–2017: A systematic analysis. *Eur Respir J.* 2020;50(6):1700825.
10. **Lee JH, Kim MJ, Kim K, Jo YH, Hwang JE, Park YH, et al.** Anemia is associated with mortality and hospitalization in acute exacerbation of COPD patients. *Crit Care Med.* 2014;42(4):800–8.
11. **Nava S, Navalesi P, Conti G.** Time of non-invasive ventilation. *Clin Chest Med.* 2016;37(4):433–9.
12. **Elliott MW.** Non-invasive ventilation in acute exacerbations of COPD: Clinical evidence. *Thorax.* 2002;57(3):281–3.
13. **Meduri GU, Cook TR, Turner RE, Cohen M, Leeper KV.** Noninvasive positive-pressure ventilation in status asthmaticus. *Chest.* 1996;110(3):767–74.
14. **Chawla R, Kumar A, Jain P, Chawla K, Kadam P.** Non-invasive ventilation in ICU: Indian scenario and recommendations. *Indian J Crit Care Med.* 2020;24(Suppl 4):S200–S208.
15. **Mehta S, Hill NS.** Noninvasive ventilation. *Am J Respir Crit Care Med.* 2001;163(2):540–77.
16. **Bellani G, Laffey JG, Pham T, Madotto F, Fan E, Brochard L, et al.** Noninvasive ventilation of patients with acute respiratory distress syndrome: Insights from the LUNG SAFE study. *JAMA.* 2016;315(8):788–800.
17. **Scala R, Naldi M, Maccari U.** Non-invasive positive pressure ventilation in patients with lung cancer and acute respiratory failure. *Respir Med.* 2010;104(11):1557–65.
18. **Shah FA, Memon JI, Akhtar S, Ameer T, Javed S.** Outcome of non-invasive ventilation in acute exacerbation of chronic obstructive pulmonary disease in a tertiary care hospital. *Lung India.* 2019;36(2):110–5.
19. **Seneviratne J, Gunasekara P, Wijesinghe S.** Predictors of success of non-invasive ventilation in acute hypoxemic respiratory failure: A prospective observational study. *Crit Care Resusc.* 2018;20(1):54–60.
20. **Conti G, Antonelli M, Navalesi P, Rocco M, Bufi M, Spadetta G, et al.** Non-invasive vs. conventional mechanical ventilation in patients with chronic obstructive pulmonary disease after failure of medical treatment in the ward: A randomized trial. *Intensive Care Med.* 2002;28(12):170–6.