BJHS
Birat Journal of Health Sciences

ISSN:

2542-2758 (Print) 2542-2804 (Online)

ARTICLE INFO:

Received date: October 20, 2025
Accepted date: December 16, 2025
Published date: December 31, 2025

KEYWORDS:

Chronic Obstructive Pulmonary Disease; Morbidity; Mortality.

CORRESPONDING AUTHOR:

Niraj Bam
Associate Professor,
Department of Pulmonology and Critical Care Medicine
Tribhuvan University Teaching Hospital, Kathmandu, Nepal, 44600
Email: nirajbam19@gmail.com
ORCID ID: 0009-0009-2851-2925

Access the article online

DOI: 10.62065/bjhs706

CITATION:

Bam N, Shrestha TN, Das SK, Shrestha B. Effect of Timing and Duration of Non-Invasive Ventilation on Outcomes in Acute Exacerbation of COPD: A Prospective Study from Nepal. 2025; 10 (3): 85-90.

Effect of Timing and Duration of Non-Invasive Ventilation on Outcomes in Acute Exacerbation of COPD: A Prospective Study from Nepal

Niraj Bam[1*], Tek Narayan Shrestha[1], Santa Kumar Das[1], Bibek Shrestha[2]

[1] Tribhuvan University Teaching Hospital, Kathmandu, Nepal
[2] Tribhuvan University, Institute of Medicine, Kathmandu Nepal

ABSTRACT

Introduction: Acute exacerbation of chronic obstructive pulmonary disease is a major cause of hospital admissions and mortality among patients with COPD, particularly in low- and middle-income countries. Non-invasive positive pressure ventilation is a cornerstone in the management of AECOPD with type 2 respiratory failure, shown to reduce intubation rates and mortality. However, clinical outcomes may depend on factors such as timing of initiation, ventilatory pressures, and duration of therapy, which remain underexplored in South Asian settings.
Objective: To evaluate the effect of timing and duration of NIPPV on clinical outcomes among patients admitted with AECOPD and type 2 respiratory failure at a tertiary care hospital in Nepal.

Methodology: A prospective observational cohort study was conducted among 246 AECOPD patients requiring NIPPV at Tribhuvan University Teaching Hospital, Kathmandu. Data on time to NIPPV initiation, pressure settings, session duration, and total NIPPV use were collected. The primary outcome was NIPPV success or failure (defined as need for invasive ventilation or in-hospital death). Statistical analyses included t-test, Mann-Whitney U, and Chi-square tests with significance at $p < 0.05$.

Results: Of 246 patients, 208 (84.6%) had successful NIPPV outcomes. Early initiation (<2 hours) showed higher success (89.4%) though not statistically significant ($p > 0.05$). Mean IPAP was significantly higher in the failure group (15.5 ± 1.0 cm H_2O) than in the success group (13.9 ± 2.4 cm H_2O, $p < 0.0001$). The duration of the first NIPPV session and the total duration of NIPPV use did not show any significant association with NIPPV success ($p > 0.05$). The length of hospital stay was longer in the failure group, although this was a secondary outcome.

Conclusion: In this cohort, early initiation of NIPPV and duration of NIPPV use did not demonstrate statistically significant effects on treatment success. While numerical trends favored early initiation, these findings are hypothesis-generating and not conclusive. Appropriate pressure titration and close monitoring remain essential for optimizing outcomes.

Introduction

Chronic obstructive pulmonary disease (COPD) is a major cause of morbidity and mortality worldwide and represents a significant public health challenge, particularly in low- and middle-income countries like Nepal.[1] Acute exacerbations of COPD (AECOPD) frequently result in acute respiratory failure, often necessitating ventilatory support.[2] Non-invasive positive pressure ventilation (NIPPV) has become an essential component in the management of AECOPD with type 2 respiratory failure, effectively reducing the need for intubation, complications,

and mortality compared to invasive mechanical ventilation.[3] However, the clinical outcomes of NIPPV are influenced by several factors, including the timing of its initiation, ventilatory pressure settings, and duration of application.

Early initiation of NIPPV is believed to prevent the progression of respiratory failure by improving gas exchange and reducing the work of breathing. Conversely, delayed initiation or inappropriate pressure titration may lead to treatment failure, requiring invasive ventilation.[4] Studies conducted in Western settings have established the efficacy of NIPPV, but there is limited evidence from South Asian populations, where disease severity, comorbidities, and healthcare resources differ.[5] Furthermore, optimal timing and duration parameters for NIPPV remain inadequately explored in the context of AECOPD in resource-limited environments.

This study was therefore designed to evaluate the effect of timing and duration of NIPPV on clinical outcomes among patients admitted with AECOPD and type 2 respiratory failure at a tertiary care center in Nepal. The findings aim to guide evidence-based NIPPV practices and improve patient outcomes in similar healthcare settings.

Methodology

This prospective observational cohort study was conducted at the Tribhuvan University Teaching Hospital, Kathmandu. The study aimed to evaluate the effect of timing and duration of NIPPV on clinical outcomes among patients admitted with AECOPD and type 2 respiratory failure. Ethical approval was obtained from the Institutional Review Committee (IRC) of the Institute of Medicine [Ref. No. 14(6-11) E2], and written informed consent was taken from all participants or their legal guardians as appropriate.

Adult patients aged 40 years and above with a clinical diagnosis of AECOPD and type 2 respiratory failure ($PaCO_2$ >45 mmHg, pH <7.35) who were initiated on NIPPV in BiPAP mode during admission were included. Patients aged below 40 years, those with prior home NIPPV use, post-extubation NIPPV, pregnancy, do-not-resuscitate (DNR) status, or refusal or inability to consent were excluded. The diagnosis of COPD was based on clinical and radiologic findings and supported by spirometry (FEV_1/FVC <70%) when available.

The sample size was calculated using Cochran's formula, assuming a 20% NIPPV failure rate from a previous study by Moretti et al, with a 95% confidence level and 5% margin of error, yielding a required sample of 246 participants.[6] Data were collected prospectively using a structured proforma including demographic details (age, sex, body mass index), clinical parameters, and NIPPV-related variables. The parameters recorded included time from presentation to NIPPV initiation, inspiratory positive airway pressure (IPAP), expiratory positive airway pressure (EPAP), and duration of the first NIPPV session. The total duration of NIPPV use and length of hospital stay were also documented. The parameters recorded included time from presentation to NIPPV initiation, inspiratory positive airway pressure (IPAP), expiratory positive airway pressure (EPAP), and duration of the first NIPPV session. Time from presentation to NIPPV initiation was recorded prospectively and calculated as the interval between the first ER clinical encounter and the start of BiPAP therapy, and was further categorized into early (<2 hours) and late (≥2 hours) initiation for analysis. The total duration of NIPPV use and length of hospital stay were also documented.

Data were checked for normality using the Shapiro–Wilk test. Normally distributed continuous variables were presented as mean ± standard deviation (SD) and compared using the independent sample t-test, while non-normally distributed variables were summarized as median (IQR) and compared using the Mann–Whitney U test. Categorical variables were presented as frequencies and percentages, and associations between categorical variables (including timing of NIPPV initiation and NIPPV outcome) were assessed using the Chi-square test or Fisher's exact test as appropriate. A p-value <0.05 was considered statistically significant.

Results

A total of 246 patients with acute exacerbation of chronic obstructive pulmonary disease (AECOPD) requiring non-invasive positive pressure ventilation (NIPPV) were included in this prospective study. The mean age of the participants was 70.7 ± 9.4 years, with the majority (43.9%) in the 71–80-year age group (Figure 1).

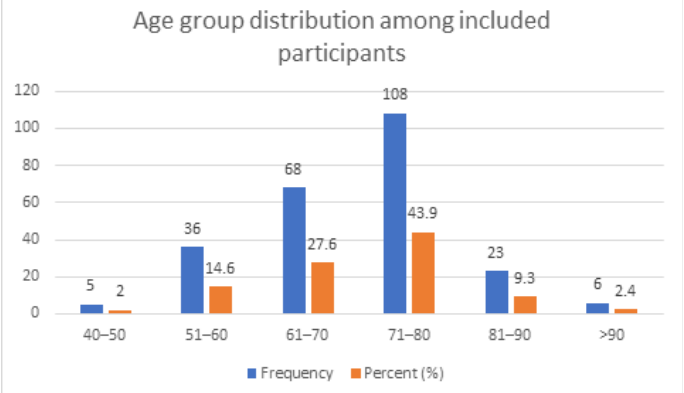

Figure 1: Age group distribution.

Female patients comprised 57.3%, while males accounted for 42.7% (Figure 2). The mean height, weight, and BMI were 63.4 ± 2.2 inches, 51.7 ± 6.1 kg, and 20.0 ± 2.5 kg/m², respectively (Table 1).

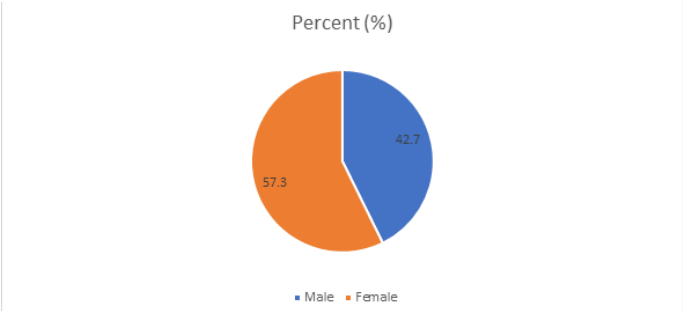

Figure 2: Sex distribution

Table 1: Demographic Characteristics of the Study Participants (n = 246)

Variable	Category / Unit	Value
Age	Mean ± SD (years)	70.7 ± 9.4
	40–50	5 (2.0%)
	51–60	36 (14.6%)
	61–70	68 (27.6%)
	71–80	108 (43.9%)
	>80 (81–90; >90 combined)	29 (11.7%)
Sex	Male	105 (42.7%)
	Female	141 (57.3%)
Anthropometry	Height (inch), mean ± SD	63.4 ± 2.2
	Weight (kg), mean ± SD	51.7 ± 6.1
	BMI (kg/m^2), mean ± SD	20.0 ± 2.5

Regarding NIPPV initiation timing, the mean time from presentation to NIPPV initiation was 1.6 ± 2.0 hours in the success group and 1.2 ± 1.7 hours in the failure group; however, this difference was not statistically significant (p = 0.122). The majority of patients (90.7%) received NIPPV early, within the first two hours of presentation, and this subgroup demonstrated a higher success rate (89.4%) compared to those initiated late (10.6%), though the difference was not significant (p > 0.05). The initial inspiratory positive airway pressure (IPAP) setting showed a statistically significant difference between the two groups. The mean IPAP among those with successful NIPPV outcomes was 13.9 ± 2.4 cm H_2O, compared to 15.5 ± 1.0 cm H_2O in the failure group (p < 0.0001), suggesting that excessively high initial pressures might be associated with poorer tolerance or outcomes. The expiratory positive airway pressure (EPAP) did not differ significantly between groups (5.1 ± 0.5 vs. 5.0 ± 0.3 cm H_2O, p = 0.374). Similarly, the duration of the first NIPPV session was comparable between success (5.6 ± 1.0 hours) and failure groups (5.7 ± 0.6 hours, p = 0.897) (Table 2).

Table 2: Association between Timing of Initiation and NIPPV Outcome

At the time of Initiation	NIPPV Outcome Success (N=208)	NIPPV Outcome Failure (N=38)	Total	P-value
Timing of initiation of NIPPV hour	1.6±2.0	1.2±1.7		0.122
Early	186(89.4%)	37(97.4%)	223(90.7%)	
Late	22(10.6%)	1(2.6%)	23(9.3%)	
IPAP at initiation	13.9±2.4	15.5±1.0	14.1±2.3	<0.0001
EPAP at initiation	5.1±0.5	5.0±0.3	5.1±0.5	0.374
Duration of 1st NIPPV	5.6±1.0	5.7±0.6	5.6±1.0	0.897

Mann-Whitney U test, Chi-Square Test

In terms of overall NIPPV use and hospitalization, the mean total duration of NIPPV until the outcome event was 16.2 ± 8.2 hours in the success group and 16.9 ± 8.0 hours in the failure group, showing no significant difference (p = 0.363). However, a marked difference was noted in length of hospital stay, which was significantly longer among patients with NIPPV failure (9.9 ± 4.2 days) compared to those who improved with NIPPV (6.3 ± 1.5 days, p < 0.0001) (Table 3, Figure 3). These finding highlights that delayed response or failure to NIPPV is associated with prolonged hospitalization and possibly more severe disease trajectory.

Table 3: Association between Duration and NIPPV Outcome

Duration	NIPPV Outcome Success (N=208)	NIPPV Outcome Failure (N=38)	Mean Difference	95% CI	P-value
Duration of NIPPV to outcome event, in Hours	16.2±8.2	16.9±8.0	0.7	0.2–32.5	0.363
Length of hospital stay, days	6.3±1.5	9.9±4.2	3.6	1.9–11.1	<0.0001

Mann-Whitney U test

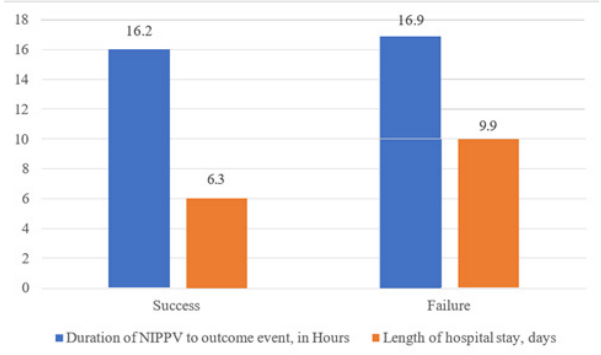

Figure 3: Association between duration and NIPPV outcome

Discussion

NIPPV has revolutionized the management of AECOPD with type 2 respiratory failure by reducing the need for endotracheal intubation, lowering complications, and improving survival outcomes.[7] Its effectiveness is now well established across various clinical settings, but the timing of initiation, pressure titration, and duration of use remain crucial determinants of success. Gudelli et al. (2024) reported an 84% NIPPV success rate with significant improvement in ABG and reduced hospital stay among 50 AECOPD patients.[8] Khilnani et al. (2010) observed that NIPPV improved gas exchange and reduced intubation need in 90% of cases with very high $PaCO_2$, while Shaheen et al. (2018)

found a 76% success rate versus 20% in conventional therapy.[7,9] Similarly, Liu et al. (2005) showed that early NIPPV reduced respiratory fatigue and intubation in 36 patients.[10]

In the present study, although a large majority of patients (90.7%) received NIPPV within the first two hours of presentation, early initiation did not demonstrate a statistically significant improvement in NIPPV success (89.4% vs. 97.4%, p > 0.05). Therefore, our findings do not establish that early initiation independently improves outcomes, and the observed numerical trend should be interpreted as hypothesis-generating rather than conclusive. Likewise, the duration of the first NIPPV session and the total duration of NIPPV use showed no significant association with treatment success. The only parameter that differed was length of hospital stay, which was longer among patients with NIPPV failure; however, this was a secondary outcome and was not the primary aim of the study. Plant et al. (2000) found that early ward-based NIPPV reduced intubation and mortality in AECOPD.[11] Brochard et al. (1995) provides strong evidence supporting this claim, demonstrating significant reductions in endotracheal intubation (from 74% to 26%), hospital stay duration (from 35 to 23 days), and in-hospital mortality (from 29% to 9%). The study's large sample size (85 patients) and statistically significant results (P < 0.001 for intubation reduction) offer robust validation of early NIV initiation benefits.[12] Additional research P. Lindenauer et al. (2014) further confirms these findings in broader clinical settings.[13] Our observation that patients in the failure group required significantly higher IPAP echoes findings from Moretti et al. (2000) who reported that excessively high starting pressures may indicate greater disease severity, reduced tolerance, or patient–ventilator asynchrony.6 Conversely another study emphasized that gradual pressure escalation tailored to patient comfort improves compliance and outcomes, supporting our recommendation for individualized pressure titration rather than fixed high settings.[14]

The mean total NIPPV duration (~16 hours) showed no significant impact on success or failure, aligning with Khilnani et al. (2010) and Carrillo et al. (2012), who reported that early physiologic improvement—within the first 1–2 hours—predicts outcome better than total ventilation time.[9,15] Our study also found a significantly longer hospital stay among NIPPV failures (9.9 ± 4.2 days) than successes (6.3 ± 1.5 days), which parallels the results of A. Taha et al. (2019) which found that NIPPV failure patients had longer hospital stays, while N. Rathi et al. (2017) reported the NIPPV failure group had the greatest hospital length of stay and highest mortality rates.[16,17] Annelijn M. Meeder et al. (2016) further confirmed that NIPPV failure was associated with longer ICU stay and lower survival rates.[18] T. Corrêa et al., 2015 specifically noted NIPPV failure was linked to increased in-hospital death risk and substantially longer ICU and hospital stays (median 12 vs. 2 days in ICU, 30 vs. 15 days in hospital).[19] Regionally, our findings resonate with Bhattacharyya et al. (2011, India), who reported early NIPPV success rates exceeding 80% when initiated promptly with moderate pressures.[4] Together, these South Asian data strengthen the evidence that timely recognition, careful titration, and protocolized monitoring can achieve outcomes comparable to high-income settings despite limited ICU resources.

Our demographic profile—with elderly predominance (mean age 70.7 years) and slightly higher female representation—reflects local epidemiology, where biomass exposure and delayed diagnosis drive COPD burden among older women, as previously noted by Adhikari et al. (2018).[1] A. Petroianni et al. (2018) found NIV efficacy in BMI subgroups below 20 kg/m², while J. Berkius et al. (2010) demonstrated long-term survival benefits for low-BMI COPD patients using NIV.[20,21] S. Budweiser et al. (2006) noted that malnourished COPD patients (BMI < 20 kg/m²) even experienced significant weight gain after NIV initiation.[22] Critically, A. Thille et al. (2021) showed NIV's differential effectiveness, with significant reintubation risk reduction in obese/overweight patients but not in normal or underweight patients.[23]

Conclusion

This study reaffirms the pivotal role of NIPPV in the management of AECOPD with type 2 respiratory failure. In our cohort, most patients responded favorably to NIPPV, reflecting both its efficacy and feasibility in a tertiary hospital setting in Nepal. In our cohort, early initiation of NIPPV was common; however, it did not demonstrate a statistically significant association with NIPPV success. Therefore, while early initiation remains clinically desirable based on prior literature, our study does not provide evidence that timing independently influences outcomes.

Equally important, our results suggest that excessively high inspiratory pressures at the onset may predict poorer tolerance or underlying disease severity, highlighting the need for gradual, patient-tailored titration rather than aggressive initial settings. The lack of significant difference in total NIPPV duration between success and failure groups indicates that early physiologic response and appropriate pressure adjustment matter more than total ventilation hours

Recommendations

Although early initiation is widely recommended in existing literature, our findings did not show a significant difference in outcomes between early and late initiation. Clinical decisions should therefore prioritize individualized assessment, careful pressure titration, and close monitoring during NIPPV rather than focusing solely on timing.Establishing standardized local protocols for timing, pressure settings, and follow-up could further enhance success rates even in resource-constrained environments. Ultimately, this study reinforces that prompt, well-calibrated NIPPV use can substantially reduce morbidity, hospital burden, and possibly mortality among AECOPD patients in Nepal and similar healthcare settings.

Limitations of the study

This was a single-center observational study, so the results may not be generalizable to all settings. Variations in clinician practice and incomplete follow-up of arterial blood gases might have influenced outcomes. Long-term outcomes such as readmission or mortality after discharge were not assessed. Despite these limitations, the study provides important real-world evidence on NIPPV use in AECOPD within a resource-limited environment.

Acknowledgements: None

Conflict of Interest: None

Financial Disclosure: None

References

1. Adhikari TB, Neupane D, Kallestrup P. Burden of COPD in Nepal. Int J Chron Obstruct Pulmon Dis. 2018 Feb;Volume 13:583-9. DOI: 10.2147/COPD.S154319 PMID: 29445275 PMCID: PMC5810531

2. Lief L, McSparron J. Acute Exacerbation of COPD. In: Hyzy RC, McSparron J, editors. Evidence-Based Critical Care: A Case Study Approach [Internet]. Cham: Springer International Publishing; 2020 [cited 2025 Oct 16]. p. 169-73. DOI: 10.1007/978-3-030-26710-0_22 PMCID: PMC7121203

3. Lightowler JV, Wedzicha JA, Elliott MW, Ram FSF. Non-invasive positive pressure ventilation to treat respiratory failure resulting from exacerbations of chronic obstructive pulmonary disease: Cochrane systematic review and meta-analysis. 2003 Jan 25 [cited 2025 Oct 16] DOI: 10.1136/bmj.326.7382.185 PMID: 12543832 PMCID: PMC140272

4. Bhattacharyya D, Prasad B, Tampi P, Ramprasad R. Early predictors of success of non-invasive positive pressure ventilation in hypercapnic respiratory failure. Med J Armed Forces India. 2011 Oct 1;67(4):315-9. DOI: 10.1016/S0377-1237(11)60075-0 PMID: 27365838

5. Mandelzweig K, Leligdowicz A, Murthy S, Lalitha R, Fowler RA, Adhikari NKJ. Non-invasive ventilation in children and adults in low- and low-middle income countries: A systematic review and meta-analysis. J Crit Care. 2018 Oct 1;47:310-9. DOI: 10.1016/j.jcrc.2018.01.007 PMID: 29426584

6. Moretti M, Cilione C, Tampieri A, Fracchia C, Marchioni A, Nava S. Incidence and causes of non-invasive mechanical ventilation failure after initial success. Thorax. 2000 Oct 1;55(10):819-25. DOI: 10.1136/thorax.55.10.819 PMID: 10992532 PMCID: PMC1745609

7. Shaheen M, Daabis RG, Elsoucy H. Outcomes and predictors of success of noninvasive ventilation in acute exacerbation of chronic obstructive pulmonary disease. Egypt J Bronchol. 2018 Sept;12(3):329-39. DOI: 10.4103/ejb.ejb_112_17

8. Gudelli M, K S, Kalathil PT, Pimple O, Shahid A, Chandradas N, et al. Effectiveness and Outcomes of Noninvasive Positive Pressure Ventilation in Patients With Acute Exacerbations of Chronic Obstructive Pulmonary Disease. Cureus [Internet]. 2024 June 20 [cited 2025 Oct 17];16. DOI: 10.7759/cureus.62746 PMID: 39036269 PMCID: PMC11259907

9. Khilnani GC, Saikia N, Banga A, Sharma SK. Non-invasive ventilation for acute exacerbation of COPD with very high PaCO2: A randomized controlled trial. Lung India. 2010 Sept;27(3):125. DOI: 10.4103/0970-2113.68308 PMID: 20931029 PMCID: PMC2946712

10. Liu L, Qiu H bo, Zheng R qiang, Yang Y. [Prospective randomized controlled clinical study of early use of noninvasive positive pressure ventilation in the treatment for acute exacerbation of chronic obstructive pulmonary disease]. Zhongguo Wei Zhong Bing Ji Jiu Yi Xue Chin Crit Care Med Zhongguo Weizhongbing Jijiuyixue. 2005 Aug;17(8):477-80. PMID: 16105426

11. 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 randomised controlled trial. The Lancet. 2000 June 3;355(9219):1931-5. DOI: 10.1016/S0140-6736(00)02323-0 PMID: 10859037

12. Noninvasive Ventilation for Acute Exacerbations of Chronic Obstructive Pulmonary Disease. N Engl J Med. 1996 Mar 14;334(11):743-743. DOI: 10.1056/NEJM199603143341125 PMID: 7651472

13. Lindenauer PK, Stefan MS, Shieh MS, Pekow PS, Rothberg MB, Hill NS. Outcomes Associated With Invasive and Noninvasive Ventilation Among Patients Hospitalized With Exacerbations of Chronic Obstructive Pulmonary Disease. JAMA Intern Med. 2014 Dec 1;174(12):1982-93. DOI: 10.1001/jamainternmed.2014.5430 PMID: 25347545 PMCID: PMC4501470

14. Szigetváry C, Szabó GV, Dembrovszky F, Ocskay K, Engh MA, Turan C, et al. Individualised Positive End-Expiratory Pressure Settings Reduce the Incidence of Postoperative Pulmonary Complications: A Systematic Review and Meta-Analysis. J Clin Med. 2024 Jan;13(22):6776. DOI: 10.3390/jcm13226776 PMID: 39597924 PMCID: PMC11595123

15. Carrillo A, Gonzalez-Diaz G, Ferrer M, Martinez-Quintana ME, Lopez-Martinez A, Llamas N, et al. Non-invasive ventilation in community-acquired pneumonia and severe acute respiratory failure. Intensive Care Med. 2012 Mar 1;38(3):458-66. DOI: 10.1007/s00134-012-2475-6 PMID: 22318634

16. Taha A, Larumbe-Zabala E, Abugroun A, Mohammedzein A, Naguib MT, Patel M. Outcomes of Noninvasive Positive Pressure Ventilation in Acute Respiratory Distress Syndrome and Their Predictors: A National Cohort. Crit Care Res Pract. 2019;2019(1):8106145. DOI: 10.1155/2019/8106145 PMID: 31641538 PMCID: PMC6766679

17. Rathi NK, Haque SA, Nates R, Kosturakis A, Wang H, Dong W, et al. Noninvasivepositive pressure ventilation vsinvasive mechanical ventilation as first-line therapy for acute hypoxemic respiratory failure in cancer patients. J Crit Care. 2017 June 1;39:56-61. DOI: 10.1016/j.jcrc.2017.01.007 PMID: 28213266

18. Meeder AM, Tjan DHT, Zanten ARH van. Noninvasive and invasive positive pressure ventilation for acute respiratory failure in critically ill patients: a comparative cohort study. J Thorac Dis [Internet]. 2016 May [cited 2025 Oct 17];8(5). DOI: 10.21037/jtd.2016.03.21 PMID: 27162654 PMCID: PMC4842833

19. Corrêa TD, Sanches PR, de Morais LC, Scarin FC, Silva E, Barbas CSV. Performance of noninvasive ventilation in acute respiratory failure in critically ill patients: a prospective, observational, cohort study. BMC Pulm Med. 2015 Nov 11;15(1):144. DOI: 10.1186/s12890-015-0139-3
PMID: 26559350 PMCID: PMC4642766

20. Petroianni A, D'Antoni L, Lorenzo JD, Couhen FZE, Oriolo F, Graziani E. Role of Comorbidities and BMI on the Efficacy of Non Invasive Ventilation in COPD with Chronic Hypercapnia. Eur Respir J [Internet]. 2018 Nov 19 [cited 2025 Oct 17];52(suppl 62). DOI: 10.1183/13993003.congress-2018.PA2385

21. Berkius J, Sundh J, Nilholm L, Fredrikson M, Walther SM. Long-term survival according to ventilation mode in acute respiratory failure secondary to chronic obstructive pulmonary disease: A multicenter, inception cohort study. J Crit Care. 2010 Sept 1;25(3):539.e13-539.e18. DOI: 10.1016/j.jcrc.2010.02.006
PMID: 20381291

22. Budweiser S, Heinemann F, Meyer K, Wild PJ, Pfeifer M. Weight gain in cachectic COPD patients receiving noninvasive positive-pressure ventilation. Respir Care. 2006 Feb;51(2):126-32.
PMID: 16441956

23. Thille AW, Coudroy R, Nay MA, Gacouin A, Decavèle M, Sonneville R, et al. Beneficial Effects of Noninvasive Ventilation after Extubation in Obese or Overweight Patients: A Post Hoc Analysis of a Randomized Clinical Trial. Am J Respir Crit Care Med. 2022 Feb 15;205(4):440-9.