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Original Research Article

PREDICTORS OF OUTCOME OF NON INVASIVE VENTILATION IN ACUTE EXACERBATION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE: A PROSPECTIVE COHORT STUDY

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ABSTRACT

Background: Non-invasive ventilation (NIV) is a proven modality for managing acute exacerbations of chronic obstructive pulmonary disease (COPD) with respiratory failure. It reduces morbidity, hospital stay, and mortality. However, failure of NIV and delayed intubation can worsen outcomes. The objective is to identify clinical and biochemical predictors of NIV outcome in patients with acute exacerbation of COPD (AECOPD) admitted with respiratory failure.

Materials and Methods: This prospective cohort study was conducted in the Intensive Respiratory Care Unit, Department of Respiratory Medicine, Government Medical College, Trivandrum, from January 2017 to July 2018. Eighty-five AECOPD patients with pH 7.2-7.35 and/or $PaCO_2$ ≥45 mmHg treated with NIV were included. ABG parameters were analyzed at 0, 2, 4, 24, and 48 hours. Patients showing clinical and ABG improvement at 48 hours were categorized as successful; others requiring intubation or death were classified as failures.

Results: NIV success was seen in 65 patients (76.4%). Poor Glasgow Coma Scale (GCS <8), serum bilirubin >1.2 mg/dL at admission, pH ≤7.3, and $PaCO_2$ ≥75 mmHg at 4 hours were independent predictors of NIV failure. Multivariate logistic regression identified pH ≤7.3 at 4 hours (OR 12.67; 95% CI 2.6-60.6; p=0.001), serum bilirubin >1.2 mg/dL (OR 8.3; 95% CI 1.2-54.7; p=0.02), GCS <8 (OR 4.46; 95% CI 1.0-19.5; p=0.04), and $PaCO_2$ ≥75 mmHg at 4 hours (OR 4.14; 95% CI 1.06-16.21; p=0.04) as significant predictors.

Conclusion: Early reassessment of ABG after 4 hours of NIV initiation is essential. Persistently low pH, high $PaCO_2$, poor GCS, and elevated bilirubin levels predict NIV failure and can guide early intubation decisions.

Keywords: ABG parameters, Bilirubin, ph, Hypercapnia, GCS, NIV failure predictors, Respiratory failure, Acute exacerbation, COPD.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a major global health problem and a leading cause of morbidity and mortality worldwide. According to the World Health Organization, COPD is currently the third leading cause of death globally, accounting for millions of deaths each year and imposing a rising disease burden, especially in low- and middle-income countries.[1]

In India, the burden of COPD is particularly high. COPD accounts for a large proportion of chronic respiratory disease morbidity and represents a significant contributor to mortality and disability-adjusted life years (DALYs) in India.[2,3] Population-based studies and systematic reviews estimate that

the prevalence of COPD among adults aged ≥30 years is around 7%, with significant regional variability,[2,4] and higher rates among smokers and individuals exposed to biomass fuel smoke and outdoor air pollution,[5,6] translating into tens of millions of affected individuals nationwide. Risk factors such as tobacco smoking, indoor biomass fuel smoke, occupational exposures, and ambient air pollution contribute to this high burden.[6]

Acute exacerbations of COPD (AECOPD) are common and recurrent events that significantly accelerate lung function decline, impair quality of life, and contribute to a large proportion of COPD-related hospitalizations and healthcare costs,[7] Severe exacerbations frequently cause acute hypercapnic respiratory failure, which is associated with increased in-hospital mortality and long-term adverse outcomes.[8]

Non-invasive ventilation (NIV) has emerged as a cornerstone in managing acute hypercapnic respiratory failure due to COPD exacerbations. Multiple randomized controlled trials and meta-analyses have demonstrated that NIV, when added to standard care, significantly reduces the need for endotracheal intubation, hospital mortality, and length of stay, and improves gas exchange and clinical outcomes compared with standard therapy alone.[9-11]

Guidelines and clinical evidence suggest that NIV is preferred over invasive mechanical ventilation as the initial mode of ventilatory support in appropriate patients with acute hypercapnic respiratory failure due to AECOPD.[12-15] In randomized trials, NIV has shown high success rates (typically 80-85%) in improving respiratory acidosis and reducing the need for invasive ventilation among patients with acute exacerbations.[10,11] Epidemiological and clinical studies indicate that approximately 20-30% of patients hospitalized with AECOPD develop respiratory acidosis requiring ventilatory support, and many of these patients benefit from early NIV.[12,14]

The increasing use of NIV in this setting over the past two decades reflects robust evidence of its benefit in reducing intubation rates, mortality, and complications associated with invasive ventilation. NIV is most effective when initiated early in patients with moderate to severe acidosis (pH <7.35 with elevated $PaCO_2$), making it a key intervention in contemporary COPD exacerbation management.[10,11]

However, delayed recognition of NIV failure - when a patient does not improve on NIV and requires escalation to invasive ventilation - increases the risk of serious complications, including ventilator-associated pneumonia and cardiovascular instability, and is associated with poorer outcomes.[12,16]

This study aims to identify early clinical and biochemical predictors of NIV outcome in AECOPD patients, enabling timely decision-making and safe escalation of care where needed.

MATERIALS AND METHODS

This study was done in COPD exacerbation patients admitted in Intensive Respiratory Care Unit of Pulmonary Medicine Department, Medical College, Trivandrum from January 2017 to July 2018. NIV is given to COPD exacerbation patients with ABG showing pH 7.2-7.35 and/ or PCO2 ≥ 45mmHg. These patients are reassessed with ABG after 2 hrs, 4hrs, 24 hrs and 48 hrs of NIV to look for improvement. Those who show improvement at 48 hrs of NIV with ABG showing pH ≥ 7.35 and/or PCO2 ≤ 45mmHg are termed as successful. Those who show clinical deterioration or ABG worsening on reassessment within 48 hrs and resulted in invasive ventilation or death are termed as failures.

Study Design: Prospective Cohort study

Study Setting: Intensive Respiratory Care Unit, Department of Pulmonary Medicine, Government Medical College, Trivandrum

Study period: January 2017- July 2018

Study Population: Acute exacerbation of COPD patients requiring NIV treatment which is decided based on ABG status (pH 7.2- 7.35 and/or PCO2 ≥ 45 mmHg), admitted in IRCU of Department of Pulmonary Medicine, Trivandrum during the period of study.

Study Subjects: Inclusion Criteria are COPD Exacerbation with Respiratory acidosis (arterial pH 7.2- 7.35 and/or PaCO2 ≥ 45 mm Hg) who are treated with NIV in IRCU, Pulmonary Medicine Department, Trivandrum MCH.

Exclusion criteria are those who are not willing for the study, Patients who are clinically unstable, Other contraindications of NIV.

Sample Size: For unequal independent groups, If the allocation ratio is r = n_1 / n_2 , the formula becomes:

$$n_1 = \frac{(1+r)(Z_{\alpha/2} + Z_{\beta})^2 \sigma^2}{r(\mu_1 - \mu_2)^2} \quad n_2 = r \times n_1$$

Where:

- r = ratio of sample sizes between groups
- n = sample size required per group
- σ^2 = pooled variance (square of standard deviation)
- $\mu_1 - \mu_2$ = expected difference between the two means
- $Z\alpha/2$ = Z value corresponding to the significance level (α)
- $Z\beta$ = Z value corresponding to the power (1 − β)
- Common values:
- α = 0.05 → $Z\alpha/2 = 1.96$
- Power = 80% (β = 0.20) → $Z\beta = 0.84$

Assuming a success-to-failure ratio of NIV of 4:1, with a type I error (α) of 0.05 and power of 80% (β = 0.20), the sample size was calculated based on the APACHE II score of the success and failure groups from a previous study.

In that study, the mean APACHE II score in the success group was 20.02 (SD = 4.81), while in the failure group it was 24.84 (SD = 6.35).

Using MedCalc software (version 16.8.4) for comparison of two means, the minimum required total sample size was calculated to be 85 participants.

Sampling technique

Consecutive sampling: All acute exacerbation COPD patients admitted in Respiratory ICU treated with NIV during the period of study were taken.

Study Variables: Sociodemographic variables such as Age, Gender, Body Mass Index

History of Smoking, Smoking index, Biomass Exposure, Comorbidities, recent infection, number of exacerbations in the past 1 year, use of inhalers, use of LTOT, h/o prior mechanical ventilation, COPD Group as per combined assessment

APACHE 2 Score at the time of admission to ICU, GCS scale

Vital signs like Heart rate, Respiratory rate, SpO2

Blood parameters like Total blood count, Fasting Blood Sugar, Serum creatinine, Serum bilirubin, Serum albumin

Sputum AFB, Sputum culture and sensitivity

ABG analysis showing pH and PCO2 at onset of NIV, 2 hrs, 4 hrs, 24 hrs and 48 hrs of NIV.

NIV Protocol: All patients received NIV using a bilevel positive airway pressure (BiPAP) ventilator via an oronasal mask. The standard starting settings included: IPAP: 10 cm H_2 O and EPAP: 4-5 cm H_2 O

Settings were adjusted based on clinical response, patient comfort, and improvement in ABG parameters. Supplemental oxygen was added to maintain SpO_2 between 88-92%.

Outcome Measures: Patients were categorized into NIV success or NIV failure.

NIV Success was defined as Improvement in clinical status, pH ≥7.35 or $PaCO_2$ ≤45 mmHg at 48 hours and No need for intubation

NIV Failure was defined as Worsening clinical status, Persistently low pH or rising $PaCO_2$, Intubation requirement, Death during hospitalization

Data Collection Tools and Technique

The above details regarding the study variables including the personal data is entered in a proforma using ABG report, ECG, Echo, Chest X ray, CT Thorax, Blood investigation report, sputum results, APACHE 2 score sheet, GCS.

Informed consent taken from all patients/ bystanders with exacerbation of COPD diagnosed as per GOLD guideline 2016 who are admitted in IRCU with respiratory failure.

Statistical Analysis: Data analysis was performed using Epi Info version 7. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Bivariate analysis and multivariate logistic regression were used to identify predictors of NIV fa.

RESULTS

This study was conducted in Intensive Respiratory Care Unit, Department of Pulmonary Medicine, Government Medical College, Trivandrum, among 85 COPD exacerbation patients in respiratory failure who were treated with NIV as per ABG criteria from January 2017- July 2018. Among the 85 patients who were treated with NIV, 65 (76.4%) had NIV success and 20 (23.6%) had NIV failure [Figure 1].

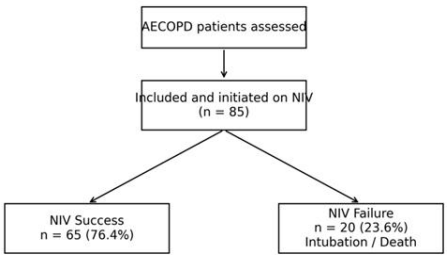

Figure 1: Study Flow Diagram

The purpose of conducting this study was to find out the predictors of outcome of NIV in COPD exacerbation patients in respiratory failure so that delayed intubation (invasive ventilation) that results in increased morbidity and mortality can be avoided. The results obtained were shown in table 1,2,3,4,5.

The association between demographic factors and study outcome is shown in Table 1. Patients aged more than 60 years had a higher risk of the outcome with a relative risk (RR) of 1.20 (95% CI: 0.9–1.5; p = 0.06), though this was not statistically significant. Male sex was also associated with a slightly increased risk (RR 1.09; 95% CI: 0.8–1.4; p = 0.20), but the association was not statistically significant.

Among lifestyle factors, smoking showed a relative risk of 0.90 (95% CI: 0.3–2.2; p = 0.40), while a smoking index greater than 400 had an RR of 1.00 (95% CI: 0.7–1.2; p = 0.40), indicating no significant association with the outcome. Biomass exposure showed a relative risk of 0.86 (95% CI: 0.6–1.0; p = 0.10), but this association was also not statistically significant.

Overall, none of the demographic variables demonstrated a statistically significant association with the study outcome.

Table 1: Association between demographic factors and study outcome

Sl. No.	Study Variable	RR	95% CI	p value
1	Age > 60 years	1.20	0.9 – 1.5	0.06
2	Male sex	1.09	0.8 – 1.4	0.20
3	Smokers	0.90	0.3 – 2.2	0.40
4	Smoking index > 400	1.00	0.7 – 1.2	0.40
5	Biomass exposure	0.86	0.6 – 1.0	0.10

RR: Relative Risk

CI: Confidence Interval

[Table 2] shows comorbidities among study population. The most common comorbidity observed was diabetes mellitus, present in 42 patients (49.4%; 95% CI: 38.3%–60.4%), followed by hypertension in 37 patients (43.5%; 95% CI: 32.8%–52.7%). Pulmonary hypertension was noted in 31 patients (36.4%; 95% CI: 26.2%–47.6%), while bronchiectasis was present in 29 patients (34.1%; 95% CI: 24.1%–45.2%).

Coronary artery disease and pulmonary tuberculosis were each observed in 22 patients (25.8%; 95% CI: 16.9%–36.5%). Asthma was present in 12 patients (18.4%; 95% CI: 10.2%–27.4%), and obstructive sleep apnea was identified in 13 patients (15.2%; 95% CI: 8.4%–24.7%).

Overall, metabolic and cardiovascular comorbidities were more common than respiratory comorbidities among the study population.

Table 2: Comorbidities among AECOPD patients in the study

Sl. No.	Comorbidity	N	%	95% CI
1	Asthma	12	18.4	10.2% – 27.4%
2	Bronchiectasis	29	34.1	24.1% – 45.2%
3	CAD	22	25.8	16.9% – 36.5%
4	Diabetes mellitus	42	49.4	38.3% – 60.4%
5	Hypertension	37	43.5	32.8% – 52.7%
6	OSA	13	15.2	8.4% – 24.7%
7	Pulmonary hypertension	31	36.4	26.2% – 47.6%
8	Pulmonary tuberculosis	22	25.8	16.9% – 36.5%

[Table 3] shows the association between selected clinical variables and the study outcome. Most of the variables evaluated did not demonstrate a statistically significant association with the outcome.

Recent infection was associated with a relative risk (RR) of 1.10 (95% CI: 0.8–1.4, p = 0.10). Similarly, patients with ≥2 exacerbations in the past year had an RR of 1.09 (95% CI: 0.7–1.6, p = 0.37). COPD patients belonging to Group C and D had an RR of 1.04 (95% CI: 0.6–1.6, p = 0.40), indicating no significant association.

Prior mechanical ventilation showed an RR of 1.08 (95% CI: 0.8–1.4, p = 0.20), while patients on long-term oxygen therapy had an RR of 0.80 (95% CI: 0.6–1.1, p = 0.20). Body mass index greater than 30 kg/m² was associated with an RR of 1.10 (95% CI: 0.8–1.7, p = 0.10). Patients with an APACHE II score greater than 25 also had an RR of 1.10 (95% CI: 0.8–1.6, p = 0.10).

Among the variables studied, only Glasgow Coma Scale < 8 showed a statistically significant association with the study outcome with an RR of 1.30 (95% CI: 0.9–1.9, p = 0.03), suggesting a higher risk of the outcome in patients with severe impairment of consciousness.

Overall, most clinical variables were not significantly associated with the study outcome, except for low Glasgow Coma Scale, which showed a significant association.

Table 3: Association between clinical variables and study outcome

Sl. No.	Study Variable	Relative Risk (RR)	95% Confidence Interval	p value
1	Recent infection	1.10	0.8 – 1.4	0.10
2	≥2 exacerbations in past year	1.09	0.7 – 1.6	0.37
3	COPD Group C & D	1.04	0.6 – 1.6	0.40
4	Prior mechanical ventilation	1.08	0.8 – 1.4	0.20
5	On long-term oxygen therapy	0.80	0.6 – 1.1	0.20
6	Body mass index > 30 kg/m²	1.10	0.8 – 1.7	0.10
7	APACHE II score > 25	1.10	0.8 – 1.6	0.10
8	Glasgow Coma Scale < 8	1.30	0.9 – 1.9	0.03

Abbreviations:

RR – Relative Risk

CI – Confidence Interval

COPD – Chronic Obstructive Pulmonary Disease

APACHE II – Acute Physiology and Chronic Health Evaluation II

[Table 4] shows the association between baseline clinical and laboratory parameters and poor clinical outcome among the study participants (N = 85). Among the variables studied, serum bilirubin >1.2 mg/dl showed a statistically significant association with poor clinical outcome (RR = 1.4, 95% CI: 0.8–2.5, p = 0.04). Other parameters including heart rate >100/min, respiratory rate >30/min, SpO_2 <70% on

room air, elevated total leukocyte count, fasting blood sugar >110 mg/dl, serum creatinine >1.2 mg/dl, serum albumin <3.5 mg/dl, and positive sputum culture did not show a statistically significant association with poor clinical outcome.

Table 4: Association of Baseline Clinical and Laboratory Parameters with Poor Clinical Outcome Using Chi-square Test (N = 85)

Sl. No.	Study Variable	Number of Patients with Exposure (n)	Relative Risk (RR)	95% Confidence Interval	p value
1	Heart Rate > 100/min	35	1.05	0.8 – 1.3	0.30
2	Respiratory Rate > 30/min	41	0.80	0.6 – 1.0	0.09
3	SpO_2 < 70% (Room Air)	36	1.10	0.9 – 1.5	0.10
4	Total Leukocyte Count > 11,000 cells/mm³	33	0.90	0.7 – 1.2	0.30
5	Fasting Blood Sugar > 110 mg/dl	58	0.80	0.6 – 1.1	0.08
6	Serum Creatinine > 1.2 mg/dl	20	1.10	0.8 – 1.5	0.20
7	Serum Bilirubin > 1.2 mg/dl	11	1.40	0.8 – 2.5	0.04*
8	Serum Albumin < 3.5 mg/dl	45	1.02	0.8 – 1.2	0.40
9	Positive Sputum Culture	21	1.00	0.7 – 1.3	0.40

Abbreviations:
RR – Relative Risk
CI – Confidence Interval
SpO_2 – Peripheral Oxygen Saturation
* $p < 0.05$ considered statistically significant

[Table 5] shows the association between arterial blood gas parameters and poor clinical outcome. pH at onset ≤7.3 and PCO_2 at onset ≥75 mmHg did not show a significant association with poor clinical outcome. However, pH ≤7.3 at 4 hours (RR = 1.6, 95% CI: 1.2–2.1, p = 0.00006) and PCO_2 ≥75 mmHg at 4 hours (RR = 1.4, 95% CI: 1.1–1.8, p = 0.001) were significantly associated with poor clinical outcome.

Table 5: Association of Arterial Blood Gas Parameters with Poor Clinical Outcome (Chi-square Test, N = 85)

Sl. No.	Study Variable	No. of Patients with Exposure (n)	Relative Risk (RR)	95% Confidence Interval	p value
1	pH at onset ≤ 7.3	45	1.09	0.8 – 1.3	0.20
2	pH at 4 hours ≤ 7.3	38	1.60	1.2 – 2.1	0.00006*
3	PCO_2 at onset ≥ 75 mmHg	49	1.10	0.9 – 1.4	0.10
4	PCO_2 at 4 hours ≥ 75 mmHg	37	1.40	1.1 – 1.8	0.001*

Abbreviations:
RR – Relative Risk
CI – Confidence Interval
PCO_2 – Partial Pressure of Carbon Dioxide
* $p < 0.05$ considered statistically significant

After bivariate analysis, the following variables were found to be significant risk factors for failure of non-invasive ventilation (NIV):

1. Glasgow Coma Scale (GCS) < 8 at the time of admission was a risk factor for NIV failure (RR = 1.3, p = 0.03).
2. Serum bilirubin > 1.2 mg/dl at the time of admission was associated with increased risk of NIV failure (RR = 1.4, p = 0.04).
3. Arterial pH ≤ 7.3 at 4 hours of NIV was a significant predictor of NIV failure (RR = 1.6, p = 0.00006).
4. $PaCO_2$ ≥ 75 mmHg at 4 hours of NIV was also associated with NIV failure (RR = 1.4, p = 0.001).

These variables were subsequently included in the multivariate logistic regression analysis.

Table 6: Multivariate Logistic Regression Analysis of Significant Study Variables

Sl. No.	Study Variable	Odds Ratio (OR)	95% Confidence Interval	p value
1	GCS < 8	4.46	1.0 – 19.5	0.04
2	pH at 4 hours < 7.3	12.67	2.6 – 60.6	0.001
3	$PaCO_2$ at 4 hours > 75 mmHg	4.14	1.06 – 16.21	0.04
4	Serum bilirubin > 1.2 mg/dl	8.3	1.2 – 54.7	0.02

Multivariate logistic regression analysis identified four independent predictors of NIV failure among patients with COPD exacerbation and respiratory failure. These included Glasgow Coma Scale < 8 at admission, serum bilirubin > 1.2 mg/dl at admission, arterial pH ≤ 7.3 at 4 hours of NIV, and $PaCO_2$ ≥ 75 mmHg at 4 hours of NIV. Among these variables, pH ≤ 7.3 at 4 hours showed the strongest association with NIV failure.

DISCUSSION

Chronic Obstructive Pulmonary Disease (COPD) is a common preventable and treatable disease and is currently the third leading cause of death in the

world.[1,3]·Exacerbation is a natural event in the history of a COPD patient that requires additional therapy. Severe exacerbation may result in respiratory failure.[7,8]

Non-invasive ventilation (NIV) is preferred over invasive ventilation in the treatment of acute exacerbation of COPD patients in respiratory failure. Patients who fail NIV should be given invasive ventilation as a rescue therapy to reduce morbidity and mortality.[9-12] Hence, it is essential to identify predictors of NIV outcome in acute exacerbation of COPD patients in respiratory failure to reduce morbidity and mortality due to inappropriate treatment.

Among the 85 COPD patients studied, 76.4% were successfully treated with NIV, giving a success-to-failure ratio of 3:1. According to GOLD 2018 guidelines, COPD exacerbation patients in respiratory failure treated with NIV have a success rate of 80-85%.[11]

The mean age in this study was 61.85 ± 8.8 years, and 60% of the study population were above 60 years. Age is considered a risk factor for COPD because airway and parenchymal changes in COPD are similar to those in ageing [16,17]. The majority of the study population were males (80%), while GOLD 2018 reports nearly equal prevalence in males and females.[11]

In this study, 76.47% were smokers. Smoking is a well-established risk factor for COPD, with a higher rate of FEV1 decline and increased mortality among smokers.[5,17] A smoking index >400 was present in 64.71% of patients, correlating with accelerated decline in lung function.[5] History of biomass exposure was present in 47% of patients, and indoor air pollution has been reported to cause over 1 million deaths per year globally.[6]

The common comorbidities observed were diabetes (49.4%), hypertension (43.5%), pulmonary hypertension (36.4%), bronchiectasis (34.1%), coronary artery disease (25.8%), past pulmonary tuberculosis (25.8%), asthma (18.4%), and obstructive sleep apnea (15.2%).[18-20] Hypertension is the most frequently occurring comorbidity in COPD.[18] Pulmonary hypertension is associated with shorter survival and worse outcomes.[19] Coronary artery disease and diabetes are linked to poor COPD prognosis.[20] Airway hyperresponsiveness in asthma-COPD overlap is associated with accelerated FEV1 decline. Past tuberculosis is a known risk factor for earlier COPD development and faster progression.

Among the study population, 34% had bronchiectasis, which is associated with prolonged exacerbations and higher mortality.[11] About 92.94% had ≥2 exacerbations in the previous year, with 75% classified as COPD group D, indicating a high-risk population.[7,12]

A history of mechanical ventilation was present in 29.4% of patients, and acute hypercapnic respiratory failure is an independent predictor of exacerbation severity. Recent infection was noted in 56.4% of patients; infections, especially viral, trigger severe exacerbations and hospitalizations.[7]

Long-term oxygen therapy was used by 21.1% of patients and was associated with improved survival in those with severe hypoxemia.[21] Regular inhaled therapy was reported in 74% of patients. Use of ICS/LAMA/LABA triple therapy was associated with improved lung function and reduced exacerbation frequency.

At admission, tachycardia was present in 41% of patients, tachypnea in 48%, and severe hypoxemia (SpO_2 <70%) in 42% of patients. Early improvement in respiratory rate during non-invasive ventilation (NIV) was strongly associated with successful NIV outcomes.[22-25] Elevated total blood counts were observed in 38.8% of patients and likely reflected physiological stress rather than infection. Hyperglycemia was present in 68.2% of patients and was significantly associated with late NIV failure (>48 hours).[24] Serum creatinine elevation was observed in 23.8% of patients, while serum bilirubin levels >1.2 mg/dL were noted in 12.9%. Hypoalbuminemia was present in 52.9% of patients and was associated with CO_2 retention.

An APACHE II score >25 was observed in 22.3% of patients and was predictive of NIV failure.[24] A Glasgow Coma Scale (GCS) score <8 at admission was present in 23.5% of patients and was associated with poor NIV outcomes.[25] Higher arterial pH and lower $PaCO_2$ values at admission and after 2-4 hours of NIV were strongly associated with successful NIV outcomes.[22,23,26]

Pathogenic bacteria were isolated in 24.7% of sputum cultures, with Pseudomonas aeruginosa accounting for 47.6% of isolates. This finding is consistent with prior reports on pathogen prevalence in severe COPD exacerbations requiring ventilatory support.[27,28] Most patients (71.7%) had a normal body mass index, while lower BMI was associated with an increased risk of CO_2 retention. Inhaled corticosteroids were linked to an increased risk of pneumonia.[29]

On bivariate and multivariate logistic regression analysis, GCS <8, serum bilirubin >1.2 mg/dL, pH ≤7.30, and $PaCO_2$ ≥75 mmHg at four hours of NIV were identified as independent predictors of NIV failure.[30] Early recognition of these predictors may allow timely escalation to invasive mechanical ventilation, improving outcomes and reducing NIV-related complications.[23,30]

This study has certain limitations. It was a single-center study with a relatively small sample size, which may limit generalizability. Only short-term in-hospital outcomes were assessed, and long-term follow-up was not performed. Variability in NIV management and exclusion of patients requiring immediate intubation may have introduced bias. Additionally, certain potential confounders and biomarkers were not evaluated.

CONCLUSION

Non-invasive ventilation remains an effective first-line strategy for managing acute exacerbations of chronic obstructive pulmonary disease complicated by hypercapnic respiratory failure. However, early identification of patients at risk for NIV failure is crucial to avoid delayed intubation and associated morbidity and mortality.

This study demonstrates that simple, readily available parameters-namely poor neurological status (GCS<8) and elevated serum bilirubin at admission, persistent acidosis (pH ≤7.3), and severe hypercapnia ($PaCO_2$ ≥75 mmHg) at four hours after NIV initiation-are strong and independent predictors of NIV failure.

Routine reassessment using arterial blood gas analysis at four hours, combined with careful clinical evaluation, can facilitate timely escalation to invasive ventilation when indicated.

Incorporating these predictors into routine clinical practice may improve decision-making, optimize resource utilization, and ultimately enhance patient outcomes in acute exacerbations of COPD.

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