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Original Research Article

# ROLE OF HACOR SCORE IN PREDICTING THE OUTCOMES OF NON INVASIVE VENTILATION IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS

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**ABSTRACT**

**Background:** Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) complicated by respiratory failure frequently require non-invasive ventilation (NIV). Although NIV reduces the need for invasive ventilation, failure to recognize non-response early may delay intubation and worsen outcomes. The HACOR score, incorporating heart rate, acidosis, consciousness, oxygenation, and respiratory rate, may provide a bedside tool for risk stratification.
**Materials and Methods:** A prospective observational study was conducted in the Department of General Medicine, MGMGH, Trichy, from February 2025 to January 2026. One hundred adults with COPD and acute respiratory failure initiated on NIV were enrolled. Clinical parameters, arterial blood gas findings, HACOR scores, NIV outcomes, intubation timing, and outcomes were recorded and analyzed using SPSS.
**Results:** Of the 100 participants, 68 were men and 32 were women. NIV was successful in 73 patients and failed in 27. Forty-seven patients had HACOR scores >5, while 53 had scores <5. NIV failure occurred in 24 (51.1%) patients with scores >5 compared with 3 (5.7%) patients with scores <5 ($p<0.001$). Mortality was also significantly higher among patients with HACOR scores >5 than among those with scores <5: 12 (25.5%) versus 1 (1.9%), respectively ($p<0.001$). Eighty-seven patients survived and 13 died. The association between early and late intubation and mortality was not statistically significant ($p=0.093$).
**Conclusion:** A higher HACOR score was strongly associated with NIV failure and mortality in patients with AECOPD and respiratory failure. The score may serve as a bedside tool for early identification of high-risk patients, closer monitoring, and timely escalation of respiratory support.
**Keywords:** HACOR score; Chronic obstructive pulmonary disease; Non-invasive ventilation; Acute respiratory failure; NIV failure; Mortality

## INTRODUCTION

COPD is among the leading causes of morbidity and mortality in the global context. It is a progressive lung disease that imposes a huge burden to the patients, families, and health systems.[1] COPD is a serious health issue that impacts millions of individuals all over the world and remains a critical issue in terms of public health due to its prevalence, frequent hospital visits, and chronic complications.[2] In acute exacerbations, respiratory failure is experienced in many patients and they need immediate medical attention.[3]
Non-invasive ventilation (NIV) has been seen as a significant component of the treatment in patients with acute exacerbation of COPD, particularly in those with respiratory failure with hypercapnia and acidosis. NIV is a non-endotracheal ventilatory aid.

It can assist in decreasing the work of breathing, enhance the amount of the exchange of gases, and aid the ventilation of the alveoli. NIV has a number of benefits when compared to invasive mechanical ventilation. It reduces chances of ventilator-associated pneumonia, prevents intubation complications, maintains airway defense mechanisms, and enables the patient to talk, swallow and have oral feeds in a more comfortable way.[4]

Due to these advantages, NIV has become an acceptable therapeutic measure in the selected COPD patients in case of acute respiratory failure. It has been demonstrated to decrease invasive ventilation, reduce hospital stay in most cases and increase clinical outcome. NIV is not, however, effective with all patients. Others do not respond to a primary attempt of NIV and end up undergoing intubation. Delays in the transition to invasive ventilation when NIV failure is not diagnosed in time can deteriorate the patient and predetermine the risk of adverse outcomes, including death.[5]

HACOR score is a scoring system that is formulated to predict the failure of non-invasive ventilation. The name HACOR is given as a result of five clinical parameters, namely Heart rate, Acidosis, Consciousness, Oxygenation, and Respiratory rate. These are the easily accessible, bedside-available, and simple variables that reflect on the intensity of respiratory distress and physiological instability. Higher score in HACOR means more chances of failure of NIV. Since the elements of the score are simple to quantify in routine clinical practice, HACOR can be useful in the emergency and critical care environments.[6]

The HACOR score can also be used to identify the patients who are unlikely to respond satisfactorily in the patients with COPD where the NIV is extensively used as the initial ventilatory support. This is significant in that, the poor responders can be identified before unjustifiable delay in intubation and patient outcome can be enhanced. Meanwhile, the patients with lesser HACOR scores can proceed with NIV at a more confident manner with the supervision.[7] The current investigation has been conducted with the aim of assessing the ability of HACOR score to forecast the prognosis of non-invasive ventilation among COPD patients. This study will determine the usefulness and practicability of the HACOR score as a bedside predictor to determine the success or failure of NIV in the management of acute COPD exacerbation with respiratory failure.

**Aim of the Study**

To study and assess the ―**Role of Hacor Score in Predicting the Outcomes of Non Invasive Ventilation in Chronic Obstructive Pulmonary Disease Patients**."

## MATERIALS AND METHODS

This prospective observational study was conducted in the Department of General Medicine, MGMGH, Trichy, from February 2025 to January 2026 among 100 patients aged >18 years with COPD and acute respiratory failure who were initiated on non-invasive ventilation (NIV). Patients with respiratory failure due to causes other than COPD, indications for emergency intubation, contraindications to NIV, intolerance to NIV despite attempts at intermittent use, and patients or their relatives who refused to participate were excluded. The study population was selected according to the predefined inclusion and exclusion criteria. Detailed clinical history was obtained, followed by a complete head-to-foot clinical examination. Clinical parameters including heart rate, Glasgow Coma Scale, oxygen saturation, and respiratory rate were recorded. All patients underwent arterial blood gas analysis and other relevant biochemical investigations as clinically indicated. Patients were enrolled after obtaining informed consent, and demographic and relevant clinical information was collected using a predesigned socio-demographic and clinical proforma. Data were recorded at the time of admission and throughout the hospital stay. The collected data were systematically compiled, analyzed, and interpreted using SPSS software.

## RESULTS

The study included 100 acutely exacerbated COPD patients who received non-invasive ventilation. Of this number, 68 patients were men and 32 were women, which indicated that the majority of the population that took part in the study was male. [Figure 1]

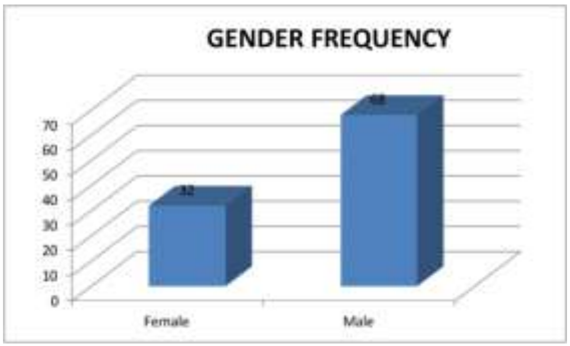


**Figure 1: Sex distribution of study participants**

Regarding age, most of the patients were in the middle and older ages meaning that in the later stages of adult life, COPD with respiratory failure was prevalent. Regarding the comorbidity with related illnesses, forty patients were without comorbidity, and the rest of the patients had a combination of one or more co-morbidity. Diabetes mellitus and hypertension were the most common comorbidities with 18 and 18 patients respectively with coronary artery disease being the next comorbidity with 11 patients. The patients with hypothyroidism, cerebrovascular accident and epilepsy were smaller.

Most patients were tachycardic at presentation on assessment of heart rate. There were forty-one patients with a heart rate of 100-120 beats per minute and 32 patients with 120-140 beats per minute. The patients with a heart rate of less than 100 beats per minute were only 15 in number and those with higher heart rate which were measured above 140 beats per minute were only 12 in number. This demonstrates that high heart rate was a typical clinical observation in the study group.

The analysis of arterial blood gases showed that mild to moderate acidosis was common. The highest number of 44 patients were found in the range of 7.30 to 7.34 and 26 patients in the range 7.25 to 7.29. A minimum of 13 patients experienced severe acidosis and the PH was less than 7.20 and only 9 patients had pH greater than 7.35. These results show that acid-base imbalance was prevalent among patients who received NIV.

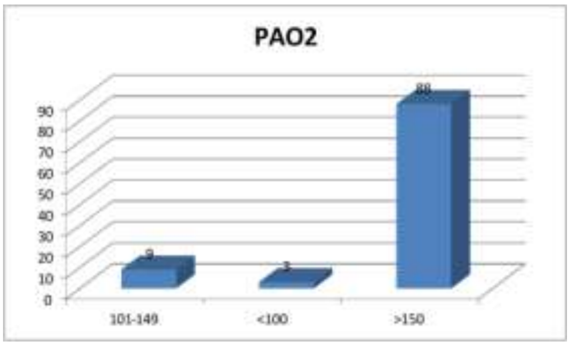


**Figure 2: $PaO_2/FiO_2$ distribution**

In terms of oxygenation condition, 88 patients recorded a PaO 2/ FiO 2 ratio greater than 150, 9 patients between 101 and 149, and 3 patients, less than 100(Figure 2). This indicates that the severe cases of oxygenation impairment occurred in a minimal number of patients. The rate of breath was also increased in most cases. There were 43 patients with a respiratory rate of 30 and 34 breaths, 20 patients with 35 and 39 breaths, and 37 with a respiratory rate of less than 30 per minute. It means that one of the common presenting features was tachypnea.

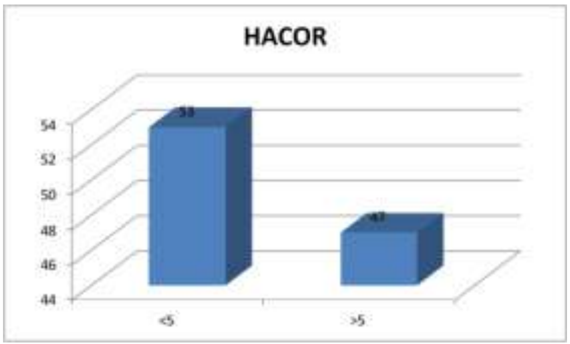


**Figure 3: HACOR score distribution**

Assessment of HACOR score showed that 53 patients had a score of less than 5, and 47 patients had a score of more than 5. Therefore, the patient allocation categories were performed fairly in terms of lower and higher HACOR (Figure 3). As far as the result of the non-invasive ventilation is concerned 73 patients responded to NIV successfully whereas 27 patients failed with the NIV. This demonstrates that NIV was effective in most patients that were used in the study.

As far as intubation was concerned, 13 patients received early intubation, 11 patients received late intubation and 76 patients did not receive intubation. This means that a majority of the patients were handled without necessarily having to undergo invasive ventilatory support. End result was that 87 of the patients survived and13 of the patients died indicating a generally positive result in the research population.

The statistical analysis was performed to determine the association between the HACOR score and the NIV outcome. There were 24 patients with NIV failure and 23 patients with NIV success among patients with a HACOR score of above 5. Conversely, with a HACOR score below 5, patients experiencing NIV failure was only 3 patients as compared to 50 patients who experienced successful NIV. This was observed to be statistically highly significant as indicated by p value of less than 0.001. The outcome shows that a greater HACOR score was closely related to failure of non-invasive ventilation. [Table 1]

**Table 1: Association between HACOR score and NIV outcome**

| HACOR score | NIV Failure n (%) | NIV Success n (%) | Total | P value |
|---|---|---|---|---|
| >5 | 24 (51.1) | 23 (48.9) | 47 | |
| <5 | 3 (5.7) | 50 (94.3) | 53 | |
| **Total** | **27** | **73** | **100** | **<0.001** |

Association between the timing of intubation and outcome was also examined. Out of 13 patients that were early intubated, 8 survived and 5 died. Out of the 11 patients that had intubated late, 3 patients survived and 8 died. Though the mortality seemed to be more in the late intubation group, it was not statistically significant with a p value of 0.093(Table 2). Thus, although late intubation had a worse numerical result, the statistically significant difference in this sample was not observed.

**Table 2: Association between timing of intubation and final outcome**

| Intubation timing | Alive n (%) | Dead n (%) | Total | P value |
|---|---|---|---|---|
| Early intubation | 8 (61.5) | 5 (38.5) | 13 | |
| Late intubation | 3 (27.3) | 8 (72.7) | 11 | |
| **Total** | **11** | **13** | **24** | **0.093** |

The correlation between the final outcome and HACOR score was also tested. Of the patients with HACOR score below 5, 52 survived and only 1 patient had passed away (Table 3). Conversely, of the individuals who had HACOR score above 5, 35 were alive and 12 patients had died. This was also found to be statistically highly significant with p value of less than 0.001. This is an indication that the patients who scored higher on the HACOR were much more at risk of dying.

**Table 3: Association between HACOR score and final outcome**

| HACOR score | Alive n (%) | Dead n (%) | Total | P value |
|---|---|---|---|---|
| <5 | 52 (98.1) | 1 (1.9) | 53 | |
| >5 | 35 (74.5) | 12 (25.5) | 47 | |
| **Total** | **87** | **13** | **100** | **<0.001** |

On the whole, the results of the current study indicate that the high HACOR score was considerably correlated with the NIV failure and with the poor final outcome, but the time of intubation was not statistically significantly correlated with mortality. These findings confirm the utility of the HACOR score as a bedside measure of COPD patients on NIV who are more likely to deteriorate and have a poor outcome.

## DISCUSSION

The aim of conducting this study was to determine the role of the HACOR score in determining the outcome of non-invasive ventilation in patients with acute COPD exacerbation. The results of the current research indicate that the higher HACOR score was strongly related to NIV failure and mortality. Conversely, the time of intubation was not statistically significantly related to the final outcome in this sample. In general, the findings indicate that HACOR score could be an effective bedside measure to identify patients with COPD undergoing NIV at an early stage.

In this case, males constituted the majority of the population as in the study. The latter trend is typical of COPD-related hospital research, particularly in those populations where smoking and workplace exposure are higher among men. Male dominance of this study can thus be due to the epidemiological pattern of COPD which is already known and not a result directly linked to NIV outcome.[13] Though the sex distribution is handy in the description of the study sample, it alone does not state the failure or success of NIV in the sample.

High percentage of patients in this research did not have comorbidity or had prevalent comorbidities, including diabetes, hypertension, and coronary artery disease. This is also clinically significant since comorbid diseases could aggravate the general state of COPD patients and make it harder to handle them in hospitals. Cardiovascular disease and metabolic disorders can decrease physiological reserve and slow up the recovery particularly during acute respiratory failure. Nevertheless, comorbidities in the current research were just explained as the characteristics when the study was conducted in the first place and were not directly compared to NIV outcome. Nonetheless, their existence demonstrates that a significant number of COPD patients undergoing NIV have medically intricate needs and might be under a tight watch.

The heart rate of a majority of patients in this study was over 100 per minute, respiratory was over 30 per minute and pH ranges of patients were mildly and moderately acidotic. The results should be anticipated during acute exacerbation of COPD with respiratory failure. Tachycardia indicates respiratory distress, sympathetic activation and physiological stress. Tachypnea displays a high work of breathing. Likewise, carbon dioxide retention and respiratory acidosis are manifested by low pH and are a major indicator to start NIV during COPD exacerbation. Hence, the clinical characteristics of the study population were in line with the patients that truly needed ventilatory support.

A notable finding during this study was that the majority of the patients recorded high values of PaO 2 /FiO 2 above 150. This indicates that in most cases, very severe oxygenation deficiency was not observed despite having respiratory failure. The problem of hypercapnia is also more dominant in acute exacerbation of COPD than the oxygenation issue. This could be the reason why NIV was effective in a significant percentage of cases. Given that NIV is specifically useful in hypercapnic respiratory failure, the rather intact oxygenation of most of such patients might have added to the overall successful response observed in the study.

The total NIV success rate, as demonstrated in this study, was 73 and NIV failure was experienced in 27 per cent of the patients. This observation indicates that NIV was useful among most patients. This has clinical significance since NIV will be able to prevent intubation and decrease associated complications of invasive ventilators, decrease recovery time and improve comfort in the selected patients. High NIV success rate in this case justifies the application of NIV as a significant primary management approach in acute exacerbation of COPD. Simultaneously, the 27% failure rate helps to keep in mind that the significant percentage of patients nonetheless worsens, despite NIV and thus require the early identification and prompt intensification of the treatment.

Non-invasive ventilation (NIV) is the primary therapeutic intervention for acute hypercapnic respiratory failure and exacerbations of chronic obstructive pulmonary disease (AECOPD).[6] Evidence syntheses confirm that early NIV initiation—defined as within two hours of emergency department (ED) presentation or during prehospital transport—significantly improves clinical trajectories compared to delayed ventilation or standard oxygen therapy.[8] Early intervention achieves a 40% to 60% relative reduction in endotracheal intubation rates and lowers hospital length of stay by 2 to 3 days.[9]

Physiologically, early application offloads fatigued respiratory muscles and reverses acute acidemia. Within two hours of NIV initiation, patients demonstrate a mean arterial pH improvement of +0.07 to +0.10 and a reduction in PaCO2 of 10 to 15 mmHg.[10] Conversely, failure to achieve early stabilization leads to prolonged hospitalization (mean 9.39 days in failure cohorts vs. 6.67 days in successful cohorts) and elevated mortality.[11]

In an acute hypoxemic respiratory failure (AHRF) cohort (n=42), a HACOR cutoff >4 demonstrated a sensitivity of 94.44%, specificity of 95.83%, and an area under the ROC curve (AUROC) of 0.96, with a mean score of 7.67±0.84 in the failure group versus 5.13 ±0.99 in the success group.[6]

In a derivation cohort (n=449), a cutoff >5 at 1 hour post-NIV predicted failure with a sensitivity of 72.6% and specificity of 90.2%.

In a large multicenter North Indian study (n=900), the original HACOR scale (cutoff >5 at 1 hour) yielded a sensitivity of 73.0%, specificity of 100.0%, positive predictive value (PPV) of 100.0%, negative predictive value (NPV) of 90.9%, and overall accuracy of 92.7%.[12]

Impact of NIV Failure Timing (Early vs. Late) on Mortality and Hospitalization

NIV failure occurs in 25% to 49% of acute hypoxemic or hypercapnic respiratory failure cases. The timing of failure serves as a critical prognostic indicator.[8]

- **Early vs. Late Failure Disparities:**
  - In a prospective evaluation of NIV failure (n=50, overall failure rate 38%), 16% experienced early failure (<12 hours) and 22% experienced late failure (>12 hours).
  - **28-Day Mortality:** While patients with successful NIV had a 28-day mortality rate of 11%, mortality rose to 88% in early failure (<12 hours) and 80% in late failure (>12 hours).[8]
- **Benefits of Timely Intubation:**
  - Timely recognition of non-response prevents delayed intubation. Prompt intubation within 12 hours significantly reduces in-hospital mortality compared with delayed intubation (66% vs. 79%; p=0.03). A prolonged trial of NIV prior to delayed transition to invasive mechanical ventilation produces a dose-dependent increase in hospital mortality.[11]

The current findings are valuable as they demonstrate that HACOR score can be used to address the gap between the initiation of NIV and decision-making regarding whether the patient is indeed improving. In most real hospital scenarios, NIV is initiated in the right way but what is difficult is when to proceed and when to discontinue and intubate. In case clinicians take too much time in a non-responding patient, the chances of poor outcome may rise. The HACOR score may prove useful in this decision-making process since it provides a premature systematic evaluation of severity and treatment response.

The other strength of the study is that the outcome measures were clinical. Important patient care outcomes include the success or failure of NIV, the necessity of intubation and mortality. These poor outcomes and the strong relationship between increased HACOR score and the poor outcomes render the findings applicable to the bedside practice. This implies that the study is not limited to describing patient features, but also provides information that can be used to initiate early intervention in the high risk patients.

Simultaneously, there are certain limitations to be taken into consideration when the findings are to be interpreted. To begin with, the sample size of the study was 100 patients, that is acceptable to conduct an observational study, but it is still relatively small to conduct a subgroup analysis, particularly of intubated patients. This could be the reason why the comparison of early and late intubation did not get statistical significance. Second, the research was carried out in one centre, and hence the results might be used to represent the patient trend and practice in that hospital in isolated cases. Third, the research was primarily a categorical one and did not investigate all potential confounding factors including the time of illness, the airflow obstruction severity, the past use of NIV, or a more detailed laboratory and radiological results. These variables are also possible to impact result.

In spite of these drawbacks, the research offers valuable evidence that the HACOR score is practical and useful in NIV COPD patients. It uses variables that are readily available in routine care as an indicator of the patients at increased risk of NIV failure and death. It is particularly relevant in the resource constrained environments, where clinicians are required to have fast and effective bedside resources to inform management. Such situations may be extremely valuable of a scoring system that is easy to use, cheap, and clinically significant.

## CONCLUSION

The current research indicates that the use of the HACOR score plays a significant role in the evaluation of the non-invasive ventilation outcome in patients with acute exacerbation of COPD. The higher the HACOR scores, the more the patients faced NIV failure and had more risk of being killed than those who had low scores. These results suggest that the HACOR score may serve as a convenient and easy to use bedside assessment tool to determine high risk patients, prior to their escalation.

The research also identified that the non-invasive ventilation proved to be effective in the majority of the patients and, therefore, it is an effective alternative to the treatment of respiratory failure related to COPD. Nevertheless, there was a subgroup of patients that did not respond and needed even more treatment. In this instance, HACOR can be used to assist clinicians to identify deterioration in time and make the correct decision about closer monitoring and intubation.

On the whole, the results indicate that HACOR scoring can be used clinically to predict the NIV outcome and eventual prognosis. Its habitual application in the management of COPD patients under NIV can enhance the early risk stratification and better treatment planning.

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