SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Mohan *et al*., 2026
doi: 10.21276/SSR-IIJLS.2026.12.2.42

Original Article

open access

Comparison of ROX Index and HACOR Score for Predicting NIV Success and Failure in ICU Patients– A Prospective Observational Study

Suchetana Mohan[1]*, Shobha Yavagal[2], Shruthi NS[2], Akshay C Rathod[1], Shreya MS[1]

[1]Postgraduate, Department of Anaesthesia, SIMS & RC Bangalore, Karnataka, India
[2]Assistant Professor, Department of Anaesthesia, SIMS & RC Bangalore, Karnataka, India

***Address for Correspondence:** Dr. Suchetana Mohan, Postgraduate, Department of Anaesthesia, SIMS & RC Bangalore, Karnataka, India
E-mail: suchetanamohan@gmail.com

Received: 02 Nov 2025/ Revised: 06 Dec 2025/ Accepted: 20 Feb 2026

ABSTRACT

Background: Non-invasive ventilation (NIV) is a key modality in managing acute respiratory failure (ARF) in ICU settings. Delayed recognition of NIV failure and late intubation are associated with increased mortality. The ROX index and HACOR score are validated tools for predicting ventilatory failure, but comparative evidence, especially in non-COPD patients, remains limited. This study aimed to compare their predictive accuracy for NIV outcomes.

Methods: This prospective observational study was conducted over six months in the ICU of Sapthagiri Institute of Medical Sciences, Bengaluru. A total of 36 patients aged >18 years with acute-on-chronic respiratory failure ($PaCO_2$ >45 mmHg, pH <7.35) initiated on NIV were included. ROX index and HACOR score were calculated at admission and at 1, 2, and 6 hours. NIV failure was defined as the need for endotracheal intubation.

Results: Among 36 patients, 14 (38.9%) required intubation. The ROX index at 6 hours showed superior predictive ability (AUC 0.87; 95% CI: 0.74–0.96) compared to the HACOR score (AUC 0.72; 95% CI: 0.55–0.86; p=0.03). A ROX cutoff ≤4.88 had 85.7% sensitivity and 81.8% specificity, whereas HACOR >5 showed 71.4% sensitivity and 72.7% specificity. Mortality among intubated patients was 42.9%.

Conclusion: The ROX index demonstrated better predictive accuracy than the HACOR score for NIV failure. Serial monitoring, particularly at 6 hours, can aid in early identification and timely decision-making for intubation in ICU patients.

Key-words: ROX index, HACOR score, Non-invasive ventilation, Respiratory failure, Intubation, ICU, Predictive accuracy

INTRODUCTION

Acute respiratory failure (ARF) remains one of the most common and life-threatening conditions encountered in the Intensive Care Unit (ICU), necessitating prompt respiratory support to prevent multiorgan dysfunction and death [1]. NIV has emerged as a pivotal therapeutic modality in the management of ARF, offering several physiological advantages, including delivery of accurately controlled prescribed oxygen, reduction in the work of breathing, improvement in gas exchange, augmentation of functional residual capacity, and counterbalancing of intrinsic positive end-expiratory pressure (PEEP) [2]. Furthermore, NIV circumvents the complications associated with endotracheal intubation and invasive mechanical ventilation, such as ventilator-associated pneumonia, airway trauma, prolonged sedation, and ICU-acquired weakness [3].

Despite these advantages, NIV failure occurs in a substantial proportion of patients, with reported failure rates ranging from 25% to 49% in patients with acute hypoxemic respiratory failure [4]. The aetiology of respiratory failure amenable to NIV extends beyond chronic obstructive pulmonary disease (COPD) exacerbations to encompass a wide spectrum of conditions, including pneumonia, acute respiratory

How to cite this article
Mohan S, Yavagal S, Shruthi NS, Rathod AC, Shreya MS. Comparison of ROX Index and HACOR Score for Predicting NIV Success and Failure in ICU Patients– A Prospective Observational Study. SSR Inst Int J Life Sci., 2026; 12(2): 9601-9608.

Access this article online
https://iijls.com/

doi: 10.21276/SSR-IIJLS.2026.12.2.42

distress syndrome (ARDS), cardiogenic pulmonary oedema, neuromuscular diseases, chest wall deformities, bronchial asthma, pulmonary embolism, and other causes of acute on chronic respiratory failure [5]. In patients who experience NIV failure, delayed intubation has been consistently associated with increased morbidity and mortality, underscoring the critical importance of timely identification of patients who are unlikely to benefit from continued NIV [6].

The challenge confronting clinicians lies in accurately distinguishing between patients who will respond favourably to NIV and those who will require escalation to invasive mechanical ventilation. Early identification of NIV failure enables timely intubation, which has been shown to improve survival outcomes compared to late intubation [4]. Several clinical prediction tools have been developed to address this diagnostic challenge. Among these, the HACOR score and the ROX index have garnered significant attention in recent critical care literature.

The HACOR score, first described by Duan *et al*., is a composite bedside scoring system that integrates five easily obtainable clinical parameters: heart rate, acidosis (assessed by arterial pH), consciousness level (assessed by Glasgow Coma Scale), oxygenation (PaO_2/FiO_2 ratio), and respiratory rate [4]. The total HACOR score ranges from 0 to 25 points, with higher scores indicating a greater likelihood of NIV failure. A HACOR score exceeding 5 at 1 hour after NIV initiation demonstrated a diagnostic accuracy of 81.8% for predicting NIV failure in the original validation study [4]. Subsequently, Duan *et al*. proposed an updated HACOR score that incorporated baseline variables, including the presence of pneumonia, immunosuppression, septic shock, and the Sequential Organ Failure Assessment (SOFA) score, further improving predictive performance [7].

The ROX index, originally developed by Roca et al. in 2016, was designed to predict the success of high-flow nasal cannula (HFNC) therapy in patients with hypoxemic respiratory failure [8]. The ROX index is calculated as the ratio of peripheral oxygen saturation (SpO_2) to the fraction of inspired oxygen (FiO_2), divided by the respiratory rate. Its simplicity and reliance on non-invasive, readily available bedside parameters make it an attractive clinical tool. While initially validated for HFNC, subsequent studies have explored the applicability of the ROX index in predicting NIV outcomes with encouraging results [9].

A limited number of studies have directly compared the predictive performance of the ROX index and the HACOR score. Valencia *et al.* compared the two tools for predicting HFNC failure in patients with SARS-CoV-2 pneumonia and reported moderate predictive capacity for both scores [10]. Praphruetkit *et al.* demonstrated that the ROX index had superior prognostic utility compared with the HACOR scale in emergency department patients with acute hypoxemic respiratory failure on HFNC [9]. However, comparative data specifically evaluating these two scoring systems in the context of NIV for non-COPD respiratory failure remain sparse. The present study was therefore designed to compare the predictive accuracy of the ROX index and the HACOR score for predicting NIV success or failure in ICU patients with respiratory failure, and to determine post-intubation outcomes in patients who failed NIV.

MATERIALS AND METHODS

Study Design and Setting- This prospective observational study was conducted at the Intensive Care Unit of Sapthagiri Institute of Medical Sciences and Research Centre (SIMS & RC), Bengaluru, Karnataka, India, over 6 months. The study was initiated after obtaining Institutional Ethics Committee (IEC) clearance. Written informed consent was obtained from all patients or their legal representatives before enrolment.

Study Population- Patients aged >18 years admitted to the ICU with acute-on-chronic respiratory failure and respiratory acidosis, initiated on NIV as first-line therapy, were included. The specific inclusion criteria were: (a) age greater than 18 years, (b) acute on chronic respiratory failure with respiratory acidosis, (c) use of NIV as first-line therapy, (d) $PaCO_2$ greater than 45 mmHg, and (e) arterial pH less than 7.35.

Patients were excluded from the study if they met any of the following criteria: (a) respiratory failure due to exacerbation COPD, (b) prophylactic use of NIV after extubation, (c) rescue use of NIV due to respiratory failure after extubation, (d) accidental extubation and subsequent use of NIV, (e) use of HFNC before or after NIV, (f) presence of multiorgan dysfunction syndrome, and (g) patients with a plan for immediate intubation after admission.

doi: 10.21276/SSR-IIJLS.2026.12.2.42

Sample Size Calculation- The sample size was calculated using the formula $\mathbf{n=2\sigma^2(Z\alpha/2 + Z1-\beta)^2/ (\mu1 - \mu2)^2,}$ based on the study conducted by Valencia *et al.*. With a confidence interval of 95%, a power of 80%, and using the mean and standard deviation values from the reference study, the minimum required sample size was determined to be 36 patients, with 18 patients in each study group (NIV success and NIV failure).

Data Collection and Study Protocol- All enrolled patients were managed by attending physicians, respiratory technicians, and nursing staff, as per the standard ICU protocol. Ventilator settings were adjusted based on the arterial $PaCO_2$ values and the severity of the patient's respiratory distress. Demographic data, including age, sex, body mass index (BMI), and comorbidities, were recorded at admission. The aetiology of respiratory failure was documented for each patient.

Both the HACOR score and the ROX index were calculated at four time points: at admission (baseline), and at 1, 2, and 6 hours after initiation of NIV. The HACOR score was calculated as the sum of points assigned for heart rate (beats per minute), acidosis (assessed by arterial pH), consciousness level (assessed by Glasgow Coma Scale), oxygenation (PaO_2/FiO_2 ratio), and respiratory rate. The maximum possible HACOR score was 25 points. The ROX index was calculated as the ratio of pulse oximetry-measured SpO_2 divided by the FiO_2, further divided by the respiratory rate (SpO_2/FiO_2 ÷ respiratory rate).

NIV failure was defined as the requirement for endotracheal intubation during the ICU stay. Indications for intubation included persistent or worsening hypoxemia, haemodynamic instability, deterioration of consciousness, inability to clear secretions, and patient intolerance to NIV. Patients who were successfully weaned off NIV without requiring intubation were classified under the NIV success group. Post-intubation outcomes, including mechanical ventilation duration, ICU length of stay, and in-hospital mortality, were recorded for all patients who failed NIV.

Statistical Analysis- Statistical analysis was performed using SPSS version 22.0. Continuous variables were expressed as mean±SD and compared using Student's t-test or Mann–Whitney U test. Categorical variables were presented as frequencies and percentages and analyzed using the chi-square or Fisher's exact test. ROC curve analysis was used to assess predictive performance, including AUC, sensitivity, specificity, PPV, and NPV. A p-value<0.05 was considered statistically significant.

RESULTS

A total of 36 patients who met the inclusion criteria were enrolled in the study over the six-month study period. Of the 36 patients, 22 (61.1%) were successfully weaned off NIV (NIV success group) and 14 (38.9%) required endotracheal intubation due to NIV failure (NIV failure group).

The demographic and clinical characteristics are shown in Table 1. The mean age was 52.4±12.6 years in the NIV success group and 57.8±11.3 years in the failure group (p=0.189). Males predominated in both groups (63.6% vs 64.3%; p=0.968). Comorbidities such as hypertension, diabetes, chronic kidney disease, and coronary artery disease were comparable between groups (p>0.05). Mean BMI was 24.8±3.2 kg/m² and 25.6±4.1 kg/m², respectively (p=0.51).

Table 1: Demographic and Clinical Characteristics of the Study Population

Parameter	NIV Success (n=22)	NIV Failure (n=14)	p-value
Age (years), Mean±SD	52.4±12.6	57.8±11.3	0.189
Male, n (%)	14 (63.6%)	9 (64.3%)	0.968
Female, n (%)	8 (36.4%)	5 (35.7%)	0.968
BMI (kg/m²), Mean±SD	24.8±3.2	25.6±4.1	0.512
Hypertension, n (%)	9 (40.9%)	8 (57.1%)	0.338
Diabetes Mellitus, n (%)	7 (31.8%)	6 (42.9%)	0.497
Chronic Kidney Disease, n (%)	3 (13.6%)	4 (28.6%)	0.269
Coronary Artery Disease, n (%)	4 (18.2%)	3 (21.4%)	0.813

doi: 10.21276/SSR-IIJLS.2026.12.2.42

The most common aetiology of respiratory failure in the study population was pneumonia, accounting for 30.6% of all cases, followed by interstitial lung disease (19.4%) and bronchial asthma (13.9%). The distribution of aetiologies across the two groups is presented in Table 2. Pneumonia was the leading cause in both groups, observed in 27.3% of NIV success patients and 35.7% of NIV failure patients.

Table 2: Aetiology of Respiratory Failure in the Study Population

Aetiology	NIV Success (n=22)	NIV Failure (n=14)	Total (n=36)
Pneumonia	6 (27.3%)	5 (35.7%)	11 (30.6%)
Interstitial Lung Disease	4 (18.2%)	3 (21.4%)	7 (19.4%)
Bronchial Asthma	4 (18.2%)	1 (7.1%)	5 (13.9%)
Pulmonary Embolism	2 (9.1%)	2 (14.3%)	4 (11.1%)
Chest Wall Deformity	2 (9.1%)	1 (7.1%)	3 (8.3%)
Neuromuscular Disease	2 (9.1%)	1 (7.1%)	3 (8.3%)
Others	2 (9.1%)	1 (7.1%)	3 (8.3%)

The ROX index values at different time points are presented in Table 3. At admission, the mean ROX index was comparable between the two groups (5.12±1.84 in the success group versus 4.38±1.62 in the failure group, p=0.213). However, from 1 hour onwards, patients in the NIV success group demonstrated a progressively increasing ROX index, whereas patients in the NIV failure group showed a declining trend. By 6 hours post-NIV initiation, the mean ROX index was significantly higher in the success group (8.42±2.14) than in the failure group (3.62±1.28; p<0.001), indicating a clear divergence in respiratory trajectories between the two groups.

Table 3: Comparison of ROX Index Values at Different Time Points Between NIV Success and Failure Groups

Time Point	NIV Success (n=22) Mean±SD	NIV Failure (n=14) Mean±SD	p-value
At Admission	5.12±1.84	4.38±1.62	0.21
1 Hour after NIV	6.24±1.76	4.16±1.53	0.001
2 Hours after NIV	7.18±1.92	3.94±1.41	<0.001
6 Hours after NIV	8.42±2.14	3.62±1.28	<0.001

The HACOR score comparison between the two groups is presented in Table 4. At admission, the mean HACOR score was higher in the NIV failure group (8.14±3.12) compared to the success group (6.82±2.46), though this difference did not reach statistical significance (p=0.167). From 1 hour after NIV initiation, the HACOR score showed a statistically significant difference between the two groups (p=0.001). In the NIV success group, the HACOR score declined progressively from 6.82±2.46 at admission to 2.86±1.42 at 6 hours, reflecting clinical improvement. Conversely, in the NIV failure group, the HACOR score increased from 8.14±3.12 at admission to 9.18±3.26 at 6 hours, indicating clinical deterioration and impending NIV failure.

Table 4: Comparison of HACOR Score at Different Time Points Between NIV Success and Failure Groups

Time Point	NIV Success (n=22) Mean±SD	NIV Failure (n=14) Mean±SD	p-value
At Admission	6.82±2.46	8.14±3.12	0.167
1 Hour after NIV	4.68±2.18	7.86±2.94	0.001
2 Hours after NIV	3.54±1.86	8.42±3.08	<0.001
6 Hours after NIV	2.86±1.42	9.18±3.26	<0.001

doi: 10.21276/SSR-IIJLS.2026.12.2.42

The receiver operating characteristic (ROC) curve analysis comparing the predictive accuracy of the ROX index and HACOR score at different time points is summarised in Table 5. The ROX index consistently demonstrated higher AUC values than the HACOR score at all time points evaluated. The ROX index at 6 hours after NIV initiation demonstrated the highest predictive accuracy with an AUC of 0.87 (95% CI: 0.74–0.96), sensitivity of 85.7%, and specificity of 81.8% at a cutoff value of ≤4.88. In comparison, the HACOR score at 6 hours yielded an AUC of 0.72 (95% CI: 0.55–0.86), sensitivity of 71.4%, and specificity of 72.7% at a cutoff of >5. DeLong's test for comparison of the two ROC curves at 6 hours demonstrated a statistically significant difference in AUC favouring the ROX index (difference in AUC=0.15, p=0.03).

Table 5: ROC Curve Analysis Comparing Predictive Accuracy of ROX Index and HACOR Score at Different Time Points

Parameter	Time Point	AUC (95% CI)	Sensitivity (%)	Specificity (%)	Cutoff
ROX Index	1 Hour	0.76 (0.59–0.89)	71.4	68.2	≤4.72
ROX Index	2 Hours	0.82 (0.67–0.93)	78.6	77.3	≤4.56
ROX Index	6 Hours	0.87 (0.74–0.96)	85.7	81.8	≤4.88
HACOR Score	1 Hour	0.68 (0.50–0.83)	64.3	63.6	>5
HACOR Score	2 Hours	0.71 (0.54–0.85)	71.4	68.2	>5.5
HACOR Score	6 Hours	0.72 (0.55–0.86)	71.4	72.7	>5

The post-intubation outcomes of the 14 patients who experienced NIV failure are detailed in Table 6. The mean duration of mechanical ventilation was 6.8±3.4 days, and the mean length of ICU stay was 11.2±4.8 days. Of the 14 intubated patients, 8 (57.1%) were successfully weaned from mechanical ventilation, while 2 (14.3%) required tracheostomy. The overall in-hospital mortality among intubated patients was 42.9% (6 of 14 patients). Notably, among patients who were intubated early (within 12 hours of NIV initiation, n=9), the mortality rate was 22.2%, substantially lower than the 80.0% observed in patients who were intubated late (after 12 hours, n=5). This finding reinforces the critical importance of early recognition of NIV failure and timely escalation to invasive ventilation.

Table 6: Post-Intubation Outcomes of Patients with NIV Failure (n=14)

Outcome Parameter	Value
Duration of Mechanical Ventilation (days), Mean±SD	6.8±3.4
Length of ICU Stay (days), Mean±SD	11.2±4.8
Length of Hospital Stay (days), Mean±SD	16.4±6.2
Successfully Weaned, n (%)	8 (57.1%)
Tracheostomy Required, n (%)	2 (14.3%)
In-Hospital Mortality, n (%)	6 (42.9%)
Early Intubation (≤12 hours), n (%)	9 (64.3%)
Late Intubation (>12 hours), n (%)	5 (35.7%)
Mortality in Early Intubation Group	2/9 (22.2%)
Mortality in Late Intubation Group	4/5 (80.0%)

doi: 10.21276/SSR-IIJLS.2026.12.2.42

DISCUSSION

The present study compared the predictive accuracy of the ROX index and the HACOR score for identifying NIV failure in ICU patients with acute-on-chronic respiratory failure. The key finding of this study was that the ROX index demonstrated superior discriminatory ability compared to the HACOR score, with an AUC of 0.87 versus 0.72 at 6 hours post-NIV initiation. This finding has important clinical implications for bedside decision-making in the ICU, as the ROX index relies entirely on non-invasive parameters and can be calculated rapidly without arterial blood gas analysis.

The overall NIV failure rate in the present study was 38.9%, which is consistent with previously reported rates in the literature. Duan *et al.* reported NIV failure rates of 47.8% and 39.4% in their test and validation cohorts, respectively [4]. Similarly, a multicenter study by Duan *et al.* involving 1451 patients in the training cohort reported comparable failure rates across different aetiologies of respiratory failure [7]. The slightly lower failure rate in the present study may be attributable to the exclusion of patients with COPD exacerbations and those with multiorgan dysfunction, which represent particularly high-risk subgroups [11].

The superior performance of the ROX index observed in this study aligns with findings reported by Praphruetkit *et al.,* who demonstrated that the ROX index had superior prognostic utility compared to the HACOR scale in predicting HFNC outcomes in emergency department patients with acute hypoxemic respiratory failure [9]. In their study of 75 patients, the ROX index outperformed the HACOR scale across multiple time points. Similarly, a recent study by Jaisankar *et al.* comparing the ROX index and updated HACOR score in patients with Type 2 respiratory failure reported that the ROX index was a more consistent and reliable predictor of NIV failure, particularly at 12 and 24 hours [12].

In contrast, the findings of Valencia *et al.* demonstrated only moderate predictive capacity for both tools in patients with SARS-CoV-2 pneumonia who failed HFNC [10]. The discrepancy may be explained by differences in study population, ventilatory support modality (HFNC versus NIV), and the unique pathophysiology of COVID-19-related respiratory failure. A retrospective cohort study from Central India involving 441 COVID-19 patients on NIV reported that the ROX index was non-inferior to the HACOR score, with AUC values increasing from 0.84 to 0.94 for the ROX index and from 0.79 to 0.92 for the HACOR score from day 1 to day 3 [13].

The HACOR score in the present study demonstrated an AUC of 0.72 at 6 hours, with a sensitivity of 71.4% and specificity of 72.7% at a cutoff of >5. These values are somewhat lower than those reported in the original HACOR validation study by Duan *et al.,* where the diagnostic accuracy exceeded 80% at a cutoff of 5 [4]. This difference may be related to the smaller sample size and the specific patient population in the present study (acute-on-chronic respiratory failure with respiratory acidosis). The HACOR score requires arterial blood gas analysis for its calculation, which may delay clinical decision-making compared to the ROX index, which utilises only pulse oximetry and respiratory rate [14].

A particularly noteworthy finding in the present study was a significantly higher mortality rate among patients who underwent late intubation (80.0%) compared with those who underwent early intubation (22.2%). This finding is consistent with the observations of Duan *et al.*, who reported that early intubation in patients with a HACOR score >5 was associated with decreased hospital mortality [4]. A multicenter study by Duan *et al.* also confirmed that high-risk patients identified early had improved outcomes when intubation was not delayed [7]. These findings collectively emphasise that clinical prediction tools enabling early identification of NIV failure have the potential to reduce mortality in critically ill patients [15].

The ROX index at 6 hours with a cutoff of ≤4.88 appeared to be the optimal parameter for predicting NIV failure in the present study. Duan *et al*. reported that ROX index values before and after 1–2 hours of NIV were significantly lower in patients with NIV failure, with AUC values ranging from 0.64 to 0.77 [16]. The slightly higher AUC in the present study (0.87) may reflect the more homogeneous patient population and the strict exclusion criteria employed. A 2025 meta-analysis involving 1529 patients reported a combined AUC of 0.75 for HACOR and 0.72 for the ROX index, suggesting that both tools have moderate predictive capacity. However, there is significant heterogeneity across studies [17].

The present study has certain limitations that warrant consideration. First, the study was conducted at a single centre with a relatively small sample size of 36 patients, which may limit the generalisability of the findings. Second, the study excluded patients with COPD

doi: 10.21276/SSR-IIJLS.2026.12.2.42

exacerbations, which constitute a significant proportion of patients requiring NIV in the ICU. Third, the study did not evaluate the updated HACOR score, which incorporates additional baseline variables and has demonstrated improved predictive performance. Future multicenter studies with larger sample sizes and inclusion of diverse aetiologies of respiratory failure are warranted to validate these findings and establish standardised protocols for the use of the ROX index and HACOR score in guiding NIV management [18].

CONCLUSIONS

The ROX index demonstrated superior predictive accuracy compared with the HACOR score for identifying NIV failure in ICU patients with acute-on-chronic respiratory failure. The ROX index at 6 hours after NIV initiation, at a cutoff of ≤4.88, yielded the highest sensitivity (85.7%) and specificity (81.8%) with an AUC of 0.87, significantly outperforming the HACOR score (AUC 0.72, p=0.03). Early intubation in patients identified as NIV failures was associated with markedly lower mortality (22.2%) compared to late intubation (80.0%), underscoring the clinical importance of timely prediction of NIV outcomes. The ROX index, being a simple, non-invasive, and readily calculable bedside tool, may serve as a reliable and practical parameter for guiding clinical decisions regarding the timing of intubation in ICU patients with respiratory failure on NIV.

CONTRIBUTION OF AUTHORS

Research concept- Suchetana Mohan, Shreya MS
Research design- Akshay C Rathod, Shreya MS
Supervision- Shobha Yavagal, Shruthi NS
Materials- Suchetana Mohan, Akshay C Rathod
Data collection- Suchetana Mohan, Akshay C Rathod, Shreya MS
Data analysis and interpretation- Shobha Yavagal, Shruthi NS
Literature search- Akshay C Rathod, Shreya MS
Writing article- Suchetana Mohan, Shreya MS
Critical review- Shobha Yavagal, Shruthi NS
Article editing- Suchetana Mohan, Akshay C Rathod
Final approval- Shobha Yavagal, Shruthi NS

REFERENCES

[1] Rochwerg B, Brochard L, Elliott MW, Hess D, Hill NS, et al. Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure. Eur Respir J., 2017; 50(2): 1602426.
[2] L'Her E, Deye N, Lellouche F, Taille S, Demoule A, et al. Physiologic effects of noninvasive ventilation during acute lung injury. Am J Respir Crit Care Med., 2005; 172(9): 1112–18.
[3] Antonelli M, Conti G, Moro ML, Esquinas A, Gonzalez-Diaz G, et al. Predictors of failure of noninvasive positive pressure ventilation in patients with acute hypoxemic respiratory failure: a multicenter study. Intensive Care Med., 2001; 27(11): 1718–28.
[4] Duan J, Han X, Bai L, Zhou L, Huang S. Assessment of heart rate, acidosis, consciousness, oxygenation, and respiratory rate to predict noninvasive ventilation failure in hypoxemic patients. Intensive Care Med., 2017; 43(2): 192–99.
[5] Thille AW, Contou D, Fragnoli C, Cordoba-Izquierdo A, Fillatre P, Maitre B, et al. Non-invasive ventilation for acute hypoxemic respiratory failure: intubation rate and risk factors. Crit Care, 2013; 17(6): R269.
[6] Demoule A, Girou E, Richard JC, Taille S, Brochard L. Benefits and risks of success or failure of noninvasive ventilation. Intensive Care Med., 2006; 32(11): 1756–65.
[7] Duan J, Chen L, Liu X, Bozbay S, Liu Y, et al. An updated HACOR score for predicting the failure of noninvasive ventilation: a multicenter prospective observational study. Crit Care, 2022; 26(1): 196.
[8] Roca O, Messika J, Caralt B, García-de-Acilu M, Sztrymf B, et al. Predicting success of high-flow nasal cannula in pneumonia patients with hypoxemic respiratory failure: the utility of the ROX index. J Crit Care, 2016; 35: 200–05.
[9] Praphruetkit N, Boonchana N, Monsomboon A, Trakarnvanich T, Vongsfak J, et al. ROX index versus HACOR scale in predicting success and failure of high-flow nasal cannula in the emergency department for patients with acute hypoxemic respiratory failure: a prospective observational study. Int J Emerg Med., 2023; 16(1): 3.
[10] Valencia CF, Lucero OD, Castro OC, Santacruz CA, Zamora LFR. Comparison of ROX and HACOR scales to predict high-flow nasal cannula failure in patients with SARS-CoV-2 pneumonia. Sci Rep., 2021; 11(1): 22559.

doi: 10.21276/SSR-IIJLS.2026.12.2.42

[11]Ding M, Han X, Bai L, Huang S, Duan J. Impact of HACOR score on noninvasive ventilation failure in non-COPD patients with acute-on-chronic respiratory failure. Can Respir J., 2021; 2021: 9960667.

[12]Jaisankar D, Ganesan M, Balakrishnan H, Rajachidambaram M, et al. Comparison of ROX index and updated HACOR score to predict failure of noninvasive ventilation in patients admitted with type 2 respiratory failure in the intensive care unit. J Neonatal Surg., 2024; 13(4): S100–S02.

[13]Verma A, Rao SS, Bhatia S. Longitudinal assessment of ROX and HACOR scores to predict non-invasive ventilation failure in patients with SARS-CoV-2 pneumonia. J Crit Care Med., 2024; 10(2): 117–28.

[14]Roca O, Caralt B, Messika J, Samper M, et al. An index combining respiratory rate and oxygenation to predict outcome of nasal high-flow therapy. Am J Respir Crit Care Med., 2019; 199(11): 1368–76.

[15]Carrillo A, Lopez A, Carrillo L, Gonzalez-Diaz G, Nolla-Salas J, Oriol-Lopez S, et al. Validity of a clinical scale in predicting the failure of non-invasive ventilation in hypoxemic patients. J Crit Care, 2020; 60: 152–58.

[16]Duan J, Bai L, Duan J, Chen L, Han X, et al. Prediction of noninvasive ventilation failure using the ROX index in patients with de novo acute respiratory failure. Ann Intensive Care, 2022; 12(1): 110.

[17]Pugazhendi S, Ozaeta A. Comparison of ROX and HACOR scales to predict noninvasive ventilation failure in acute respiratory failure: a systematic review with meta-analysis. Chest, 2025; 168(4): S1124–25.

[18]Guia MF, Boléo-Tomé JP, Imitazione P, Polistina GE, Alves C, Ishikawa O, et al. Usefulness of the HACOR score in predicting success of CPAP in COVID-19-related hypoxemia. Respir Med., 2021; 187: 106550.