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"Systematic review of utility of the hacor score in predicting the failure of non-invasive ventilation"

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INTRODUCTION

HACOR score with parameters of Heart rate, Acidosis, Consciousness, Oxygenation, and Respiratory rate (HACOR) is a bedside tool to predict the early failure of NIV in hypoxemic respiratory failure patients.

AIMS AND OBJECTIVES

To systematically review the studies on HACOR score in respiratory failure receiving non-invasive ventilation.

METHODOLOGY

MEDLINE, PUBMED and Embase data were searched with keywords "HACOR score". Eligible articles were filtered according to relevance to the study and power of the study. Selected studies were analysed systematically and reviewed.

CONCLUSION

HACOR score is excellent tool for predicting the failure of NIV at bedside in patients with acute hypoxemic respiratory failure. Early identification of the patients who need invasive ventilation will reduce the mortality, morbidity and prolonged period of mechanical ventilation and ICU stay. It is a simple score which can be applied in with minimal laboratory facility and peripheral centres as well.

Keywords: HACOR score, Acute hypoxemic failure, Non-invasive ventilation, Mechanical ventilation,

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Introduction

Respiratory failure is defined as failure to sustain an adequate gas exchange and is characterized by abnormalities of arterial blood gas tensions. It is usually characterized by life-threatening derangements in arterial blood gases and acid–base status. Non-invasive ventilation has been effectively applied in patients with acute respiratory failure with a significant reduction in mortality rate, need for endotracheal intubation, and length of stay.

Non-invasive ventilation reduces inspiratory muscle effort and improves oxygenation in hypoxemic patients with acute respiratory failure. As it offers several major advantages over invasive ventilation (e.g., preserving the ability to swallow, cough, and communicate verbally), NIV is widely used to avoid intubation. Use of non-invasive ventilation (NIV) can avoid intubation in some patients with respiratory failure by temporarily supporting ventilation during initial treatment.

Improved respiratory dynamics, especially during the first 30 minutes after the application of NIV treatment is associated with a better patient outcome. (1) The advantages of NIV are several like it can be managed in wards by nurses and respiratory therapists and does not require physicians, intensivists, or anaesthesiologists all the time.

However, the rate of NIV failure is 40–54% in hypoxemic patients. Moreover, NIV failure is associated with increased length of ICU stay, increased morbidity and mortality. (2) Among patients who experience NIV failure, late failure further increases mortality. Therefore, early identification of patients at high risk for NIV failure and early application of invasive ventilation may reduce mortality. Identifying the predictors of non-invasive ventilation (NIV) failure has attracted significant interest because of the strong link between failure and poor outcomes.

Clinicians and researchers attempted to relate SOFA, APACHE II, and SAPS II scores with NIV failure in studies performed in patients with hypoxemic acute respiratory failure due to sepsis, pneumonia or other causes. (3) A SAPS II score ≥34 was identified as an independent risk factor for NIV failure in hypoxemic acute respiratory failure. However, validations studies of these indexes have not consistently showed the sensitivity and specificity. (4)

In this context, Duan et al designed a composite score-based index – HACOR. Each of the five parameters identified - Heart rate, Acidosis, Consciousness, Oxygenation, and Respiratory rate (HACOR) was assigned points such that the combined HACOR score ranged from 0 to 25 points with higher scores indicating higher likelihood of NIV failure. Patients with a HACOR score of more than 5 were found to have a very high risk of NIV failure. Subsequently, it has been validated for predicting NIV failure in non-COPD, acute on chronic respiratory-failure patients with respiratory acidosis. (5)

The HACOR scale variables are easily available at the bedside and easy to apply. It is a reasonable tool to use and would benefit the patient for early identification of those who are in high risk of requiring early intubation rather than trial of NIV.

As with any index scores, HACOR score is not bereft of criticism. It has been argued that there is some risk of circularity bias here, and some parameters assigned high points in the HACOR score (e.g., GCS score <13, PaO2/FiO2 <125) seem like obvious triggers for intubation. There also been criticism that HACOR score is more a refinement of older scores like SOFA and APACHE than of its own.

There is a paucity of literature characterising the subset of patients who could tolerate NIV well and those who do not, based on indexed score systems. Such characterisation would scientifically enhance the understanding of various factors affecting NIV success or failure early in the course. The present systematic analysis and review intends to plug the lacunae in the literature by systematically analysing the research studies of HACOR score in respiratory failure receiving non-invasive ventilation.

Aim of the Study

To systematically review the studies on HACOR score in respiratory failure receiving non-invasive ventilation.

Methodology

MEDLINE, PUBMED and Embase data were searched with keywords “HACOR score”. Eligible articles were filtered according to relevance to the study and power of the study. Selected studies were analysed systematically and reviewed.

Definitions

HACOR scoring system

Variables	Category (j)	Assigned points
Heart rate, beats/min	≤120	0
	≥121	1
pH	≥7.35	0
	7.30–7.34	2
	7.25–7.29	3
	<7.25	4
GCS	15	0
	13–14	2
	11–12	5
	≤10	10
PaO_2/FiO_2	≥201	0
	176–200	2
	151–175	3
	126–150	4
	101–125	5
	≤100	6
Respiratory rate, breaths/min	≤30	0
	31–35	1
	36–40	2
	41–45	3
	≥46	4

Type 1 respiratory failure:

Respiratory failure with partial pressure of oxygen (PaO2) < 60 mmHg with normal or low partial pressure of carbon dioxide (PaCO2)

Review of Studies

In a landmark study by **Duan et al,** researchers constructed HACOR score based on Heart rate, Acidosis (pH), Consciousness (GCS), Oxygenation, and Respiratory rate with differential weightage to each clinical scenario. Their study observed that at 1 hour of NIV, odds ratio of NIV failure is 1.73 for every 1-point increase in HACOR score of test cohort. Patients with NIV failure shows a higher HACOR score at 1, 12, 24, and 48 hours of NIV. HACOR score improves in patients with NIV success and remains unaltered in patients with NIV failure. The diagnostic accuracy for NIV failure of a HACOR score above 5 at 1 hour of NIV was 81.8% (test cohort) and 86% (validation cohort). This remained above 80% regardless of NIV duration, diagnosis, age, or disease severity (APACHE 2 score). Patients who failed NIV and were intubated early (within 12 hours) had a HACOR > 5 at NIV initiation and 1 hour NIV than those intubated later (after 12 hours of NIV). Study concluded that HACOR is a potentially useful bedside tool for the prediction of NIV failure. HACOR score accurately predicts NIV failure in patients with hypoxemic respiratory failure in this single centre study. A HACOR score >5 at 1hour of NIV highlights patients with a >80% risk of NIV failure regardless of diagnosis, age, and disease severity. (5)

Mannarino et al tested the ability of the HACOR score to predict adverse outcomes in hospitalized COVID-19 patients with acute respiratory failure. Four hundred patients were categorized according to high (>5) or low (≤5) HACOR scores measured at baseline and 1 h after the start of NIRS treatment. The association between a high HACOR score and either in-hospital death or the need for intubation was evaluated. NIRS was employed in 161 patients. Forty patients (10%) underwent intubation and 98 (25%) patients died. A baseline HACOR score > 5 was associated with the need for intubation or in-hospital death in the whole population (HR 4.3; $p < 0.001$), in the subgroup of patients who underwent NIRS (HR 5.2; $p < 0.001$) and in no-NIRS subgroup (HR 7.9; $p < 0.001$). In the NIRS subgroup, along with the baseline HACOR score, also 1-h HACOR score predicted NIRS failure (HR 2.6; $p = 0.039$). In conclusion, the HACOR score is a significant predictor of adverse clinical outcomes in patients with COVID-19-related ARF. (6)

Guia et al conducted study on 128 patients requiring NIV with Pa02/Fio02 < 300. , mean age 61,7 years. Mean HACOR at 1 h after starting CPAP was 3,27 ± 3,84 and mean PaO_2/FiO_2 was 203,30 ± 92,21 mmHg; 35 patients (27,3 %) presented CPAP failure: 29 underwent oro-tracheal intubation and 6 died due to COVID-19 (all having a do-not-intubate order). HACOR accuracy for predicting CPAP failure was 82,03 %, while PaO_2/FiO2 accuracy was 81,25 %. Study concluded that although HACOR score had a good diagnostic performance in predicting CPAP failure in COVID-19-related ARF,

PaO_2/FiO_2 has also shown to be a good predictor of failure. (7)

Teh et al studied NIV with patients with Decompensated heart failure and COPD exacerbation. HACOR scores are much lower in the NIV success patients and 100% NIV failure rate for the HACOR score ≥7 at 1 h and 2 h of NIV. A different cut-off value of HACOR score was been tested to determine its diagnostic accuracy in predicting NIV failure upon patient presentation, 1 h and 2 h post NIV application. A cut-off value of ≥5 in 1 h of NIV, the diagnostic power is 86.27% with the sensitivity of 62.50% and specificity of 90.70%. Whereas in 2 hours of NIV with the HACOR score of ≥5, its diagnostic power is 87.50% with the sensitivity of 50% and specificity of 95%. In 0-2 hours of NIV, AUC for predicting NIV failure is 0.788, 0.868 and 0.925. In a comparison of diagnostic accuracy between AECOAD and ADHF subgroups, the latter was shown to be more accurate in the prediction of NIV failure with a diagnostic accuracy of 59.62% and sensitivity of 80% and 54.76% specificity. (8)

Innocenti et al studied pneumonia patients who required NIV. Patients, who needed mechanical ventilation, showed a higher HACOR score (6 [5-7] vs 6 [6-7], p=.057; Day+2: 6 [6-6] vs 6 [4-6], p=.013) .An HACOR score >5 was more frequent among nonsurvivors (Day0: 82% vs 58%; Day2: 82% vs 48%, all p<0.01) and it was associated with in-hospital mortality (Day0: RR 5.88, 95%CI 2.01-17.22; Day2: RR 4.33, 95%CI 1.64-11.41). An HACOR score >5 was independently associated with increased mortality rate. (9)

Ding et al studied 148 patients with respiratory failure. They observed that 19 (13%) experienced NIV failure. From initiation to 24 h of NIV, the HACOR scores of patients who experienced NIV failure were much higher than those of patients who received successful NIV. The area under the receiver operating characteristic curve was 0.69, 0.91, 0.91, and 0.94 when the HACOR score was tested at initiation and after 1-2, 12, and 24 h of NIV, respectively. To obtain the best sensitivity and specificity, the cutoff value at initiation was 7 with a sensitivity of 68% and a specificity of 61%. After 1-2 h of NIV, it was 5 with a sensitivity of 90% and a specificity of 85%. After 12 h of NIV, it was 4 with a sensitivity of 82% and a specificity of 91%. After 24 h of NIV, it was 2 with a sensitivity of 100% and a specificity of 76%. Study concluded that the HACOR score has high sensitivity and specificity for predicting NIV failure among non-COPD patients who receive NIV due to acute-on-chronic respiratory failure with respiratory acidosis. (10)

Ishikawa et al conducted a trial to validate HACOR score in respiratory failure. They recruited patients aged >18 placed on NIV during hospitalization, totalling 77. They adopted the same HACOR scale and score cutoff from the original study, and examined if outcomes differed for those who scored >5, or <5. HACOR score was also trended 1 to 2 hours after NIV initiation, to see if score differences correlated with outcomes. Their study observed that a total of 45 patients had an initial score <5, of which 44% were later intubated. HACOR score 1 to 2 hours after NIV was calculated in 36 of 45. Of those with improved scores, only 20% ultimately required intubation. In patients whose score did not change, intubation rate was 48%. Of the 32 with initial score >5, 50% were later intubated. In this group, 62% with improved scores and 67% with unchanged or worsened scores were intubated. Average time to ETI for scores >5 was 40 hours. In-hospital mortality between initial score <5 versus >5 was 22% and 28%, respectively. Study concluded that HACOR scale can be applied for all types of ARF. Scores >5 had higher rates of NIV failure. Rates were lowest for those with initial score <5, with a downtrend after. (11)

Laimoud et al studied adult patients with left ventricle ejection fraction (LV EF) <50% admitted to the intensive care unit (ICU) with community-acquired pneumonia and acute respiratory failure on NIV. The mean age of the study cohort was 64.1± 12.6 years, with a male predominance (73.4%) and a mean LV EF of 36.4 ± 7.8%. Almost 55.9% of the studied patients had diabetes mellitus, 45.8% had chronic systemic hypertension, 73.4% had ischemic heart disease, 20.3% had chronic kidney disease, and 9.6% had liver cirrhosis. No significant differences were observed between the NIV success and NIV failure groups regarding underlying morbidities or inflammatory markers. .High initial HACOR scores, persistent hyperlactatemia and non-decrementing LUS score were associated with early NIV failure in patients with cardiac dysfunction presenting with community-acquired pneumonia, and could be used as clinical and paraclinical variables for early decision making regarding invasive ventilation.(12)

Conclusion

HACOR score is excellent tool for predicting the failure of NIV at bedside in patients with acute hypoxemic respiratory failure. Early identification of the patients who need invasive ventilation will reduce the mortality, morbidity and prolonged period of mechanical ventilation and ICU stay. It is a simple score which can be applied in with minimal laboratory facility and peripheral centres as well.

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