ORIGINAL ARTICLE

Comparison of the Recent ExPreS Score, WEANSNOW Score, and the Parsimonious HACOR Score as the Best Predictor of Weaning: An Externally Validated Prospective Observational Study

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Abstract

Background: Since weaning failure is multifactorial, comprehensive weaning scores encompassing not only the respiratory component but also nonrespiratory aspects are quintessential for successful weaning prediction.

Materials and methods: This was a single-center prospective observational study on 128 intensive care unit (ICU) patients undergoing spontaneous breathing trials (SBT). The extubation prediction score (ExPreS), heart rate, acidosis, consciousness, oxygenation, respiratory rate (HACOR), and weaning parameters, endotracheal tube size, arterial blood gas analysis, nutrition, secretions, neuromuscular affecting agents, obstructive airway problems and wakefulness (WEANSNOW) scores were compared for their diagnostic accuracy for successful weaning prediction.

Results: Out of 128 patients, 49 (38.3%) patients had weaning failure, and 79 (61.7%) had weaning success. The patients in the weaning failure group had significantly higher APACHE II scores, WEANSNOW scores, HACOR scores, MV days, and significantly lower ExPreS scores as compared to the successful weaning group. Multivariable regression analysis showed that ExPreS score $p = 0.015$, adjusted OR 0.960, 95% CI (0.929–0.992) and HACOR score $p < 0.001$, adjusted OR 1.357, 95% CI (1.176–1.567) were independent predictors of weaning failure. The HACOR score had an AUC of 0.830, cut-off ≥5, $p < 0.001$, sensitivity 76%, specificity 68%, diagnostic accuracy 70% to predict weaning failure. The ExPreS score had an AUC of 0.735, cut-off ≥69, $p < 0.001$, sensitivity of 70.9%, specificity of 69.4%, and diagnostic accuracy of 70.3% to predict weaning success. Both the HACOR and ExPreS scores were good models for predicting weaning outcomes (model quality 0.76 and 0.64 respectively).

Conclusion: The parsimonious HACOR score is comparable to the ExPreS score for the prediction of weaning outcomes in critically ill patients.

Keywords: ExPreS score, HACOR score, Predictors, Weaning, WEANSNOW score.

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Highlights

This is the first study comparing three recent weaning scores – The extubation prediction score (ExPreS) score, heart rate, acidosis, consciousness, oxygenation, respiratory rate (HACOR) score, and weaning parameters, endotracheal tube size, arterial blood gas analysis, nutrition, secretions, neuromuscular affecting agents, obstructive airway problems and wakefulness (WEANSNOW), and shows that the HACOR score which needs only arterial blood gas and clinical parameters, yet reflects the parameters of multiorgan function, is as reliable as the ExPreS score for predicting weaning outcomes.

Introduction

Unnecessary delay or premature extubation can lead to adverse outcomes like increased incidences of ventilator-associated pneumonia (VAP), days of mechanical ventilation (MV), length of intensive care unit (ICU) stay, morbidity, and mortality.[1] Often the extubations are delayed due to a lack of physician proximity as they are preoccupied with other critical procedures or consultations.[2] Extubation decisions taken by respiratory therapists expedite the weaning process.[2] However, the pathophysiology of weaning is multifactorial, and not just a reflection of the respiratory function.[3] Thus, a simple, easy-to-perform yet comprehensive score encompassing the function of multiple organs which can be evaluated by all healthcare personnel (HCP) in the ICU for prediction of successful weaning is a necessity. Extubation failure defined as the requirement of any form of MV within 48 hours of

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planned extubation, is highly prevalent in ICUs ranging from 6 to 47%.[4,5] Extubation readiness is based on the outcome of the spontaneous breathing trial (SBT) lasting between 30 and 120 minutes.[6] However, in critically ill ICU patients, a 120-minute-SBT tolerance may be required in certain patient cohorts, as patients who tolerate a 30-minute SBT may often fail a 120-minute SBT.[7] Though a 120-min SBT has also been performed for the prediction of weaning, the respiratory mechanics alone cannot precisely predict it in critically ill.[8,9] Many studies have identified potential objective single parameters to identify extubation outcomes such as age, cause for intubation, vital signs like heart rate, respiratory rate, blood gas values, lung mechanics, oxygenation, ventilation electrolyte values, days on MV, and consciousness level.[10–12] Certain weaning indices focused on only respiratory function parameters, which have poor accuracy in predicting weaning success.[13–16]

Recently, Baptistella AR et al. identified the respiratory and nonrespiratory parameters contributing to extubation failure and derived a score called "extubation prediction score (ExPreS)".[17] This score was calculated during SBT and comprised of eight components namely rapid shallow breathing index (RSBI), dynamic lung compliance, days of MV, Glasgow coma scale (GSW), muscle strength, hematocrit, creatinine, and neurological comorbidity.[17]

In 2020, Lin FC et al. studied the WEANSNOW checklist in predicting extubation success in the critically ill.[18] The score comprised eight components namely, weaning parameters, endotracheal tube size, arterial blood gas analysis, nutrition, secretions, neuromuscular affecting agents, obstructive airway problems, and wakefulness. Recent literature published in 2022 showed that the HACOR score originally developed to predict failure of non-invasive ventilation is an excellent predictor of weaning failure as well.[19,20]

The authors of the ExPReS score have also encouraged studies comparing the ExPreS score to other standard weaning indices as external validation studies.[17] Therefore, we intended to compare the predictive ability of the comprehensive ExPreS and WEANSNOW scores requiring extensive resources with the HACOR score consisting of five point-of-care variables in predicting the weaning outcomes in an externally validated cohort.

Aim

To determine the usefulness of the HACOR score as compared to ExPreS WEANSNOW scores for predicting weaning outcomes.

Objectives

Determine the diagnostic accuracy and cut-off of ExPreS, WEANSNOW, and HACOR scores for predicting weaning outcomes.

Materials and Methods

Study Approvals and Settings: The study had approvals from the Institutional Research Board (IRC-MCHP-Mpl/IRC/PG/2022/034), the Institutional Ethics Committee (IEC2: 118/2022), and registered in the Clinical Trial Registry of India (CTRI/2022/07/044298). A prospective observational study was conducted in adult ICUs of a tertiary care teaching hospital between August 2022 and March 2023.

Sample Size

The sample size was calculated based on the formula used for the comparison of two diagnostic tests with paired design (within-subjects) for outcome prediction.

$$n = \frac{\left[Za\sqrt{\psi} + Z\beta\sqrt{\psi - (P_1 - P_2)^2}\right]^2}{(P_1 - P_2)^2}$$

$\psi min = P_2 - P_1$

$\psi max = P_1 x (1P_2) + P_2 x (1P_1)$

Yates continuity corrections

$$= n / 4(1 + \sqrt{1 + 4\left(\left(n|P_1 - P_2|\right)\right)})^2$$

Considering the power of the study of 80%, type I error of 5%, about 90% sensitivity of weaning prediction of ExPreS score (P_2), 80% sensitivity of weaning prediction of HACOR score (P_1), 10% being the minimum disagreement between ExPreS and HACOR scores, 26% being the maximum disagreement between the two scores, the mean disagreement being 18%, and after the Yate's correction, the sample size was 128.[17,20]

Inclusion Criteria

- Age >18 years and <80 years.
- Invasively ventilated for more than 24 hours.
- Planned for extubation (decided as per the treating physician).

Exclusion Criteria

- Those extubated without undergoing SBT: Self/accidental extubation by the patient/Extubation as part of palliative care.
- Patients who were unfit for SBT as per the treating physician of the unit.

Data Collection

All consecutive patients admitted to ICU were assessed daily for inclusion/exclusion criteria, written informed consent was obtained from legally authorized representatives, and then recruited to the study. Figure 1 depicts patient recruitment into the study. Every morning all eligible patients were screened by the intensivist, respiratory therapist, and allocated nurse for weaning after assessing the patientrelated issues. SBT was given if the patient was awake with good cough reflex, a fraction of inspired oxygen (FiO_2 < 0.5), positive end-expiratory pressure (PEEP) <5 cm H_2O; minute ventilation (MV) <10 LPM; PaO_2/FiO_2 ratio ≥150 mm Hg; afebrile with temperature <38.5°C; no hemodynamic instability; no serum sodium, potassium and calcium abnormalities. Spontaneous breathing trial (SBT) was given for 120 minutes. At the end of 120 minutes following parameters collected were:

- Demographics and patientrelated: Age, gender, diagnosis, number of days on MV, acute physiology and chronic health evaluation (APACHE II) score on admission, sequential organ failure assessment (SOFA) score on admission, incidence of VAP, days of MV.
- APACHE II and SOFA scores on the day of extubation, ExPreS, WEANSNOW, and HACOR scores were noted.

  Patients were extubated if they tolerated the designated SBT for 120 minutes. Prior to extubation, a cuff leak test was done. If the cuff leak volume is >110 mL and the percentage of cuff leak is >10% the cuff leak test is considered negative (i.e., lower risk of upper airway edema). Postextubation till 48 hours the patient's respiratory and hemodynamic parameters were continuously monitored. The decision to reintubate or use non-invasive ventilation was decided solely by the treating intensivist who was blinded to the current research.

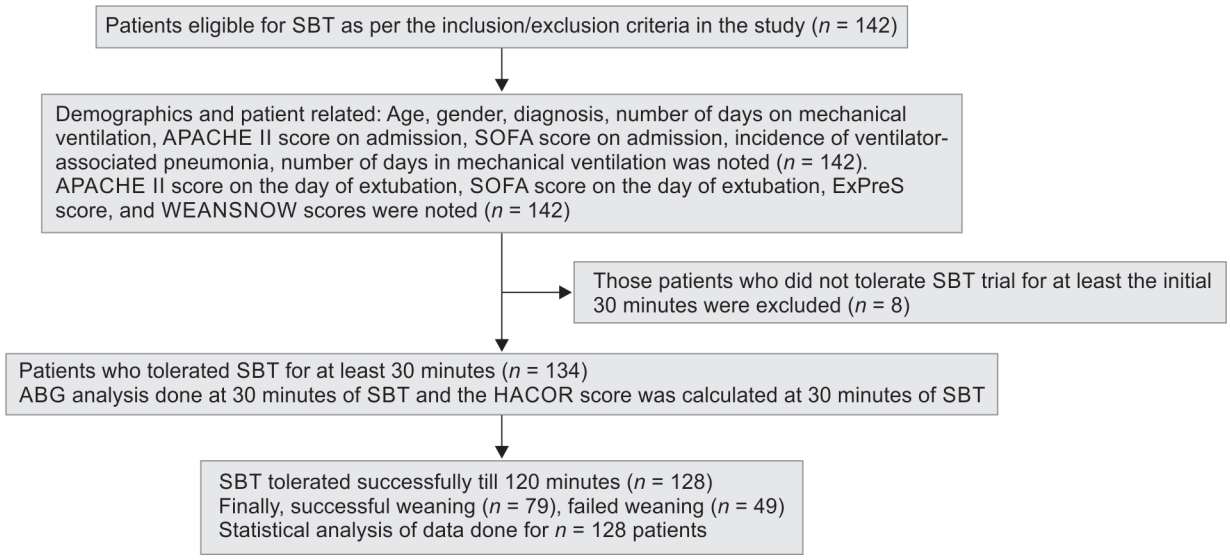

Fig. 1: Depiction of patient enrollment into the study

ABG, arterial blood gas; APACHE, acute physiology and chronic health evaluation; ExPreS, extubation prediction score; HACOR, heart rate, acidosis, consciousness, oxygenation, respiratory rate; SBT, spontaneous breathing trial; SOFA, sequential organ failure assessment; WEANSNOW, weaning parameters, endotracheal tube size, arterial blood gas analysis, nutrition, secretions, neuromuscular affecting agents, obstructive airway problems and wakefulness

The study endpoint was extubation outcome in terms of extubation success or extubation failure. Extubation success is defined as a non requirement of reintubation or any form of MV support within 48 hours of extubation.

Statistical Analysis

Statistical analysis was performed using the IBM Statistical Package for Social Sciences (SPSS) statistics software for the Windows operating system, version 29 (IBM Corporation, Armonk, NY, USA). The numerical frequencies were expressed as percentages. The normality of distribution of continuous variables was analyzed using the Kolmogorov–Smirnov test and the Shapiro–Wilk test ($p > 0.05$ indicating normally distributed data). The variables following normal or parametric distribution were expressed as mean and standard deviation (SD), whereas the non-parametrically distributed continuous variables were expressed as median and interquartile range (IQR). The difference in means between the parametrically distributed variables was determined by the independent-student *t*-test, whereas in the case of non-parametrically distributed variables, the Mann–Whitney *U*-test was used. For the prediction of extubation failure, the variables that were found to be different between the groups of failed and successful extubation were compared. Those variables with p-value ≤ 0.05 were selected for univariate analysis to predict failed weaning. Variables in univariate analysis with a p-value < 0.2 were selected for multivariable logistic regression analysis, for prediction of extubation failure, and the adjusted odds ratio (OR) with 95% confidence interval (CI) was calculated. The Hosmer and Lemeshow test p-value > 0.05 indicated a good-fit model. The variables that were found to be the independent predictors of extubation failure after multivariable logistic regression were used to plot the receiver operating characteristic (ROC) curve and the area under the curve (AUC), cut-off score, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy was determined. Using the cut-off values of the predictors of extubation failure, the odds ratio (OR) was calculated to predict extubation failure in patients with scores above or below the cut-offs. The categories of patients above and below the cut-off scores were compared using the Chi-square test to predict extubation failure. For all analyses except those aforementioned mentioned specifically, a p-value ≤ 0.05 was considered significant. The comparison of ExPreS and HACOR scores were compared using the SPSS forecasting and model analysis, with a model value >0.5 was considered as a "good model".

Results

A total of 128 patients were included in the study, with 79 (61.7%) patients having successful extubation and 49 (38.3%) patients having failed extubation (Table 1). The median (IQR) of APACHE II and SOFA scores on admission and on the day of weaning, along with those of ExPreS scores, WEANSNOW scores, and HACOR scores are depicted in Table 1.

The difference between the successful extubation and failed extubation groups showed that the APACHE II score on the day of extubation was significantly higher in the failed extubation group [12 (9–15)] as compared to the successful extubation group [10 (6–12)] ($p = 0.002$, Mann-Whitney *U*-test) (Table 2). Similarly, the WEANSNOW score and HACOR scores were significantly higher in the failed extubation group as compared to the successful extubation group ($p = 0.006$ and $p < 0.001$ respectively, Mann-Whitney-*U*-test), whereas the ExPreS score was significantly lower in the failed extubation group ($p < 0.001$, Mann-Whitney *U*-test) (Table 2). Other variables like the days of MV, incidence of VAP, and difficult/prolonged weaning were also significantly higher in the failed extubation group (Table 2). However, there was no significant difference between the extubation success and failed groups in terms of age, APACHE II score at admission, SOFA score at admission, SOFA score on the day of extubation, frequency of prone ventilation administered, use of corticosteroids or prolonged skeletal muscle relaxant use.

Table 1: Demographic details of study participants, *N* = 128 patients

Variables	*Values*
Age (years), Mean ± SD	56.76 ± 15.90
Gender, *n* (%)	Males 87 (68%)
APACHE II score admission (Mean ± SD)	12 (7.25–20)
APACHE II score weaning (Mean ± SD)	10 (7–13.75)
ExPreS score (Mean ± SD)	72 (58–83)
SOFA score admission [Median (IQR)]	5 (3–8)
SOFA score weaning [Median (IQR)]	4 (3–5.75)
MV days [Median (IQR)]	4 (3–5)
Length of ICU stay [Median (IQR)]	7 (4–9)
WEANSNOW score [Median (IQR)]	1 (0–1.75)
HACOR score	4 (2–8)
Extubation success *n* (%)	79 (61.7%)
Extubation failed *n* (%)	49 (38.3%)
Prone ventilation *n* (%)	1/128 (0.8%)
Prolonged skeletal muscle relaxant *n* (%)	1/128 (0.8%)
VAP *n* (%)	20/128 (15.6%)
Corticosteroid prior to extubation *n* (%)	8/128 (6.3%)
NIV within 48 hours of extubation *n* (%)	50/128 (39.1%)
Reintubation within 48 hours of extubation *n* (%)	9/128 (7%)
Simple weaning *n* (%)	119 (93%)
Difficult weaning *n* (%)	9 (7%)
Survived *n* (%)	118 (92.2%)

APACHE, acute physiology and chronic health evaluation; ExPreS, extubation prediction score; HACOR, heart rate, acidosis, consciousness, oxygenation, respiratory rate; ICU, intensive care unit; IQR, interquartile range; MV, mechanical ventilation; NIV, non-invasive ventilation; SD, standard deviation; SOFA, sequential organ failure assessment; VAP, ventilator-associated pneumonia; WEANSNOW, weaning parameters, endotracheal tube size, arterial blood gas analysis, nutrition, secretions, neuromuscular affecting agents, obstructive airway problems and wakefulness

After univariate and multivariable logistic regression, the ExPreS score ($p = 0.015$, adjusted OR 0.960, 95% CI (0.929–0.992) and the HACOR score ($p < 0.001$, adjusted OR 1.357, 95% CI (1.176–1.567) were the independent predictors of extubation failure (Table 3). The Hosmer and Lemeshow test *p*-value was 0.846, showing that the model was a good fit model.

The ROC of ExPreS score to predict successful extubation had AUC 0.735, cut-off ExPreS score ≥69, sensitivity 70.9%, specificity 69.4%, PPV 78.9%, NPV 59.7%, diagnostic accuracy 70.3% $p < 0.001$, 95% (0.642–0.828) (Fig. 2).

In patients with ExPreS score ≥69, a majority of 79% of patients had extubation success, whereas in those with ExPreS score <69, only 40% had extubation success ($p < 0.001$, Chi-square test) (Table 4). The univariate analysis using the cut-off ExPreS score to predict extubation success showed that patients with higher ExPreS score ≥69 increases the likelihood of successful extubation by 5.52 times as compared to those with an ExPreS score <69, $p < 0.001$, OR 5.52, 95% CI (2.536–12.011) (Table 5).

The ROC of HACOR score to predict extubation failure had an AUC of 0.830, cut-off score ≥5, $p < 0.001$, 95% CI (0.759–0.901), sensitivity 76%, specificity 68%, PPV 59%, NPV 82%, and a diagnostic accuracy 70% (Fig. 3). A comparison of the ROC curves of the ExPreS and HACOR scores to predict weaning outcomes showed that there was no significant difference between the AUC ($p = 0.072$) (Fig. 4). A high ExPreS score predicts weaning success, whereas a high HACOR score predicts weaning failure. To get the comparison of both the ROC of ExPreS score and the HACOR score on the same graph, the HACOR score and the value of (100-ExPreS score) were plotted together so that higher values of both predict the same outcome of weaning failure and can be compared on the same ROC plot analysis.

The comparison of ExPreS and HACOR scores using the analysis of SPSS version 29 showed that the HACOR score had a higher overall model quality of 0.76 as compared to ExPreS of 0.64 (Fig. 5).

Table 2: Difference in parameters between successful weaning and failed weaning groups

Variables	*Weaning success N = 79*	*Weaning failure N = 49*	*p-value*
Age (years), Mean ± SD	54.84 ± 16.35	59.86 ± 14.78	0.076*
APACHE II score admission, [Median (IQR)]	12 (8–20)	13 (6.5–20.50)	0.848**
APACHE II score, [Median (IQR)] (Day of extubation)	**10 (6–12)**	**12 (9–15)**	**0.002****
SOFA score admission, [Median (IQR)]	5 (3–8)	4 (3–7)	0.236**
SOFA score, [Median (IQR)] (Day of extubation)	4 (2–5)	4 (4–6)	0.062**
ExPreS score, [Median (IQR)]	**77 (67–84)**	**60 (45–74)**	**<0.001****
HACOR Score, [Median (IQR)]	**4 (2–5)**	**8 (4.5–13)**	**<0.001****
MV days, [Median (IQR)]	**3 (3–5)**	**4 (3–6.5)**	**0.014****
WEANSNOW score, [Median (IQR)]	**1 (0–1)**	**1 (1–2)**	**0.006****
Difficult/prolonged weaning, *n* (%)	**2 (2.5%)**	**7 (14.3%)**	**0.027**#**
Prone ventilation, *n* (%)	0 (0%)	1 (2%)	0.383#
VAP, *n* (%)	**7 (8.8%)**	**13 (26.5)**	**0.008**#**
Prolonged skeletal muscle relaxants, *n* (%)	0 (0%)	1 (2%)	0.383#
Corticosteroid prior to extubation, *n* (%)	3 (3.8%)	5 (10.2%)	0.258#

*Independent student *t*-test; **Man–Whitney *U*-test; #, Bold values indicates high statistical significance. Fisher exact test; APACHE, acute physiology and chronic health evaluation; ExPreS, extubation prediction score; HACOR, heart rate, acidosis, consciousness, oxygenation, respiratory rate; ICU, intensive care unit; IQR, interquartile range; MV, mechanical ventilation; SD, standard deviation; SOFA, sequential organ failure assessment; VAP, ventilator-associated pneumonia; WEANSNOW, weaning parameters, endotracheal tube size, arterial blood gas analysis, nutrition, secretions, neuromuscular affecting agents, obstructive airway problems and wakefulness

Table 3: Univariate and multivariable logistic regression for failed extubation

	Univariate			*Multivariable logistic regression*		
Variables	*p-value*	*OR*	*95% CI*	*p-value*	*Adjusted OR*	*95% CI*
APACHE II score on the day of SBT	0.008	1.103	1.03–1.19	0.279	1.050	0.961–1.147
ExPreS score	**<0.001**	**0.946**	**0.92–0.97**	**0.015**	**0.960**	**0.929–0.992**
HACOR score	**<0.001**	**1.405**	**1.23–1.60**	**<0.001**	**1.357**	**1.176–1.567**
WEANSNOW	0.011	1.699	1.13–2.55	0.403	0.774	0.425–1.410
MV days	0.095	1.143	0.977–1.34	0.608	0.941	0.747–1.186
VAP	0.010	3.714	1.363–10.12	0.395	1.741	0.485–6.257

Bold values indicate high statistical significance. APACHE, acute physiology and chronic health evaluation; CI, confidence interval; ExPreS, extubation prediction score; HACOR, heart rate, acidosis, consciousness, oxygenation, respiratory rate; MV, mechanical ventilation; OR, odd's ratio; SBT, spontaneous breathing trial; VAP, ventilator-associated pneumonia; WEANSNOW, weaning parameters, endotracheal tube size, arterial blood gas analysis, nutrition, secretions, neuromuscular affecting agents, obstructive airway problems and wakefulness

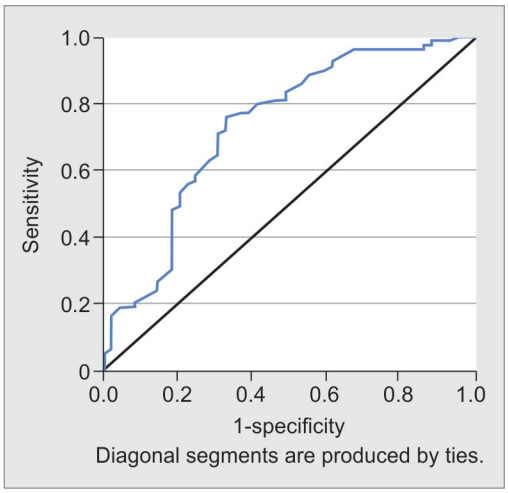

Fig. 2: The ROC curve of ExPreS score to predict weaning success, AUC 0.735, cut-off ExPreS score ≥69, sensitivity 70.9%, specificity 69.4%, diagnostic accuracy 70.3%

AUC, area under the ROC; ExPreS, extubation prediction score; ROC, receiver operating characteristic

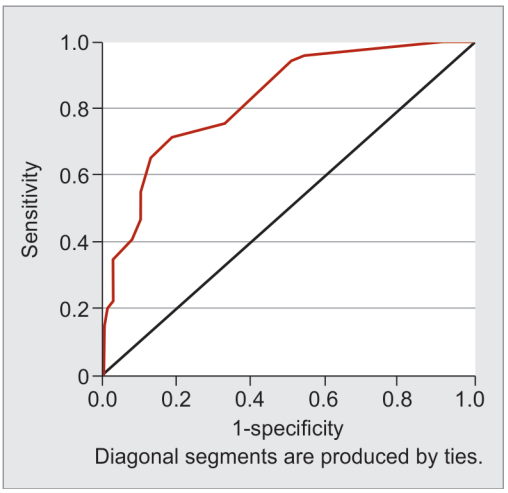

Fig. 3: The ROC of the HACOR score to predict extubation failure had an AUC of 0.830, cut-off score ≥5, sensitivity of 76%, specificity of 68%, and diagnostic accuracy of 70%

AUC, area under the ROC; HACOR, heart rate, acidosis, consciousness, oxygenation, respiratory rate; ROC, receiver operating characteristic

Table 4: ExPreS score high ≥69 vs ExPreS score low <69 for predicting weaning success ($p < 0.001$, Chi-square test)

Variable	*Extubation success*	*Extubation failure*	*Total*
ExPreS score high ≥69, *n* (%)	56 (79%)	15 (21%)	71 (100%)
ExPreS score low <69, *n* (%)	23 (40%)	34 (60%)	57 (100%)

ExPreS, extubation prediction score

Table 5: ExPreS score high ≥69 predicting weaning success

Variable	*p-value*	*OR*	*95% CI*
ExPreS score high (≥69)	<0.001	5.52	2.536–12.011

CI, confidence interval; ExPreS, extubation prediction score; OR, odd's ratio

In patients with HACOR score <5, only 18.5% had extubation failure, whereas, in those with HACOR score ≥5, about 58% had extubation failure ($p < 0.001$, Chi-square test) (Table 6). Univariate analysis using the cut-off HACOR score ≥5 showed that the patients with HACOR score ≥5 have a 6.28 times higher risk of extubation failure as compared to the HACOR score <5, which is significant with a $p < 0.01$, 95% CI (2.817–14.025).

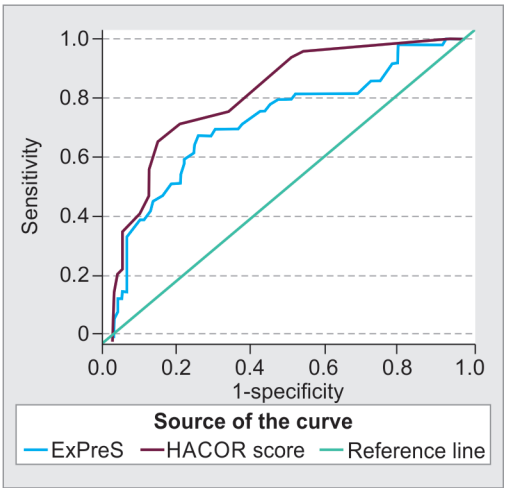

Fig. 4: The comparison of the ROC curves of the ExPreS scores (AUC 0.735) and the HACOR score (AUC 0.830) to predict weaning outcomes showed that there was no significant difference ($p = 0.072$)

AUC, area under the ROC; ExPreS, extubation prediction score; HACOR, heart rate, acidosis, consciousness, oxygenation, respiratory rate; ROC, receiver operating characteristic

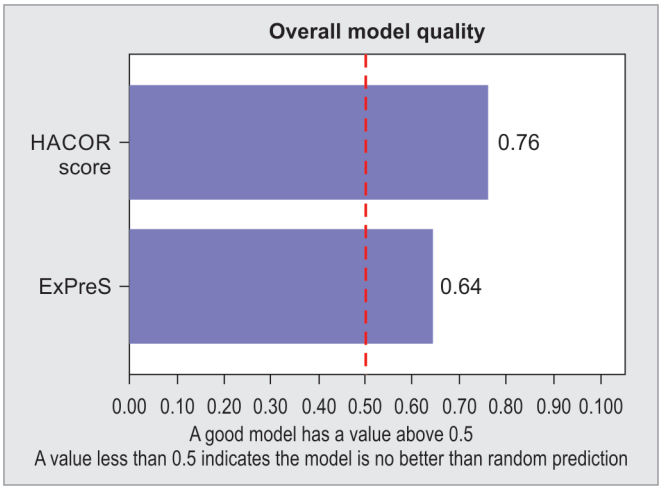

Fig. 5: Comparison of the model quality to predict weaning outcomes of HACOR and ExPreS scores, showing that both are comparable

ExPreS, extubation prediction score; HACOR, heart rate, acidosis, consciousness, oxygenation, respiratory rate

Table 6: HACOR cut-off scores (≥5) and extubation success

Variable	*Extubation success*	*Extubation failure*	*Total*
HACOR score <5, *n* (%)	53 (81.5%)	12 (18.5%)	65 (100%)
HACOR score ≥ 5, *n* (%)	26 (41.3%)	37 (58.7%)	63 (100%)
Chi-square *p*-value < 0.001			

HACOR, heart rate, acidosis, consciousness, oxygenation, respiratory rate

Discussion

The weaning decisions for the critically ill are taken by different healthcare professionals (HCPs) across different regions.[21] In North America, it's the respiratory therapists who play a lead role in initiating weaning and completing the decision-making process, whereas across Europe, it's the critical care nurses.[22,23] In most places, collaborative teamwork between HCPs is the norm for weaning decisions.[21] Since a multidisciplinary healthcare team with varying backgrounds is involved in the decision for the complicated weaning process, simple and objective scores that reflect the optimal functioning of cardiorespiratory and neurological parameters are essential. A systematic approach incorporating the "ABCDE" or airway and lung, brain, cardiac, diaphragm, and endocrine evaluation for weaning prediction is advised.[3] Though ultrasound-based evaluation of diaphragm and weaning indices are popular, certain issues limit its use.[24] As weaning involves multiple HCPs who may not be equally trained in ultrasound, its use may not be done by all stakeholders of weaning, like nurses.[24] Manpower and equipment resource limitations and certain patientrelated factors like abdominal surgeries with dressings over the diaphragm impede the proficient use of ultrasound for weaning.[24]

With this background, the use of objective, simple, practical, multisystem-encompassing comprehensive weaning scores that can be accurately evaluated by all HCPs in the ICUs has been studied recently, like ExPreS, HACOR, and WEANSNOW.[17,18,20] We aimed to determine the performance of these three scores as compared to each other for successful weaning prediction.

Though the ExPreS score incorporates respiratory and nonrespiratory parameters and decreased the chances of extubation failure from 8.2 to 2.4% in the original study, it requires the accurate estimation of dynamic lung compliance, muscle strength as per the six-point medical research council (MRC) grade, both of which may not be feasible at all times by all HCPs.[17,25]

Likewise, the WEANSNOW score necessitated the measurement of parameters like maximum inspiratory pressure, maximum expiratory pressure, and clinical absence of obstruction of airways assessed by breathing sounds, chest radiography, ventilator display, and cuff deflation leak percentage ≥15.5%.[18] This may again be difficult across all ICUs by all the HCWs.

The parsimonious HACOR score requiring only a bedside ABG and clinical parameters, though originally used for the prediction of non-invasive ventilation failure, has also been shown to be a good predictor of weaning outcome.[19,20] It encompasses components reflecting respiratory (PaO_2/FiO_2 and $PaCO_2$), cardiac (weaning-induced pulmonary edema causing low PaO_2/FiO_2 and a high heart rate), diaphragmatic dysfunction ($PaCO_2$ rise), and neurological dysfunction (Glasgow coma scale), and may be easily be evaluated by any HCP at bedside, using point-of-care ABG, without need for any other investigations.[20] For the ExPreS score, other laboratory investigations like hematocrit and creatinine are essential, whereas for WEANSNOW, serum albumin, and electrolytes are essential. Thus, we performed the study comparing the recent weaning indices like ExPreS and WEANSNOW with the parsimonious HACOR score. Though the APACHE II score was devised for the evaluation during the first 24 hours of ICU admission, the conceptualized dynamic APACHE II score on day 3 is a good predictor of adverse outcomes among ICU patients, and thus we incorporated it along with SOFA on the day of weaning to determine if they are confounding factors.[26]

We found that the ExPreS and HACOR scores were comparable in terms of independently predicting weaning outcomes. However, as compared to the study where the ExPreS score was devised, we found a higher cut-off of ≥69 for weaning success, whereas the original study showed that a score ≥59 was associated with weaning success.[17] This finding was despite the lower median APACHE II score of 10 on admission in our study group, as compared to the score of 17 in original ExPreS study group patients.[17] The median SOFA score of 5, age, and the days of MV were comparable in our study population and the previous ExPreS study group patients.[17] We also obtained a much lower AUC of the ROC of ExPreS score to predict weaning outcomes as compared to the previous original study (0.730 vs 0.875).[17] Whether a higher incidence of VAP (26.5%) among the failed weaning group could have caused a higher cut-off ExPreS score among our patients cannot be analyzed.

Regarding the HACOR score, as compared to the previous study where a higher AUC of HACOR to predict weaning failure was found (0.950), we found a much lower AUC of HACOR (0.830).[20] As compared to the previous study on HACOR to predict weaning, the median admission SOFA score of patients was much higher in our study (5 vs 3) and on the day of weaning (4 vs 3).[20] The cut-off HACOR scores of ≥5 were however the same in previous as well as this study.[20]

These findings raise the possibility of different AUC and cut-off scores of ExPreS and HACOR depending on the extent of organ dysfunction at baseline. Just like the organ dysfunction scores have been shown to have different performance ranges based on patient cohort, the weaning scores may also behave similarly.[27,28] ExPreS score may have a higher cut-off for weaning success in severe SOFA patients (17–24) compared to mild SOFA patients (0–7).

Our study has certain strengths. We compared weaning scores from recent literature that specifically incorporate respiratory and nonrespiratory components. We also compared them considering the organ dysfunction scores on admission and the day of weaning, days of MV, corticosteroid use, and VAP as confounding variables. However, the limitations were that it was a single-center study with a heterogeneous population. Though we devised a cut-off of ExPreS and HACOR scores to predict weaning outcomes, their scores with respect to the high or low organ dysfunction scores like APACHE II and SOFA were not performed. We did not compare the performance of these scores with ultrasound-based weaning indices.

Conclusion

The parsimonious HACOR score is comparable to the ExPreS score for independently predicting weaning outcomes. ExPreS score ≥69 predicts successful weaning with about 70% diagnostic accuracy, and the HACOR score ≥5 predicts weaning failure also with about 70% diagnostic accuracy.

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