

# Heart Rate, Acidosis, Consciousness, Oxygenation, and Respiratory Rate: A Perfect Weaning Index or Just a New Kid on the Block

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## ABSTRACT

Successful weaning is when spontaneous breathing is sustained for more than 48 hours after extubation. Despite a plethora of individual and composite weaning indices being available, most indices have not found much clinical utility, and weaning continues to be largely based on clinical assessment. Heart rate, acidosis, consciousness, oxygenation, and respiratory rate (HACOR) is a new score for prediction of failure of noninvasive ventilation (NIV) in hypoxemic patients receiving NIV. The present study explores its utilization in weaning from invasive ventilation.

**Keywords:** Difficult weaning, Heart rate, acidosis, consciousness, oxygenation, and respiratory rate score, Weaning from mechanical ventilation, Weaning predictors.

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Successful weaning is when spontaneous breathing is sustained for more than 48 hours after extubation.<sup>1,2</sup> Failed weaning reflected as extubation failure and reintubation worsens prognosis and increases the risk of mortality, length of stay, length of ventilation, and ventilation-associated events.<sup>3</sup> The resulting prolonged mechanical ventilation (MV) can lead to complications like nosocomial pneumonia, gastrointestinal (GI) bleeding, and deep venous thrombosis.

Many indices have been proposed in the past to accurately predict the success of weaning—like vital capacity, minute ventilation, maximum inspiratory pressure (MIP or  $P_{imax}$ ), and  $P_{0.1}$ . A  $P_{0.1} < 4.2$  seconds,  $P_{imax} < 25$ -cm H<sub>2</sub>O, and a  $P_{0.1}/P_{imax}$  ratio  $< 0.14$  are shown to be associated with successful weaning.<sup>4</sup> However, except for MIP, the predictive power of these indices has been poor. In 1991, Yang and Tobin described the Rapid Shallow Breathing Index (RSBI) as the number of breaths per minute/tidal volume (VT) in liters. Rapid shallow breathing index has been found to be a better indicator and a value  $> 105$  breaths/min/L is associated with weaning failure, and a value  $< 105$  breaths/min/L predicted weaning success with a sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of 97%, 64%, 78%, and 95%, respectively.<sup>5</sup> However, on comparison, MIP was found to be better and a more accurate predictor of successful weaning than RSBI.<sup>6</sup>

Composite indices have also been proposed—the Integrated [an acronym for compliance rate, oxygen, and pressure (CROP)] index was described in 1991 with a predictive power higher than previous indices.<sup>5</sup> However, subsequent work has shown that the CROP index is not more sensitive than RSBI. Tobin's CROP index was later modified to a new integrated weaning index (IWI)— $Cst \times rs \times SaO_2 / (f/TV)$  with IWI  $> 25$  being a better predictor with a positive predictive of 0.99 and a negative predictive value of 0.86. A new integrative index—the CORE index [ $Cdyn (P_{imax}/P_{0.1}) (PaO_2/PaO_2)$ ]/ $f$  derived from modification of CROP index was found to be a good predictor for weaning when index value was  $> 8$ .<sup>7</sup> Despite RSBI and MIP being more popular than a plethora of other individual and composite weaning indices, most indices have not found

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much clinical utility, and weaning continues to be largely driven by clinical assessment.

Heart rate, acidosis, consciousness, oxygenation, and respiratory rate is a new score described by Duan et al. for prediction of failure of NIV in hypoxemic patients receiving NIV. Patients with a HACOR score of more than 5 were found to have a very high risk of NIV failure.<sup>8</sup> Subsequently, it has been validated for predicting NIV failure in non-COPD, acute on chronic respiratory-failure patients with respiratory acidosis. Although the rate of NIV failure was low in these patients, the HACOR score was associated with a high sensitivity (82%) and specificity (91%) for predicting NIV failure.<sup>9</sup> A study in SARS COVID-2 pneumonia patients with hypoxemia also suggested a high accuracy of HACOR score to predict continuous positive airway pressure (CPAP) failure.<sup>10</sup> Another, rather aggressive study looking at the impact of HACOR score on NIV outcomes in moderate ARDS patients ( $PaO_2/FiO_2 < 150$ ) found that a reduction of HACOR score by more than 1 point, after one to two hours of NIV could identify the patients who respond well to NIV, despite high failure of NIV and high mortality with delayed intubation reported in the study.<sup>11</sup>

The current prospective observational study explores the application of HACOR score in predicting weaning failure in intubated patients.<sup>12</sup> Declaring spontaneous breathing trial (SBT)

as a success or failure in the study was decided by the clinician oblivious to the HACOR score, and SBT termination was based on the clinical assessment as well as RSBI >105. The study showed that a HACOR score  $\geq 5$ , evaluated after 30 minutes of a 120-minute SBT trial, could predict failed weaning with a sensitivity of 83.8% and a specificity of 96.4%. The high HACOR score was an independent predictor of weaning failure on multivariate analysis. This study shows promise as HACOR score has never been used in weaning from invasive ventilation before.

The present work is limited by being a small single-center study that excludes patients with prolonged weaning. A recent updated HACOR score that includes additional factors like presence of pneumonia, cardiogenic edema, pulmonary ARDS, immunosuppression, septic shock, and SOFA has shown significantly improved predictive power for NIV failure compared with the original HACOR score.<sup>13</sup> It would be interesting to see whether, in the future, a large-scale multicenter study using the new updated HACOR score helps in weaning failure prediction in patients on invasive ventilation.

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## REFERENCES

- Boles J-M, Bion J, Connors A, Herridge M, Marsh B, Melot C, et al. Weaning from mechanical ventilation. *Eur Respir J* 2007;29(5):1033–1056. DOI: 10.1183/09031936.00010206.
- Macintyre NR. Evidence-based assessments in the ventilator discontinuation process. *Respir Care* 2012;57(10):1611–1618. DOI: 10.4187/respcare.02055.
- Thille AW, Harrois A, Schortgen F, Brun-Buisson C, Brochard L. Outcomes of extubation failure in medical intensive care unit patients. *Crit Care Med* 2011;39(12):2612–2618. DOI: 10.1097/CCM.0b013e3182282a5a.
- Nemer SN, Barbas CSV, Caldeira JB, Guimarães B, Azeredo LM, Gago R, et al. Evaluation of maximal inspiratory pressure tracheal occlusion airway pressure, and its ratio in the weaning outcome. *J Crit Care* 2009;24(3):441–446. DOI: 10.1016/j.jccr.2009.01.007.
- Yang KL, Tomin MJ. A Prospective study of indexes predicting the outcome of trials of weaning from mechanical ventilation. *N Engl J Med* 1991;324(21):1445–1450. DOI: 10.1056/NEJM199105233242101.
- Nemer SN, Barbas CSV, Caldeira JB, Cárias TCM, Santos RG, Almeida LC, et al. A new integrative weaning index of discontinuation from mechanical ventilation. *Crit Care* 2009;13(5):R152. DOI: 10.1186/cc8051.
- Delisle S, Francoeur M, Albert M, Ouellet P, Bellemare P, Arsenault P. *Respir Care* 2011;56(10):1500–1505. DOI: 10.4187/respcare.00768.
- Duan J, Han X, Bai L, Zhou L, Huang S. Assessment of heart rate, acidosis, consciousness, oxygenation and respiratory rate to predict non-invasive ventilation failure in hypoxemic patients. *Intensive Care Med* 2017;43(2):192–199. DOI: 10.1007/s00134-016-4601-3.
- Ding M, Han X, Bai L, Huang S, Duan J. Impact of HACOR score in non-invasive ventilation failure in 148 non-COPD patients with acute non-chronic respiratory failure. *Can Respir J* 2021:9960667. DOI: 10.1155/2021/9960667.
- Guia MF, Boleo-Tome JP, Imitazione P, Polistina GE, Alves C, Ishikawa O, et al. Usefulness of HACOR score in prediction success of CPAP in COVID-19 related hypoxemia. *Respir Med* 2021;187:106550. DOI: 10.1016/j.rmed.2021.106550.
- Bai L, Ding F, Xiong W, Shu W, Jiang L, Liu Y, et al. Early assessment of the efficacy of non-invasive ventilation tested by HCAOR score to avoid delayed intubation in patients with moderate to severe ARDS. *Ther Adv Respir Dis* 2022;16:17534666221081042. DOI: 10.1177/17534666221081042.
- Chaudhuri S, Gupta N, Adhikari SD, Todur P, Maddani SS, Rao S. Utility of the one-time HACOR score as a predictor of weaning failure from mechanical ventilation: A prospective observational study. *Indian J Crit Care Med* 2022;26(8):900–905.
- Duan J, Chen L, Liu X, Bozbay S, Liu Y, Wang K, et al. An updated HACOR score for predicting the failure of noninvasive ventilation: a multicenter prospective, observational study. *Crit Care* 2022;26:196. DOI: 10.1186/s13054-022-04060-7.