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Integrative Weaning Index: Can it be Used Routinely as a Predictor of Weaning Success?

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Abstract

Objective: Application of Integrative Weaning Index in predicting weaning success. *Materials and Methods:* A prospective study on the mechanically ventilated 26 patients; after minimum 24 hours of ventilation criterias of readiness for weaning were recorded; those who met criteria were given 2 hour spontaneous breathing trial and Integrative Weaning Index (IWI) was calculated; those who tolerated the trial were immediately extubated; outcome was measured by the ability to maintain spontaneous, unassisted breathing for more than 48 hours aftet extubation. *Results:* IWI has high sensitivity (93%) and good negative predictive value of 75%. *Conclusion:* Extubation using criteria of readiness for weaning and IWI >25 has good success rate of extubation with lower reintubation rate.

Keywords: Integrative Weaning Index; Reintubation rate.

Introduction

Invasive mechanical ventilation is life-saving for patients with acute respiratory failure, but it is sometimes associated with multiples risks. Therefore, after the adequate recovery, efforts focus on weaning the patient from the ventilator support as early as possible. The extubation period is one of the most challenging aspects for an intensive care team. Timely recognition of the return to spontaneous ventilation is essential for reducing morbidity, mortality and also cost. Several indices for predicting successful weaning were studied in an attempt to evaluate the outcome of removing ventilatory support and the significant physiologic weaning parameters are included in Integrative Weaning Index (IWI) may make it a better predictor than traditional ones [1].

Materials and Methods

This is a prospective study carried out on a 26 adult patients of both sexes from January 2016 to April 2016 in Red zone of Emergency Medicine department of JJM medical college, Davanagere, after approval by the Hospital Ethical Committee.

Inclusion Criteria

All patients requiring mechanical ventilation for ³ 24 h and considered ready for weaning.

Exclusion Criteria

Age£ 18 years, neuromuscular disease, pregnancy.

Criteria of Readiness for Weaning Included All the Following:

i. Reversal of the condition required ventilator support.
ii. Oxygen saturation (SpO_2) of >90% with a fraction of inspired oxygen (FiO_2)<50%.
iii. $PaO_2 / FIO_2 \geq 200$.
iv. Carbon dioxide tension in arterial blood ($PaCO_2$) <45 mmHg.
v. PH ≥ 7.3.

vi. Respiratory rate (RR) < 30 breaths / min.

vii. Tidal volume (TV) > 5 ml / kg.

viii. Minute ventilation < 15 L / min.

ix. RR / TV <105 breaths / min / L with a positive end-expiratory pressure (PEEP) level < 8 cm H_2O.

x. Stable neurological status (awake and responsive).

xi. Require bronchial toilet less than twice in the 8 h preceding the assessment.

xii. No need for vasoactive drugs.

xiii. Receiving only minimal or no sedation.

xiv. Serum electrolyte within normal.

xv. Body temperature between 36°C and 38°C.

xvi. Haemoglobin >7 g / dl.

The following parameters were recorded before performing the spontaneous breathing trial (SBT). Demographic data, including age, diagnosis, admission Acute Physiology and Chronic Health Evaluation (APACHE) II score, duration of mechanical ventilation and date of Intensive Care Unit (ICU) admission to estimate length of ICU stay later on; hemodynamic data, including heart rate and mean arterial blood pressure using, fluid balance in the 24 h preceding the start of the SBT.

After meeting inclusion criteria, patient was allowed for 2 h Spontaneous Breathing Trial (SBT).

During the 1st min on SBT mode, the pressure support (PS) was turned to zero and by doing arterial blood gas (ABG) analysis, the amounts of recorded SpO_2 was measured at fixed FiO_2 40% to avoid FiO_2 variation. The Static compliance (Cst) of the respiratory system (rs) was measured after an inspiratory hold for 0.5-1 seconds and could be collected from the data on the screen. The amounts of TV and spontaneous breathing were recorded, and Rapid Shallow Breathing Index (RSBI) was obtained by dividing RR by spontaneous TV (in litres) and IWI was calculated.

$$IWI = [\text{Static compliance} \times SaO_2 \times RR] / TV$$

$$\text{Static compliance} = TV / (P_{Plat} - PEEP)$$

where P_{Plat} = Plateau pressure

2 h SBT started using Pressure support ventilation (5 Cm of H_2O). Evaluation of SBT and the decision of extubation were made by the physician in charge.

Tolerance of the trial was continuously monitored. Features of poor tolerance included: RR > 35 breaths / min for 5 min or longer, SaO_2 < 90%, increase in heart rate >140 beats / min, an increase in systolic blood pressure >180 mmHg or decrease to <90 mmHg, and increased anxiety, diaphoresis or thoracoabdominal paradox. For patients not tolerating the breathing trial, full ventilatory support was reinstituted, while patients who tolerated the trial underwent immediate extubation and received supplemental oxygen via a face mask. The groups of patients who failed to satisfy some of all criteria of IWI but tolerated 2h SBT were also considered for extubation based on clinical decisions and were considered as comparing group for this study.

Reintubation rate for failed extubation was defined as the need for reintubation within 48 h after extubation and was performed in the following conditions: Hypoxemia (oxygen saturation <90% for more than 5 min while receiving FiO_2 >0.5), presence of respiratory acidosis (arterial pH <7.3 with $PaCO_2$ >50 mmHg), inability to protect the airway because of upper airway obstruction (stridor); and evidence of excessive respiratory work (RR $\geq$ 35 breaths / min 5 min, diaphoresis or thoracoabdominal paradox). The reason for and time to reintubation (rounded off to the nearest hour) were noted.

The outcome measure was successful extubation, defined as the ability to maintain spontaneous, unassisted breathing for longer than 48 h after removal of the endotracheal tube. This definition includes both the number of patients tolerating the breathing trial and the number able to maintain spontaneous breathing after extubation. All patients were followed until hospital discharge or death.

Statistical Analysis

Master chart was prepared on Microsoft excel sheet with columns containing patient name, diagnosis, fulfilment of all criteria for readiness of weaning and calculated IWI and outcome in the form of successful extubation or reintubation within 48 h of extubation.

Descriptive and analytic statistics were performed using SPSS software package under windows operating systems.

Sensitivity (SE=true positive / true positive + false negative), specificity (SP= true negative / true negative+ false positive), positive predictive value (PPV= true positive / true positive + false positive), negative predictive value (NPV= true negative / true negative + false negative), and diagnostic accuracy = (true positive + true negative) / (true positive + true negative + false positive + false negative).

Results

Out of total 26 patients, 84.6% (22) were successfully extubated and 15.4% (4) were reintubated within 48 h of extubation. Out of 14 patients who satisfied all criteria of readiness for weaning and IWI >25, 92.86% (13) were successfully extubated (sensitivity) and only 7.14% (1) was reintubated. Out of 12 patients who failed to satisfy one or more of 15 criteria of readiness for weaning and extubated based on SBT, 75% (9) extubations were success and 25% (3) cases were reintubated.

Out of 22 patients who were extubated after withstanding 2 h SBT, 59.1% (13) were satisfied criteria of readiness for weaning with IWI>25 and 40.9% (9) weren't. Out of 4 patients who were reintubated, only 25% (1) were satisfied all criteria of readiness for weaning with IWI >25 and rest 75% (3) weren't.

Sensitivity of the test was 0.93 which means that 93% of the times of successful extubation were satisfied all criteria of readiness for weaning with IWI> 25.

Positive predictive value of the test was 0.59 which means 59% of the times IWI predicted successful extubation correctly.

		All Criteria of Readiness for Weaning Are Fulfilled?		Total
		Yes	No	
OUTCOME	Successful extubation	13	9	22
	Reintubation	1	3	4
	Total	14	12	26
Sensitivity = 0.93	Specificity = 0.25	PPV = 0.59	NPV = 0.75	

Discussion

The purpose of weaning indices is to identify patients who can be successfully weaned. Clinical judgment is not enough to predict weaning outcome accurately [2,3,4] (50% PPV and 67% NPV). Long-term intubation and mechanical ventilation increased risk of mortality and morbidity due to fatal complications, as ventilator-associated pneumonia, tracheal stenosis, prolong ICU stay, and increases health care costs [5]. So the search for better indices or parameters that can best predict weaning outcome has been attempted by most international weaning researchers. SBT were introduced lately showing a positive weaning predictive value of 85% [2]. However, 15% of the patients who can complete an SBT require reintubation in the following 48 hours after extubation. This indicates that there are patients that tolerate short SBTs but no longer ones. Although SBT represented advancement, it is not totally satisfying. In the study by Frutos-Vivar and colleagues [6], extubation failure occurred in 121 of the 900 patients (13.4%) that completed the SBT. Among the routinely measured clinical variables, f/Vt ratio, positive fluid balance 24 hours prior to extubation, and the presence of pneumonia at the beginning of mechanical ventilation were the best predictors of extubation failure [6]. This fact reinforces the hypothesis that not only the clinical evaluation, but also the evaluation of weaning indexes (as the f/Vt ratio) could be helpful.

More than 50 different weaning predictors have been studied [7]. These studies have been observational, with predictors measured and then correlated with weaning outcome [8,9,10].

In our study also use of IWI decreases failure of extubation trial. Out of 14 patients with IWI >25, only 1 was reintubated with 93% of successful extubation. Our study also showed that though many patients can be extubated just based on tolerance of 2 h SBT, chances of getting reintubated were more (75%) in groups with IWI < 25.

In the study of Nemer et al. [11], on use of IWI as a predictor of weaning, 18% of patients who tolerated the SBT were re-intubated. IWI predicted extubation failure in nine out of 10 patients who presented unsuccessful extubation. IWI presented the highest probability of weaning success when the test was positive (0.99) and the lowest probability of weaning success when the test was negative (0.14). In our study only 15% of the patients who tolerated SBT were reintubated and IWI has predicted 3 out of 4 failed extubations.

Madani et al. [12], assessed validity of IWI for discontinuation from mechanical ventilation in Iranian ICUs. It was studied in six ICU patients with different characteristics, and sensitivity of 94.59, Specificity equal to 66.67, PPV of 97.22, NPV equal to 50, positive likelihood ratio of 2.84, negative likelihood ratio equal to 0.08 and accuracy of 92.5 were obtained; and could prove persistence of

successful weaning in a 48-h period with an accuracy above 90%.

Limitations of this are the sample size. Due to Emergency department (ED) setup and lack of follow up facility, study couldn't be performed on large number of patients.

Conclusion

This study confirms that fulfilment of all criteria of readiness for weaning and an IWI > 25 during trial of 2 h SBT has high success rate of Extubation than 2 h SBT alone. Study also confirms lower rate of reintubation. Thus we recommend routine use of IWI before extubation in mechanically ventilated patient to reduce duration of stay in ICU and to reduce complications of mechanical ventilation and during reintubation.

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