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Assessment of Rapid Shallow Breathing Index as a Predictor for Weaning in Respiratory Care Unit

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Background: At present, air way support plays pivotal role in management of patients in the ICU (Intensive Care Unit) and also RCU (Respiratory Care Unit). Ventilator weaning is an important step in the care of ICU and RCU patients. It is the gradual removal of mechanical ventilatory support. Different predictors are used for initiation of weaning. This study was designed to investigate the rapid shallow breathing index (RSBI) as a predictor for successful weaning.

Materials and Methods: This cross-sectional study was conducted on 70 patients who had mechanical ventilation for more than 48 hours in a respiratory care unit in Tehran Labbafi Nejad Hospital. They were clinically stable and had the criteria for weaning from the ventilator. We measured RSBI, and then evaluated the value of RSBI for successful extubation. RSBI was calculated when patients were on spontaneous breathing mode with PSV=0 and PEEP=0 for one minute.

Results: A total of 70 patients were included in this study; 63(90%) patients had RSBI ≤105 (breath/min/L), among them 49 (77%) patients had successful weaning and did not need re-intubation while the remaining had unsuccessful weaning (P=0.001). The mean weaning index for patients with successful extubation was 66 ± 57.2 and 76.9 ± 28.1 for patients with unsuccessful extubaion. We could not find a significant difference between the means (P=0.433).

Conclusion: Although RSBI <105 is a helpful index for weaning, application of RSBI alone may mislead the physicians. General status of the patient, concomitant diseases and duration of hospital stay should all be considered for successful weaning

Key words: Weaning, Rapid shallow breathing index, Respiratory care unit

INTRODUCTION

At present, airway management and respiratory support are of great importance in both ICU (Intensive care Unit) and RCU (Respiratory Care Unit) (1). Weaning is a transmission process through which patients resume spontaneous breathing after mechanical ventilation (1, 2). Accurate weaning time is critically important in ICU and RCU. Any delay in ventilation removal may lead to ventilator acquired pneumonia and other possible side effects (3,4). Premature removal may increase the length of ICU stay or result in patient's death (5). On the other hand, increase in number of patients who need ICU hospitalization and high relevant expenses have resulted in using a variety of indices including maximal inspiration pressure (PImax), minute ventilation and vital capacity for successful weaning. These indices have different specificity and sensitivities (6). Rapid Shallow Breathing Index (RSBI) is one of the most commonly used indices which was first

introduced by Yang and Tobin (7). RSBI is calculated by this formula: $\frac{\text{Respiratory rate}}{\text{Tidal volume}}$

Several medical centers perform weaning if RSBI is less than 105 (8). A variety of studies have defined different specificities and sensitivities for RSBI (9-12). The present study was designed to define specificity, sensitivity, negative predictor value and positive predictor value of RSBI in RCU and compare these values with those reported by previous studies.

MATERIALS AND METHODS

This cross-sectional study was performed in Tehran Labbafi Nejad Hospital in 2010 on 70 patients who were clinically stable and had the criteria for weaning from the ventilator. Subjects were under ventilation for 9.4 ± 2.3 days. RSBI was calculated when patients were on spontaneous breathing mode with PSV=0 and PEEP=0 for one minute. Subjects who had RSBI>105 were reventilated and RSBI was calculated on the next day. Patients with RSBI<105 were set on T-peace and extubated within 2 hours by taking into account all the medical conditions of the patient. If the patient tolerated spontaneous respiration for 48 hours, the weaning would be considered successful. Failure criteria were as follows: $PaCO_2$>50 or more than 7mmHg increase in $PaCO_2$, PH<7.33, PaO_2<60 with FIO_2, cold sweat, tachycardia, arrhythmias, increase in respiration struggle and hypotension. The local ethics committee approved the study and all subjects gave written informed consent.

Data analysis

We used SPSS version 11.5 software for data analysis. Frequency and proportion were used for numeric variables and mean and standard deviation for string variables. We used repeated measures ANOVA for comparisons within groups followed by Bonferroni test. Multivariate ANOVA was used for comparisons between groups. P <0.05 was considered statistically significant.

RESULTS

A total of 70 patients were included in this study. Table 1 summarizes the baseline characteristics of the subjects. There were 29 females (41.4%) and 41 (58.6%) males. Age range was 40-91 yrs. and the mean age was 69.4 ± 13.1 yrs.

Table 1. Baseline characteristics of study patients

Characteristics	Value
Men/Women	41/29
Age, Years	
Mean± SD	69.4 ± 13.1
Range	40-91
Concomitant diseases	
pneumonia	19 (27.1)
Heart failure	16 (22.9)
COPD exacerbation	16 (22.9)
Renal failure	6 (8.6)
Sepsis	5 (7.1)
Other	8

Data are shown as number (%) or mean± SD

Subjects' concomitant diseases are shown in Table 2; among them pneumonia was the most common (27.1%) and sepsis (7.1%) was the least common concomitant disease. Duration of mechanical ventilation ranged from 2 to 45 days (mean=17 days).

Table 2. Concomitant diseases of the patients

Disease	Frequency (%)
Pneumonia	27.1
Heart failure	22.9
COPD exacerbation	22.9
Kidney failure	8.6
Sepsis	8.1
Other	9.3

Table 3 shows mechanical ventilation information and also patients' status. Figure 1 compares frequencies of x-ray findings of patients. Seven patients never reached RSBI<105 and were excluded from the study. From a total of 63 patients, 49 (77%) subjects had successful weaning, while 14 (23%) patients had unsuccessful weaning. In patients with successful weaning, the mean RSBI was 65±37.2. This rate was 76.9±28.1 for unsuccessful weaning group. In the present study RSBI<105 was considered as the threshold and RSBI specificity, sensitivity, negative predictor value and positive predictor value were 77.8%,

71.4%, 96.1% and 26.3%, respectively. A total of 51 subjects out of 63 had RSBI<80 of which 46 (90.2%) patients had successful weaning while 5 (9.8%) had unsuccessful weaning (P=0.001). If we consider RSBI <80 as the threshold, RSBI specificity, sensitivity, negative predictor value and positive predictor value will be 92.25, 73.7%, 90.1% and 73.7%, respectively.

Table 3. Mechanical ventilation and patients' status.

Variables	Mean±SD	Range
FIO_2	0.44±0.06	0.4-0.6
Breath/min	20.3±5.7	10-36
Tidal volume	430±133	300-720
PEEP	4.9±0.44	4-6
Pressure support	11.6±3.7	5-12
PH	7.4±0.09	7.25-7.45
Pco_2	38.9±12.4	30-50
Hco_3	26.08±8.07	18-50
Sao_2	94.3±2.7	89-99
Weaning Index	69.7±50	20-200

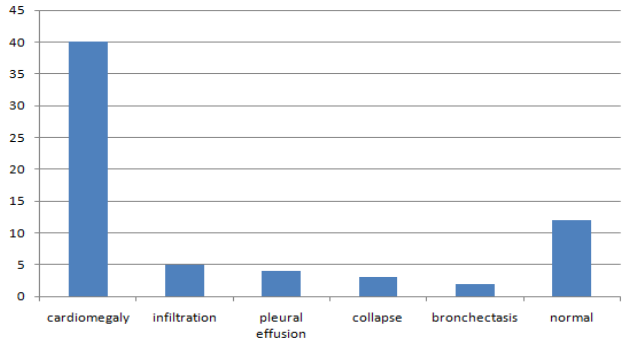

Figure 1. Chest X-ray findings of subjects

DISCUSSION

In this study, we evaluated specificity and sensitivity of RSBI in a medical ICU. Finding the cause of respiratory failure is the first step in management of patients who are under mechanical ventilation. The second step is to select patients who can have spontaneous respiration and can breathe without the aid of ventilator (13). A standard assessment method for weaning should be simple and safe (13).

For the first time Yang and Tobin used RSBI for weaning in 1991. They reported RSBI as the most specific and most sensitive index for weaning. For tidal volume measurement they used a special spirometer which was connected to the trachea (7). Although some studies have considered RSBI as a useless method (14,15), many ICUs use RSBI for weaning (13). Such differences may be attributed to sample size or absence of a global definition for weaning (16). Patel and his colleagues (4) tried different methods for RSBI measurement. They proved that CPAP application with 5 CmH_2O can cause significant decrease in RSBI but method of measurement or time of measurement could not change this index. Therefore, CPAP application for measurement of RSBI can increase the measured RSBI up to 25% although its role in outcome of the disease is not well studied.

Another study revealed that CPAP application with 5 CmH2O can increase RSBI up to 49% after heart surgery (9). In the present study patients underwent ventilation for 1 minute by PEEP:0 and PSV:0 and then we measured RSBI. The two mentioned studies measured RSBI after 1 minute of ventilation. In the primary studies of Tobin and Yang, they measured RSBI when patients inhaled room air. But in the next studies they used higher FIO_2 levels. It seems that Yang and Tobin's method for measurement of RSBI should be modified with current methods. In our study, from a total of 63 patients, 48 (77%) had successful weaning with mean RSBI =65 but this index was 76.9 in patients who had unsuccessful weaning. This difference was not statistically significant (P=0.433). RBSI≤105 showed relatively high sensitivity (77.8%) but low specificity (71.4%). Decreased RSBI can cause an increase in sensitivity and specificity. For RSBI <80 we found sensitivity = 90.2% and specificity =73.7%.

CONCLUSION

Although RSBI <105 is a helpful index for weaning, it is presumed that application of RSBI alone can be misleading. General status of the patient, concomitant diseases and duration of ICU stay should all be taken into account for successful weaning.

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