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Original Article

Frequency of Successful Extubation in Patients with Rapid Shallow Breathing Maximum ($RSBI_{max}$)

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ABSTRACT

Prolonged mechanical ventilation and premature removal from mechanical ventilation (MV) are independent risk factors for morbidity and mortality. Weaning and liberation from MV remain critical stages of a patient's ICU stay. To date, no weaning predictive index has proven to be ideal. **Objectives**: To determine the frequency of successful extubation in patients on mechanical ventilation after 2 hour of spontaneous breathing trial (SBT). **Methods:** A total of 100 consecutive patients admitted in Medical ICU, meeting the inclusion criteria was enrolled. Non probability purposive sampling was employed. Patients of both gender and age ≥18 years, on mechanical ventilator for more than 48hrs were included. Two hours of SBT was performed in a semi seated position. RSBI were measured at 1 min after extubation. Patient who have not developed any feature of SBT intolerance, was continued on SBT up to 120 min. All collected data was entered into Statistical Package for Social Sciences (SPSS) version 24.0 for analysis. **Results:** Successful extubation was found to be (86%). in patients with $RSBI_{max}$ ≤105. Among 43 patients with successful extubation, 60.5% were male and 39.5% were female. The average age was 53± 14.6 yrs and the average days of MV were 7± 2.3 days. Rate of successful extubation was high with the age ≤ 60 yrs, in male gender and with duration of MV ≤7 days. **Conclusion**: It is concluded from the above study that patients with $RSBI_{max}$ ≤105 were found to have successful extubation.

INTRODUCTION

In intensive care units, 40-65% of patients requisite mechanical ventilation (MV).Its eases the breathing labor and provides suitable magnitude of oxygen among these individuals [1]. MV is imperative to sustain life in critically sick patients, though if the MV is used for extended interval it is connected with multiple hitches including lung damage, respiratory muscles weakness and Ventilator associated Pneumonia. To evade these problems, prompt elimination of MV is enforced [2, 3]. Beside that, untimely elimination of MV is associated with elongated hospitalizations, increase stay at intensive care units, augmented medical expenditure, heightened mortality and morbidity [1, 4]. There is also extubation failure in some individuals regardless of planned weaning from MV. This extubation failure blown up the risk of complications which in turn leads to higher mortality. Extubation Failure is defined as requirement of intubation within 72 hours [5]. Weaning is the technique of decreasing ventilator support, it may include either an quick shift from complete ventilatory sustenance to a period of breathing without support from the ventilator (i.e, a spontaneous breathing trial [SBT]) or a steady lessening of ventilator support comprising, Continuous Positive Airway Pressure (CPAP), Pressure Support (PS) with marginal support [6]. Weaning inability is frequently associated with the development of a rapid shallow breathing pattern. The RSBI is a significant predictor of outcome [7]. Yang and Tobin pioneered RSBI, which is now the most widely used predictor of weaning and extubation outcome. Many other studies in both children and adults have supported it. RSBI is defined as

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the ratio of respiratory rate (RR) to tidal volume (VT) measured by spirometer during the first minute after disconnecting from ventilatory support while patients are still intubated and breathing spontaneously on room air. Values of RSBI >105 have been established as being predictor of unsuccessful weaning and extubation failure. RSBI predict success in weaning with a sensitivity of 97%, specificity of 64%, positive predictive value of 78% and negative predictive value of 95% [8, 9]. The present study measures RSBI at 1 minutes of two hours of spontaneous breathing trial which may be an accurate, noninvasive and simple determination that can be used in critical care setting as a predictor of successful extubation. This will result in decreasing the complications of prolonged MV and of premature removal from MV.

METHODS

After the approval from the ethical committee of the Faisal hospital, This Case-series study was conducted at Medical ICU from 1-July- 2021 to 31-December-2021. A total of 100 consecutive patients admitted in Medical ICU, meeting the inclusion criteria was enrolled. A written informed consent was taken from attendant of patients. Non probability purposive sampling was employed. Patients of both gender and age ≥18 years, intubated with tube size ≥7.0mm, on mechanical ventilator for more than 48hrs were included. Patients with known upper airway obstruction, having copious secretions with cough, with status of "Do Not Resuscitate" and having tracheostomy were excluded. The critical care physician with more than five years of expertise decided to conduct a weaning study. A trial of spontaneous breathing was conducted while semi-seated. The assisted-controlled-ventilation was stopped while each patient will breath spontaneously through the ventilator circuit on spontaneous mode of ventilation (pressure support 5 cm H_2O, $FiO_2 \leq 40\%$, PEEP: 0). Patient who have not developed any feature of SBT intolerance, was continued on SBT up to 120 min. Values of respiratory rate RR (breaths/min) and tidal volume VT (Liter) was provided by digital output of the ventilator. RSBI was calculated as the ratio RR/VT at 1 minute. Blood pressure, ECG, and SpO2 were all continuously monitored during SBT. Clinical and demographic data, as well as mechanical ventilation duration and comorbidities, were collected. The critical care team considered extubation if subjects tolerated the SBT. Subjects who will maintain spontaneous breathing >48 hour following extubation was considered as having successful extubation and subjects who were required re-intubation within 48 hours following extubation was considered as having extubation failure. All collected data was entered into Statistical Package for Social Sciences (SPSS) version 24.0. Mean ± SD was calculated for Age of patient, Days on mechanical ventilation, Maximum increase in RSBI ($RSBI_{max}$). Frequency and percentages was calculated for Gender, Successful extubation, Medical comorbid and Indication for mechanical ventilation. Stratification was done with regard to age, gender, duration of mechanical ventilation, comorbid and indication of mechanical ventilation to see the effects of these on outcome.

RESULTS

A total of 100 patients were included in the current study. The patients mean age was 55.1 ± 14.7 yrs. Out of 100 patients 56 (56%) were male and 44 (44%) were female. Among 100 patients who were extubated after 2 hours of SBT, 86 found to have successful extubation.

RSBI	Successful Extubation		Total n = 100
	Yes (n=86)	No (n=14)	
≤ 105	80 (93%)	2 (14.28)	82 (82%)
>105	6 (7%)	12 (85.7)	18 (18%)

Table 1: Successful extubation with RSMI

The average $RSBI_{max}$ in patients with successful extubation was 76.3 ± 22.5 breaths/min/lit. Rate of successful extubation in patients with maximum increase in RSBI ($RSBI_{max}$) ≤ 105 was (93%) while in patients with $RSBI_{max}$ > 105, successful extubation was observed in (7%).

Indication for MV	Successful Extubation		Total n = 100
	Yes (n=86)	No (n=14)	
Pneumonia	30 (34.8)	6 (42.8)	36
Sepsis	25 (29)	4 (28.5)	29
Acute pulmonary edema	20 (23.2)	2 (14.2)	22
Poisoning	11 (12.7)	2 (14.2)	13

Table 2: Successful extubation with respect to comorbids

The average age of patients with successful extubation was 55.1 ± 14.6 yrs. Rate of successful extubation was observed 58/60 (96.7%) in the age 60 yrs or below. While in the age above 60 yrs, rate of successful extubation was 28/40 (70%). Rate of successful extubation was found to be higher in male than in female, 92.8% vs77.3%.

Diagnosis	Successful Extubation		Total n = 100
	Yes (n=86)	No (n=14)	
COPD	7 (8.1)	3 (21.4%)	10
Asthma	6 (6.9)	0	6
Cardiac	13 (15.11)	1 (7.1%)	14
Diabetes mellitus	26 (30.23%)	5 (35.7%)	31
Hypertension	34 (39.5%)	5 (35.7%)	39

Table 3: Successful extubation with respect to diagnosis

The average days of mechanical ventilation in patients with successful extubation were 7 ± 2.3 days. Rate of successful extubation was observed 48/50 (96%) in patients with duration of mechanical ventilation ≤ 7 days while in patients with duration of mechanical ventilation >7 days rate of successful extubation was 38/50 (76%). Successful

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extubation in patients after 2 hours of SBT was correlated with various indications of mechanical ventilation. Rate of successful extubation was 12.7% in patients with poisoning while 34.8% in patients with pneumonia. Successful extubation in patients after 2 hours of SBT was also studied with respect to various co morbid. Rate of successful extubation in patients with hypertension was 34/39 and in patients with diabetes was 26/31.

Age Groups (Years)	Successful Extubation		
	Yes (n=86)	No (n=14)	
≤ 60	58 (96.7%)	2 (3.3%)	
> 60	28 (70%)	12 (30%)	
Male	52 (92.8%)	4(7.1%)	
Female	34 (77.3%)	10 (22.7%)	
≤ 7days	48 (96%)	2 (4%)	
>7 days	38 (76%)	12 (24%)	

Table 4: Successful extubation with respect to age, gender and days on mechanical ventilation

DISCUSSION

Successful weaning and liberation from mechanical ventilation continue to be crucial phases of that patient's ICU stay once they recovered from acute respiratory failure [8]. Weaning decisions based only on expert clinical judgment are not always correct. The rapid shallow breathing index (RSBI) was evaluated by at various studies and can be considered the most used predictor of weaning. In this study, the average age of the patients was 55.1±14.7 yrs. This corresponds to a study done at intensive care unit of Iran by Ghiasi L *et al* which shows mean age 55.1±21.48 years [10]. Another study done at Shifa International Hospital Islamabad by Khan M *et al* shows mean age of patients 55± 16 years [8]. Also close to a study conducted by Tonnelier J *et al* in which the mean age in Protocol-directed weaning group was 57 ± 18 years and in Physician-directed weaning group was 56 ± 18 years [11]. Among 100 patients who were extubated, Gender difference was found out with 56% males and 44% females. This is close to a study conducted by Nuttopol *et al* in which 57% of the participants were female [12]. In the present study, 82 % of patients with $RSBI_{max}$ ≤105 were found to have successful extubation while 18% of patients with $RSBI_{max}$ > 105 have failed extubation. Our this finding of successful extubation was correlated with Khan M *et al*, in this study they concluded that RSBI is better predictor of weaning outcomes than diaphragmatic excursion (DE) but DE can be used along with RSBI in predicting successful outcome [8]. However Kim *et al*. matched the accuracy of DE versus RSBI and found that both were similar in predicting the weaning outcome [13]. Tanaka A *et al* had also concluded that those with lower levels of RSBI had successful extubation. (32 breaths/min/L vs 37 breaths/min/L) [14]. RSBI is consisted of diaphragm and non-diaphragm muscle functions. Non diaphragmatic muscles can compensate when the diaphragm muscles failing to maintain the tidal volume. Though non-diaphragmatic muscles are weaker and get fatigued earlier and cannot sustain to provide sufficient ventilation for long time period [15]. Therefore RSBI can deliver false positive extubation standards and can produced extubation failure despite suitable tidal volume at the beginning [16]. This finding was supported by a systematic review of 20 RSBI studies [17]. Another study conducted by Epstein revealed that 14.6% of 84 patients (16.6%) with RSBI 100 failed extubation, with 13 of these failures attributed to issues with other organ systems, and it was concluded that RSBI was not physiologically suitable to predict extubation success [18]. The failure of RSBI to predict the result of extubation has also been found in other investigations [19, 20]. According to this study, mechanical ventilation is most frequently indicated by pneumonia. This is close to a study that reported 27% patients of pneumonia as an indication of mechanical ventilation [21]. In this study, rate of successful extubation was found to be highest 88.9% in patients with poisoning and this could be due to the fact that the patients with acute poisoning were mostly young and without comorbid.

CONCLUSIONS

It is concluded from the above study that patients with $RSBI_{max}$ ≤105 were found to have successful extubation. It is helpful to predict successful extubation and may be an accurate, noninvasive and simple determination that can be used in the critical care setting to predict successful extubation. However, additional studies are necessary to authenticate the importance of this forecasters for weaning.

Conflicts of Interest

The authors declare no conflict of interest

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