RESEARCH ARTICLE

Success Rate of Weaning from Mechanical Ventilation in Patients Admitted to the Intensive Care Unit with Utilization Burn's Wean Assessment Program

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Background: Weaning from mechanical ventilation is one of the main stages of treatment as well as applying a tool that can predict the success in weaning is very important. This study aimed to evaluate the success rate of weaning from ventilator in patients admitted at the Intensive Care Unit (ICU) using Burn's Wean Assessment Program (BWAP) checklist.

Methods: The present analytical cross-sectional study was carried out on 100 mechanical ventilation-dependent patients connected to the ventilator for more than 72 hours. All patients were selected by simple available sampling based on purposive sampling method and examined by BWAP checklist and were weaned from ventilator by obtaining scores over 18.

Results: The total number of patients participating in the study was 100, 71 males and 29 females. There was no significant relationship between gender and success or failure of weaning process based on chi-square test ($p<0.784$). There was no relationship between weight and the result of weaning according to t-test. T-test showed a relationship between the number of hospitalization days with the result of weaning ($P<0.001$). Mann-Whitney test showed a significant relationship between age and the result of weaning according to which higher age leads to less success ($p<0.001$). Logistic regression indicated that age and airway could predict the result of weaning up to 78%.

Conclusion: Investigating preparation for weaning using Burn's Scale is more useful for patients who had no prolonged hospitalization at ICU and ventilated through an endotracheal tube.

Keywords: burn's wean assessment program BWAP checklist; mechanical ventilation; successful weaning

Mechanical ventilation is one of the most common forms of medical treatments for patients hospitalized at ICU [1]. Moreover, it is an integral part of the treatments for most patients in critical stages and those with multiple complications [2]. An important step in the process of treatment at ICU is weaning patients from mechanical ventilation and this process can take more than 56%-90% of the time of mechanical ventilation. Therefore, determining the patient's readiness for separating and managing the process of weaning from mechanical ventilation is a very important event [1]. Since mechanical ventilation is associated with many complications and weaning patients improperly from mechanical ventilation can also lead to respiratory failure and re-intubation, therefore, weaning from ventilatory support should be done as soon as the patient is able to breathe voluntarily [3-4]. Patients who are weaned later from mechanical ventilation have higher mortality and experience pneumonia and more ventilator-induced lung injury [5]. On the other hand, early weaning and unsuccessful extubation can lead to tracheal reintubation. Reintubation has been reported as 4%-33% [6]. Tracheal reintubation potentially leads to the airway trauma, aspiration and acute lung injury. Statistics show that reintubation increases the risk of nosocomial pneumonia eight times, and the mortality rate 6-12 times. Accordingly, cutting mechanical ventilation should be planned [7]. The decision of weaning from mechanical ventilation is based on the subjective judgment of physicians and this will prolong the duration of mechanical ventilation and increase patient's costs [1]. There are different tools for assessment of patients' readiness for weaning from mechanical ventilation. These tools check the patient's readiness for weaning from the device and lead to timely and successful weaning from it [8]. This device systematically and comprehensively measures criteria for weaning from mechanical ventilation. The use of this checklist is easy and its parameters assessment lasts 10 minutes [9]. In a study carried out by Burn et al., by examining the effectiveness of this checklist for 5 years at ICU, it was found that the use of this device

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led to successful weaning from mechanical ventilation in 88% of cases in patients undergoing mechanical ventilation for more than 72 hours [10]. In a study by Salman et al, it was found that the use of BWAP checklist in patients receiving mechanical ventilation for over 48 hours, the duration of mechanical ventilation was significantly lower than that of the group weaned from the ventilator by medical judgment [11].

In another study by Suzanne et al. BWAP checklist was used for weaning patients of 5 special sections and it was concluded that patients qualified with 20 BWAP checklist items would have a successful weaning and, among the sections under study, neurosurgical intensive care patients had a better weaning with BWAP checklist compared to other patients [12]. According to studies carried out in Iran, in most ICUs, weaning from mechanical ventilation has been performed on an experimental basis and with evaluating some criteria and only under medical supervision and no tool is used to assess readiness. This can lead to failure of weaning patients and patient's reintubation and prolonged mechanical ventilation, and increasing the patient's length of stay in the intensive care unit [13-14]. Thus, this study aimed to evaluate the success rate of weaning from ventilator for patients in the intensive care unit with applying BWAP checklist.

Methods

This analytical cross-sectional study was conducted after obtaining the necessary approval from Zahedan University of Medical Sciences, Iran, and receiving code of ethics (IR.ZAUMS.REC.1394.335) from the ethics committee of the university in 2015 on 100 mechanical ventilation-dependent ICU patients in Khatam-ol-Anbia Hospital of Zahedan.

The sample size was determined according to previous studies and the sample size formula [4,11]. All patients were selected based on simple available sampling based on purposive sampling method. Informed written-consent forms were taken from their first-degree relatives due to the lack of consciousness of the patient. Inclusion criteria were as follows:

Being connected to mechanical ventilation over 72 hours, absence of active and uncontrolled respiratory infection, acute myocardial infarction and pleural effusion, and consciousness level of 9 and higher, Glasgow Coma Scale (GCS) was used and for lack of obesity, BMI >30, and being on breathing modes with voluntarily respiratory function (spont, cpap, psv).

Exclusion criteria included:

The patient's death and unplanned removal of endotracheal tube by the patient or during the situation change and bed sheet change, and alternative spontaneous breathing exercise intolerance in 24 hours. In this study, BWAP checklist was used to evaluate the patients. Burn et al. developed this checklist including 26 phrases of which 12 cases are the patient's general assessment tool and 14 phrases measure the patient's respiratory function. There are some three-choice questions (Yes/No/Not Checked) out of which "yes" is scored 1, "No" and "Not Checked" will receive the score of zero. The total score of Readiness Assessment questionnaire is 26 and after receiving the score of 17 or higher, the process of weaning can be started, (Table 1) [10,12].

The use of this checklist is recommended to evaluate the readiness of all patients at ICU [15]. Face validity method was used to assess the validity of checklist. In this case, the English version and the Persian translation of it were given to Anesthesiology and Critical Care Nursing faculty members to discuss the validity of checklist and announce their opinion in this regard. For the reliability of instrument, three researchers (an MSc in Critical Care Nursing, an anesthesiologist and a specialty of intensive care), two residents of anesthesiology and two nurses were recruited for 10 patients with the same diagnosis as pilot that had good reliability with Cronbach's alpha coefficient of 0.91. After beginning the study, the patients were assessed with BWAP checklist and appropriate corrective treatments were carried out based on the results of the evaluation and the treatment outcome was followed up to complete correction of abnormalities. This assessment was conducted only in morning and afternoon shifts, and the assessment was stopped at night shifts due to the patient's need to relax and the impossibility of weaning process. In addition, after the patient received the score above 18 from the checklist, the process of weaning was performed as follows:

Initially, the patients' sedation was discontinued and if the patient needed to continue medication injection for pain relief, only Fentanyl was injected with a minimum dose of 1 μg/ kg/hour infusion and the injection of hydrocortisone 2 mg/kg was conducted in four sessions of 6 hours. Using BWAP checklist, the patient was examined frequently. By obtaining score over 18 at any stage of the assessment, the process of weaning was attempted so that the patient was put on T-tube with 6-7 liters of oxygen for half an hour and was returned to spontaneous ventilation mode once more and spontaneous breathing exercise was carried out for four 30-min sessions. Some patients could not tolerate alternative spontaneous breathing exercise in 4 hours and it was continued for them up to 24 hours based on the patient's needs. In the case of tolerance and lack of arterial blood oxygen saturation, if the patient was intubated, after receiving pre-oxygenation with 100% oxygen and oral and tracheal suctioning, patient's endotracheal tube was removed and if having a tracheostomy, administration of oxygen with T-tube was stopped. Following that, the patient was reexamined for respiratory failure (Arterial oxygen desaturation, dyspnea, and the use of accessory muscles of respiration, apnea) to be re-intubated if needed or be connected to mechanical ventilation through a tracheostomy and be classified as unsuccessful cases of weaning. By tolerating weaning and lack of respiratory distress and lack of drop in level of arterial blood oxygen saturation was considered as successful cases before being transferred to the public sector. The data were then analyzed in SPSS software. To check the normality of data, Kolmogorov-Smirnov was used and normal data were compared with Independent Samples T Test and abnormal data were compared with Mann-Whitney. Chi-square test was used to check the nominal data with the result of weaning and logistic regression was used for the predictability of the result of weaning all variables.

Table 1- Burn wean assessment check list

Row	Burn wean assessment check list	Yes	No	Not Checked
1	Checking the general condition Is the hemodynamic status of patient constant? (Heart fixed-rate and rhythm and blood pressure, the use of vasopressor drugs or any oral agent applied to control rhythm, rate and blood pressure except low-dose of dopamine and dobutamine)			
2	The absence of factors that increase or decrease the metabolic demand (Seizure, temperature, sepsis, Bacteremia, hypo-or hyperthyroidism)			
3	Hematocrit is more than 25% (baseline?) Consider a drop in hematocrit synonymous with bleeding and also blood transfusions			
4	There is a proper systemic hydration (weight is close to the base weight. And absorption and excretion are suitable)			
5	Patient's nutrition is good (his/her Albumin is more than 2.5 and parenteral or gastrointestinal nutrition is maximum) If patient's albumin is low and there is edema, hydration score (No. 4) should be considered as nine			
6	The electrolytes level is normal (calcium, magnesium and phosphorus). Correct calcium level with albumin.			
7	Pain is controlled.			
8	Sufficient rest and sleep.			
9	The level of anxiety and agitation of these patients is acceptable and appropriate.			
10	There is no intestinal problems (diarrhea, constipation and intestinal paralysis, i.e., the absence of bowel sounds in the past 3 days)			
11	There is enough muscle power (he/she can sit up in bed or hold himself/herself in a sitting position even if he/she needs help this factor is considered as positive)			
12	A chest radiograph situation is appropriate (better than before)			
13	Evaluation of respiratory function Breathing pattern is normal (spontaneous breathing less than or equal to 25, lack of dyspnea and not using accessory respiratory muscles)			
14	The absence of abnormal breathing sounds (crackles, rhonchi, and wheeze). The answer is ''no'' for each sound.			
15	Lung secretions is minimal (the amount of discharges and their concentration, and the number of suctions should be considered)			
16	Musculoskeletal disease or deformity of the chest does not exist			
17	There is no abdominal distention, obesity and ascites. (If distention is even caused by ileus, ''no'' should be considered)			
18	Endotracheal tube ≥7.5, or track ≥6.5.			
19	swallowing reflex and cough reflex			
20	The negative inspiratory pressure less than or equal to 20 cm water			
21	Expiratory positive pressure is more than or equal to 30 cm of water			
22	The current volume of spontaneous breathing is 5cc/kg			
23	The vital capacity is more than 10-15 cc/kg			
24	pH is ranging from 7.30-7.45			
25	PCo2 is about 40 mm Hg or at the base of the first day of hospitalization, and minute ventilation is less than 10 l/min			
26	Pao2 is more than 60 mm Hg with inspiratory oxygen less than or equal to 40% and end-expiratory positive airway pressure of at least 5 cm of water			
	Total score: 26			

Results

The number of patients participating in the study was 100 of which 71 were male and 29 were female. 60 patients required mechanical ventilation due to trauma: 14 patients due to respiratory failure, 5 patients due to stroke, 5 patients due to drug toxicity, 7 patients due to loss of consciousness caused by unknown reasons, 3 patients due to cardiac respiratory arrest induced by dysrhythmias and 6 patients due to brain tumor surgery. The average age of the participants in the study was 37 ± 19 years with an average weight of 69 ± 13kg. The weaning was successful in 81 cases of which 58 were male (71.6%) and 23 were female (28.4%). The average age among those weaned successfully was 33.41 ± 16.68 years and weaning was unsuccessful in 19 cases of which 13 were male (68.4%) and 6 were female (31.6%). The average age in the unsuccessful weaning group was 53±13 years. The average weight in the successful weaning group was 69.65 ± 13.81 kg and the average weight in the unsuccessful weaning group was 70.49 ± 9.34 kg.

In reviewing with chi-square, no significant relationship was found between success and failure ($p<0.784$). Besides considering the normality of data, Independent Samples T Test was used which showed that there was no significant relationship between weight and the success of weaning from ventilator. The average days of hospitalization, was

11.14 ± 6.63 in the successful weaning group and 19.89±10.03 in the unsuccessful weaning group. Moreover, Independent T Test was used to evaluate the relationship between the days of hospitalization with the success rate and the failure of weaning. This test showed a significant relationship between the number of hospitalization days with the success rate of weaning from ventilator with Burn's Scale and the patients connected to the ventilator for a longer time had the highest probability of success (P<0.001). In patients successfully weaned from ventilator, 55 patients required mechanical ventilation due to trauma (67.9%), 5 patients suffered from respiratory failure (6.2%), 3 patients suffered from stroke (3.7%), 5 patients due to drug toxicity (2.6%), and 6 patients suffered from decreased level of consciousness with unknown reasons (7.4%).

One subject due to cardiac arrest (1.2%) and 6 subjects after brain tumor surgery needed ventilation (7.4%). In an unsuccessful weaning group, 5 subjects experienced trauma (26.3%), 9 subjects experienced respiratory failure (47.4%), 2 subjects were diagnosed with stroke (10.5%), one subject was diagnosed with decreased level of consciousness with unknown cause (5.3%) and 2 subjects experienced cardiac arrest. However, due to the lack of establishing conditions of diagnostic inter-group comparison test, the results have not been reported.

From among 81 patients with successful weaning, 75 were ventilated with an endotracheal tube (92.6%) and 6 patients with tracheostomy (7.4%) and in patients of unsuccessful weaning group, 9 patients were ventilated with endotracheal tube (47.4%) and 10 patients with tracheostomy (52.6%). In a statistical comparison between the two groups, a significant relationship was observed between the airway and the result of mechanical ventilation with chi-square according to which the patients were ventilated with endotracheal tube obtained odds ratio of 14 from chi-square test which showed that the success rate of weaning from ventilator was 14 times greater than that of those with tracheostomy (p<0.001). Non-parametric Mann-Whitney test was used to compare age and success/failure.

There was a significant relationship between age and the success rate according to which higher age leads to less success of weaning (p<0.001). The average score of weaning with Burn's scale was 22 for all patients with the minimum of 17 and maximum of 24. The average score of weaning with Burn's scale was 22.23 in the successful weaning group and 21.47 in the unsuccessful group.

In comparing the patients' scores from Burn's Scale with the success rate of weaning from ventilator, Mann-Whitney non-parametric test was used according to which a significant relationship was observed between the two groups (P<0.028) (Table 2). The average score of patients from the Glasgow Coma Scale (GCS) was 9.95 in the successful weaning group and 10.10 in the unsuccessful weaning group and no significant relationship was found in investigation with Mann-Whitney U test (P<0.451). To examine the predictive effect, all measured variables (age, weight, sex, airway, days of hospitalization, level of consciousness and the score obtained from BWAP checklist) on the success or failure of weaning, backward logistic regression was used in which the number of hospitalization days, airway and age were significant (p<0/05). But in the end, only age and airway were predictive of 87% of the result of weaning.

Table 2- score BWAP in two grope

The score obtained from BWAP checklist	The number of patients in the successful group	The number of patients in the unsuccessful group
17	1	0
18	3	1
19	2	0
20	6	4
21	8	3
22	23	7
23	14	3
24	24	1

Discussion

The results showed that the use of BWAP checklist can correctly predict the successful weaning from mechanical ventilation and using it for patients with early age and less length of stay is useful.

Based on the results of this study, patients whose airway was endotracheal tube experienced a more successful weaning than those with tracheostomy. Moreover, the failure level of elderly patients in weaning process was higher compared with the others. Jung-Rern Jiang et al used the modified BWAP checklist to wean patients hospitalized at ICU for a long time (more than 21 days).

They reported that this is a very good predictor for weaning and extubation and corresponds with the results of this study only because it has reported Burn's Wean Scale as a good predictor of weaning and extubation. However, considering that it has also highly succeeded in patients with prolonged length of stay, it is not consistent with the results of this study, because patients with prolonged length of stay were exposed to less successful weaning.

However, the mentioned study was different with the current one because indices such as the resistance of airway (RAW) and lung compliance (LCs) and Rapid Shallow Breathing Index (RSBI) have also been investigated. It seems that the reasons for the different study results are related to this. In the mentioned study, the patients with tracheostomy were less rather than those with endotrachial tube. Considering the patients' prolonged length of stay, it is likely to be due to Thai families' dissatisfaction with Tracheostomy [16].

In Salmani's study, BWAP checklist was used to compare the length of stay and success rate compared to the usual method of decision-making for weaning. It was also reported that in patients evaluated and weaned by the nurse using this checklist, the success rate was higher. Moreover, the length of stay in the ward was less in the group evaluated with BWAP checklist, which is consistent with the results of the present study. Although this study did not carry out a two-group comparison but it is confirmed that the use of this

checklist can predict the success of weaning and extubation [11].

DuBose et al also reported that the use of daily evaluation checklist to assess progress of trauma patients reduces the length of stay and ventilator-associated pneumonia in the intensive care unit [17]. Burn et al reported in their study that the use of this checklist predicts the chance of success of weaning from mechanical ventilation up to 88% [10].

In another study, Sadeghi-Nezhad et al compared the success rate of patients in the normal group where evaluation is done by a physician and a group in addition to convent criteria, standard index of weaning from ventilator is measured and reported as IWI= (C st, rs×Sao2)/(f/tv). The success rate in a group weaned based on RSBI and were extubated was more than the group weaned according to normal data such as (Level of consciousness, coughing and secretion removal and the ability to move and measurable indices, such as ABG indices and Rapid Shallow Breathing Index (RSIB) and lung compliance and the ability to create spontaneous breathing volume and the positive end-expiratory pressure. Although, in the mentioned study, the method of the present study had not been used but it is consistent with the results of this study because it shows that weaning patients cannot be merely done according to objective judgment and patients must be weaned according to a determined standard method and the exact data [18].

Moreover, Epstein et al used Burn's checklist to investigate the success rate of weaning from ventilator in elderly patients hospitalized at ICU for a long time due to different surgeries (12 days on average). The obtained results showed that the use of Burn's checklist could increase the success rate of weaning from ventilator in these patients, which is not consistent with the results of the present study because the success rate of weaning and extubation and weaning from tracheostomy was low in elderly patients and those hospitalized for a longer time [19].

Research limitations:

One of the limitations in this study was the lack of ventilators to measure negative inspiratory pressures and positive expiratory pressures for all patients and accordingly negative inspiratory pressure was measured only for some of the patients.

Conclusion

Based on the results of this study, the use of BWAP checklist could be useful for patients who were ventilated through endotracheal tube and had less hospital length of stay. However, it is better to use other scales in elderly patients with tracheostomy.

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