Validity and reliability of “Persian Weaning Tool” in mechanically ventilated patients

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Abstract

Background: “Persian Weaning Tool (PWT)” is the only specific, national protocol designed to assess patients’ readiness for weaning from mechanical ventilation in Iran. This study was developed to determine the validity and reliability of this protocol.

Materials and Methods: This is a psychometric study conducted on 31 patients connected to mechanical ventilation were ready from weaning according to anesthesiologist’s diagnosis and was selected through convenient sampling. The patients selected from Intensive Care Units (ICUs) of Al-Zahra Hospital in Isfahan. The sheet data collection includes demographic data, PWT; Burn’s Wean Assessment Program (BWAP), and Morganroth’s scale. To determine the inter-rater reliability between researcher and his partner, Pearson correlation and paired t-test were used. To assess the criterion validity of the PWT in relation to Burn’s and Morganroth’s weaning scales (as criteria), Pearson correlation and McNemar tests were used. To specify a minimum acceptable score of the PWT for weaning from mechanical ventilation, receiver operating characteristic curve was used.

Results: The results showed that there was statistically significant correlation between score of PWT and BWAP ($r = 0.370$ with $P < 0.05$) and there were no statistically significant differences between these tools in terms of identification of patients’ readiness for weaning ($P = 0.453$). There was statistically significant correlation between PWT score obtained by researcher and his colleague ($r = 0.928$), and the reliability of this tool was approved. The PWT’s cut of point was calculated as 57 (sensitivity = 0.679, specificity = 1).

Conclusions: The reliability and validity of the PWT were confirmed for this study’s sample size. Consequently, the findings of this study can be used to measure the PWTs effectiveness and applicability in ICUs.

Key Words: Intensive Care Units, mechanical ventilation, reliability, Persian weaning tool, validity

INTRODUCTION

Mechanical ventilation is a common method used in the treatment of patients transferred to Intensive Care Unit (ICU). Over 90% of critically ill patients require mechanical ventilation and getting a patient off a ventilator comprises 40% of the duration of
mechanical ventilation.\[2\] Mechanical ventilation can have negative effects on the cardiovascular, respiratory, gastrointestinal, and musculoskeletal systems along with water and electrolyte status and mental state of the patients.\[3\]-\[6\] Moreover, long-term use of mechanical ventilation increases care costs; thus, patients should be weaned from mechanical ventilator as soon as possible.\[7\] Several studies have shown that daily screening based on weaning protocols may shorten the duration of mechanical ventilation and hospitalization in ICU and reduce costs and rates of weaning failure.\[8,9\] Nurses are able to wean patients from mechanical ventilator safely; therefore, physicians have more opportunities to perform tasks cannot be delegated to nonmedical teams.\[10\] In addition, performing based on interprofessional approaches and building relationships between members of health teams provide higher quality care for patients.\[11\]-\[12\] Nonetheless, no definite indicator has been developed yet for weaning patients from mechanical ventilator. In Iran, there is little research on this area and no native protocol exists to determine patients’ readiness for being weaned from mechanical ventilators; thus, anesthesiologists wean patients by measuring a number of parameters.\[5,7\] For these reasons, weaning process may be started with a delay or patients become weaned prematurely which leads to further complications.\[13\] In a qualitative study with Delphi multitriangulation design, Irajpour et al. developed the Persian weaning tool (PWT). By reviewing related literature, they noticed that there is no comprehensive tool to determine patients’ readiness for being weaned from mechanical ventilation. Given that there is no local research on the determination of reliability and validity of the PWT and that the tool must be reliable and valid to be used for Iranian patients, the present study aimed at evaluating some psychometric properties of the mentioned tool.

**MATERIALS AND METHODS**

The present methodological study was conducted to evaluate some of the psychometric properties of the PWT used in ICUs. The study population consisted of all patients transferred to ICUs of Isfahan’s Al-Zahra Hospital in 2015. Based on the formula used in reliability studies (with level of significance 95%, statistical power 80%, the minimum acceptable reliability 85%, and durability expected 90% and 2 repeated measurements) a sample size of 31 was determined.

\[
n = 1 + \frac{2 \left( Z_{1-\alpha} + Z_{1-\beta} \right)^2 K}{\left( \ln C_o \right)^2 (K - 1)}
\]

\[
K = 2
\]

\[
\alpha = 0.05 \rightarrow \text{level of significance 95%}
\]

\[
\beta = 0.2 \rightarrow \text{statistical power 80%}
\]

The samples were selected using the convenience sampling method. The inclusion criteria were being mechanically ventilated for >48 h\[14\] and <14 days,\[15\] lack of chronic cardiovascular or other underlying diseases, level of consciousness higher than 9 (based on Glasgow Coma Scale), not being in the middle of weaning process and patients’ or patients’ families’ willingness to participate in the study. Dead or spontaneously extubated patients or those who needed surgery were excluded from the study. The required data were collected by a two-part questionnaire: (1) The first part included demographic characteristics, the cause of being mechanically ventilated, underlying diseases and consciousness level at the beginning of the study; (2) and the second part consisted of Burn’s Wean Assessment Program (BWAP), Morganroth’s criteria for weaning from prolonged mechanical ventilation, and the PWT [Figure 1].

**Instruments**

*Burn’s Wean Assessment Program*

The BWAP was developed in 1999 by Burn et al. In the BWAP, every positive answer has 1 point, and the overall score is the sum of all positive answers. This scale includes 26 items: 12 items for assessing general criteria and 14 for assessing respiratory functions. Each item has three options. The BWAP checklist requires the assignment of 1 of 3 responses (yes, no, or not assessed). A yes response indicates that the factor meets the established threshold definition. A no response means that the factor does not meet the established threshold definition, and the response not assessed is used when not enough data are available. When a patient’s score is over 17, she/he is ready for being weaned from the ventilator. Yazdannik et al. confirmed the BWAP’s content validity, in a study conducted by a group of experts including three ICU nurses, four nursing faculty members, and three anesthesiologists.\[13\] In a study conducted on 40 ICU patients in Thailand, Plang-Wan determined reliability of the BWAP and reported a Cronbach’s alpha of 0.92.\[16\] Yazdannik et al. conducted a pilot study on five patients and reported a Cronbach’s alpha of 0.85 for the BWAP.\[13\]

*Morganroth’s criteria for weaning from prolonged mechanical ventilation*

Morganroth et al. developed a set of standard criteria for weaning from mechanical ventilation in 1984. This scale includes two parts: (1) The first part examines patients’ overall status through 21 items; (2) and the
second part examines issues related to mechanical ventilation through 6 items. Based on the descriptions provided in the scale, each item has a specific score, and the total score is the sum of scores obtained in the two mentioned parts. The highest possible score in this scale is 75 and scores <55 indicate an increase in the probability of successful weaning. Morganroth reported a sensitivity of 93% and a specificity of 86% for the scale.\[17\] The applicability of this scale has been examined in several studies.\[18\]

The Persian weaning tool
This tool has three areas which include respiration status (9 items), cardiovascular status (4 items), and general status (13 items) of the patients. Each item is scored either 1 (for the critical conditions in which the patients need immediate intervention), 2 (for the conditions in which the patient need care), or 3 (for patients with appropriate condition regarding the related item). The PWT has also a “not applicable” option used when there is no definite answer for an item. The lowest and the highest possible scores in this scale are 26 and 75, respectively (scores higher than 50 indicate patients’ readiness for weaning).

When a patient was ready to be weaned from mechanical ventilation, the researcher and his partner collected the required information. The researcher completed all three research tools and his partner completed only the PWT. Finally, the patients were weaned from the ventilator under the supervision of a physician. To access the external validity intraclass correlation coefficient (ICC) index was calculated. To determine the inter-rater reliability between researcher and his partner, Pearson correlation and paired \( t \)-test were used. To assess the criterion validity of the PWT in relation to Burn’s and Morganroth’s weaning scales (as criteria), Pearson correlation and McNemar tests were used. To specify a minimum acceptable score of the PWT for weaning from mechanical ventilation, receiver operating characteristic (ROC) curve was used. All statistical analyses were performed using the SPSS-20 (that produced by The International Business Machines Corporation (IBM). It is an American multinational technology and consulting corporation, with corporate headquarters in Armonk, New York) software (\( P < 0.05 \)).

RESULTS
The results showed that 58.1% of the examined patients were male and 41.9% were female. The average age of participants was 51.42 years, the average duration of mechanical ventilation was 6.97 days, and the average consciousness level of the patients when being mechanically ventilated was 14.13. Most of the patients were mechanically ventilated due to medical reasons. The average scores of BWAP, Morganroth’s criteria, and PWT were 17.65, 13.94, and 57.48, respectively. The clinical conditions of the patients are presented in Table 1. During the study, two patients died and one patient were extubated spontaneously that were excluded and three other patients were replaced them. From 31 weaning, six of which were failed and patients were connected to ventilator again, and PWT was predicted five of unsuccessful weaning correctly.
The results showed a significant relationship between PWT scores and BWAP scores ($r = 0.370; P = 0.040$). However, no significant relationship was found between PWT scores and Morganroth’s scale scores ($r = 0.209; P = 0.260$). PWT scores given by the researcher were significantly correlated with PWT scores given by his partner ($r = 0.928; P < 0.001$). All results that were presented above reported based on Pearson’s correlation test [Table 2]. Moreover, paired t-test results showed no significant difference between the mentioned two sets of scores (researcher and his partner) $P = 0.189$.

The external validity was proved (ICCs = 0.962 with 95% confidence interval = 0.921, 0.981). ROC curve was calculated to determine the minimum acceptable PWT score for weaning from mechanical ventilation; accordingly, a cutoff point of 57, sensitivity of 0.679, specificity of 0.804, and area of under the curve 0.804 (asymptotic 95% confidence interval = 0.643, 0.964) were obtained [Figure 2]. After determination of the cutoff point, the samples were grouped based on their readiness or unreadiness specified in the BWAP and the PWT and then McNemar’s test was conducted. The results showed no significant difference in the determination of patients’ readiness/unreadiness for being weaned from mechanical ventilator between the PWT and the BWAP ($P = 0.453$). Nonetheless, a significant difference was observed in the determination of patients’ readiness/unreadiness for being weaned from mechanical ventilator between the PWT and Morganroth’s scale ($P = 0.031$).

**DISCUSSION**

The present study was conducted to determine some of the PWT’s psychometric characteristics. The results showed a significant relationship between PWT and BWAP score. Given the sample size and the $P$ value ($P < 0.05$), that correlation indicated criterion validity of the PWT. However, no significant relationship was found between PWT and Morganroth’s scale scores. The results of McNemar’s test showed no significant difference in the determination of patients’ readiness/unreadiness for being weaned from mechanical ventilator between the PWT and the BWAP. Nonetheless, a significant difference was observed in the determination of patients’ readiness/unreadiness for being weaned from ventilator between the PWT and Morganroth’s scale. Accordingly, all examined patients were ready for being weaned based on Morganroth’s scale, whereas six patients were still unready for that process based on the PWT. The average of Morganroth’s scale scores was almost 14. In Morganroth’s scale, scores <55 indicate an increase in the likelihood of successful weaning. Thus, there was a great difference between the obtained average score (i.e., 14) and the determined cutoff point (i.e., 55). On the other hand, the average of BWAP scores was 17.65 which were very close to the determined cutoff point (i.e., 17). This contradiction caused a lower correlation between scores of Morganroth’s scale and scores of the PWT, which could be due to the differences in parameters and scoring procedure between Morganroth’s scale and BWAP.

![ROC Curve](image)
and the other two tools. In the BWAP, there is a “not assessed” option for each item. Similarly, in the PWT, there is an “inapplicable” option for each item. Selection of these options in the BWAP and PWT negatively impacts the overall score. However, Morganroth’s scale does not have such options and not assessed or inapplicable cases do not receive any score resulting in lower overall scores. Moreover, in Morganroth’s scale, there are conditions that score was not assigned to it. Bagheri et al. conducted a study in 2012, to determine reliability and validity of the weight satisfaction scale. In that study, the body shape questionnaire was simultaneously completed by the samples to determine the scale’s validity. In testing validity, scores of the weight satisfaction scale were highly correlated with scores of the body shape questionnaire ($r = 0.72; P < 0.05$).[19]

The results also showed that PWT scores given by the researcher were significantly correlated with PWT scores given by his partner ($r = 0.923; P < 0.001$) indicating a high level of agreement between the two observers and inter-rater reliability of the PWT. In 2013, Dalvandi and Bahramipour examined reliability and validity of the Iranian prehospital stroke scale. To determine the scale’s reliability, they used inter-rater reliability and found a correlation coefficient of 0.96.[20]

Using ROC curve and based on the BWAPs cutoff point, the minimum acceptable PWT score of 57 was determined for weaning from mechanical ventilation. In 2013, Dehghan and Habibi conducted a study to validate a questionnaire used for heat strain evaluation in women. They calculated a ROC curve based on the standard oral temperature and found a cutoff point of 17 for the examined questionnaire.[21]

CONCLUSIONS

According to the findings of the present study, both reliability and validity of the PWT were confirmed for this study’s sample size. The results also showed a minimum acceptable PWT score of 57 for weaning from mechanical ventilation which was determined based on the BWAP. Consequently, the findings of this study can be used to measure the PWTs effectiveness and applicability in ICUs. However, further studies with greater sample sizes are required to examine other psychometric characteristics of the PWT.

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Conflicts of interest

There are no conflicts of interest.

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