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ORIGINAL ARTICLE

Sequential Organ Failure Assessment (SOFA) Scores as Predictive Indices for Weanability from Mechanical Ventilation

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Abstract

Background: *Sequential Organ Failure Assessment (SOFA) score was designed for describing the severity of a patient's illness resulted from the affected degree of six organ failure or dysfunction, There was little knowledge about application of SOFA scoring system to predict weanability from mechanical ventilation.*

Aims: *The aim of the study was to determine the SOFA score as a predictive index for weaning of the patients from mechanical ventilation.*

Materials & Methods: *This prospective observational study conducted at the Department of Respiratory Medicine in National Institute of Diseases of the Chest and Hospital (NIDCH) from March 2020 to February 2021 in collaboration with the Department of Respiratory Intensive Care Unit (ICU). A total of 42 critically ill patients admitted to Respiratory ICU of NIDCH were enrolled in this study. SOFA score measured every day and weaning process involved spontaneous breathing trial with a T piece. Statistical analyses of the results were obtained by using windows based computer software devised with Statistical Packages for Social Sciences (SPSS-23).*

Results: *Among the 42 patients with a mean age of 58.5±18.6 years requiring MV, 34(81%) patients were successfully weaned from Mechanical Ventilation. Male patients were predominant 39(92.9%) with male to female ratio was 13:1.The most common reason for ICU admission was acute exacerbation of COPD (AECOPD) with Type 2 Respiratory Failure 7(16.7%). Fifty seven percent patients had DM followed by 21(50.0%) HTN. Among 42 patients, 8(19.0%) patients were died and 31(73.8%) were survived. The mean SOFA score maximum was found 8.0±2.0 with range from 5 to 14. Based on the receiver-operator characteristic (ROC) curves SOFA score maximum had area under curve 0.991. Receiver-operator characteristic (ROC) was constructed by using SOFA score level, which gave a cut off value ≥9.5 with 87.5% sensitivity and 97.1% specificity for prediction of mortality. With cut off SOFA score ≥9.5 mean duration of mechanical ventilation was 6.8±3.3 days. There were no significant association of socio-demographic variables and co-morbidities compared with successful weaning and weaning failure patients.*

Conclusion: *In conclusion, SOFA score may be used as predictive index for weanability from mechanical ventilation.*

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Introduction:

Critical illness is any disease process which causes physiological instability leading to disability or death within minutes or hours. Mechanical ventilation (MV) is commonly needed in critically ill patients for variable periods. Over the last decade there has been an exploration of new ventilator techniques that present a bewildering array of the alternative for the treatment of respiratory failure[1]. Over the past few years our understanding of the detrimental as well as beneficial effects has increases many folds and now majority of the patients requiring mechanical ventilation in the ICU are safely weaned from ventilation within a short period of time. Accurate prediction of MV duration is important for patients and their family members. It is also an essential first step in the allocation of resources and appropriate use of weaning centers

Weaning from mechanical ventilation can be defined as the process of abruptly or gradually withdrawing ventilator support. Weaning from mechanical ventilation usually implies two separate but closely related aspects of care, discontinuation of mechanical ventilation and removal of any artificial airway. A variety of criteria have been used as predictors of weaning outcome. More recently, the respiratory rate (f) to tidal volume (Vt) ratio (f/Vt); CROP index {compliance (thoracic), respiratory (rate), oxygen (arterial), pressure (maximal inspiratory- Pimax); relative inspiratory effort (RIE); and a new weaning index (WI), based on ventilatory endurance and the efficiency of gas exchange have been proposed as predictors of the success or failure of weaning attempts. However, all these weaning indices have been used to predict only the immediate outcome of weaning attempts; they are difficult to apply in daily clinical practice. The SOFA score evaluates the severity of the patient's illness with an assessment of six organ systems[2]. This study would offer an insight into the potential use of SOFA score as predictive index for weaning from mechanical ventilation. By doing so, it would provide clinicians a reliable, convenient, cost effective and routinely measured tool as SOFA score to assess prediction of weaning from mechanical ventilation patients.

Materials and methods The study was designed as prospective cross sectional observational study ,conducted in the Respiratory ICU, National Institute of Diseases of the Chest and Hospital (NIDCH), Mohakhali, Dhaka from March 2020, to February 2021. Critically ill patients treated with mechanical ventilation were included in the study.

Inclusion criteria

- Patient who were admitted and mechanically ventilated in ICU
- Age ≥18 years.

Exclusion criteria

- Patient with history of Cardiac surgery within last 4 weeks.
- Patient admitted due to traumatic injuries.
- Patient referred from another ICU.
- Patient attendants who refused to be part of study.
- Patients with incomplete follow up.

Operational definition

The SOFA score

Ranges from 0 to 24 and includes points related to six organ systems: respiratory (hypoxaemia defined by low PaO2/FiO2); coagulation (low platelets); liver (high bilirubin); cardiovascular (hypotension); central nervous system (low level of consciousness defined by Glasgow Coma Scale); and renal (low urine output or high creatinine). Sepsis is defined by an increase in the sepsis-related SOFA score of e" 2 points. The baseline score is assumed as '0' if data are not available [3] .

Weaning from mechanical ventilation

Weaning from mechanical ventilation is the process of reducing ventilatory support, ultimately resulting in a patient breathing spontaneously and being extubated. This process can be achieved rapidly in 80% of patients when the original cause of the respiratory failure has improved. The remaining cases will require a more gradual method of withdrawing ventilation[4].

Observations and results

The mean age was 58.5±18.6 years with range from 19 to 90 years. Majority (92.9%) patients were male. Among the admitted patients 7(16.7%) patients were found Acute Exacerbation of COPD with Type 2 Respiratory Failure, 6(14.2%) post TB fibrosis, 5(11.9%) Pneumonia and 4(9.5%) bronchial carcinoma. Regarding co-morbidities 24(57.1%) patients had Diabetes Mellitus followed by 21(50.0%) HTN, 9(21.4%) IHD, 8(19.0%) Cor-pulmonale, 7(16.7%) CKD, 6(14.3%) CVD, 5(11.9%) BEP and 4(9.5%) had pulmonary hypertension.

Regarding duration of mechanical ventilation, 35(83.3%) patients were in mechanical ventilation for ≤7 days. The mean duration of mechanical ventilation was found 6.0±1.9 days with range from 2 to 11 days. In our study it was found that 8(19.0%) patients died, 31(73.8%) were survived and 3(7.1%) were switched to multidisciplinary ICU. Weaning were successful in 34(81%) patients and 8(19.0%) patients had unsuccessful weaning. Low SOFA score ≤6 was found in 9 cases and their mean duration of mechanical ventilation was 4.7±1.2 days. Medium SOFA score 7-10 was found in 28 cases and their mean duration of mechanical ventilation was 6.3±1.7 days. High SOFA score >10 was found in 5 cases and their mean duration of mechanical ventilation was 7.0±2.9 days. The difference was statistically significant ($p<0.05$) among three groups. It was found that 3(37.5%) patients was found SOFA score 7-10 in patents who didn't survive, 2(66.7%) in switched to multidisciplinary facility ICU and 23(74.2%) in survived group. Based on the receiver-operator characteristic (ROC) curves SOFA score maximum had area under curve 0.991. Receiver-operator characteristic (ROC) was constructed by using SOFA score level, which gave a cut off value 9.5, with 87.5% sensitivity and 97.1% specificity for prediction of mortality. It was found that positive predictive value was 87.5% and negative predictive value was 97.1%. It was found that SOFA score ≥9.5 was found in 8 cases and their mean duration of mechanical ventilation were 6.8±3.3 days. SOFA score <9.5 was found in 34 cases and their mean duration of mechanical ventilation were 5.8±1.4 days. The difference was statistically significant ($p>0.05$) between two groups. SOFA score ≥9.5 was found in 7(87.5%) patients who did not survived, 1(33.0%) in switched to multidisciplinary facility ICU and SOFA score cut off was <9.5 those who survived. The difference was statistically significant ($p<0.05$) among three groups.

Table-I

Demographic characteristics of the study patients (n=42)

Demographic characteristics	Number of patients	Percentage
Age (years)		
Mean±SD		58.5±18.6
Range (min-max)		19.0-90.0
Sex		
Male	39	92.9
Female	3	7.1

Table-II

Distribution of the study patients according to co-morbidities (n=42)

Co-morbidities	Number of patients	Percentage
DM	24	57.1
HTN	21	50.0
IHD	9	21.4
Cor-pulmonale	8	19.0
CKD	7	16.7
CVD	6	14.3
BEP	5	11.9
Pulmonary hypertension	4	9.5

Table-III

Distribution of the study patients according to diagnosis (n=42)

Diagnosis	Number of patients	Percentage
Acute severe asthma	3	7.1
Bronchiectasis	2	4.8
Post TB fibrosis	6	14.2
AECOPD with T2RF	7	16.7
Aspiration pneumonia with CVD	3	7.1
Bronchial carcinoma	4	9.5
Pneumonia	5	11.9
Post COVID fibrosis	2	4.8
Sepsis with ARDS	3	7.1
DPLD	3	7.1

Table-IV

Distribution of the study patients according to duration of mechanical ventilation (n=42)

Duration of mechanical ventilation (days)	Number of patients	Percentage
≤7	35	83.3
>7	7	16.7
Mean±SD	6.0	±1.9
Range (min-max)	2.0	-11.0

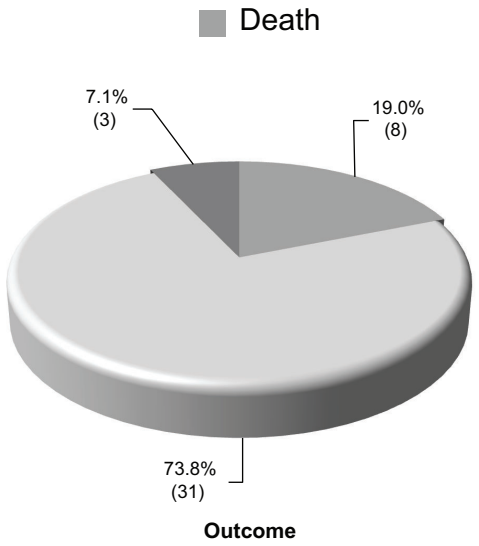


Fig.-1: *Outcome of mechanical ventilation*

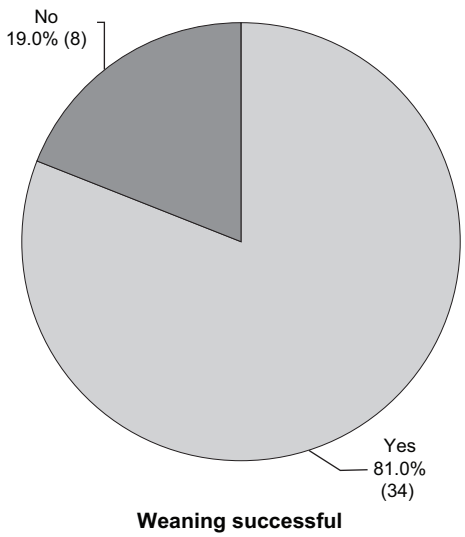


Fig.-2: *Weaning from Mechanical Ventilation*

Table-V

Association between SOFA score maximum with duration of mechanical ventilation (n=42)

SOFA score	Number of patients	Duration of mechanical ventilation (days) Mean±SD	P value
≤6 (Low)	9	4.7±1.2	
7-10 (medium)	28	6.3±1.7	0.04[s]
>10 (high)	5	7.0±2.9	

s= significant

P value reached from ANOVA test

Table-VI

Association of SOFA maximum score with outcome (n=42)

SOFA score	Outcome						P value
	Death (n=8)		Switched to multidisciplinary facility ICU (n=3)		Survived (n=31)		
	n	%	N	%	n	%	
≤6 (Low)	0	0.0	1	33.3	8	25.8	
7-10 (Medium)	3	37.5	2	66.7	23	74.2	0.001[s]
>10 (High)	5	62.5	0	0.0	0	0.0	

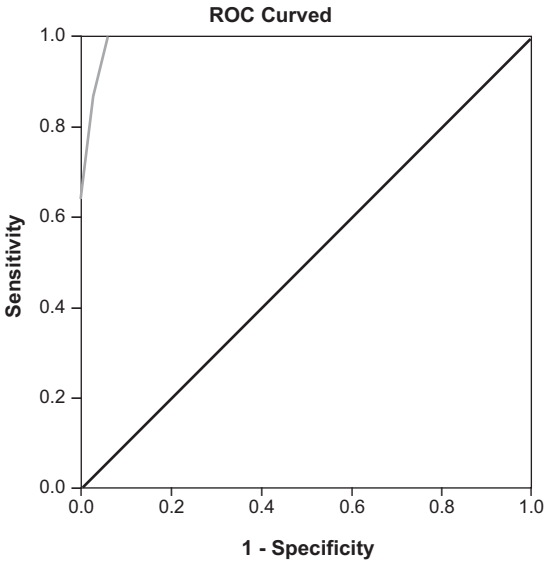
s= significant

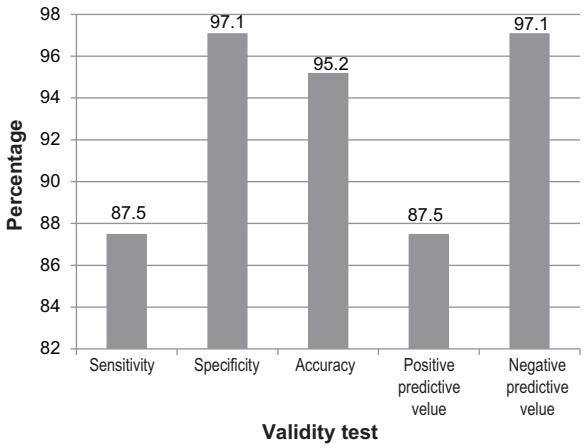
P value reached from chi square test

Table-VII

Receiver-operator characteristic (ROC) curve of SOFA score maximum level for prediction of mortality

	Cut of value	Sensitivity	Specificity	Area under the ROC curve	95% Confidence interval (CI)	
					Lower bound	Upper bound
SOFA score maximum	9.5	87.5	97.1	0.991	0.970	1.000





Receiver-operator characteristic curves of SOFA score maximum.

Table-VIII

Association between SOFA score cut off value with duration of mechanical ventilation (n=42)

SOFA score	Number of patients	Duration of mechanical ventilation (days) Mean±SD	P value
≥9.5	8	6.8±3.3	0.022[s]
<9.5	34	5.8±1.4	

s= significant

P value reached from unpaired t-test

Table-IX

Association between SOFA score cut off value with outcome (n=42)

SOFA score	Outcome						P value
	Death (n=8)		Switched to multidisciplinary facility ICU (n=3)		Survived (n=31)		
	n	%	N	%	n	%	
≥9.5	7	87.5	1	33.3	0	0.0	0.001[s]
<9.5	1	12.5	2	66.7	31	100.0	

s= significant

P value reached from chi square test

Discussion:

In this present study it was observed that 12(28.6%) patients belonged to age 61-70 years. The mean age was found 58.5±18.6 years with range from 19 to 90 years. Almost same study conducted by Anami et al. (2010) where they found patient ages ranged from 18 to 104 years, with a mean (±SD) of 56.7 (±19.1) years[5], supports our current study findings.

In this study it was observed that majority 39(92.9%) patients were male. Dehghani et al. (2016) reported that of the 61 patients in the sample, 46 were males (75.4%) and 15 were females (24.6%)[6]. Lee et al. (2017) had observed that male was 67.0% and female was 33.0%[7].The dominance of the male patients may be due to the fact that most of our patients were COPD patients and COPD is most commonly seen in male in our country.

Regarding co-morbidities in this study it was observed that 24(57.1%) patients had DM followed by 21(50.0%) HTN, 9(21.4%) IHD, 8(19.0%) corpulmonale, 7(16.7%) CKD, 6(14.3%) CVD, 5(11.9%) BEP and 4 (9.5%) were pulmonary hypertension. Almost similar findings were reported in several other studies. Muzaffar et al. (2017) documented that most of them had cardiac co-morbidities (coronary artery disease) (41%) followed by diabetes mellitus (33%), chronic kidney disease (12%), respiratory co-morbidities (chronic obstructive pulmonary disease, asthma, or history of pulmonary tuberculosis) (10%), and both respiratory and cardiac co-morbidities (4%)[8]. Consisted that 49 participants had diabetes mellitus (27%) and 24 patients (13%) had chronic kidney disease[9].

Nearly two-third (73.8%) of patients in our study survived and 19% patients died. Lee et al. (2017) reported that the mortality rate was 23%[7]. Muzaffar et al. (2017) had observed ICU mortality 33.0%[8]. Described the overall mortality seen in the study was 30% (60 patients)[9]. The mortality reported in earlier studies varied from 5 to 20% (Freund et al. 2017)[10]. This dissimilarity in this study may be explained by the fact that this study was conducted at a specialized respiratory ICU and hence a majority of the patients included were cases referred from other centers.

In this study it was observed that in 35(83.3%) patients, duration of mechanical ventilation were ≤7 days. The mean duration of mechanical ventilation was found 6.0±1.9 days with range from 2 to 11 days. In this study it was observed that in 22(64.7%) patients weaning started from more than 3 days. The mean weaning days were found 3.8±0.9 days with range from 2 to 5 days. Several other study findings are almost consistent with our findings. Afessa et al. (1999) documented that 57 patients (48%) were successfully weaned from MV within 3 days of weaning assessment, and 67 (57%) were weaned within 7 days[11]. Muzaffar et al. (2017) also found the median weaning duration was 14 (9.5 - 19) days[8]. However, those are not in agreement with our study result may be due to different multidisciplinary ICU setting.

Regarding SOFA score in this study we have found SOFA score (maximum) 7-10 were in 28(66.7%) patients. The mean SOFA score (maximum) was found 8.0±2.0 with range from 5 to 14. Lee et al. (2017) consisted that the average of SOFA score from the first day of admission of respiratory care center was 5.5±2.3[7]. Our findings almost correspond with the other studies.

In this study based on the receiver-operator characteristic (ROC) curves SOFA score maximum had area under curve 0.991. Receiver-operator characteristic (ROC) was constructed by using SOFA score level, which gave a cut off value 9.5, with 87.5% sensitivity and 97.1% specificity for prediction of mortality and accuracy 95.2%, positive predictive value 87.5% and negative predictive value 97.1%. In a study done by Lee et al. (2017) where they observed the area under ROC curve of SOFA score was 0.645 (P value=0.012). The optimal cut-off point of SOFA score for weaning predict was 4.5 with 72.0 % sensitivity and 54.0% specificity[7]. Dehghani et al. (2016) described the area under the ROC curve was 0.499 in predicting the failure of the first weaning based on the SOFA score at admission and the cut off point for the SOFA score at admission was 5.5. The sensitivity and specificity for predicting in-hospital mortality were 68% and 69%, respectively[6]. Other studies have reported a sensitivity and specificity of 70% and 79%, respectively, which is similar to what was observed in the study[10]. Timing of ICU admission may be an important cause of the different values in different studies. In this respect our results are consistent with other studies.

In our study we found that SOFA score ≥9.5 in 8 cases and their mean duration of mechanical ventilation was 6.8±3.3 days and among them

7(87.5%) patients expired. SOFA score <9.5 was found in 34 cases and their mean duration of mechanical ventilation was 5.8±1.4 days were successfully liberated from mechanical ventilation. The difference was statistically significant (p>0.05) between two groups. Similar study carried out by Afessa et al. (1999) documented that 57 patients (48%) were successfully weaned from MV within 3 days of weaning assessment, and 67 (57%) were weaned within 7 days[11]. This finding is almost consistent with our current study.

A limitation of our study is that it was a single center study. The study period was short. Further multicenter study with long duration may be carried out.

Conclusion:

In conclusion, SOFA score may offer a cut off value 9.5 with successful weaning among mechanically ventilated patients. SOFA score is a better way to predict early weanibility from mechanical ventilation. SOFA scores may be used as an important predictive index for weaning outcome of patients' from mechanical ventilation..Further large scale multicenter study may be carried out.

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