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Comparison Of Acute Physiology And Chronic Health Evaluation II Score With Organ Failure Scores At The Time Of Admission To Predict Clinical Outcome In Critically Ill Patients

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Abstract

Background

Various scoring systems to predict the severity, prognosis and risk of in-hospital mortality in critically ill patients including those suffering from severe sepsis have been developed till date. Therefore, this study was undertaken to individually evaluate and compare the ability of APACHE-II and SOFA scoring systems to predict mortality of critically ill patients in intensive care unit.

Material and Methods

The study was conducted at intensive care unit, Tertiary care Hospital, Bhopal during the period of 2 years. This Observational Prospective cohort study was conducted In 110 patients aged ≥ 18 years with sepsis, multi-organ dysfunction and septic shock. The APACHE II and SOFA scoring were computed on day of admission and compared.

Results

Overall mortality was 33.64%. The mean APACHE II for non-survivors was 21.81±7.968 compared to 17.26±7.401 for survivors, which was significant (p=0.004). Whereas the mean SOFA score between non-survivors and survivors was 6.97±3.158 Vs 5.81±3.252 (p=0.076), which was non-significant.

Conclusion

APACHE II scoring system was better than SOFA scoring system in this study**.**

Keywords: SOFA- Sequential Organ Failure Assessment, APACHE II- Acute Physiology And Chronic Health Evaluation II

Introduction

Sepsis is the most vital reason for MODS everywhere.[1] Sepsis is a life-threatening organ dysfunction due to a dysregulated host response to infection. Sepsis develops when the immune system releases inflammatory mediators into the bloodstream to fight an infection that cause inflammation in the entire body. There is nothing as severe sepsis in present criteria, it simply involves Sepsis & septic shock.

The sepsis-3 Task force, convenced in 2014 by the Society of Critical Care Medicine and also the European Society of Intensive Care Medicine, introduced new definitions for sepsis and septic shock. A principal change within the new definitions is the requirement that sepsis should be triggered by

infection.[2] This pathobiological understanding removes Systemic Inflammatory Response Syndrome from the definition of sepsis, as numerous conditions apart from infection may cause Systemic Inflammatory Response Syndrome.

Sepsis-3 Definitions[3]:

1. SIRS and severe sepsis removed from definition.
2. Sepsis is a life-threatening organ dysfunction caused by a dysregulated patient response to infection.
3. Sepsis is a life-threatening condition that arises when the individual response to infection causes injury to itself and its organs.
4. Septic shock is seen in patients with sepsis who develop underlying circulatory and metabolic abnormalities leading to hypotension that need vasopressors to maintain a MAP of ≥ 65 mmHg and having a serum lactate level of ≥ 2 mmol/L despite adequate volume resuscitation, leading to higher risk of mortality.

Multiple scoring systems like Sequential Organ Failure Assessment Score, Acute Physiology and Chronic Health Evaluation II score, which are available for assessment and prognosticate the severity of illness.[4] The Acute Physiology and Chronic Health Evaluation (APACHE) II model was developed in 1985 and has been evaluated by many ICUs.[5-7] Although newer versions of the APACHE II prognostic model have been developed, it is still commonly used in many ICUs worldwide for clinical outcome as it is easy to use. The APACHE II score utilizes the worst values of 12 physiological variables like body temperature, heart rate and blood pressure during the first 24 hours following ICU admission, together with an evaluation of the patient's chronic health, age and type of ICU admission to calculate the APACHE II score.[6] However, the validity of the APACHE II score has been challenged because it doesn't consider the medical therapy delivered to the patient or the next course of disease after primary 24 hours in the ICU.[5]

Multiple organ failure is common among patients admitted in ICU and is a leading contributor to mortality in critically ill patients. Attempts have therefore been made to quantify organ failure through the event of a classification system within which serial measurements of the quantity and severity of organ failure during the ICU stay is employed to predict outcome.[5,7]Several organ failure or dysfunction scores are developed to be used in critically ill patients and Sequential Organ Failure Assessment (SOFA) score is one in all the most typical organ failure scores employed in ICUs. The SOFA score was developed following a consensus conference[7] and the total score consists of components of six major organ systems. However, the ability of the SOFA score to discriminate survivors from non-survivors has been found to be inconsistent across studies.[7]

Aim And Objectives:

The aim of the present study is to assess the usefulness of SOFA and APACHE II score on admission in the patients admitted in intensive care unit who had sepsis, septic shock or multiorgan dysfunction syndrome (MODS).

1. To assess the performance of the currently used APACHE II score & SOFA score to predict clinical outcome

2. To compare the performance of the APACHE II score with that SOFA score to predict clinical outcome.

Materials & Methods:

The study was conducted at intensive care unit, Tertiary care Hospital Bhopal during the period of 2 years. This was an Observational prospective cohort study done on subjects with sepsis, multi-organ dysfunction and septic shock.

Inclusion Criteria:

1. All critically ill patients admitted in ICU with evidence of organ dysfunction.

2. Patients with sepsis and shock

3. Age ≥ 18 years

Exclusion Criteria:

1. Age < 18 years

2. Patients who get discharged against medical advice which prevents follow up on outcome

3. Acute coronary syndrome

4. Burns patients

5. Patients operated 1 week before or after the ICU admission.

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6. Terminal malignancy

7. Do not resuscitate patients

8. Patients whose duration of stay less than 24 hour

9. Patients in whom any of the 12 physiological variables are missing

Data Collection Procedure:

This study was undertaken over an 18-months period and included all the admissions which fit the inclusion criteria.

1. A clinical proforma was filled up for each patient incorporating details regarding particulars of the patient, history, clinical examination and investigations.
2. APACHE II Score and SOFA Score were calculated on admission to ICU using the worst value of 12 variables.

Statistical Analysis

Data so collected was tabulated in an excel sheet, under the guidance of statistician. The means and standard deviations of the measurements per group were used for statistical analysis (SPSS 22.00 for windows; SPSS inc, Chicago, USA).

Results:

The patients admitted in the ICU of tertiary care medical college in Bhopal, Madhya Pradesh fulfilling inclusion criteria, were enrolled in the study. The final data set comprised of 110 patients. Among patients who survived males were 65.8% and females were 34.2%. Similarly among those who did not survive, males were 64.9% and females were 35.1%.

Table 1: Sex Distribution Vs Outcome

Sex		Outcome		Total
		Survivor	Non-Survivor	
Female	Count	25	13	38
	%	34.2%	35.1%	34.5%
Male	Count	48	24	72
	%	65.8%	64.9%	65.5%
Total	Count	73	37	110
	%	100.0%	100.0%	100.0%

Table 2: Age group Vs Outcome

Age Groups		Outcome		Total
		Survivor	Non-Survivor	
<30 Years	Count	5	2	7
	%	6.8%	5.4%	6.4%
30-50 Years	Count	17	6	23
	%	23.3%	16.2%	20.9%
50-70 Years	Count	27	17	44
	%	37.0%	45.9%	40.0%
70-90 Years	Count	24	12	36
	%	32.9%	32.4%	32.7%

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Total	Count	73	37	110
	%	100.0%	100.0%	100.0%

Table II shows that in Non-Survivor category, the higher percentage are in age group 50-70 Years (45.9 %) and 70-90 Years (32.4%), but in Age group 30-50 Years mortality was 16.2% and lowest mortality was in age group < 30 years (5.4 %).

Table 3: System involved Vs Outcome

	System Involved	Outcome		Total
		Survivor	Non-Survivor	
Cardiovascular diseases	Count	1	1	2
	%	1.4%	2.7%	1.8%
Endocrinal diseases	Count	1	1	2
	%	1.4%	2.7%	1.8%
Gastrointestinal disease	Count	7	5	12
	%	9.6%	13.5%	10.9%
Hematological disorders	Count	1	1	2
	%	1.4%	2.7%	1.8%
Infectious diseases	Count	4	0	4
	%	5.5%	0.0%	3.6%
Neurological disorders	Count	28	14	42
	%	38.4%	37.8%	38.2%
Renal diseases	Count	5	1	6
	%	6.8%	2.7%	5.5%
Respiratory diseases	Count	15	12	27
	%	20.5%	32.4%	24.5%
Other	Count	11	2	13
	%	15.1%	5.4%	11.8%
Total	Count	73	37	110
	%	100.0%	100.0%	100.0%

Table III shows thatin both survivor and non-survivor category higher percentage is of Neurological disorders followed by Respiratory diseases.

Table 4: Comparison of Mean SOFA, APACHE II and Different Outcome Status Groups

Variable	Outcome	N	Mean	Std. Deviation	T Test	p Value
SOFA_Admission	Survivor	73	5.81	3.252	-1.792	0.076
	Non-Survivor	37	6.97	3.158		

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APACHE II Score	Survivor	73	17.26	7.401	-2.969	0.004*
	Non-Survivor	37	21.81	7.968		

Table IV shows the mean APACHE II for non-survivors was 21.81±7.968 compared to 17.26±7.401 for survivors, which was significant (p=0.004). Whereas the mean SOFA score between non-survivors and survivors was 6.97±3.158 Vs 5.81±3.252 (p=0.076), which was non-significant.

Table 5: Association between SOFA_Admission and APACHE II Score

SOFA_Admission		APACHE II Score								Total
		0-4	5-9	10-14	15-19	20-24	25-29	30-34	>=35	
<=5	Count	1	12	12	15	4	6	0	0	50
	%	100.0%	85.7%	60.0%	60.0%	16.0%	42.9%	0.0%	0.0%	45.5%
6-10	Count	0	2	8	10	17	4	4	2	47
	%	0.0%	14.3%	40.0%	40.0%	68.0%	28.6%	57.1%	50.0%	42.7%
11-15	Count	0	0	0	0	4	4	3	2	13
	%	0.0%	0.0%	0.0%	0.0%	16.0%	28.6%	42.9%	50.0%	11.8%
Total	Count	1	14	20	25	25	14	7	4	110
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table V shows the association between SOFA_Admission and APACHE II Score of the respondents which found to be significant (P <0.05). It implies that SOFA Admission of patients differ significantly with the APACHE II Score they had.

Table 6: "Discrimination, sensitivity, and specificity of SOFA score at admission"

SOFA_Admission		Outcome		Total
		Survivor	Non-Survivor	
Negative	Count	56	17	73
	%	76.7%	45.9%	66.4%
Positive	Count	17	20	37
	%	23.3%	54.1%	33.6%
Total	Count	73	37	110
	%	100.0%	100.0%	100.0%
Calculation		Value	Df	P Value
Pearson Chi-Square		10.412	1	0.001
Sensitivity		54.10%		

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Specificity	76.70%
PPV	54.05%
NPV	76.71%
Accuracy	76.00%
Area Under ROC	61.4%

Table VI & VII show the Discrimination, sensitivity and specificity of SOFA score at admission and APACHE II score which were found to be significant (P <0.05). Moderate Accuracy of 76% justify that the SOFA at Admission is tool for correct prediction of negative grade, but low performance tool for predicting positive grades as compare to final Mortality Status.

SOFA generated an area under ROC curve of 0.614 for a cut off value of 7. The low sensitivity (54.01%), high specificity (76.70%) and moderate accuracy (76.0%) for predicting disease positive outcome of patients by SOFA at Admission against Mortality Status concluded that SOFA at Admission score should not be used as appropriate tool to predict the final outcome.

Graph 1: Receiver Operating Characteristic Curve of SOFA_Admission score

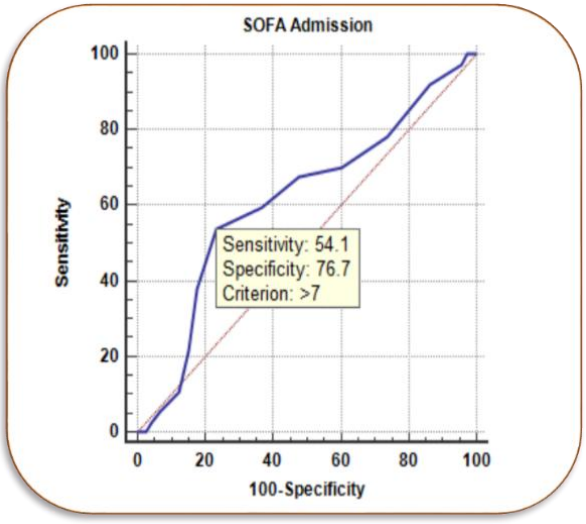

Table 7: "Discrimination, sensitivity, and specificity of APACHE II score"

APACHE II Score		Outcome		Total
		Survivor	Non-Survivor	
Negative	Count	60	20	80
	%	82.2%	54.1%	72.7%
Positive	Count	13	17	30
	%	17.8%	45.9%	27.3%
Total	Count	73	37	110
	%	100.0%	100.0%	100.0%
Calculation		Value	Df	P Value

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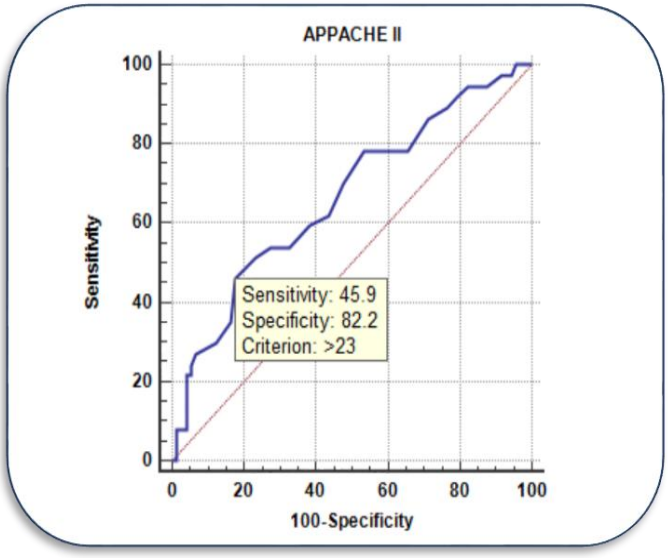
Pearson Chi-Square	9.801	1	0.002
Sensitivity	45.94%		
Specificity	82.20%		
PPV	56.67%		
NPV	75.00%		
Accuracy	77.00%		
Area Under ROC	66.66%		

Table VII shows the "Discrimination, sensitivity, and specificity of APACHE II score" which found to be significant (P <0.05). The area under the ROC for APACHE II with cut off value 23 was 0.667 indicating a good discrimination between survivors and non-survivors. The score showed lower sensitivity of 45.94% and specificity was 82.20%. The low sensitivity, high specificity and high accuracy (81.00%) for predicting disease positive outcome of patients by APACHE II Score against outcome status conclude that APACHE II Score can be used as reliable tool to predict the final negative outcome.

Graph 2: Receiver Operating Characteristic Curve of APACHE II score



Discussion:

Our study shows that both scoring system APACHE II and SOFA has a good predictive capabilities in predicting outcomes in critically ill patients, however the APACHE II score had highest specificity of 82.2% followed by SOFA_admission (76.70%). APACHE II showed better discrimination power (area under the curve:0.667) followed by SOFA_admission which was slightly inferior with area under the curve:0.614. During the evaluation we inferred that all the scores beyond a certain cut off point were associated with increased mortality and poor outcome. However, it should be emphasized that scoring systems are intended to determine patients' medical management. In clinical setting, these scoring systems and the predicted mortality should not influence the decision to discontinue treatment.

Comparison of the demographic Characteristics:

A total of 110 patients were enrolled in the study. Majority of the patients (40.0%) were between the 5th to 7thdecades of life. The overall mortality rate was 33.64% in our study which was higher than that of Kim YH et al.[8] who documented 22% mortality in their study comparing the three scoring systems in patients of organophosphorus poisoning admitted in intensive care setting. In an India study done by Sathe PM et al.[9] the overall mortality in was 17.7%. Khan MS et al.[10] et al in their study conducted in southern India experienced almost similar mortality

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rate (34%) as compared to the our study. This difference in the mortality rate could be attributed to non-inclusion of patients may be with likelihood of as they were discharged against the medical advice. Also the present study included all the patients admitted in the ICU with varied levels of severity and diagnosis.

The mean age of the study population among survivors was 59.301 ± 18.378 and 60.378 ± 15.300 was in non-survivors. Indicating that majority of the patients in our study belonged to older age group. Whereas in a similar kind of study comparing the predictability of scoring system in critical care unit by Khan MS et al.[10] the mean age was 39.4 ± 17.3. The mean age (52.2 ± 16.4) was almost similar to our study in a cross-sectional study conducted by Johnson A et al in Manipal.[11]

In our study, Majority of patients were male comprising of 65.5% of study population. A Labaf, MR Zarei et al.[12]reported 389 cases including 236 males (60.7%) were enrolled into the study.Rajnish Gupta & V.K. Arora et al.[13] reported 229 (69.4%) were males and 101 (30.6%) were females. K. M. Ho et al.[14] reported 806 were males and 505 were females. Samir desaietal.[1] reported 27 were females and 23 males.

APACHE II score:

We found that the APACHE II severity score showed a decent calibration and discriminatory value across a range of disease processes. Higher APACHE II score was associated with increased mortality. The mean APACHE II score in the survivors was 17.26 compared to 21.81 in nonsurvivors. Our data showed that lower the APACHE II score higher was the probability of survival.

12 variables used to compute APACHE II scores among survivors and non-survivors. The mean APACHE II for non-survivors was 21.81±7.968 compared to 17.26±7.401 for survivors, which was significant (p=0.004). The area under the ROC for APACHE II with cut off value 23 was 0.667 indicating a good discrimination between survivors and non-survivors. The score showed lower sensitivity of 45.94% and specificity was 82.20%. The low sensitivity, high specificity and high accuracy for predicting disease positive outcome of patients by APACHE II Score against outcome status conclude that APACHE II Score can be used as reliable tool to predict the final negative outcome.

In a study by Georgescu AM et al the APACHE II, SOFA and SAPS II scores were determined prospectively, within 24 hours after admission, for all 56 patients with septic shock who were included during study.[10]The average APACHE II score was 25.36±7.477. For the APACHE II and SOFA scores the differences when non-survivors and survivors were compared were not statistically significant (APACHE II: 26.76±6.742 vs 23.18±8.175 respectively and for SOFA: 8.029±3.099 vs 7.136±3.342). The areas under ROC for the three scores are 0.622 for APACHE II, 0.575 for SAPS II and 0.705 for SOFA.

Rajnish Gupta & V.K. Arora et. Al reported the mean APACHE II scores, being respectively 11.34±6.75 (range 1-37) and 23.09±10.01 (range 5- 47), were significantly different ($p<0.01$).[13]

Almost similar findings were seen in patients of organophosphorus poisoning as seen in the study done by Kim YH et al.[8] in 2013. In their study, APACHE II had an area of 0.716 with a cut off value of 11. The specificity and sensitivity of the model was found to be 68.6% and 65.6% respectively. The score performed much better in out setting as compared to the above study. Another study by Hashmi et al[15] from Pakistan in 2016 showed AUC of 0.827 (0.77-0.88) with sensitivity of 55.71% and specificity of 90.21%.

In a recent systemic review by Haniffaet al.[16] in 2018, they have shows that there is a wide variability in the results of different studies carried out in different parts of the world. The discrimination power of APACHE II range from as low as AUC 0.6 Galalet al.[17] to as high as 0.936 Khwannimit B et al.[18]Different studies have documented the sensitivity from 51% to 93% whereas specificity ranges from as low as 49% to as high as 97%.[16] The main criticism of the APACHE II score is that it does not include in account to the medical therapy delivered to the patient or the subsequent course of disease after the first 24 hrs in the ICU. Omission of this variable could be responsible for the vast variation in the ability of score to predict mortality.

Sofa Score:

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In our study we too tried to compare the capability of SOFA score in predicting mortality with APACHE II. We utilized the SOFA score on admission to predict mortality and found that the score was useful for predicting the outcomes in ICU set up.

The mean SOFA score was significantly higher in non-survivors as compared to survivors 6.97 and 5.81, respectively. Similarly, when we tested the score for its calibration, SOFA generated an area under ROC curve of 0.614 for a cut off value of 7. The low sensitivity (54.01%), high specificity (76.70%) and moderate accuracy (76.0%) for predicting disease positive outcome of patients by SOFA at Admission against Mortality Status conclude that SOFA at Admission score cannot be used as appropriate tool to predict the final outcome.

In our study, The SOFA score at admission was noted to have good predictive correlation with mortality. The score was noted to be higher in the non-survivor group. SOFA_admission was lacked significant association between survivors and non-survivors with outcome. This indicates that a daily monitoring of the SOFA score is more important than a single value SOFA score and that progressively increasing score is more indicative and more predictive of mortality than absolute values.

In a study done by Kim et al.[8] to assess usefulness of SOFA, APCHE II and SAPS II in patients of organophosphorus poisoning, the mean SOFA score was comparable to our study for both non-survivors and survivors 6.7±2.2 Vs 3.0±1.9 Respectively. In their study they found that the predictive power of SOFA was significantly higher as compared to APACHE II but was not significantly different from that of SAPS II score. The specificity of SOFA (82.4%) was much higher than that of APACHE II (68.6%) but almost similar to SAPS II (77.5%). In our study, the specificity of APACHE II (82.80%) was much higher than that of SOFA_Admission (76.7%) and SOFA_48 hrs (60.30%).

In a study conducted by Khan MS et al.[10] in south India they also found similar results in their cohort of 85 patients. They too found statistically significant difference in the mean SOFA score at 24 hrs between survivors and non-survivors (5.16 ± 3.05 vs 6.76 ± 2.60; $p < 0.001$ respectively). When SOFA score was compared to APACHE II and SAP II score, APACHE II scoring system was found to be best for predicting outcomes in ICU. SAP II score could not perform well compared to the other two scoring system. When the predictive ability of SOFA was studied in patients of meningitis, SOFA score performed poorly compared to APACHE II and SAP II score.[19]Although the results of SOFA scoring system are variable in different clinical settings, it is an easy score to compare at the bedside. The laboratory and clinical date required for computation of SOFA score is most of the times easily available in the emergency department. The added advantage of this scoring system is that it does not require a definitive final diagnosis of the acute process.

In our study, the association between Respiratory failure and APACHE II Score was found to be significant ($P < 0.05$). 71.4% Patients having Respiratory failure show 30-34 APACHE II Score. It implies that APACHE II Score of patients differ significantly with the Respiratory arrest they had. The association of SOFA_Admission Score with Respiratory Failure, Liver dysfunction, Shock, AKI and ARDS was found to be significant ($P < 0.05$). It implies that SOFA_Admission Score of patients differ significantly with these morbidity types they had.

Amongst the variables used to compute SOFA_admission and APACHE II score between survivors and non-survivors; Pulse, hematocrit and Total leukocyte count statistically significant associated with outcome. However, all other variables lacked significant association with mortality.

Limitations (i) patients lost to follow-up. (ii) scoring was done with the variables at the time of admission only, subsequent variables were not considered.

Conclusion:

Our study shows that both tested scoring models (APACHE II and SOFA) would be accurate enough for our ICU patients. The initial scores of both APACHE II and SOFA scoring systems had poor predictive value (AUROC 0.667 and 0.614 respectively). APACHE II has showed better calibration and discrimination power than SOFA.

Declarations

Ethics approval and consent to participate

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The study protocol was approved by Institute of ethical committee (IEC), vide letter no: LNMC&RC/Dean/2019/Ethics/018. Written informed consent was taken from the patients' legal representative before enrollment in the study.

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