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SOFA and APACHE 2 in Determining Early Mortality in Diabetes and Non-Diabetes: Retrospective Observational Analytical Study

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ABSTRACT

Background: To compare SOFA and APACHE scores in predicting early mortality in diabetic and non-diabetic patients admitted to a critical care unit.

Method: This is a time-bound retrospective observational analytical study conducted in the Department of Internal Medicine ICU, AIIMS, Rishikesh. All patients ≥18 years of age admitted to ICU from January 2021 to December 2021 were eligible for the study. APACHE II and SOFA scores were calculated and compared in diabetic and non-diabetic patients. The predictive accuracy of APACHE II and SOFA scores in predicting early mortality was measured using the Receiver operative curve.

Results: Of the 196 patients, 95 patients were Diabetic, 101 patients were non-Diabetic, and the mean APACHE II scores (23± 8 *vs* 20±7) were more than the mean SOFA scores (11 ±3 *vs* 10±3) in patients with early mortality was more than patient with more than late mortality in diabetic patients. A similar trend was seen in APACHE II (19±7 *vs* 16±7) and SOFA (10 ± 3 *vs* 8 ± 3) scores of non-diabetic patients with early and late mortality.

Conclusion: APACHE II or SOFA scores were not superior in predicting early mortality in diabetic and non-diabetic patients. However, we would like to use the SOFA score to predict the outcome of a patient admitted to a critical care unit, as it is easier than the APACHE II score.

Keywords: APACHE II; SOFA; Diabetes

INTRODUCTION

Diabetes Mellitus is one of the leading causes of mortality and morbidity in the current jargon of diseases facing globally. It is expected to increase globally by 200 million by 2040.[1] Diabetes mellitus is forecasted to increase significantly, especially in the middle- and lower-income countries, due to the ever-changing lifestyle and urbanization.[2] India's Disability-adjusted Life Year, DALY, and mortality are taking the forefront with 11.2 million

disability and millions of deaths till 2017 and is expected to increase manifold.[3] The persistent hyperglycemic state in diabetes leads to several chronic complications like retinopathy, nephropathy, neuropathy, diabetic foot, and increased risk of cardiovascular mortality and morbidity. Diabetic ketoacidosis, hyperglycemic hyperosmolar state, and diabetic coma are some of the acute complications of untreated diabetes.[4,5] Apart from the dreaded acute and chronic complications, it's fast becoming a fact that diabetes is also associated with an increased risk of infections and a cause of mortality among critically ill patients.[6,7] It has been found that critically ill diabetic patients with poorly controlled blood sugar levels tend to have a prolonged Intensive Care Unit, ICU requirements, and an increased mortality risk.[8] The poorly controlled hyperglycemic patient tends to have poor sepsis control due to increased production and activation of anti- and pro-inflammatory mediators.[9,10] Acute Physiology and Chronic Health Evaluation II (APACHE II) and Sequential Organ Failure Assessment (SOFA) are two most frequently used tools in ICU setting to predict mortality, with a sensitivity of 89.9% and 90.1%, and specificity of 97.6%, and 96.6% respectively.[11]

METHODOLOGY

This was a time-bound retrospective observational analytical study conducted in the Department of Internal Medicine ICU, AIIMS, Rishikesh. All patients ≥18 years of age admitted to ICU from January 2021 to December 2021 were enrolled for the study. Patients with missing baseline data, mortality within one day of ICU admission, and medico-legal cases were excluded from the study.

The data were extracted from the medical records department maintained for clinical research and administrative purposes. The following data were obtained: Diabetic or not; if diabetic- on medication (Oral Hypoglycemic Agents (OHA) or insulin), Duration of Diabetes, Fasting blood sugar, Random blood sugar, and HbA1c, other associated chronic disease, A-a gradient or PaO2 (depending on FiO2), PaO2/FiO2, Temperature (rectal), Mean Arterial Pressure (MAP), use of inotrope, pH (arterial), Heart Rate (HR), Respiratory Rate (RR), Sodium (serum), Potassium (serum), Chloride (Serum) Creatinine, Hematocrit, White blood cell count (WBCs), Glasgow Coma Scale (GCS) at the time of admission and APACHE-II and SOFA score were calculated at the time of admission.

Patients were classified into Diabetic and Non-diabetic based on ADA guidelines of Diabetes definition: Fasting Plasma Glucose (FPG) ≥126mg/dl (7.0mmol/L) or 2-hour Plasma Glucose (PG) ≥200mg/dl (11.1mmol/L) during Oral Glucose Tolerance Test (OGTT) or Hb1AC ≥6.5% or a Random Plasma Glucose level of ≥200mg/dl in a patient with classic symptoms of hyperglycemia or hyperglycemic crisis.[12] Our study defined early mortality as a patient with mortality in less than seven days of ICU admission.

Collected data were entered in Microsoft Excel, and IBM SPSS v23 software was used for statistical analysis. Statistical significance was set at a *P*-value <0.05. Descriptive statistics were elaborated in the form of means ± standard deviation for continuous variables and frequencies/percentages for categorical variables. Student t-test was

used to compare group differences for continuous data. Spearman's coefficient was used to analyze the correlation between variables. The Receiver operative curve was used to establish the accuracy of each score in predicting mortality.

RESULT

One hundred and Ninety-Six patients admitted to the Medicine ICU, Department of Internal medicine, were included in the study. The mean age of patients was 51.94 ± 16.74 years. Among 196 patients 76 (38.8 %) were females and 120 (61.2 %) were males (Table 1.). There were 101(51.5%) non-diabetic patients and 95 (48.5%) diabetic patients with a mean duration of diabetes of 36 ± 37.497 months. Mean HbA1C was 6.59 ± 1.738. Among diabetic patients, 12 (12.63%) were taking insulin, 80 (84.21%) patients were taking Oral Hypoglycemic Agents, and three patients were diagnosed to be diabetic in hospital according to HbA1c and were not on any medication as their in-hospital blood glucose were in the normal range. Mean APACHE - II score was 19.80 ± 7.715, and the mean SOFA was 9.95 ± 3.267 for 196 patients admitted to the Medicine ICU. Since admission to ICU, the mean mortality day was 8.32 ± 8.986 days (Table 2). There was a statistically significant correlation (*P*-value = 0.01) between them on bivariate analysis, with a Pearson correlation coefficient of 0.555 indicating moderate correlation (Table 3).

Table 1: Age distribution

Age	Sex		
	Female	**Male**	**Total**
<20	2	6	8
21 - 30	6	12	18
31 - 40	9	12	21
41 - 50	23	22	45
51 - 60	16	25	41
61 - 70	14	21	35
>70	6	22	28
Total	76 (38.8%)	120(61.2%)	196 (Mean= 51.94±16.74)

Demographic profile:

Table 2a:

		Diabetes	**Non-Diabetes**
Sex	Male	67 (34.18%)	53(27.04%)
	Female	28 (14.28%)	48 (24.48%)
Comorbidities	COPD	11	13
	Hypertension	31	22
	CKD	11	11
	CAD	6	5
Days to mortality		8.53 ±10.52	8.09 ± 7.04

Table 2b:

	OHA	Insulin
No. of patients	80(84.21%)	12(12.63%)
HbA1c (%)	7.78 ± 1.7065	8.78± 2.74
Duration of Diabetes (months)	48.77	55.75
Mean duration of diabetes (months)	36 ± 37.497	

Table 3: Correlation

		Apache II	Sofa
Apache II	Pearson Correlation	1	.555**
	Sig. (2-tailed)		0
Sofa	Pearson Correlation	.555**	1
	Sig. (2-tailed)	0	

The mean APACHE II score among patients with early mortality was higher (21±8) than patients with late mortality (18±7), with a statistically significant *P*-value (0.01). The mean SOFA score among patients with early mortality was higher (10 ± 3) than for patients with late mortality (9±3), with a statistically significant *P*-value (0.028). (Table 4)

Table 4:

		≥7 days	<7 days	p-value
Apache II	**Overall**	18 ± 7	21 ± 8	0.01
	Diabetic	20 ± 7	23 ± 8	0.01
	Non-diabetic	16 ± 7	19 ± 7	0.005
Sofa	**Overall**	9 ± 3	10 ± 3	0.028
	Diabetic	10 ± 3	11 ± 3	0.02
	Non-diabetic	8 ± 3	10 ± 3	0.001

Patients with early mortality had higher APACHE II scores (23±8 and 20±7, respectively) than patients with late mortality (19±7 and 16±7, respectively) in both diabetic and non-diabetic groups with a *P*-value of 0.01 and 0.005, respectively. A similar pattern was seen in the SOFA score, which was higher in patients with early mortality (11±3 and 10±3 respectively) than in late mortality (10±3 and 8±3 respectively in both diabetic and non-diabetics groups with a *P*-value of 0.02 and 0.001 respectively.

To check the accuracy of each score in predicting early mortality, a Receiver Operator Curve analysis was done, and it's given in Table 5. APACHE II score presented the largest area under the Receiver Operative Curve (ROC) in both

overall and diabetic patients (0.603 and 0.610) than the SOFA score (0.598 and 0.563) (Figure 1). In non-diabetic patients, the SOFA score had a larger area under ROC (0.643) than APACHE II (0.610) (Figure 2). However, either SOFA or APACHE II score is not superior in predicting early mortality as ROC curves cross at least one point.

Table 5: Area under ROC curves

	APACHE II	SOFA
Overall	0.603	0.598
Diabetic	0.61	0.563
Non-diabetic	0.61	0.643

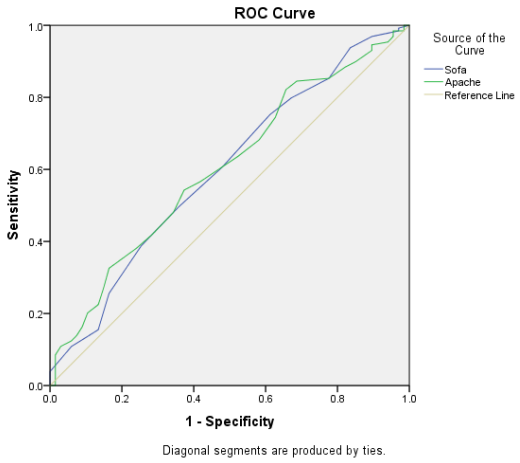

Figure 1: Overall

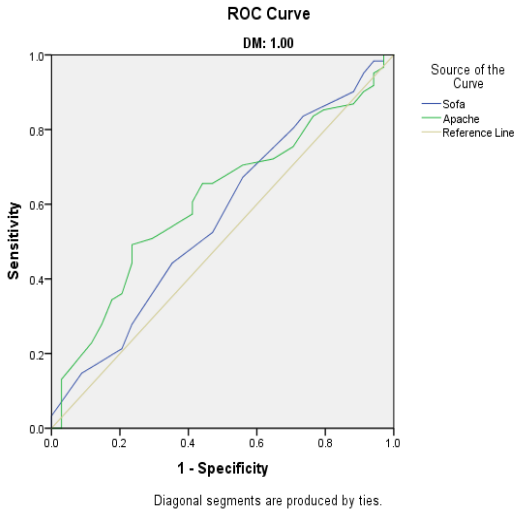

Figure 2a: Diabetic

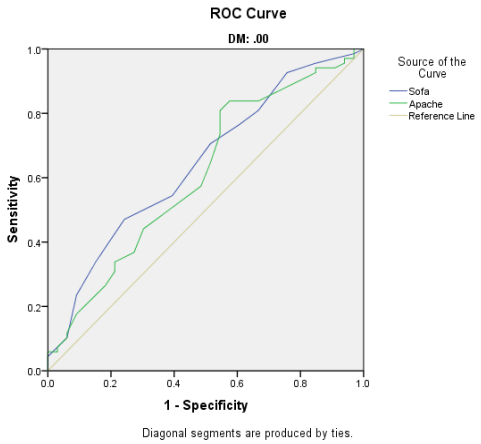

Figure 2b: Non diabetic

DISCUSSION

APACHE II score developed by Knaus et al. is a revised version of the prototype APACHE score, which uses 12 acute physiological parameters measured within 24 hours of ICU admission, patient's age, and Chronic health status to estimate the mortality.[13] Based on measurements, a score is calculated, which ranges from 0 to 71; the higher the score, the more severe the disease and the higher risk of mortality. The major drawback of the APACHE score is that physiological variables are all dynamic, and ongoing resuscitation and treatment changes influence these physiological variables, which can lead to overestimation of predicted mortality in ICU settings.[14]

The SOFA score was developed during a consensus conference organized by the European Society of Intensive Care and Emergency Medicine. The SOFA score calculates a summary value for the degree of dysfunction for six organs (respiratory, coagulation, liver, cardiovascular, central nervous system, and renal). Four levels of dysfunction are identified for each of the organ systems for the SOFA score. Organ dysfunction is associated with high rates of ICU morbidity and mortality, and as such, treatment of these disorders accounts for a high proportion of the ICU budget. The score was primarily developed to quantify the severity of illness, but few prospective studies have shown that it can be used to estimate mortality roughly.[14,15]

Previous studies have shown that the APACHE score is better than the SOFA score in predicting mortality in critically ill patients.[16,17] Ferreira et al. found that models based on the SOFA score at admission have only slightly worse performance than the APACHE II score in predicting mortality in medical and surgical ICU patients.[18] Another study by Ho KM et al. showed that the APACHE II score was better in discrimination and predicting mortality than either the SOFA or Royal Perth Hospital Intensive Care Unit (RPHICU) organ failure score in predicting hospital mortality of critically ill patients.[19] A study by Q Qiao et al. compared the APACHE II score and the SOFA score in predicting mortality outcomes in critically ill elderly patients. It was found that the mean APACHE II and SOFA scores in survivors were lower than in those of non-survivors.[20] But our study found that neither the SOFA nor the APACHE II was better in predicting mortality in critically ill patients.

The mean APACHE II and SOFA scores of patients with early mortality were more than the mean APACHE II and SOFA scores for late mortality, indicating that Both APACHE II and SOFA scores predicted early mortality in critically ill diabetic patients. However, our study has established that the SOFA score is as good as the APACHE II in predicting mortality in ICU both in diabetic and non-diabetic patients, hence SOFA score alone can be reliably used in place of the APACHE II score, which is time-consuming.

The limitation of our study is that it is a single-center study and there was no standardized case management of the admitted patients due to the wide variety of treated cases. The insulin and OHA dose and type were not considered.

CONCLUSION

The SOFA score is a simple yet effective prognosticator, comparable to APACHE II, to describe organ dysfunction/failure in critically ill patients. APACHE II score needs 12 acute physiological parameters and Chronic health status to calculate it, which is not possible in all critically ill patients admitted to ICU. The SOFA score is based on the dysfunction of 6 organ systems. Daily scoring of individual and composite scores is possible during ICU stay in SOFA scores, and it's comparatively easy to calculate in ICU settings. So, the current study concludes that SOFA can be predictably and reliably used in patients admitted to ICU.

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