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Correlation of SAPS II, SOFA score and APACHE II score as markers for predicting mortality in patients with Sepsis

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Abstract
Aim: To assess and compare the validity of 3 mortality prediction systems for the severe sepsis and septic shock patient population.
Materials and Methods: The present prospective observational study was conducted in Muzaffarnagar Medical College, Muzaffarnagar among 200 cases. Patients fulfilling all inclusion criteria and exclusion criteria were enlisted in the study after informed consent. Patients were evaluated with Clinical History taking and Physical Examination. Blood sampling for CBC, RFT, LFT and Arterial Blood Gas Analysis was done Patients were evaluated by SAPS II, SOFA and APACHE II at the time of admission. Also, the various scoring models were compared. Patients were given routine medical care and were studied upto discharge or death.
Results: The mean SAPS2, APACHE II and SOFA score was higher in the mortality group as compared to the discharge group. The predicted mortality of SAPS 2, APACHE II and SOFA was found to be 56%, 66% and 45% respectively. It was found that SAPS2 and SOFA predicted a slightly lower mortality rate than the actual mortality, whereas APACHE II predicted a higher mortality than the actual mortality.
Conclusion: We conclude that the SAPS II score was superior to the APACHE II and SOFA scores for predicting survival in patients with septic shock.

Keywords: SAPS 2, APACHE II, SOFA, mortality

Introduction

Sepsis is a life-threatening organ dysfunction caused by a dysregulated host response to infection. Spectrum of sepsis includes sepsis, severe sepsis and septic shock. Severe sepsis and septic shock are major reasons for intensive care unit (ICU) admission and leading causes of mortality in non-coronary ICUs [1, 3].

Data from western countries puts the overall incidence of sepsis ranging from 10% to 30% with mortality ranging from 10% to 56%. Data from India suggest that the overall mortality of all sepsis patients is approximately 14% and that of severe sepsis alone is higher than 50%. According to the 2018 World Health Organization Health Report [4], infectious and parasitic diseases caused 17 million out of 56.9 million deaths globally, including 3.0 million deaths from acute lower respiratory infections, 1.7 million from tuberculosis, 1.0 million from diarrhoeal diseases, 4 lakh from malaria and 1.0 million from HIV/AIDS. Infectious and parasitic diseases accounted for 43% of the 40 million deaths occurring in the developing countries in 2016. The health care system in India grew rapidly to state-of-the-art levels over the past two decades, and this development has brought with it the challenges that face modern medicine, including transplantation complications, cancer therapy and advanced surgery [5, 6, 7].

Scoring systems for use in intensive care unit (ICU) patients have been introduced and developed over the last 30 years. Several of these systems are known simply by their acronym (e.g. APACHE and MODS). Other scoring systems are repetitive and collect data sequentially throughout the duration of ICU stay or over the first few days. Examples of repetitive systems are the SOFA and Multiple Organ Dysfunction Score (MODS). Both first day and sequential scoring systems can be further divided into subjective and objective scores. Subjective scores are produced by taking variables that have been agreed by a panel of experts, and then applying a numerical weighting to each variable to produce a subjective score. The weighting is usually determined by consensus opinion [7]. Objective scores are developed from a large database of clinical data taken from many ICUs. A computer-based multipurpose probability model is then used to determine which variables to use and the weighting to be applied to each variable. The objective of the present study was to assess and compare the validity of 3 mortality prediction systems for the severe sepsis and septic shock patient population.

Materials and Methods

The present prospective observational study was conducted in Muzaffarnagar Medical College, Muzaffarnagar among 200 cases. Patients fulfilling all inclusion criteria and exclusion criteria were enlisted in the study after informed consent.

Inclusion Criteria

Patients diagnosed with Sepsis, temperature higher than 38°C (100.4°F) or lower than 36°C (96.8°F), heart rate (HR) higher than 90 beats/min, respiratory rate (RR) higher than 20 breaths/min or arterial carbon dioxide tension (PaCO2) lower than 32 mm Hg, white blood cell (WBC) count higher

than 12,000/µL or lower than 4000/µL or with 10% immature (band) forms, significant edema or positive fluid balance >20ml/Kg over 24 hours, oliguria (urine output < 30 mL or 0.5 mL/kg for at least 2 hours despite adequate fluid resuscitation, coagulation abnormality INR > 1.5 and hyperglycemia (Plasma Glucose > 140mg/dL in absence of Diabetes) were included in the study.

Exclusion Criteria

Patient with burns, coronary artery disease and stroke were excluded from the study.

Patients were evaluated with Clinical History taking and Physical Examination. Blood sampling for CBC, RFT, LFT and Arterial Blood Gas Analysis was done Patients were evaluated by SAPS II, SOFA and APACHE II at the time of admission. Also, the various scoring models were compared.

Methods

All patients were selected after applying the inclusion and exclusion criteria. Informed consent was taken from the patients or their relatives after explaining the nature of study and the risks involved in participation of the study. The clinical and demographic profile at the time of admission to emergency ward including the age, sex, associated chronic illnesses like hypertension and diabetes, and hyperlipidemia were recorded for all the study subjects. A careful and detailed history was recorded according to the Proforma to assess the onset and duration of clinical events and the probable risk factors for the same. A detailed general physical examination was performed including assessment of the Nervous System, Cardiovascular system, Abdomen and Respiratory system as per the Proforma. A detailed examination was done on day of admission.

SAPS 2, APACHE II and SOFA scores were calculated on the day of admission. The SAPS II, APACHE II and SOFA score were calculated using Medcal. Laboratory investigations were performed within 24 hours of admission.

Functional Outcome

Patients were given routine medical care and were studied upto discharge or death.

Statistical Analysis

All the data were analyzed using computer-based software (SPSS). Descriptive statistics were used to investigate the general characteristics of the patients. Measures of the central tendency including mean and standard deviation were used to ascertain the data regarding the different laboratory parameters. An independent t test was used to evaluate the differences between SAPS 2, APACHE II and SOFA scores between the survivors and non survivors. A P value of less than 0.05 was considered to be statistically significant throughout the study.

Results

The majority of the study population comprised of the age group 40-60 years accounting for 40.5% of the total study group. 38.5% of the study population was more than 60 years. It was found that 56.5% of the patients comprised of males and the remaining 43.5% comprised of females. The majority of patients had a diagnosis of Pneumonia (17.5%), followed by chronic obstructive pulmonary disease (10%), urinary tract infection (9%) and diabetic ketoacidosis (9%). Other aetiologies included Tuberculosis (7%), meningitis (6% each), complicated malaria (5%), AGE with sepsis (4.5%), chronic liver disease and chronic kidney disease (4% each), Enteric Fever (3.5%), Septic Shock with MODS (2%) and septic encephalopathy (1.5%). In this study 57 out of 200 patients required invasive ventilation. 143 patients did not require invasive or non-invasive ventilation. Out of 200 patients included in this study, 138 patients were successfully treated and discharged. 62 patients died in the hospital while receiving treatment.

Table 1 compares the physiological parameters and mortality. It was found that the age was higher in the mortality group as compared to the discharge group. The mean heart rate in the discharge group was104.39±17.61, whereas in the mortality group it was higher, 123.97±18.80.

The respiratory rate in the discharge group was lower as compared to the mortality group. The PaO2 and PaCO2 in the discharge group were 79.98±11.8 and 31.01±17.65, whereas the readings in the mortality groups were 83.15±57.6 and 28.8±14.6. The difference for both PaO2 and PaCO2 were statistically insignificant. The difference in the mean Glasgow Coma Scale between the discharge and mortality group was also found to be statistically significant. (p value <0.01).

The mean SAPS2, APACHE II and SOFA score was higher in the mortality group as compared to the discharge group (table 2). Table 3 show the comparison between the predicted mortality by SAPS 2, APACHE II and SOFA models versus the actual mortality. The predicted mortality of SAPS 2, APACHE II and SOFA was found to be 56, 66 and 45 respectively. It was found that SAPS2 and SOFA predicted a slightly lower mortality rate than the actual mortality, whereas APACHE II predicted a higher mortality than the actual mortality. It was also found that SAPS 2 and SOFA had 100% specificity whereas APACHE II had a specificity of 92.5%. However, it was observed that APACHE II had 100% sensitivity as a model for mortality prediction.

Table 1: Physiological Variables and Mortality

Variables	Discharged (138)		Mortality (62)		t test	p value
	Mean	SD	Mean	SD		
Age	54.47	16.13	57.08	14.57	0.69	0.49
HR	104.39	17.61	123.97	18.80	27.44	<0.01*
RR	23.53	6.01	30.24	9.42	18.39	<0.01*
Temperature	100.73	1.48	101.69	1.61	10.45	<0.01*
Systolic BP	117.10	22.64	90.61	24.39	28.16	<0.01*
DBP	75.08	11.45	55.94	16.68	44.51	<0.01*
MAP	88.96	14.29	67.49	18.86	39.48	<0.01*
PO2	79.98	11.82	83.15	57.64	0.19	0.82

PaCO2	31.01	17.65	28.81	14.68	0.49	0.61
TLC	$17.63*10^3$	$5.17*10^3$	$24.11*10^3$	$11.46*10^3$	15.30	<0.01*
Platelet count	$232.31*10^3$	$118.03*10^3$	$148.45*10^3$	$81.34*10^3$	13.54	<0.01*
Hct	29.59	6.46	32.06	7.01	2.97	0.05
Urea	60.76	56.22	117.26	60.94	20.61	<0.01*
BUN	28.07	26.10	54.80	28.47	21.30	<0.01*
S. Na	134.93	5.66	133.21	10.42	1.39	0.25
S. HCO3	22.75	7.31	17.31	9.25	10.01	<0.01*
GCS	13.65	2.58	5.77	3.73	49.24	<0.01*
T. Bil	1.64	3.09	1.79	1.93	2.61	0.08

*: statistically significant

Table 2: SAPS2, APACHE II and SOFA score and mortality

	Discharge		**Mortality**	
	Mean	**SD**	**Mean**	**SD**
Mean SAPS2 score	27.63	12.04	74.79	18.21
t test	67.07			
p value	<0.01*			
APACHE II	13.66	6.82	30.97	7.79
t test	57.18			
p value	<0.01*			
SOFA score	2.84	2.93	11.11	4.21
t test	39.01			
p value	<0.01*			

*: statistically significant

Table 3: Estimated Mortality by SAPS2, APACHE II and SOFA and Accuracy of the models

Scoring Model	**Estimated Mortality**		**Actual Mortality**
SAPS 2	56		62
APACHE II	66		
SOFA	45		
Parameters	SAPS 2	APACHE II	SOFA
Positive Predictive Value	100%	90.05%	100%
Negative Predictive Value	95%	100%	84%
Sensitivity	90.32%	100%	72.58%
Specificity	100%	92.53%	100%

Discussion

In this study it was found that the mean heart rate of patients who died was much higher than those who survived. with statistically significant difference. L. Leibovici *et al.* [8] also reported the presence of a relatively higher heart rate in the mortality cohort and concluded that tachycardia in patients of sepsis is an independent risk factor for mortality.

In our study, the Systolic Blood pressure, Diastolic blood pressure and Mean Arterial pressure was significantly lower in the mortality group. These findings were in agreement to previously conducted studies. Marjut Varpula *et al.* [9] also concluded that SBP, DBP and MAP were independently associated with mortality in patients of sepsis. In our study the mean platelet count in the mortality cohort was significantly less than the mean platelet counts in discharge cohort. We can conclude that a lower platelet count is associated with higher mortality rate probably because of DIC as well as abnormal platelet function in septicaemia. Previous studies support our finding. Shapiro NI *et al.* [10] concluded that a platelet count of less than 1,50,000 was an independent multivariate predictor of death.

In our study, the best discrimination was provided by SAPS 2 score (AUROC= 0.976), followed by APACHE II (AUROC=0.945) and SOFA (AUROC=0.940). Several studies have compared the different outcome prediction scoring systems. For example, in a study of 10,393 patients from Scottish ICUs, Livingston and colleagues [11] compared the APACHE II, an APACHE II using United Kingdom-derived coefficients (UK APACHE II), SAPS II, and MPM0 and MPM24. These authors reported that all models showed good discrimination, although observed mortality was significantly different from that predicted by all models. SAPS II had the best performance overall.

In the present study, we evaluated the ability and validity of APACHE II and SAPS II systems to accurately predict hospital mortality. Both models showed excellent discrimination, although we found that discrimination was better for SAPS2 than for APACHE. Good discrimination of both models has been reported in previous studies [12, 14].

In a study by Anca-Meda Georgescu *et al.* [15], the areas under ROC for the three scores in his study are 0.622 for APACHE II, 0.575 for SAPS II and 0.705 for SOFA. The study concluded that the SAPS II score was superior to the other scores for predicting survival in patients with septic shock.

The results of our study differ from those of Kim [16] who identified the SOFA score as being the most predictive in patients poisoned with organophosphates. An explanation for the observed difference may stem from the more complex nature of septic shock as compared with poisoning both in onset and evolution. Moreover, the simplicity of the SOFA score, in particular the absence of parameters related to associated diseases makes it more relevant to organ dysfunctions, unlike SAPS II and APACHE II that evaluate multiple organ dysfunction specific to the critically septic patient. While the APACHE II score is a predictor for morbidity, the SAPS score is a predictor of mortality.

The limitations of the study are the low number of studied cases that were concentrated within a single centre. Moreover, the study does not take into account deaths that could have occurred immediately after discharge. These scores are complementary and have certain limitations. They do not provide individual prediction but may assist therapeutic and managerial decisions. For a complex pathology such as sepsis, a more complex score could be more informative.

Conclusion

It can be concluded from the results of the present study that SAPS 2 and APACHE II both show excellent discrimination; however, in our study SAPS 2 was superior to APACHE II. However, a combination of factors must be taken in consideration to estimate the prognosis in the ICU.

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