Prognostic applicability of simplified acute physiology score (saps 3) in critically ill adult surgical patients in a tertiary Indian hospital: A preliminary study

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Abstract

Introduction and Aims: Prognostic indices are infrequently practiced in surgical intensive care units (SICU) of Indian tertiary care hospitals to assess the overall outcomes. Simplified Acute Physiology Score 3 (SAPS 3) prognostic system is now practiced globally and comprises easily measurable parameters on admission of patient in intensive care unit (ICU).The objective of the present study was to evaluate SAPS 3 index as a predictor of mortality in postoperative critically ill surgical patients admitted to ICU in a northern Indian setup.

Materials and Methods: This prospective observational study was performed in the ICU of a tertiary hospital in northern India. SAPS 3 global model was applied to measure the predicted ICU mortality. Standardized mortality ratio (SMR) was computed by comparing the observed and predicted mortality rates. To predict ICU mortality the discrimination and calibration properties of the SAPS 3 index were analysed. Data were prospectively collected at the time of admission of surgical patients in ICU. Estimated mortality rates were measured by SAPS 3 scores. Discrimination was estimated by area under receiver operating characteristic (AUROC) curves. Calibration was interpreted by Hosmer-Lemeshow goodness-of-fit C-statistic test to appraise the agreement between observed and expected number of survivors and non- survivors in alliance to the probability of death. In this analysis, $P > 0.05$ denotes good test adjustment.

Results: A total of 55 postoperative patients were included over 3 months period. The observed ICU mortality was 17.1%. Standardised mortality ratio (SMR) was 1.07. The SAPS 3 score of 42 showed sensitivity and specificity of 83.3% and 45.8% respectively. SAPS 3 global index had fair discrimination with an area under the receiver operating characteristic curve (AUROC) of 0.743 (CI 0.55-0.93). Patient calibration by Hosmer-Lemeshow test displayed good adjustment (P -0.388 and X^2 -6.32).

Conclusion: This group of postoperative SICU patients, the performance of SAPS3 prediction model showed reasonable discrimination and good calibration in predicting mortality risk in northern Indian tertiary hospital.

Keywords: Calibration, Discrimination, Intensive care unit, Mortality, Validation.

Introduction

In the modern era, the intensive care units (ICUs) constitute a prodigious segment of health care resources owing to the expansive technical framework and the health care professionals involved. Proficient management of these resources is the basis of providing quality of care to the admitted patients. In the critical care setups, the prognostic indices such as Simplified Acute Physiology Score (SAPS) and Acute Physiology and Chronic Health Evaluation (APACHE) are commonly endorsed to quantify the severity of the admitted patients.[1,2] These indices may indirectly ascertain the performance of the critical care providers, the cost-benefit ratio of the critical units and can provide the guide for further allotment of health care personnel and equipments.[3] In recent years, the number of surgical patients admitted to intensive care units (ICUs) has heightened dramatically.[4] The surgical outcome of these patients is immensely influenced by their preoperative physiologic status, the nature of surgical intervention and the postoperative care.[5] Hence the predictive data of risk for morbidity and mortality for this subset of patients is of utmost importance.[6] The subset of patients undergoing surgical interventions were initially evaluated and stratified by the grading proposed by the American Society of Anaesthesiologists (ASA), which provides the physical status of the patients prior to the surgery and hence have limited predictability of the clinical outcome. Therefore more established and validated prognostic indicators and predictability outcome measures are required.

The evolution of the SAPS 3 system comprises the evaluation of a colossal data from more than 300 critical care units.[7,8] It has been observed that SAPS3 has better discriminatory assessment when compared to SAPS II and APACHE II and hence the later systems being discouraged in clinical practice. SAPS 3 surpass other prognostic indices as this model evaluates the data entirely in the first hour after ICU admission and hence ideal for ICU screening and reflects the real clinical status of the patient.SAPS3 index is simple and easy to calculate and should be routinely used in surgical patients in ICUs for risk stratification and for predicting the clinical outcomes and hence may act as a functional stratagem for this subset of patient. Though various studies have validated SAPS 3 prognostic system and subsequently integrated in ICU protocols,[7-11] only few developed it in surgical patients in critical care settings.[4,10,12-14] SAPS 3 is extensively used both in Europe and America continent in the ICUs[10] while evidence is sporadic is India in clinical practice.[15,16] Therefore, the objective of the present study was to analyse SAPS 3 index as a predictor of mortality in postoperative critically ill patients admitted to ICU in an northern Indian setup.

Materials and Methods

The present prospective observational study was performed in a intensive care unit of tertiary hospital in northern India with a total of 10 beds, coordinated primarily by a qualified intensivists and critical care nursing staff under department of Anaesthesia and Intensive care.

After approval of the present study by the Institutional Ethics Committee (IEC) (No.GMCH-TA-1-2015/04983), a written informed consent was obtained from the legal representative of the patients. The present study did not involve any invasive procedures. Confidentiality of the patient was maintained and patient or his/ her relative were given right to opt out of study at any given point of time.

All consecutive adult surgical patients admitted to ICU in a 3 month period were included in the study. Patients younger than 18 years, stay in ICU less than 24 hours, readmissions and those admitted only for diagnostic interventions were excluded from the study. Patients follow up was done till discharge from the ICU/ hospital or had expired. Data were collected and recorded in the first hour post-admission in ICU by independent investigator. All patients were managed as per ICU protocol of the hospital and no intervention in the therapeutic regimen were made.

The SAPS 3 prognostic index comprises 20 variables, measured on admission in ICU. The parameters are grossly divided into three parts, demographic variables, cause for admission in the ICU, and physiologic parameters. (Appendix 1) A score was assigned to each parameter, and after taking the airthmetic summation of all subscores, the SAPS 3 score is calculated. A total SAPS 3 score of 16 and 217 as the lowest and highest score respectively. Physiologic parameters included were systolic blood pressure, heart rate, temperature, oxygenation, arterial pH, haematocrit, leukocytes, platelets, creatinine, bilirubin, and Glasgow coma scale (GCS).

Demographic variables were showed as mean ± standard deviation, median (25-75percentile), or percentage and frequency. To analyse the discrimination, defined as ability to classify non-survivors and survivors, sensitive and specific tests were applied for different SAPS 3 scores. ROC (Receiver Operating Characteristics) curve was plotted and the area under the curve was calculated. The optimum discriminating value was chosen by the calculated maximum specificity and sensitivity. Cut-off point was taken as the higher value derived from this result. Confidence intervals (CI) of 95%were calculated for true and false positive rates and for the correct stratification of the outcome. The Hosmer-Leme show goodness-of-fit C-statistic test was applied to appraise the concordence between the observed and expected number of survivors and non-survivors respectively, in association to the likelihood of death. In this analysis, $P > 0.05$ denotes good test adjustment. The standardized mortality ratio (SMR) was studied by ratio of the observed and predicted mortality rate.

Results

Total of 55 patients were admitted in the ICU in the study time period. Twenty patients were excluded as they were admitted exclusively with medical problems. Rest of the 35 patients admitted have undergone surgical intervention and were included in the study. Out of these 35 patients, 5 patients were excluded as they were not fulfilling the inclusion criteria [readmission (n=1), <24 hour ICU stay (n=2), admitted exclusive for diagnostic intervention (n=2)]. Mean patient age was 44.30 ± 17.48 years, out of which 20% were females **(Table 1)**. Patient who underwent gastrointestinal surgeries predominated (76.6%), followed by orthopaedic surgeries (10%) **(Table 1)**. In the present study, the lowest and highest SAPS 3 score was 22 and 70 respectively, with a mean of 45.36 ± 11.97 **(Table 1)**. The observed and predicted mortality was 17.1% and 15.84% respectively. Standardised mortality ratio (SMR) was 1.07. The SAPS 3 score of 42 showed specificity and sensitivity of 45.8% and 83.3% respectively, for ICU mortality with an area under the receiver operating characteristic curve (AUROC) of 0.743, 95% CI (0.55-0.93), thus reasonably discriminating the mortality in the study population **(Fig. 1)**. Higher rate of survival was observed in patients whose SAPS 3 score was ≤ 42. Among patients with SAPS 3 scores > 42, 83.3% were non-survivors versus 54.2% of survivors **(Fig. 2).** Patient calibration in accordance with the Hosmer-Lemeshow test revealed good adjustment (P -0.388 and X^2 -6.32) **(Fig. 3)**.

Table 1: Patient distribution characteristics, SAPS 3 score, type of surgery and ICU mortality

Characteristics	Parameter
Patient numbers	30
Elective surgery	56.7%
Age (years)	44.3 ± 17.47
SAPS 3 score	45.36 ± 11.97
Before surgery in hospital days	3.57 (1-5)
Type of surgery	
Gastrointestinal	76.6%
Orthopaedic	10%
Others	13.4%
ICU Mortality	17.1%

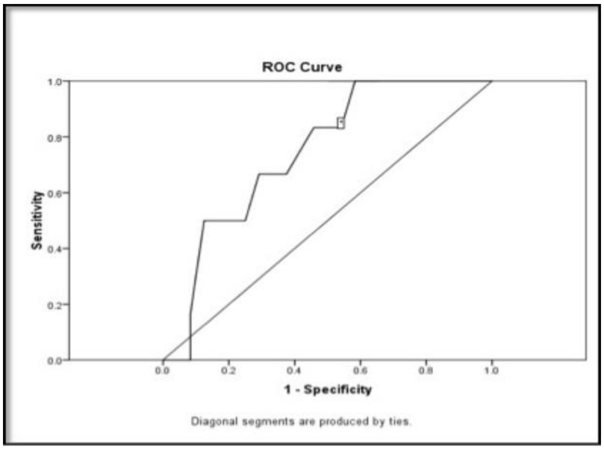

Fig. 1: AUROC Curve for prediction of hospital mortality

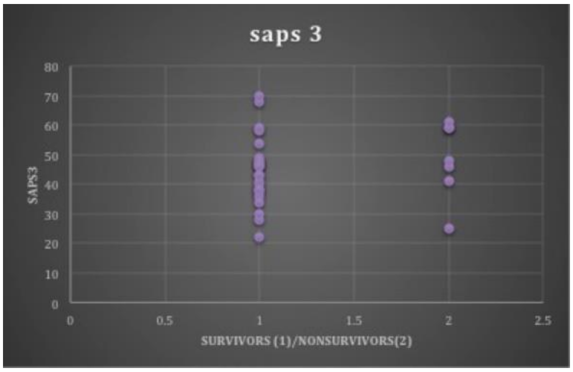

Fig. 2: Patient distribution according to SAPS 3 score (survivors 1 and non-survivors 2)

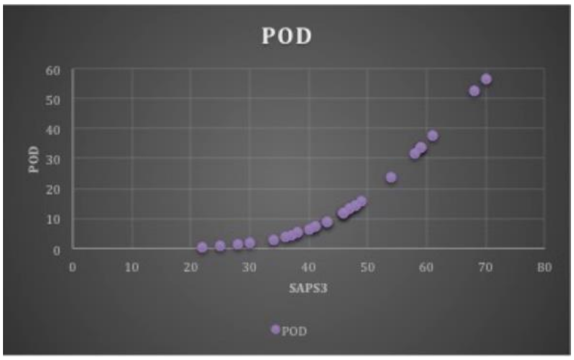

Fig. 3: Relationship between the SAPS 3 score and the probability of death (POD)

Appendix 1: SAPS 3 prognostic index variables

Demographics/previous health status		Diagnostic category		Physiologic parameters on admission	
Parameters	**Score**	**Parameters**	**Score**	**Parameters**	**Score**
Age		**Urgency**		**Heart rate**	
< 40	0	Non-surgical	5	<120	0
≥ 40<60	5	Elective	0	≥ 120< 160	5
≥ 60< 70	9	Emergency	6	≥ 160	7
≥ 70< 75	13	Scheduled admission	0	**Systolic blood pressure**	
≥ 75<80	15	Non-scheduled admission	3	< 40	11
≥ 80	18	**Reason for admission**		≥ 40< 70	8
In-hospital days before ICU		Neurologic		≥ 70< 120	3
< 14	0	Seizures	4	≥120	0
≥ 14-28	6	Coma, confusion, agitation	4	**Glasgow Coma Scale (GCS)**	
≥ 28	7	Focal deficit	7	3-4	15
Comorbidities		Intracranial mass effect	11	5	10
Others	0	**Infection**		6	7
Chemotherapy	3	Nosocomial	4	7-12	2
ICC NYHA IV	6	Respiratory	5	≥ 13	0
Hematologic neoplasia	6	Others	0	**Temperature**	
Cirrhosis	8	**Abdomen**		< 34.5	7
AIDS	8	Acute abdomen	3	≥ 34.5	0
Metastasis	11	Severe pancreatitis	9	**Oxygenation**	
Vasoactive drugs		Liver failure	6	Mechanical ventilation PaO2/FiO2 < 100	11
Yes	0	Others	0	Mechanical ventilation PaO2/FiO2 ≥ 100	7
No	3	**Cardiac cause**		Without mechanical ventilation PaO2 < 60	5
Origin		Arrhythmia	5	Without mechanical ventilation PaO2 ≥ 60	0
Operating room	0	Hemorrhagic shock	3	**pH**	
Emergency Room (ER)	5	Non-hemorrhagic hypovolemic shock	3	≤ 7.25	3
Other ICU	7	Distributive shock	5	> 7.25	0
Others	8	**Type of surgery**		**Bilirubin**	
		Transplantation	11	< 2	0
		Trauma	8	≥ 2< 6	4
		MR without valve	6	≥ 6	5
		Stroke surgery	5	**Creatinine**	
		Other	0	< 1.2	0
		ICU admission	16	≥ 1.2-< 2.0	2
				≥ 2.0< 3.5	7
				≥ 3.5	8
				Leukocytes	
				< 15,000	0

		≥ 15,000	2
		Platelets	
		< 20,000	13
		≥ 20,000< 50,000	8
		≥ 50,000< 100,000	5
		≥ 100,000	0

Discussion

Contemporary intensive care unit (ICU) utilizes a sizeable proportion of health resources owing to the advancement in the technology for diagnostic and therapeutic interventions, required for the critically ill patients. Prognostic indices to determine the severity of the illness are adjudged as a major factor to determine the cost-benefit ratio of these units. These indices may guide for appropriate allocation of specialized equipments and health care personal required in critical care units. American Society of Anaesthesiologists (ASA) physical status has been extensively used till now to evaluate the health status of surgical patients. However, ASA physical status dispense information of only patient health status prior to the surgical intervention, hence poorly correlates with the severity risk of surgical patients admitted in ICU.

For many years, SAPS II and APACHE II prognostic models are frequently used scoring system in ICU.[13] SAPS 3 is currently the most widely practiced prognostic severity index in ICU setups.[10] In the SAPS 3 model the whole data is recorded within the first hour of the ICU admission in contrast to the previous versions, where data collection is done within first 24 hour of the admission.[7,8] In addition, unlike previous versions, in the SAPS 3 model, most of the data of the patient admitted in ICU is recorded from the information provided prior to ICU admission, hence making this model a potential tool for triage of ICU patients.[13] Moreover, data obtained after first hour of ICU admission of patient may not be labled precisely for screening, as it largely reflects the ongoing ICU care administered to the admitted patients.[13] Previous severity scores are largely computed on data observed after 24 hours of ICU admission and may be affected by so called “Boyd and Grounds effect”.[8] This effect explains that the predicted mortality of patient admitted in ICU is directly linked to the abnormal physiological values and subsequent severity scores, in the first 24 hours post ICU admission.[17] The administration of sub-optimal care in ICU, may be one of the factor affecting the severity scores and successive predicted mortality of admitted patients.[8]

Previously, a multi centric and multinational cohort study was conducted across 35 countries in more than 300 ICUs, to evaluate the SAPS 3 index in general ICU patients.[7,8] They concluded that SAPS 3 database efficiently quantify the severity of the critical patients admitted in ICU, and its admission score in ICU was able to predict the clinical status at hospital discharge.[8] However, the authors mentioned that external validation of this index is required in surgical patients.[8] Discrimination indicates the extent to which the severity score model distinguishes between the survivors and non-survivors. Calibration of a severity score model describes the extent to which the predicted mortality mirrors the observed mortality. The discrimination and calibration is required to analyse SAPS 3 index. In the present study, the SAPS 3 score (cut-off of 42 score) demonstrated 83.3% of non- survivors versus 54.2% of survivors, hence demonstrating a fair discriminatory power. The observed mortality (17.1%) and predicted mortality (15.84%) was 17.1% and 15.2% respectively and was in proximity with standardized mortality ratio (SMR) of 1.07. These values demonstrates a good calibration in the study population. We infer that the probability of death increases noticeably with higher SAPS 3 scores. Our results are in agreement with Silva et al,[4] who evaluated the applicability of SAPS 3 in Brazilian hospital.

The present study has certain limitations. The sample size was small since it was a preliminary study done in limited time frame in a single (10 bedded) ICU. The study population was further reduced owing to the exclusion of non-surgical patients. In the present study the higher SAPS 3 score was mainly because of patients admitted after gastrointestinal surgery. These patients are mainly operated for perforation peritonitis and are hypovolemic, have severe bacterial infection and frequently have co-morbid associations, particularly involving the respiratory system. In addition, hypovolemia diminish the perfusion of end organs, particularly kidney leading to deranged renal functions. In the present study, the reason of admission in ICU (acute abdomen: gastrointestinal surgeries) and serum creatinine score were particularly high in northern Indian population and was similar to the Brazilian population conducted by Silva et al.[4] This in turn has resulted in higher values of SAPS 3 score.

SAPS 3 prognostic model was initially developed from data of general ICU population pool and it may not be the precise representative of specific population.[7,8,11] In the present study, we have not customized the equation of SAPS 3 prognostic model but follow the standard global equation for post-surgical patients admitted in ICU. Investigators in the past, conducted studies to externally validate the customized equation of SAPS 3 prognostic admission model in patients admitted in critical care.[9-11] They observed that customized SAPS 3 equation was though comparable in terms of discrimination with standard equation but certainly has improved calibration and may provide more precise estimation of SMR closer to unity.[9-12] Further studies with larger sample size are certainly required for external validation of customised SAPS 3 index in post-surgical Indian patients admitted in ICU, to obtain more beneficial results in particular local settings.

SAPS 3 prediction index is exclusively based on data collected in first hour of ICU admission therefore applicable for ICU triage in postoperative patients, as it displays the clinical status of patient and not the standard of care as seen with other prediction models.[12,13] In addition, it may also be applied in preoperative period in high risk surgical patients to predict severity of illness and risk of postoperative complications requiring ICU admission.[14]

Conclusion

In the present study it was observed that SAPS3 prognostic index demonstrated reasonable discriminatory power with ability to distinguish survivors and non survivors. SAPS 3 scoring system seems to be a useful prognostic tool for acute surgical patients admitted in ICU. However, a larger subset of surgical patients with inclusion of multicentric ICUs is certainly required to establish its prognostic applicability in Indian population. The scoring system is easy to calculate, having readily available electronic applications, without need of complex analysis and may be routinely applied in critical care settings, to stratify the risk associated in surgical patients.

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