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Research Article

Performance of simplified acute physiology score 3 admission score as a predictor of ICU mortality in a tertiary care hospital of rural Telangana, India

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ABSTRACT

Background: This study was aimed to assess the performance of Simplified Acute Physiology Score 3 (SAPS3) as a predictor of Intensive Care Unit (ICU) mortality in critically ill patients of different case mixes admitted to an intensive care unit.
Methods: This study was performed from 1st August 2014 to 31st July 2015, in ICU of Govt. tertiary hospital in Rural Telangana. Predicted ICU mortality was calculated using SAPS3 global model. Observed versus predicted mortality rates were compared. The discrimination and calibration characteristics of the SAPS3 system to predict ICU mortality were assessed.
Results: A total of 491 patients were included. The majority (370, 75.3%) of the cases included in study were medical cases, with Cerebro-vascular accidents (150, 33.4%) and Shock, all types (96, 19.5%) as the most frequent primary diagnoses. Mean age of patients was 57.2 years with Males (296, 60.3%) predominance. Observed ICU mortality is 140 (28.5%) and SAPS 3 predicted mortality [(%), mean±SD - 41.4±14.80]. The discriminative power of the SAPS 3 model was good for the whole population (AUROC = 0.81, 0.77-0.83. Calibration was seen with Hosmer-Lemeshow goodness of fit.
Conclusions: The global SAPS 3 prediction model showed Good discrimination and Fair or satisfactory calibration in predicting mortality in our intensive care unit. Different levels of discrimination and calibration across the different subgroups analyzed suggest that overall ICU performance is affected by case mix variations. It is recommended that this model be tested in other centers and that a consolidated database be formed.

Keywords: SAPS3, Intensive care unit, Mortality, Predicted mortality, Discrimination, Calibration

INTRODUCTION

A critical care program or unit can be assessed using a variety of severity scoring systems or models that allow us to predict outcome and prognosis, guide the clinical decision making process, monitor and assess new therapies, compare care between different centers, standardize medical research and perform cost-benefit analysis with regard to resource utilization. While not specifically designed for individual patient care, scoring systems may guide (but will not replace) clinical decision making regarding withdrawal of treatment and/or futility of continued aggressive care.[1,2]

However, reliability of a severity score reportedly deteriorates when applied to different populations, probably due to case mix, the level and quality of care, and the development of new treatment options changing overall patient outcomes.[2] Application of a severity scoring system in the intensive care unit with different case mixes raises issues of the system's reliability and validity.[1] ICU scores divided into outcome prediction

scores - based on disease severity on admission (e.g. acute physiology and chronic health evaluation (APACHE), simplified acute physiology score (SAPS), mortality probability model (MPM)), organ dysfunction scores – assess the presence and severity of organ dysfunction (e.g. multiple organ dysfunction score (MODS), sequential organ failure assessment (SOFA)), Scores that assess nursing workload use (e.g. therapeutic intervention scoring system (TISS), nine equivalents of nursing manpower use score (NEMS)).

The simplified acute physiology (SAPS) 3 admission score is one of these models used to predict hospital mortality from admission data taken within the first hour of the patients' admissions (It includes 20 variables divided into 3 sub-scores related to patient characteristics prior to ICU admission, circumstances related to ICU admission and the degree of physiologic derangement within 1 hour before or after of ICU Admission.[2] This is in contrast to all prior models that utilized a 24-hour time window.[12]

The total score can range from 0 to 217) from this score, global and region-specific equations for hospital mortality have been derived.[3] The performance of this model has shown mixed results among different case mixes in different studies.[3] Discrimination and calibration are two characteristics used to judge a scoring system. Severity scoring system reliability can be quantified in terms of calibration, which represents the level of accordance between observed and predicted probabilities of the outcome (describes how an instrument performs over a wide range of predicted mortalities.

An instrument would be highly calibrated if it were accurate at mortalities of 90%, 50% and 20%).[4] This is derived from tests such as the Hosmer-Lemeshow goodness- of- fit test or the calibration belt.[4,5,9] Discrimination, another essential quality, is quantified with measures such as sensitivity, Specificity, and more completely, the area under the receiver operating characteristic curve (AUROC) (refers to the accuracy of a given prediction e.g. if a scoring system predicts mortality of 90%, discrimination is perfect if the observed mortality is 90%).[5,8]

An AUROC of 0.5 indicates that the model does not predict better than chance. The discrimination of a prognostic model is considered perfect if AUROC= 1, good if AUROC >0.8, moderate if AUROC is between 0.6 and 0.8, and poor if AUROC <0.6.[6] This study aims to assess the performance of the SAPS 3 in its ability to predict ICU mortality among critically ill patients of different case mixes admitted to our hospital.

METHODS

After ethical committee approval, This retrospective study was conducted in intensive care unit of Mahatma Gandhi Memorial hospital, an 20-beded medical and surgical units serving adults (>14years) critically ill patients from all departments of the Institution. Data was collected from all ICU admissions from 1st August 2014 to 31st July 2015.

Inclusion criteria

- Age >14years,
- Both medical and surgical patients ,
- At admission data available,
- Only the 1st ICU admission of patients with multiple ICU admissions during single hospital stay

Exclusion criteria

- Incomplete data availability,
- patients expired with in 1st hour of admission,
- Post resuscitation patients.

Data is collected which included all components of the SAPS 3 score described by the original SAPS 3.[7] All data was collected by medical residents to formulate the predicted mortality rates based on the SAPS 3 severity score, using SAPS3 Integrated score database tool (Microsoft office Access database, MBD)

Statistical analysis was done MedCalc Software 12.3.0 (MedCalc Software, Belgium) was used to perform the statistical analysis. A p value of less than 0.05 was set as statistically significant.

Discrimination was determined by analysis of the area under a receiver operating characteristic curve (AUROC) using the method described by Hanley and associates.[8]

Calibration was assessed using the Hosmer- Lemeshow goodness-of-fit statistics in the analysis, lower Hosmer-Lemeshow $\hat{C}$ values and a p value of more than 0.05 would indicate a good fit of the model.

RESULTS

Baseline characteristics of patients

There were 577 distinct admissions during the study period. A total 491 (85.09%) of patients were included in this study. 86 patients were excluded, 2 (0.02%) for age <14 years, 39 (45.3%) for readmission to the ICU during the same hospital admission, and 45 (52.3) for incomplete SAPS 3 data.

The majority (370, 75.3%) of the cases included in study were medical cases, with Cerebro-vascular accidents (150, 33.4%) and Shock, all types (96, 19.5%)as the most frequent primary diagnoses. Mean age of patients was 57.2 years (SD-12.6) with Males (296, 60.3%) predominance and females 195(39.7%) Observed ICU mortality is 140 (28.5%) and SAPS 3 predicted mortality [(%), mean ± SD - 41.4±14.80].

Calibration of SAPS 3 scores

The SAPS 3 model exhibited satisfactory calibration for the entire population (Ĉ=12.2, p=0.24, Figure 1). Subgroup analysis showed that the SAPS 3 model showed good calibration for age >50 years (Ĉ=5.7, p=0.68), all medical conditions treated as a group (Ĉ= 8.4, p=0.31), and all surgical conditions treated as a whole (Ĉ=4.8, p=0.48), as shown in Table 1.

Poor calibration was noted with patients aged" 50 years (Ĉ= 17.1, p = 0.04) and patients admitted with Pneumonia, of all types (Ĉ= 19.1, p = 0.01).

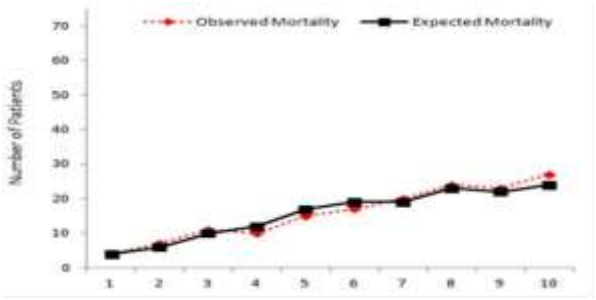

Figure 1: Calibration curve for SAPS 3 model comparing actual and predicted ICU mortality. Hosmer and Lemeshow "Goodness of fit" test Showed satisfactory calibration (Ĉ=12.2, p=0.24).

Table 1: Calibration of SAPS 3 for all patients and various sub-groups.

Group	Number	Actual mortality number and %	Predicted mortality %	Goodness of fit
All	491	140 (28.5%)	41.4±10.8	Ĉ=12.2, p=0.24
Medical	370	111 (30%)	42.2±19.1	Ĉ=8.4, p=0.31
Cerebrovascular accidents	150	40 (26.6%)	53.6±20.4	Ĉ=8.4, p=0.31
Shock, all types	96	28 (29.1%)	60.1±17.1	Ĉ=9.3, p=0.52
Acute respiratory failure	36	11 (30.5%)	58.8±21.8	Ĉ=13.8, p=0.09
Septic shock	58	14 (24.1%)	41.6±14.1	Ĉ=6.4, p=0.61
Pneumonia. All types	57	11 (19.3%)	31.1±11.1	Ĉ=19.1, p=0.01
Encephalopathy, all types	82	14 (17.07%)	56.1±25.1	Ĉ=17.2, p=0.04
Heart failure	43	6 (13.9%)		
Surgical	121	29 (23.9%)	33.7±12.6	Ĉ=4.8, p=0.48
Intestinal obstruction	41	9 (21.9%)		
Peritonitis, all types	50	20 (40%)	22±14.8	Ĉ=4.8, p=0.48

Comparison of discrimination

The discriminative power of the SAPS 3 model was good for the whole population (AUROC=0.81, 0.77-0.83, Figure 2) and exhibited moderate discrimination for medical cases (AUROC = 0.79, 0.77-0.80) with different discriminatory patterns noted, from poor for Pneumonia, of all causes (AUROC = 0.58, 0.39-M.74) to good for groups like Septic Shock (AUROC = 0.93, 0.74-1.0) and patients with Acute respiratory failure (AUROC=0.88, 0.74-0.91).

Table 2: Discrimination of SAPS3 for all patients and various sub-groups.

GROUP	AUROC (95% C.I.)
All	0.81 (0.77-0.83)
Age<50Y	0.77 (0.74-0.79)
Age>50Y	0.82 (0.80-0.84)
Medical	0.79 (0.77-0.80)
Cerobrovascular accidents	0.72 (0.69-0.76)
Shock, all types	0.79 (0.77-0.80)
Septic shock	0.93 (0.74-1.0)
Acute respiratory failure	0.88 (0.74-0.91)
Pneumonia, all types	0.58 (0.39-0.74)
Encephalopathy, all types	0.61 (0.33-0.84)
Surgical	0.84 (0.81-0.88)

The model showed better discrimination for surgical cases, with good discriminatory power (AUROC=0.84, 0.81-0.88). Table 2 shows discrimination power of SAPS3 in different sub-groups.

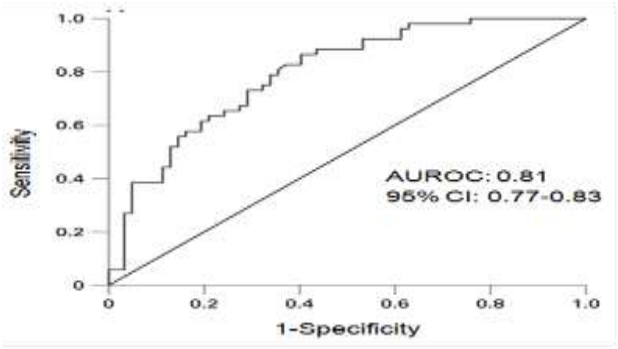

Figure 2: Receiver operating curve for population as defined by SAPS 3.

DISCUSSION

The study evaluated the Validity of the SAPS 3 mortality prediction model when used in a local Government tertiary centre's intensive care unit. Itis important to validate the performance of SAPS3, prior to application to other Similar centres, for its use to make quality of care assessments.[2,12]

The model showed Satisfactory calibration in our study population, true for both medical and Surgical patients, this was Particularly true inpatients >50 years, Shock in particular for Septic shock, But model's calibration suffered heterogenisity in different subgroups, Particularly in patients with Pneumonia and Encephalopathy where it showed Poor Calibration.

The study showed that the SAPS 3 global model had good discriminative power, which was comparable with other studies for whole population and also hold the same for both medical and surgical patient groups, model's discrimination remained relatively homogenous in different subgroups except in pneumonias and encephalopathy, where model's discrimination performance is poor.[2,3,13,14]

Evidence of different levels of calibration and discrimination on subgroup analysis supports that the global SAPS 3 model was indeed affected by differences in case mix.

There are several limitations to our study. First, ,this is a retrospective study; another issue is that the study derived its data from a single centre ICU, limiting the sample size as well as the case mix included in the study compared to the original SAPS 3 cohort and affecting generalizability. Our subgroup analyses had smaller samples that make the statistical analysis less robust. The last limitation is one inherent to the Hosmer-Lemeshow goodness-of-fit test, which depends on the sample size.

CONCLUSION

The global SAPS 3 prediction model showed Good discrimination and Fair or satisfactory calibration in predicting mortality in our intensive care unit. Different levels of discrimination and calibration across the different subgroups analyzed suggest that overall ICU performance is affected by case mix variations.

It is recommended that this model be tested in other centres and that a consolidated database be formed.

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Ethical approval: The study was approved by the institutional ethics committee

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