ORIGINAL ARTICLE

Mortality assessment of a Sergipe ICU according to the Simplified Acute Physiological Score 3 (SAPS 3)

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ABSTRACT

Justification and Objectives: severity assessment and prognosis assumption of admitted patients are essential characteristics in intensive care medicine. This article aims to describe the epidemiological profile and assess the mortality of patients in an intensive care unit (ICU) according to the calculation of the Simplified Acute Physiology Score (SAPS) 3 through its global and customized (for Latin America) equations. **Methods**: this is a prospective cohort conducted in an ICU in Sergipe, with cases between September 2018 and March 2019. Clinical, demographic, and standard data to calculate the score were collected from medical records. The Standardized Mortality Ratio (SMR), discrimination, and calibration were calculated for both equations. **Results:** seventy-eight patients were included; 60% of them were male. The mean age was 61.7 ± 17.2 years. Respiratory infections were the main causes of hospitalization (32.1%). The lowest value of SAPS 3 was 13, and the highest was 90, mean of 65.9 ± 25.5. The mortality observed was 61.5%, and the presumed mean was 47.4% through the global equation (SMR= 1.3) and 57.8% through the customized equation (SMR= 1.04). SAPS 3 showed adequate discrimination and calibration. **Conclusion:** the study identified a high mortality rate, however, the mean SAPS 3 score also found was higher than most publications. The epidemiological profile found was close to those of other similar units. The equations presented adequate calibration and discrimination, with superior performance of the customized equation.

Descriptors: Intensive Care Unit; Hospital Mortality; Epidemiology; Disease Severity Index; SAPS 3.

INTRODUCTION

Intensive Care Units (ICUs) are dedicated to promoting recovery of at-risk or severe patients through resources such as ventilatory support, hemodynamic monitoring, and control of the various organic systems. More than in other sectors within a hospital service, ICUs

should have the presence of a full-time nursing and medical team, in addition to multidisciplinary support from various specialties such as nutritionists, psychologists, and physiotherapists.[1]

Disease severity assessment and prognosis assumption are essential characteristics in intensive care medicine. The first initiatives to create objective criteria to try to numerically translate estimates of the prognosis of patients began in the 1980s. Since then, the adoption of such foundations has become an important aspect of clinical assessment, in addition to analyses about costs/benefits and performance of ICUs.[2–4]

To assess ICU patients, different prognostic indexes were described such as the Acute Physiology and Chronic Health Assessment (APACHE), the Mortality Probability Model (MPM), the Sequential Organ Failure Assessment (SOFA), and the Simplified Acute Physiological Score (SAPS). SAPS had its first version published in 1984, and it was reviewed 10 years later, thus emerging SAPS 2, validated using data from clinical and surgical ICUs, in 12 countries. A new version of this index, SAPS 3, was published in 2005, based on a prospective cohort of 16,784 patients from all continents.[5-9]

In recent years, many studies have been developed validating and applying SAPS 3 as a reference for prognostic assessment in several ICUs from different continents. In Brazil, the data needed to calculate index are mandatorily collected to compose a database of clinical and epidemiological databases as recommended by the Brazilian National Health Surveillance Agency (*Agência Nacional de Vigilância Sanitária*, abbreviated ANVISA) and the Brazilian Association of Intensive Care Medicine (*Associação de Medicina Intensiva Brasileira*, abbreviated AMIB).[3,5,6,10-19]

Adjusted mortality rates based on mortality predictions provided by prognostic scores have been increasingly used to assess the quality of care provided by different services. In countries such as the UK, Australia and New Zealand, successful database projects have contributed to improving the quality of care.[6]

This study aims to describe the epidemiological profile and assess mortality of patients in ICUs, according to calculation of SAPS 3 through its global and customized (for Latin America) equations.

METHODS

This is an observational, prospective cohort study conducted in an Adult Intensive Care Unit (A-ICU) of a university hospital, managed by the Brazilian Hospital Services Company (*Empresa Brasileira de Serviços Hospitalar*, abbreviated Ebserh), in the city of

Lagarto in the center-western Sergipe. The hospital has 130 beds, 12 of which are A-ICU, of which two are of isolation. The unit is intended to care for clinical and surgical patients over 14 years old.

All patients admitted to A-ICU from September 4, 2018 to March 4, 2019 were included in the study. Patients under 18 years old, who stayed at A-ICU for less than 24 hours, who had readmissions and also those without hospital outcome (discharge or death) up to 30 days after the study period were excluded.

Data were collected at admission to the unit with standards necessary to calculate SAPS 3 composed of 20 variables. For each variable analyzed, a weight is conferred. The score takes into account arithmetic mean of the variables distributed in three categories. In the first, the preconditions for patients' admission at A-ICU are contemplated, as well as the characteristics of this admission (age, comorbidities, previous length of hospital stay, patient's hospital origin sector and previous use of vasoactive drugs). In the second, cause and electivity or not for hospitalization, presence and type of infection, in addition to anatomical location of the surgical procedure are analyzed. Finally, the following are the physiological variables: Glasgow coma scale, serum bilirubin, platelets, creatinine, pH leukocytes, oxygenation, heart rate, temperature, and systolic blood pressure. For all hospitalizations included, the score was calculated, correlating this value with the observed and expected death rate, according to the equations of this index.[9]

The database was organized with Excel 2007 Microsoft Corporation, where calculations of indicators and preparation of charts and tables were performed. For analysis of the variables, mean and standard deviation, percentages and frequencies were used, comparing survivors and those who evolved to death, with a 95% confidence interval (95% CI). Statistical analysis was performed using free R software.

The Standardized Mortality Ratio (SMR) was calculated, which is the relationship between the mortality observed in the assessed ICU and that predicted by SAPS 3. SMR < 1 means that the score overestimated reality while values > 1 indicate underestimation of the mortality found.

Score performance was obtained by calculating discrimination and calibration. Discrimination is the model's ability to distinguish patients who will survive from those who will die, and is calculated using the Area Under the Receiver Operating Characteristics (AUROC), the area below the ROC curve ensures discriminatory capacity of the assessed score. This curve is formed from the sensitivity (prediction of death) and specificity (discharge prediction) of the patients assessed. AUROC = 1 represents a test with perfect

discriminatory capacity with 100% sensitivity and specificity. An AUROC = 0.5 shows that discrimination is no better than a chance at random; values equal to or greater than 0.7 and less than 0.8, an acceptable discrimination; when above 0.8 and below 0.9, excellent discrimination; when equal to or above 0.9, represents exceptional discrimination.

Calibration was calculated from goodness of fit test, which obtains the result of deaths observed by the expected ones. Values of $p > 0.05$ indicate that the instrument described well the observed mortality, i.e. adequate calibration. A $p \leq 0.05$ indicates significant discrepancy between predicted and observed, i.e. inadequate calibration.[20]

The study was submitted to the Research Ethics Committee of *Universidade Federal de Sergipe*, CAAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration) 07025019.6.000.5546, and was approved under Opinion 3,210,335, meeting Resolution 466/2012 of the Brazilian National Health Council (*Conselho Nacional de Saúde*).

RESULTS

Of the 90 patients admitted to the A-ICU in the period, 12 were excluded. Among the reasons for exclusion, one was under 18 years old, three had a stay of less than 24 hours, three were transferred to another hospital and five had no hospital outcome until one month after the study period.

Mortality observed was 61.5%, mortality predicted by SAPS 3 by global equation was 47.4%, and customized equation for Latin America was 57.8%. Thus, SMR in relation to general equation was equal to 1.30 (95%CI 0.97 – 1.70), and for the customized equation it was 1.04 (95%CI 0.78 – 1.38).

The mean age of the patients was 61.7 ± 17.2 years, significantly higher in people who died (66.5 ± 15.4 years). The mean length of hospital stay was 25.7 ± 20.7 days, and at the ICU was 17.5 ± 16.8 days. The mean SAPS 3 index was 65.9, significantly higher progressed to death (73.8 ± 11.7) compared to survivors (54.4 ± 15.8) (Table 1).

Table 1. Mean and standard deviation of the variables and outcomes of ICU hospitalizations of the university hospital. Lagarto, Sergipe, 2018-2019

Variabless	**Outcome**		**ICU hospitalization (n = 78)**	**P value**
	Discharge (n=30)	**Death (n=48)**		
	Median(sd)	**Median(sd)**	**Median(sd)**	
Age (years)	54.0 (17.7)	66.5 (15.4)	61.7 (17.2)	*< 0.05*

Hospital stay (days)	25.5 (21.0)	24.4 (19.8)	25.7 (20.7)	*0.76*
ICU stay (days)	13.0 (11.9)	18.6 (18.0)	17.5 (16.8)	*0.13*
SAPS 3	54.4 (15.8)	73.8 (11.7)	65.9 (16.2)	*< 0.05*
Mortality assumed by SAPS 3 (global equation) (%)	28.2 (20.4)	59.9% (20.3)	47.7 % (25.5)	*< 0.05*
Mortality assumed by SAPS 3 customized (for Latin America) equation (%)	37.0% (24.7)	71.7% (20.2)	58.4 % (27.7)	*< 0,05*

sd = Standard Deviation; ICU = Intensive Care Unit. SAPS 3 = Simplified Acute Physiology Score 3.

The majority (59.0%) was 60 years and older, being this the age group with the highest risk of death (RR = 2.1). Most patients (70.5%) came from wards or emergency room, and had a mortality rate 2.1 times higher than those who came from the operating room (Table 2).

Table 2. Sociodemographic variables and outcomes of ICU hospitalizations of the university hospital. Lagarto, Sergipe, 2018-2019

Sociodemographic variables	Outcome				ICU hospitalization		RR (95%CI)	P value
	Discharge		Death					
	n	%	n	%	n	%		
Age group								
< 40 years old	5	71.4	2	28.6	7	9	0.4 (0.1 – 1.4)	*0.070*
40 – 59 years old	15	60	10	40	25	32.1	0.5 (0.3 – 0.9)	*< 0.05*
60 years and older	10	21.7	36	78.3	46	59	2.1 (1.3 – 3.0)	*< 0.05*
Sex								
Female	11	34.4	21	65.6	32	41	1.1 (0.8 – 1.6)	*0.270*
Male	19	41.3	27	58.7	46	59	0.9 (0.6 – 1.3)	*0.270*
Color/Race								
White	3	33.3	6	66.7	9	11.5	1.1 (0.7 – 1.8)	*0.380*
Black	10	55.6	8	44.4	18	23.1	0.7 (0.4 – 1.2)	*0.070*
Mixed-race	17	33.3	34	66.7	51	65.4	1.2 (0.8 – 1.9)	*0.150*
Origin								
Surgery Center	15	65.2	8	34.8	23	29.5	0.5 (0.3 – 0.8)	*< 0.05*
Ward/Emergency Room	15	27.3	40	72.7	55	70.5	2.1 (1.2 – 3.7)	*< 0.05*
Total	**30**	38.5	**48**	61.5	**78**	100		

RR = Relative Risk; 95% CI = 95% Confidence Interval; ICU = Intensive Care Unit.

Infectious clinical conditions were responsible for 34 ICU hospitalizations, 25 for respiratory infections. Acute abdomen (16.7%), second main reason for hospitalization, and polytrauma (9%), stand out among surgical diagnoses (Table 3).

Table 3. Initial diagnoses of ICU hospitalizations at the university hospital. Lagarto, Sergipe, 2018-2019

Initial diagnosis	Outcome				Hospitalization	
	Discharge		Death			
	n	%	n	%	n	%
Polytrauma	7	100	0	0	7	9
Acute abdomen	6	46.2	7	53.8	13	16.7
CNS disorders	3	37.5	5	62.5	8	10.3
Metabolic disorder	1	50	1	50	2	2.6
Cardiovascular disease	2	50	2	50	4	5.1
Crohn's disease	0	0	1	100	1	1.3
COPD	2	40	3	60	5	6.4
Toxic hepatitis	0	0	1	100	1	1.3
Lupus erythematosus	0	0	1	100	1	1.3
Exogenous intoxication	2	100	0	0	2	2.6
Infection of soft tissues	2	40	3	60	5	6.4
Urinary tract infection	1	33.3	2	66	3	3.8
Infection with an undetermined focus	0	0	1	100	1	1.3
Respiratory infection	4	16	21	84	25	32.1

CNS = Central Nervous System; COPD = Chronic Obstructive Pulmonary Disease.

Half of the population studied used vasoactive drugs, with highest mortality (76.9%) (Table 4).

Table 4. Clinical variables and outcomes of ICU hospitalizations at the university hospital. Lagarto, Sergipe, 2018-2019

Clinical Variables	Discharge (n = 30)		Death (n = 48)		RR (95%CI)	P value
	n	%	n	%		
Use of vasoactive drugs						
No	21	53.8	18	46.2		
Yes	9	23.1	30	76.9	1.7 (1.1 – 2.4)	< *0.05*
Type of hospitalization						
Surgical	15	65.2	8	34.8		
Clinical	15	27.3	40	72.7	2.1 (1.2 – 3.7)	< *0.05*
Mechanical ventilation						
No	11	73.3	4	26.7		
Yes	19	30.2	44	69.8	2.6 (1.1 – 6.2)	< *0.05*
Creatinine dosage						
< 1.2 mg/dl	17	45.9	20	54.1	0.8 (0.5 – 1.1)	*0.20*
≥ 1.2 < 2.0 mg/dl	6	33.3	12	66.7	1.1 (0.7 – 1.6)	*0.61*
≥ 2- < 3.5 mg/dl	7	30.4	16	69.6	1.2 (0.8- 1.7)	*0.34*

RR = Relative Risk; 95%CI = 95% Confidence Interval.

AUROC related to global equation was 0.834 (95%CI 0.742-0.927), and for customized equation, 0.856 (95%CI 0.733-0.940). It showed excellent discrimination by the model for both equations. Calibration according to goodness of fit test obtained both for global (2.914 and p= 0.893) and customized equation (2.802 and p= 0.903), showing adequate calibration (Figure 1).

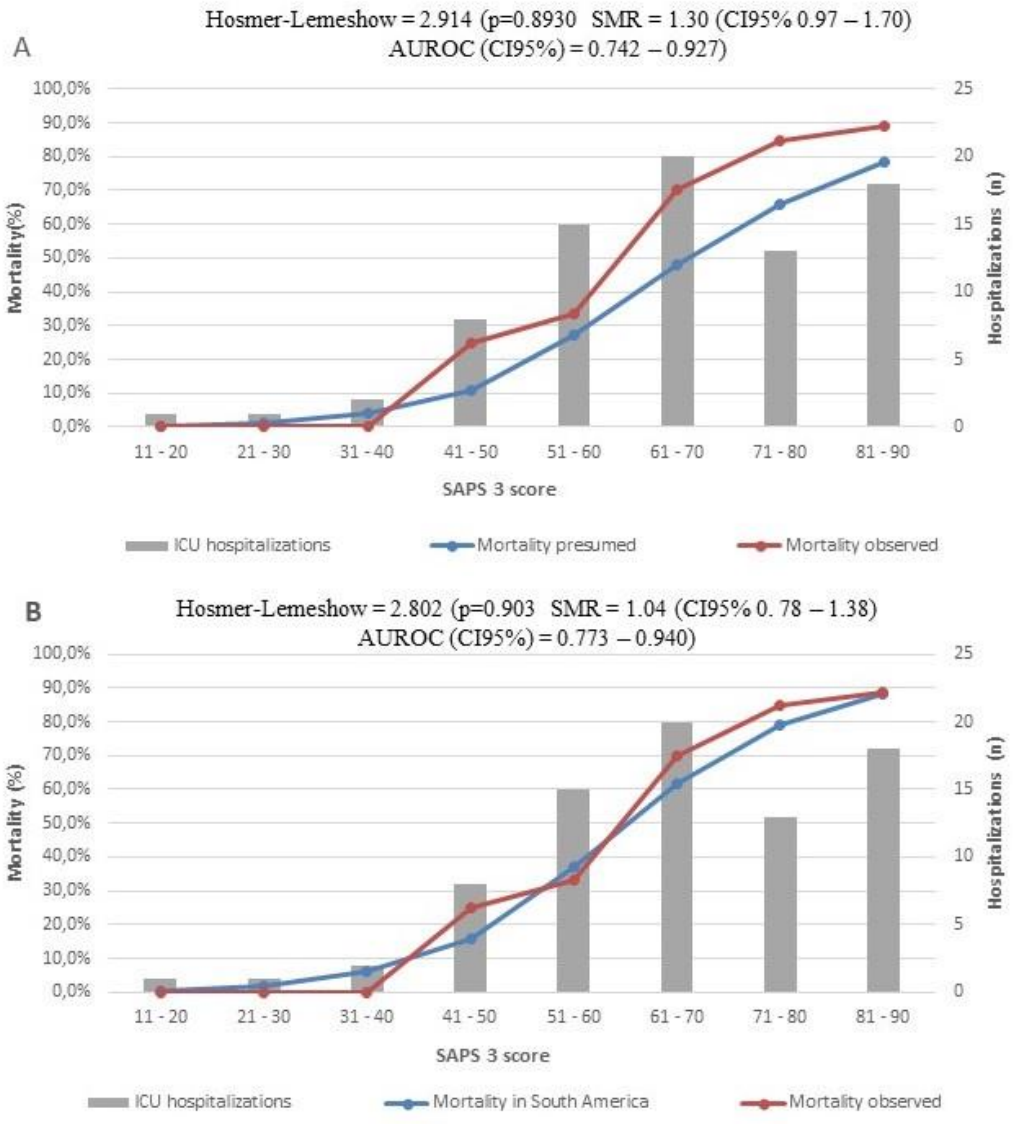

Figure 1. Hospital mortality observed at the ICU of the university hospital according to SAPS 3. A – Correlation with presumed mortality by SAPS 3 global equation 3. B - Correlation with mortality assumed by SAPS 3 customized (for Latin America) equation.

Caption: SMR - Standardized Mortality Ratio; AUROC - Area Under the Receiver Operating Characteristics; 95%CI - 95% Confidence Interval; SAPS 3 - Simplified Acute Physiology Score 3.

DISCUSSION

In Brazil, the largest database of critically ill patients is part of the Brazilian ICUs project conceived by AMIB in conjunction with Epimed Solutions®. According to data from Epimed Monitor®, by the end of January 2019 the project is present in 136 cities distributed across the country covering more than 470 hospitals, 891 ICUs, 14,530 beds, more than 30% of all A-ICU beds in Brazil.[6,21]

The studied population presents heterogeneity inherent to non-specialized A-ICUs. Demographic characteristics of patients such as sex, color/race and age were equivalent to those of units with similar profile. Concerning age, there was a remarkable predominance of patients over 60 years old (59%), the only age group with a relative risk with evident influence on the outcome.[10,17,21]

The mean ICU (17.5 days) and hospital stay (25.7 days) are above the means demonstrated in other ICU studies or those demonstrated by Epimed Monitor® for public national ICUs.[14,17,18]

The main cause of hospitalization was infectious causes, especially respiratory infections that represented almost one third of the sample, being also the cause with the highest mortality (84%). The double risk of death of patients from the wards/emergency room in relation to those coming from the operating room points to a considerable relevance of origin in the outcome of the patients, a fact that is taken into account in the calculation of the prognostic score chosen for analysis.[6,9,19,21]

Modern ICUs use a large portion of health resources due to the need for advanced diagnostic and care technology that critical patients demand. Calculation of prognostic scores applied to determine severity of diseases is a fundamental factor in the cost-benefit and performance analysis of these units.[22]

Due to the practicality of calculating SAPS 3, it is suggested that it can be introduced into ICU routines to identify patients with higher probability of death, assisting in analysis of mortality and severity of hospitalized patients. The 61.5% mortality found in the study is considerably higher than other publications and that demonstrated by Epimed Monitor® for mixed ICUs (20.34%). The data gains greater notoriety when compared to the general mortality of the units covered by the system (10.65%).[6,10,17,19,21,23,24]

It is essential to emphasize that severity of patients admitted is also higher when compared to the same publications and database. Half of the population studied used vasoactive drugs before admission to the ICU and more and 80.7% underwent mechanical ventilation, interventions that demonstrated a great impact on the outcome of patients, a fact

already noted in the development of SAPS 3, since, together with the origin, they are variables that attribute high scores in the assessment of disease severity. The percentage of use of invasive supports in public units is 45.36%, and 25.4% for mechanical ventilation and use of vasoactive amines.[9,21]

The use indexes of these interventions are reflected in high mean score (65.9) and mean mortality assumed by the score (47.4% for global equation and 57.8% for customized (for Latin America) equation), while the most recent national data point to an mean SAPS 3 of 47.1 in public units and 45.28 for mixed units, with an assumed mean mortality of 18.18% and 22.48%. This fact explains the need for further studies on care and processes related to conditions prior to the admission of patients to the ICU.[21]

The standardized reason of death was calculated by dividing the mortality rate observed by the predicted. SMR 1.3 value constitutes an underestimation of the actual mortality by SAPS 3 calculated by the global equation, however, there is conformity between the data found and that related to the public ICUs analyzed by the largest national database that in recent years ranged from 1.44 to 1.5. The 1.04 standardized ratio evidences superiority of the customized equation in describing the behavior of the mortality curve observed, with both curves presenting the same tendency except when SAPS 3 is in the range 51-60 where there is discrete desynchrony. This superiority of the equation adapted to the Latin American reality was also demonstrated in other similar studies.[17,21,23,24]

From AUROC, the study was discriminated against, i.e. a higher probability of non-survivors was conferred in relation to survivors among the predicted deaths. In the present work, AUROC, attributed to the score calculated by its global equation and related to the customized (for Latin America) equation, presented an excellent discrimination, a value close to that found in other validation studies.[5,12,23,24]

Goodness of fit test, both for global (2.914 and p= 0.893) and customized (2.802 and p= 0.903) equations showed good calibration, with better adequacy of the latter for the studied population similar to that found in similar studies. This fact differs from what Moralez et al. attest, which recommend that customized (for Latin America) equation should no longer be used, however, about 90% of the hospitals included in the study were deprived different from the reality of the service analyzed.[12,17,20,23,24]

It is essential to emphasize that, despite the progress developed in the area of prognostic scores, the use of such indexes has limitations, considering that they are instruments with recognized utility in the risk stratification of critically ill patients, but

inadequate for individual analysis, and should not be used to guide the initiation or suspension of therapeutic interventions of patients.[14]

Although it has been demonstrated that SAPS 3 presented good discriminatory and calibration power, our study has limitations. It was performed in a single unit, subject there are possible biases related to the type of patient and treatment received. Moreover, sample size can hide calibration failures.

The study identified a mortality rate at the ICU studied higher than several studies, which can be attributed both to operational factors related to health care and clinical-epidemiological profile of admitted patients. It is important to highlight that the mean prognostic score used was higher than in other studies in non-specialized ICU-A, being influenced by a longer hospital stay and higher percentage of use of interventions, such as mechanical ventilation and vasoactive drugs prior to ICU hospitalization, attesting to a greater severity of patients admitted by the unit.[6,9,10]

This study showed that the use of clinical and epidemiological characteristics of patients at ICU hospitalization had a good ability to differentiate between survivors and non-survivors. Both global and customized (for Latin America) equations presented good calibration and discrimination, with the latter being more appropriate for the population under analysis.

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Authors' contributions

ASSIS, LGR; NERY-NETO, CS RAMOS, GS; SANTOS, AW; SILVA, CHS and BARROS, JF contributed to conception, design, analysis, and writing of the article; MENDES, TS and GOES, MAO contributed to planning and design, review, and final approval of the article; all authors approved the final version to be published and are responsible for all aspects of the work, including ensuring its accuracy and integrity.