

Predictive performance of the National Early Warning Score 2- Brazilian Version for septic patients

*Performance preditiva do National Early Warning Score
2-Versão Brasileira para pacientes sépticos*

*Rendimiento predictivo del National Early Alert Score
2-Versión Brasileña para pacientes sépticos*

Alldren Silva de Sousa^{a,b} 

Giovanna da Rosa Soares^c 

Jaqueline Pereira da Costa^b 

Cristiano Rossa da Rocha^b 

Karina de Oliveira Azzolin^{b,d} 

Janete de Souza Urbanetto^e 

Michelle Dornelles Santarem^{b,d} 

Rita Catalina Aquino Caregnato^{a,c} 

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ABSTRACT

Objectives: To evaluate the predictive performance of the National Early Warning Score 2 – Brazilian Version, as compared to two other instruments for clinical deterioration, Intensive Care Unit admission, and in-hospital mortality of patients with suspected or confirmed sepsis admitted to an Emergency Service.

Methods: Prospective cohort study conducted from October 2021 to February 2022 with 295 adult patients in a public hospital in southern Brazil. Data collection was performed using a specific instrument developed by the researchers, with two assessments at different times: at risk classification in emergency services, and as the patient was transferred to another service for the last time. Predictive performance was assessed using the area under the curve (AUC) of the ROC, sensitivity, and specificity, comparing the scores across the evaluated outcomes and time points.

Results: For clinical deterioration, the National Early Warning Score 2 – Brazilian Version showed an AUC of 0.703, 95% CI (0.63–0.77), $p < 0.001$, and an AUC of 0.871, 95% CI (0.82–0.91), $p < 0.001$ in the first and second assessments, respectively. For admission to the Intensive Care Unit, all three scores remained accurate only in the second assessment, with the National Early Warning Score 2 – Brazilian Version yielding the best results, AUC: 0.830, 95% CI (0.76–0.89), $p < 0.001$ compared to the others. For in-hospital mortality, it presented an AUC of 0.770, 95% CI (0.70–0.83), $p < 0.001$ in the second assessment.

Conclusion: National Early Warning Score 2 – Versão Brasileira showed better predictive performance metrics compared to the other scores in the evaluated stages.

Descriptors: Critical care; Clinical deterioration; Nurses; Early warning score; Sepsis.

RESUMO

Objetivos: Avaliar a performance preditiva do *National Early Warning Score 2-Versão Brasileira*, comparado a outros dois escores, para deterioração clínica, internação em Unidade de Terapia Intensiva e mortalidade hospitalar de pacientes com suspeita/diagnóstico de sepse admitidos em Serviço de Emergência.

Método: Coorte prospectiva, de outubro/2021 a fevereiro/2022, com 295 pacientes adultos, em hospital público do sul do Brasil. Foi realizada uma coleta de dados com instrumento elaborado pelas pesquisadoras realizada em dois momentos: classificação de risco no serviço de emergência e na transferência definitiva do serviço. A avaliação da performance preditiva foi estimada pela área sob a curva (AUC) da curva ROC, sensibilidade e especificidade, comparando os escores nos desfechos e momentos avaliados.

Resultados: Para deterioração clínica, o *National Early Warning Score 2-Versão Brasileira* apresentou AUC: 0,703, IC95% (0,63–0,77), $p < 0,001$ e AUC: 0,871, IC95% (0,82–0,91), $p < 0,001$ no primeiro e no segundo momento. Para internação em Unidade de Terapia Intensiva, os três escores mantiveram-se acurados somente no segundo momento, sendo o *National Early Warning Score 2-Versão Brasileira* com melhores resultados, AUC: 0,830; IC95% (0,76–0,89); $p < 0,001$ em relação aos demais. Para mortalidade hospitalar, apresentou AUC: 0,770; IC95% (0,70–0,83); $p < 0,001$ no segundo momento.

Conclusão: *National Early Warning Score 2-Versão Brasileira* mostrou melhores métricas para performance preditiva comparado aos demais escores nos desfechos avaliados.

Descritores: Cuidados críticos; Deterioração clínica; Enfermeiras e enfermeiros; Escore de alerta precoce; Sepse.

^a Universidade Federal de Ciências da Saúde de Porto Alegre (UFCSPA), Programa de Pós-Graduação em Enfermagem. Porto Alegre, Rio Grande do Sul, Brasil.

^b Hospital de Clínicas de Porto Alegre (HCPA). Porto Alegre, Rio Grande do Sul, Brasil.

^c Universidade Federal de Ciências da Saúde de Porto Alegre (UFCSPA), Graduação em Enfermagem. Porto Alegre, Rio Grande do Sul, Brasil.

^d Universidade Federal do Rio Grande do Sul (UFRGS). Porto Alegre, Rio Grande do Sul, Brasil.

^e Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS). Porto Alegre, Rio Grande do Sul, Brasil.

RESUMEN

Objetivos: Evaluar el desempeño predictivo del *National Early Warning Score 2 – Versión Brasileña*, en comparación con otros dos instrumentos, con respecto al deterioro clínico, el ingreso a la Unidad de Cuidados Intensivos, y la mortalidad hospitalaria de pacientes con sepsis sospechada/diagnosticada en un Servicio de Urgencias.

Métodos: Estudio de cohorte prospectivo hecho entre octubre de 2021 y febrero de 2022 con 295 pacientes adultos en un hospital público del sur de Brasil. La recolección de datos se realizó con un instrumento desarrollado por los investigadores, en dos momentos: la clasificación de riesgo en el servicio de emergencia y la transferencia definitiva del servicio. El desempeño predictivo se evaluó mediante el área bajo la curva (AUC) de la ROC, sensibilidad y especificidad, comparando los puntajes en los desenlaces y momentos evaluados.

Resultados: Para el deterioro clínico, el *National Early Warning Score 2 – Versión Brasileña* mostró un AUC de 0,703, IC95% (0,63–0,77), $p < 0,001$, y un AUC de 0,871, IC95% (0,82–0,91), $p < 0,001$ en el primer y segundo momento, respectivamente. Para el ingreso en la Unidad de Cuidados Intensivos, los tres puntajes se mantuvieron precisos solo en el segundo momento, siendo el *National Early Warning Score 2 – Versión Brasileña* el que obtuvo los mejores resultados, AUC: 0,830, IC95% (0,76–0,89), $p < 0,001$ en comparación con los demás. Para la mortalidad hospitalaria, presentó un AUC de 0,770, IC95% (0,70–0,83), $p < 0,001$ en el segundo momento.

Conclusión: El *National Early Warning Score 2 – Versión Brasileña* mostró mejores métricas de desempeño predictivo en comparación con los demás puntajes en los desenlaces evaluados.

Descriptores: Cuidados críticos; Deterioro clínico; Enfermeras y enfermeros; Puntuación de alerta temprana; Sepsis.

■ INTRODUCTION

Sepsis is the result of an unbalance between inflammatory and anti-inflammatory factors of the host of an infection. It is characterized by an inflammatory response that generates life-threatening organic dysfunction, being globally considered one of the main causes of morbidity and mortality⁽¹⁻³⁾. In Brazil, the overall death rates due to sepsis are high, at approximately 32.2%, though the numbers differ between public and private hospitals. As a consequence, it increases hospital costs and overcrowding, accounting for 55% of hospitalizations in Intensive Care Units (ICUs)⁽²⁾.

The international consensus titled *Third International Consensus Definitions for Sepsis and Septic Shock* (Sepsis-3) states that the SARS-CoV-2 infection can increase the risk of sepsis, highlighting the relevance of the context experienced⁽¹⁾. Recognizes that SARS-CoV-2 infection can increase the risk of sepsis, highlighting the relevance of the context⁽¹⁾. Sepsis must be diagnosed as soon as possible, in order to enable the early start of treatment; it can be found in patients in several in-hospital health units⁽⁴⁾, with the Emergency Service (ES) standing out as a sector where many patients with sepsis and clinical deterioration are diagnosed⁽⁵⁾.

Early Warning Scores (EWS) are tools used to identify the clinical deterioration of the patient, such as the National Early Warning Score (NEWS) and the National Early Warning Score2 (NEWS2), the Modified Early Warning Score (MEWS), the quick Sequential Organ Failure Assessment (qSOFA), and similar systems. They are applied by health workers that are directly involved in the monitoring and care of patients, helping detect cases and ascertain their severity^(6,7). Multiple different professionals can fill the EWS form (physicians, nurses, nursing technicians, physical therapists), but the interpretation and decision making that results from it is usually a responsibility of nurses and physicians⁽⁸⁾.

The International Surviving Sepsis Campaign (2021) no longer recommends the qSOFA as the only tool to screen for cases of sepsis or septic shock, recommending the Systemic Inflammatory Response Syndrome (SIRS), the MEWS, or the NEWS as tools to predict organic dysfunctions⁽⁹⁾. The MEWS evaluates systolic blood pressure (SBP), heart rate (HR), respiratory rate (RR), temperature, and level of consciousness. Values ≥ 4 are considered warnings for the need of evaluating the patient^(10,11). In turn, the NEWS, created by the London Royal College of Physicians, evaluates the severity of this issue analyzing vital signs and level of consciousness⁽⁸⁾. After being

updated in 2017, NEWS2 could be used in patients with respiratory failure and those with chronic obstructive pulmonary disease (COPD)⁽⁸⁾ and can be applied to patients with acute diseases such as sepsis, helping triage and assessments of severity, from admission to outcome^(2,8). It is widely used in international ES and considered the most accurate tool to evaluate hospital mortality and ICU admissions⁽²⁾; however, since its transcultural adaptation into Brazil (NEWS2-BR) is recent, from 2021⁽¹²⁾, it is still seldom used in Brazilian ESs^(2,13).

The nursing team has an essential role in applying the EWS, helping recognize the clinical deterioration of the patient using simple variables collected at the bedside. It gives support to the decision-making process of the nurse, with the goal of avoiding adverse events, and reduces hospital mortality and the need for intensive care^(7,14). To ensure good performance and an effective prediction of outcomes, it should be validated in the context where it is going to be used⁽¹⁵⁾.

The NEWS, broadly used for ES patients, was the most accurate in predicting hospital mortality and the need for admission to the ICU, followed by MEWS, the Hamilton Early Warning Score (HEWS), and the qSOFA^(2,16). After the recent transcultural adaptation of the National Early Warning Score 2 – Brazilian Version (NEWS2-BR)⁽¹²⁾, its predictive validity was analyzed, considering the outcomes of discharge and death in adults with COVID-19⁽¹³⁾. Continuing their studies about the NEWS2-BR, the members of the group that carried out its transcultural adaptation and validation in Brazil found that it was necessary to evaluate its predictive capacity in patients with suspected or confirmed sepsis diagnoses. Therefore, this research was based on the following question: How does the predictive performance of the NEWS2-BR compare to that of MEWS and qSOFA in the identification of the clinical deterioration of the patient with sepsis admitted into an ES? To answer this question, our objective was to evaluate the performance of the National Early Warning Score 2- Brazilian Version, as compared to those other scores, in predicting clinical deterioration, hospitalization in Intensive Care Units, and hospital mortality of patients with suspected/ diagnosed sepsis, admitted into Emergency Services.

METHOD

This is a prospective cohort with patients with suspected or confirmed diagnoses of sepsis. It was carried out in the adult ES of a public university hospital in Rio Grande do Sul (RS), Brazil, from October 2021 to February 2022. At time of research, patients with suspected cases of sepsis were evaluated, in the Reception with Risk Classification (RRC) of this ES, using the qSOFA.

The ES that was the setting of this study operates 24/7, with 56 beds that are exclusive for the Single Health System (SUS). It is the reference center for patients with the following health issues: stroke, chest pain, acute coronary syndrome, acute respiratory failure, sepsis, acute abdomen, COVID-19, and victims of sexual violence.

To conduct and report the study, we used the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)⁽¹⁷⁾.

The sample calculation was based on the tool Power and Sample Size for Health Researchers, online version (18), to estimate the sensitivity and specificity of the NEWS2-BR, in order to achieve a 95% confidence interval in clinical deterioration diagnoses, with a 20% amplitude for this confidence interval and considering a global incidence of sepsis of 48.9%⁽³⁾, an expected sensitivity of 84.5%, and an expected specificity of 49%. The calculation thus generated recommended 203 participants, with 30% added to compensate for possible losses. As a result, the final sample would be 290, and our final sample included 295 patients.

This study included patients with suspected or confirmed sepsis diagnoses, treated in the ES, 18 years old or older, of both sexes, receiving clinical care, with or without qSOFA records in the RRC according to the Manchester Screening System (MSS), as performed by the nurse in the electronic records. We excluded patients who were attended by the gynecology and/or obstetrics team, as they receive care in the specialized sector of the hospital; surgical patients, as they are emergency cases; and incomplete records, where the vital signs were not recorded, or in cases where the patients were discharged and there was no second data collection. It is worth noting that the total number of patients attended added up to 313, but 18 (5.75%)

were excluded according to these criteria. 15 of them were excluded because they were transferred into other institutions, and the data collection could not be performed a second time, as planned; 3 of them had incomplete vital sign information. Therefore, the final sample included 295 patients.

The participants were selected after a suspected or confirmed case of sepsis was identified by the nurse via the application of the qSOFA (purple sign and inclusion of a sepsis protocol in the electronic records of the patient). Then, researchers met with the patient or a relative and applied the informed consent. The patients were monitored through the information in their electronic records after their admission into the ES, until discharge, transference, or death.

The instrument used for data collection was developed by the researchers and included the following independent variables: sociodemographic data (age, sex, ethnicity education, marital status, occupation, and origin); clinical data (previous comorbidities, Charlson Comorbidity Index [CCI], smoking, alcoholism, death, cause of death, triple burden of disease, diagnosis, antibiotic therapy treatment, volume replacement, vasoactive medication); risk classification (main complaint, discriminator used, level of priority assigned, vital signs, and qSOFA on arrival); and hospitalization (length of stay in days, and ICU admission). The instrument was filled in by ES nurses previously trained to use it, in addition to the three scores evaluated: National Early Warning Score 2-Brazilian Version (NEWS2-BR)(12); quick Sequential Organ Failure Assessment (qSOFA)(1); and Modified Early Warning Score (Mews)(11).

Data collection was carried out by two previously trained emergency nurses in all shifts (morning, afternoon, and night). The instrument developed for this research was applied after consulting the electronic records of the eligible patients. Data collection took place at two separate times: 1) at RRC; and 2) when the patient was transferred from the ES into other units. The main outcome measured was the clinical deterioration of patient with suspected or confirmed sepsis diagnoses; the secondary outcomes were: ICU admission and death in the hospital. The RRC was based on the MSS, attributing a color to indicate priority: emergency (red); very urgent (orange); urgent (yellow); not very urgent (green); and not urgent (blue)(19).

The NEWS2-BR (0-20 points) is calculated by adding up the scores attributed to vital signs: SpO₂, HR, SBP, RF, temperature, oxygen use, and level of consciousness. The scores found indicated the minimum frequency of monitoring: 0 (zero) = patient should be monitored every 12 hours; 1-4 = every 4-6h; 3 in a single parameter = every hour; ≥ 5 = every hour; and ≥ 7 = continuous monitoring (12).

The MEWS score was calculated by adding up the scores of vital signs, PAS, FC, FR, temperature, and level of awareness. For a score of 0-2 = monitor every 6 hours if MEWS is constant or every 4h if there is progressive elevation; for a score of 3, warn the nurse and physician and monitor every hour; and if the score is ≥ 4 , monitor constantly, medical staff must evaluate immediately, and patient must be transferred into critical care(10).

The qSOFA score, from 0 to 3 points, was also calculated, using the Glasgow Coma Scale and the PAS, according to the institutional protocol. Scores of ≥ 2 indicate an increased risk of death and ICU admission(9).

A MEWS score ≥ 4 was considered to be the gold standard for the analysis of the predictive performance of the NEWS2-BR(12) and qSOFA(9). The patient was considered to be a case of clinical deterioration when they reached a score of 3 or higher in a single NEWS2-BR parameter or a score ≥ 5 in NEWS2-BR as a whole(12); when the patient reached a qSOFA score ≥ 2 points(9); and when the patient reached a MEWS score ≥ 4 (10,11). These scores were calculated at the RRC and at the time the patient was transferred out of the ES. Patients whose scores were not calculated at both moments were considered losses.

Data collected was stored in an Excel® spreadsheet. To avoid a typing bias, they were verified by two professionals. During analysis, data was adjusted to account for the age of patients (most patients in the sample were older persons), to avoid confounding bias in the results.

Continuous variables were analyzed using means and standard-deviation or median and interquartile ranges, and compared using student's t or Mann-Whitney-U. The Kolmogorov-Smirnov test was used to check the normality of numerical data, and based on these results, statistical tests were selected to verify the association of the variables between the groups (patients with and without clinical deterioration). Categorical variables were described using frequencies

and proportions, and compared using chi-square or Fisher's exact. The characteristics of patients with and without clinical deterioration were scored using the NEWS2-BR at the two moments selected, and then compared; this corresponds to the primary outcome of the study. A confidence interval of 95% was adopted.

After the NEWS2-BR, MEWS, and qSOFA were applied at both moments, the inter-rater reliability was evaluated using the Kappa coefficient (k) or the adjusted Kappa coefficient (PABAK). This analysis, conducted for each element in the list of verification and global agreement, classified reliability as: weak (0-0.2); reasonable (0.21-0.4); moderate (0.41-0.6); strong (0.61-0.8); and almost perfect (0.81-1)⁽²⁰⁾. The analysis was carried out before the accuracy of scores was calculated in regard to the outcomes.

The Receiver Operating Characteristic Curve (ROC curve) was analyzed by estimating the area under the curve (AUC). The score was considered accurate for the outcome when $AUC > 0.7^{(21)}$. The analysis of the predictive performance of NEWS2-BR was estimated using the area under the ROC, sensitivity and specificity metrics, and compared to the values to the other two scores (MEWS and qSOFA). To measure the ideal cutoff point for the outcome, the product of sensitivity and specificity was assessed, and the three higher values among them were selected. After the accuracy of these points was ascertained, the cutoff point was evaluated through a significance assessment (Youden test). The software Statistical Package for the Social Sciences®, version 23.0, was used for these analyses.

This study is associated with the project "Clinical outcomes and nursing care management of critically ill adult patients: a multicenter study". It received opinion No. 4.131.571 and CAAE 32560920.0.1001.5327, being approved by the ethics committee of the hospital that was its setting, and ensuring all ethical principles were respected.

■ RESULTS

Sample profile: 151 (51.2%) male; 233 (79%) white; median age 66 years old, interquartile range [54-75], minimum of 18 years and maximum 103 years; regarding their educational level, 190 (64.4%) had up to nine

years of study; 164 (55.6%) had no partner; and 169 (57.3%) from Porto Alegre.

Considering case severity according to RRC for patients with suspected or confirmed cases of sepsis ($n = 295$), there were 75.2% "very urgent or orange" and 19% "urgent or yellow" (Table 1). The CCI had a median of 5 [3-7]; 71.9% had a triple burden of disease. The most common diagnosis was suspected sepsis (66.4%); followed by sepsis (29.5%); and septic shock (4.1%). The treatment used was: antibiotics (92.5%); volume replacement (22.7%); and vasoactive drugs (7.8%). The median length of stay was 11 [6-17] days. Outcomes: hospital mortality rate 16.6%; 19.3% had a score of 3 in a single parameter or ≥ 5 in the NEWS2-BR, altered in the RRC; 23.7% died as they were being transferred out; 11.9% were admitted into the ICU; and 50% were hospitalized for > 10 days (Table 1).

Scores, when crossed with the clinical outcomes of patients with suspected or confirmed sepsis diagnoses in the RRC: NEWS2-BR median of 6 ([4;9]; $p=0.004$) for in-hospital mortality; 7 ([4;8]; $p=0.004$) for ICU admission; and 5 ([2;7]; $p=0.243$) for prolonged hospitalization (> 10 days). For MEWS, the median was 4 ([2;5]; $p=0.021$) for in-hospital mortality; 4 ([2;5]; $p=0.014$) for ICU admission; and 3 ([2;5]; $p=0.416$) for prolonged admission (> 10 days). The qSOFA, in turn, presented a median of 1 ([1;2]; $p=0.097$) for in-hospital mortality; 1 ([1;2]; $p=0.112$) for ICU admission; and 1 ([0;2]; $p=0.596$) for prolonged admission (> 10 days).

At the transfer from the ES, the NEWS2-BR obtained a median of 6 ([4;8]; $p=0.0001$) for in-hospital mortality; 7 ([5; 9]; $p=0.0001$) for ICU admission; and 4 [2;6]; $p=0.177$) for prolonged hospitalization (> 10 days). The MEWS presented a median of 3 ([2;4]; $p=<0.0001$) for in-hospital mortality; 3 ([2;5]; $p=<0.0001$) for ICU admission; and 2 ([1;3]; $p=0.538$) for prolonged admission (> 10 days). The qSOFA presented a median of 1 ([1;2]; $p=<0.001$) for in-hospital mortality; 1 ([1;2]; $p=<0.0001$) for ICU admission; and 1 ([0;1]; $p=0.385$) for prolonged admission (> 10 days).

The results indicate that the cutoff points of the NEWS2-BR were accurate, with qSOFA being accurate for clinical deterioration, in-hospital mortality, and ICU admission. Regarding in-hospital mortality, scores were only accurate at the second moment of evaluation. The results can be found at table 2 and figure 1.

Table 1. Characteristics of patients concerning risk classification, clinics, and hospitalization of patients with suspected or confirmed sepsis diagnoses (n = 295), admitted to the Emergency Service of a public university hospital. Porto Alegre, Rio Grande do Sul, Brazil, 2022.

Characteristics concerning risk classification, clinics, and hospitalization			Clinical deterioration considering the risk assessment of the Emergency Service			Clinical deterioration in the final transfer out of the Emergency Service		
		Total (n = 295)	YES NEWS2-BR* 3 in a single parameter or ≥5 (n = 212)	NO NEWS2-BR* <5 (n = 83)	<i>p</i>	YES NEWS2-BR* 3 in a single parameter or ≥5 (n = 190)	NO NEWS2-BR* < 5 (n = 105)	<i>p</i>
		n (%)	n (%)	n (%)		n (%)	n (%)	
Severity	Orange	222 (75.2)	177 (83.5)	45 (54.2)	< 0.001^{†‡}	149 (78.4)	73 (69.5)	0.002^{†‡}
	Yellow	56 (18.9)	20 (9.4)	36 (43.4)		26 (13.7)	30 (28.6)	
	Red	17 (5.7)	15 (7.1)	2 (2.4)		15 (7.9)	2 (1.9)	
Comorbidities according to the Charlson Comorbidity Index								
Charlson Comorbidity Index	Score Median [IQR]	5 [3-7] [§]	5 [3-7] [§]	6 [3-7] [§]	0.9 ^{20**}	5 [3-7] [§]	5 [3.5-7] [§]	0.9 ^{97**}
Triple burden of disease	Yes	212 (71.9)	194 (91.5)	77 (92.8)	0.722 [‡]	19 (10)	190 (100)	0.115 [‡]
Diagnosis	Suspected sepsis	196 (66.4)	132 (62.3)	64 (77.1)	0.051 [‡]	120 (63.1)	76 (72.3)	0.074 [‡]
	Sepsis	87 (29.5)	70 (33.0)	17 (20.5)		59 (31.0)	28 (26.6)	
	Septic shock	12 (4.1)	10 (4.7)	2 (2.4)		11 (5.7)	1 (0.9)	

Tabela 1. Cont.

Characteristics concerning risk classification, clinics, and hospitalization			Clinical deterioration considering the risk assessment of the Emergency Service			Clinical deterioration in the final transfer out of the Emergency Service		
Treatment (antibiotic therapy)	Yes	273 (92.5)	198 (93.4)	75 (90.4)	0.372 [‡]	174 (91.6)	99 (94.3)	0.397 [‡]
Treatment (volume replacement)	Yes	67 (22.7)	53 (25.0)	14 (16.9)	0.134 [‡]	47 (24.7)	20 (19)	0.264 [‡]
Treatment (vasoactive drug)	Yes	23 (7.8)	19 (9.0)	4 (4.8)	0.233 [‡]	18 (9.5)	5 (4.8)	0.148 [‡]
Length of stay (days)	Median [IQR]	11	[6-17] [§]	11.0	[6-17] [§]	9	[6-17] [§]	0.6 ^{18**}
Outcomes								
In-hospital death	Yes	49 (16.6)	41 (19.3)	8 (9.6)	0.044^{†‡}	45 (23.7)	4 (1.4)	< 0.001^{†‡}
Cardiac arrest	Yes	7 (2.4)	6 (2.8)	1 (1.2)	0.677 [‡]	7 (3.7)	0 (0)	< 0.047^{†‡}
Intensive Care Unit admission	Yes	35 (11.9)	31 (14.6)	4 (4.8)	0.019^{†‡}	34 (17.9)	1 (1)	< 0.001^{†‡}
Prolonged hospitalization (> 10 days)	Yes	150 (50.8)	112 (52.8)	38(45.8)	0.276 [‡]	103 (54.2)	47 (44.8)	0.120 [‡]

*NEWS2-BR – National Early Warning Score 2 – Brazilian Version; †Statistically significant; ‡Chi-square test; §IQ – Interquartile Range;

**Mann-Whitney U test

Table 2. Predictive performance of the National Early Warning Score 2 - Brazilian Version, compared to the quick Sequential Organ Failure Assessment and Modified Early Warning Score, Brazilian version, for clinical deterioration, admission to Intensive Care Unit, and in-hospital mortality of patients with suspected or confirmed sepsis diagnoses (n=295) admitted to the Emergency Service of a public university hospital. Porto Alegre, Rio Grande do Sul, Brazil, 2022.

Outcomes	Moments	Scores measured	Cut-off point*	Sensitivity	Specificity	AUC [†]	CI [‡] 95%	p
Clinical deterioration	First assessment: Risk classification	NEWS2-BR [§]	≥ 5.5	67. ^{3**}	65.*	0.703 ^{††}	0.63-0.77	< 0.001 ^{††}
		qSOFA ^{‡‡}	≥ 0.5	83. ^{6**}	37. ^{9**}	0.630	0.55-0.70	0.003
		MEWS ^{§§}	≥ 4.5	54. ^{5**}	79. ^{2**}	0.700 ^{††}	0.62-0.77	< 0.001 ^{††}
	Second assessment: final transfer of the patient	NEWS2-BR [§]	≥ 4.5	85. ^{5**}	72. ^{1**}	0.871 ^{††}	0.82-0.91	< 0.001 ^{††}
		qSOFA ^{‡‡}	> 0.5	90. ^{9**}	52. ^{5**}	0.796 ^{††}	0.73-0.86	< 0.001 ^{††}
		MEWS ^{(9)§§}	≥ 4.0	87. ^{0**}	85.*	0.860 ^{††}	0.81-0.91	< 0.001 ^{††}
ICU hospitalization ^{***}	First assessment: Risk classification	NEWS2-BR [§]	≥ 2.50	88. ^{6**}	69. ^{6**}	0.648	0.56-0.73	0.005
		qSOFA ^{‡‡}	≥ 1.50	31. ^{4**}	26. ^{9**}	0.578	0.48-0.67	0.133
		MEWS ^{§§}	≥ 4.50	42. ^{9**}	25.*	0.626	0.53-0.71	0.016
	Second assessment: final transfer of the patient	NEWS2-BR [§]	≥ 2.50	97. ^{1**}	60.*	0.830 ^{††}	0.76-0.89	< 0.001 ^{††}
		qSOFA ^{‡‡}	≥ 1.50	8. ^{6**}	0.4**	0.735 ^{††}	0.64-0.82	< 0.001 ^{††}
		MEWS ^{§§}	≥ 4.50	28. ^{6**}	5.8**	0.731 ^{††}	0.64-0.81	< 0.001 ^{††}

Tabela 2. Cont.

Outcomes	Moments	Scores measured	Cut-off point*	Sensitivity	Specificity	AUC [†]	CI [‡] 95%	p
In-hospital mortality	First assessment: Risk classification	NEWS2-BR [§]	≥ 2.50	83.7**	69.5**	0.629	0.54-0.71	0.004
		qSOFA ^{¶¶}	≥ 1.50	30.6**	26.8**	0.571	0.48-0.65	0.118
		MEWS ^{§§}	≥ 4.50	36.7**	25.2**	0.603	0.52-0.68	0.023
	Second assessment: final transfer of the patient	NEWS2-BR [§]	≥ 2.50	91.8**	58.9**	0.770^{††}	0.70-0.83	< 0.001^{††}
		qSOFA ^{¶¶}	≥ 1.50	0**	1.6**	0.678	0.59-0.76	< 0.001
		MEWS ^{§§}	≥ 4.50	22.4**	5.7**	0.726^{††}	0.64-0.80	< 0.001^{††}

*To determine the best cutoff point, the Youden test was used; [†]AUC - area under the curve; [‡]CI - confidence interval; [§]NEWS2-BR - National Early Warning Score 2;

**Percentage (%); ^{††}Statistically significant; ^{¶¶}qSOFA - quick Sequential Organ Failure Assessment; ^{§§}MEWS - Modified Early Warning Score;

***ICU - Intensive Care Unit.

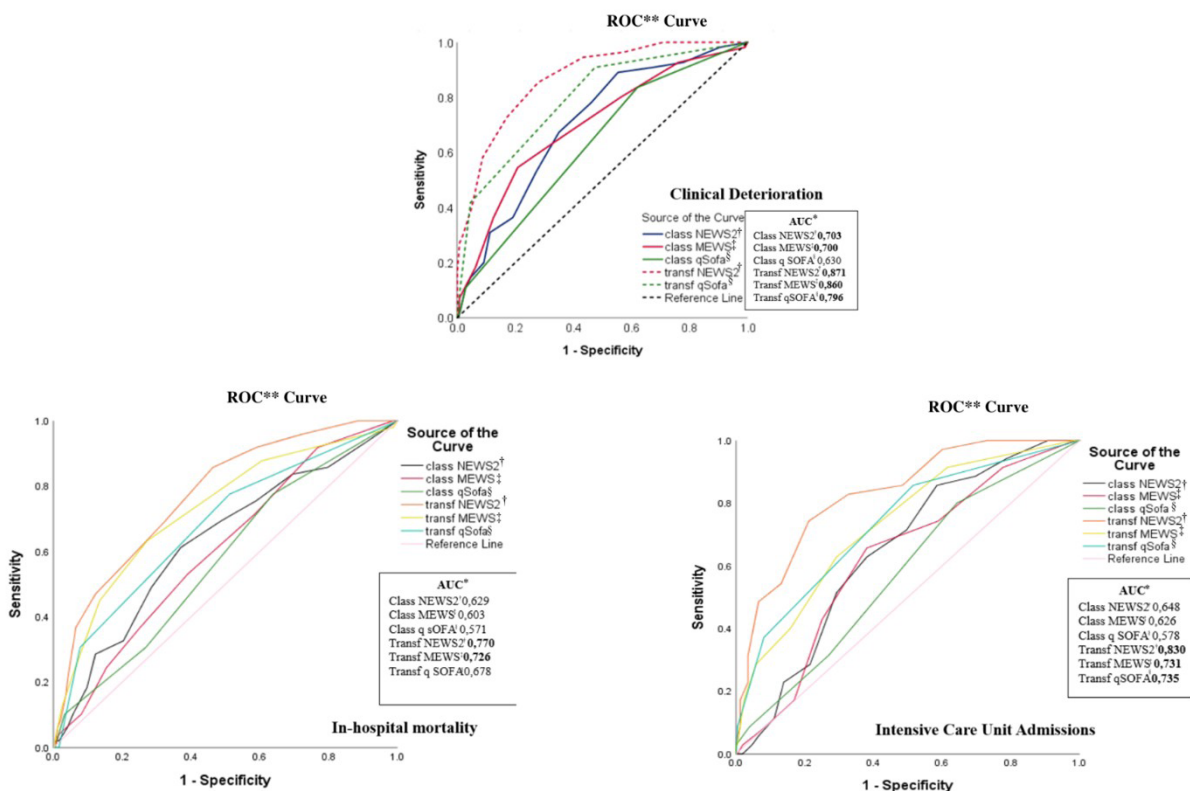


Figure 1 – Predictive performance and accuracy regarding clinical deterioration, admission to the Intensive Care Unit, and in-hospital mortality of the National Early Warning Score 2-Brazilian Version, the Modified Early Warning Score, and the quick Sequential Organ Failure Assessment, of patients with suspected or confirmed sepsis diagnoses (n = 295) admitted to an Emergency Service of a public university hospital.

*AUC - Area Under the Curve; [†]NEWS2-BR - National Early Warning Score 2 – Brazilian Version; [‡]MEWS - Modified Early Warning Score; [§]qSOFA - quick Sequential Organ Failure Assessment; ^{**}ROC - Receiver Operating Characteristic.

DISCUSSION

In regard to the study sample, the low proportion of exclusions (less than 10%) can be an indication that our recruitment of participants was well planned, increasing the reliability of this study. When compared to the other scores, the NEWS2-BR showed a better predictive performance for clinical deterioration at the RRC and when transferring the patient out of the ES for in-hospital mortality and ICU admissions.

The evaluation of the predictive performance of NEWS2-BR, MEWS, and qSOFA found that they were only accurate at the time of the final transfer of the patient. The NEWS2-BR (AUC=0.77) stood out with a sensitivity of 91.8% and a specificity of 58.9% for in-hospital mortality, and a sensitivity of 97.1% and a specificity of 60% for ICU admission.

The sociodemographic profile found that most participants were male - with a median of 66 years old. This corroborated the results found by a Spanish study in which most septic patients were male, with a mean age of 73⁽²²⁾ years old, and a North American study, in which septic patients were older and had more comorbidities than the non-septic ones⁽²³⁾

A previous study⁽²⁴⁾ evaluated and compared the precision of qSOFA, SIRS, MEWS, and NEWS for patients with suspected infections in the ES and nursing wards, evaluating in-hospital mortality, deaths, and ICU admissions. It found a higher prevalence of: black persons; females; antibiotic treatments (36%); and vasoactive drug treatments (9%). Their findings regarding treatment are similar to those in this study, in which antibiotics (92.5%) and vasoactive drugs (7.8%) were the most common forms of treatment, despite the

higher percentage when it comes to antibiotics. Both studies presented a long length of stay. In agreement with our results, the qSOFA was found to be less precise than the NEWS and the MEWS to predict deaths and ICU admissions⁽²⁴⁾.

Sepsis is one of the main causes of death, being related to strokes, acute myocardial infarctions, atrial fibrillation, and congestive heart failure; this has been shown by the fact that 79.4% of patients with sepsis in the first week of hospitalization were the victims of cardiovascular events, which caused long ICU stays⁽²⁵⁾. This finding is related to mortality and morbidity in this study, which contribute to a longer length of stay.

The EWS were found to be good predictors for the detection of sepsis, especially NEWS and NEWS2⁽⁸⁾, which could identify these outcomes earlier and reduce in 20% the death rates caused by sepsis as associated to cardiac arrests, while also reducing length of stay in 50%⁽²⁶⁾. The NEWS2, recently used for early detection and treatment of sepsis, showed better results when predicting in-hospital mortality; whenever its score is ≥ 5 , sepsis should be suspected^(2,8).

The evaluation of comorbidities and prognoses by the CCI shows the risk of patient death⁽²⁴⁾, showing that 71.9% had a triple burden of disease and a median of 5 [3-7], which indicates many comorbidities (score ≥ 3) in the sample.

According to a research that evaluated the qSOFA, the SIRS, and the NEWS, these scores have different specificity and sensitivity⁽²⁴⁾. Our results have shown that the qSOFA has a low sensitivity (18%) for in-hospital mortality, confirming the prospective observational study carried out in the ES of a Dutch university hospital⁽²⁷⁾, although our findings indicating a high specificity (94%) differed from theirs.

A Dutch study found that NEWS, qSOFA, and SIRS, applied at the triage in the ES, were accurate in regard to the clinical deterioration of septic patients, with outcomes related to ICU hospitalizations and mortality. NEWS prognoses were more precise in <72 h, while qSOFA was the least precise⁽²⁸⁾. These findings corroborate the present research, in which NEWS2-BR stands out as the most precise in regard to clinical deterioration at triage and at the final transfer from the ES when compared to MEWS and qSOFA, showing itself

as a good predictor for the final transfer and admission into the ICU, in regard to in-hospital mortality, while MEWS and qSOFA were less precise regarding hospital mortality and ICU admissions. The NEWS is easy to apply and can be used by different profiles of patients, including those with COPD, ensuring a safe RRC and early interventions⁽²⁾.

A Spanish study in the pre-hospital stage found that NEWS2 was superior to the qSOFA⁽²⁹⁾. As for the MEWS, we evaluated it in regard to in-hospital mortality outcomes (sensitivity 22.4% and specificity 5.7%) and ICU admission (sensitivity 28.6% and specificity 5.8%); the same was done for the qSOFA regarding in-hospital mortality (sensitivity 0% and specificity 1.6%) and ICU admission (sensitivity 8.6% and specificity 0.4%). Although the qSOFA can predict the outcome of hospital mortality, its low sensitivity means there is a high rate of false-negatives, which can lead to losses or delays in the treatment of life-threatening patients and morbidity⁽³⁰⁾. In the case of sepsis, which has a high level of lethality, high sensitivity is more important than high specificity when it comes to diagnosis and predictions of mortality⁽³⁰⁾.

Another study⁽¹⁶⁾, compared the accuracy of several scores (qSOFA, SOFA, MEWS, NEWS, and the electronic Cardiac Arrest Risk Triage - eCART), showing the same precision ranking found in this study, although it included NEWS, which was considered the most precise, and was followed by MEWS and qSOFA. Nonetheless, the MEWS was still the most prevalent in the ES⁽¹⁶⁾, which corroborates our findings: the NEWS is much more precise in detecting clinical deterioration than qSOFA and MEWS.

A limitation of this study is the fact that participants were selected when the application of the qSOFA indicated that they were suspected of sepsis, since this was the tool routinely used in the ES at the time. This pre-selection may have influenced the results in favor of qSOFA, especially at the first assessment. This study is innovative in the way it carries out two assessments of the scores (at the risk classification and at the final transfer out of the ES), using the cutoff point of ≥ 4 for sepsis clinical deterioration for MEWS, since no previous study analyzed this score at the times of assessment used in this study.

■ CONCLUSION

The NEWS2-BR had a better predictive performance for clinical deterioration in the ES, both at the time of risk classification and when the patient was transferred out of the service. It also showed higher sensitivity and specificity than the other scores. The NEWS2-BR and the MEWS were more accurate than qSOFA regarding hospital mortality and ICU admission. It is worth noting that the NEWS2-BR is easy to apply and evaluates a broader roster of vital signs than the other scores measured and studied.

The NEWS2-BR is an innovative tool in the Brazilian settings, not only for teaching and research, but especially, from the point of view of health care. This score can be applied at the bedside or at the time the patient arrives at the ES, helping the decision-making process of nurses, helping achieve better outcomes, and optimizing the treatment of patients with suspected or confirmed cases of sepsis.

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■ Data and material availability

The dataset may be accessed upon request to the corresponding author.

■ Author contributions

Conceptualization: Alldren Silva de Sousa, Giovanna da Rosa Soares, Rita Catalina Aquino Caregnato
Data curation: Alldren Silva de Sousa
Formal analysis: Alldren Silva de Sousa, Giovanna da Rosa Soares, Karina de Oliveira Azzolin, Janete de Souza Urbanetto, Rita Catalina Aquino Caregnato
Funding acquisition: Alldren Silva de Sousa, Rita Catalina Aquino Caregnato
Investigation: Alldren Silva de Sousa, Giovanna da Rosa Soares, Jaqueline Pereira da Costa, Cristiano Rossa da Rocha, Rita Catalina Aquino Caregnato
Methodology: Alldren Silva de Sousa, Giovanna da Rosa Soares, Karina de Oliveira Azzolin, Janete de Souza Urbanetto, Michelle Dornelles Santarem, Rita Catalina Aquino Caregnato
Project administration: Alldren Silva de Sousa, Giovanna da Rosa Soares, Karina de Oliveira Azzolin, Michelle Dornelles Santarem, Rita Catalina Aquino Caregnato
Resources: Alldren Silva de Sousa, Rita Catalina Aquino Caregnato
Supervision: Alldren Silva de Sousa, Michelle Dornelles Santarem, Rita Catalina Aquino Caregnato
Writing - original draft: Rita Catalina Aquino Caregnato, Rita Catalina Aquino Caregnato
Writing - review and editing: Alldren Silva de Sousa, Giovanna da Rosa Soares, Janete de Souza Urbanetto, Michelle Dornelles Santarem, Rita Catalina Aquino Caregnato

The authors declare that there is no conflict of interest.

■ Corresponding author

Alldren Silva de Sousa
E-mail: assousa@hcpa.edu.br

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