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Original article

National Early Warning Score 2 – Brazilian version: predictive validity for adults with COVID-19*

National Early Warning Score 2 – versão brasileira: validade preditiva para adultos com COVID-19

National Early Warning Score 2 – versión brasileña: validez predictiva para adultos con COVID-19

Ana Paula Amestoy de Oliveira[I], Andressa Golembieski Machado[I], Giovana Rossi Usevicius[I], Janete de Souza Urbanetto[I]

[I] Pontifícia Universidade Católica of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil

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Abstract

Objective: perform the predictive validity of *National Early Warning Score* 2 – Brazilian version (NEWS 2 – BR) in discharge and death outcomes in patients with COVID-19. **Method:** cross-sectional study with predictive validity analysis. Social-demographical and clinical variables, outcomes and the score components were collected with an electronic health record and analyzed through descriptive and inferential statistics. **Outcomes:** 400 patients were included, with median age of 61 years. The score, at the moment of admission, had a median of 5 points, with a range from 0 to 21. There is an association between the highest scores and the death outcome and the lowest scores and the discharge outcome. The predictive validity of NEWS 2 – BR for death was established by the analysis of the ROC curve and the most accurate cut-off point was six points. **Conclusion:** The Brazilian version of NEWS 2 is a valid score to assess patients with COVID-19.

Descriptors: Clinical Deterioration; Early Warning Score; COVID-19; Validation Study; Hospital Mortality

Resumo

Objetivo: realizar a validade preditiva do *National Early Warning Score* 2 – versão brasileira (NEWS 2 – BR) nos desfechos alta e óbito em pacientes com COVID-19. **Método:** estudo

transversal com análise de validade preditiva. Variáveis sociodemográficas, clínicas, desfechos e os componentes do escore foram coletados em prontuário eletrônico e analisados por meio da estatística descritiva e inferencial. **Resultados:** incluíram-se 400 pacientes, com mediana de idade de 61 anos. O escore na admissão teve mediana de 5 pontos, com amplitude de 0 a 21. Houve associação entre escores mais altos com o desfecho óbito e escores mais baixos com a alta. A validade preditiva do NEWS 2 – BR para o óbito foi realizada pela análise de curva ROC e o ponto de corte de maior acurácia foi de seis pontos. **Conclusão:** a versão brasileira do NEWS 2 é um escore válido para avaliação de pacientes com COVID-19.
Descritores: Deterioração Clínica; Escore de Alerta Precoce; COVID-19; Estudo de Validação; Mortalidade Hospitalar

Resumen

Objetivo: realizar la validez predictiva del National Early Warning Score 2 – versión brasileña (NEWS 2 – BR) en los resultados alta y fallecimiento en pacientes con COVID-19. Método: estudio transversal con análisis de validez predictiva. Variables sociodemográficas, clínicas, resultados y los componentes del score fueron recolectados en prontuario electrónico y analizados por medio de la estadística descriptiva e inferencial. Resultados: se incluyeron 400 pacientes, con mediana de edad de 61 años. El score en la admisión tuvo mediana de 5 puntos, con amplitud de 0 a 21. Hubo asociación entre scores más altos con el resultado fallecimiento y scores más bajos con el alta. La validez predictiva del NEWS 2 – BR para el fallecimiento fue realizada por el análisis de curva ROC y el punto de corte de mayor precisión fue de seis puntos. Conclusión: la versión brasileña del NEWS 2 es un score válido para la evaluación de pacientes con COVID-19.
Descriptores: Deterioro Clínico; Puntuación de Alerta Temprana; COVID-19; Estudio de Validación; Mortalidad Hospitalaria

Introduction

The profile of patients admitted in healthcare services throughout history resulted in the need to create tools that could categorize them according to their risk and severity. An example of that is the early warning score, an instrument that provide inputs for decision-making regarding assistance for patients in different care stages.[1] Such instruments are based on vital signs changes, measured on bed side, as signs of clinical deterioration of the patient's health condition, enabling to phase care stages with scientific and safe foundation.[2]

In that context, facing the COVID-19 pandemic scenario that struck the world, the assessment of patients suffering from that disease was necessary. The pathology is characterized by a usually light pulmonary infection, with fever, dyspnea, headache, cough, changes in taste and smell, among other symptoms.[3] However, many cases

evolve to critical forms, especially in the elderly and individuals with comorbidities, causing significant ventilatory failure and septic shock.[4]

One of the early warning scores used internationally in the assessment of patients with COVID-19 was the National Early Warning Score 2 (NEWS 2), in its original version, due to its performance and the inclusion of oxygen saturation in its assessment.[5-11] The NEWS 2 uses, in addition to that parameter, heart rate, systolic blood pressure, respiratory rate, temperature, use of auxiliary oxygen and level of awareness as items to compose the final score.[12] The NEWS 2 was cross-culturally adapted to Brazilian Portuguese in 2019, being called NEWS 2 - Brazilian version (NEWS 2 – BR).[13]

During the COVID-19 pandemic in Brazil, a lack of investigation of the performance of NEWS 2 in such patients was identified, leading to the development of the research hypothesis: The NEWS 2 – BR is valid for prediction of the discharge and death outcomes in patients suffering from COVID-19. Therefore, the objective of this investigation was to perform the predictive validity of the National Early Warning Score 2 – Brazilian version (NEWS 2 – BR) in discharge and death outcomes in patients with COVID-19.

Method

Cross-sectional study with predictive validity analysis of NEWS 2 – BR for hospital outcome of patients with COVID-19 (discharge and death). In a retrospective and quantitative approach, the individuals were assessed in their admission in a university hospital in the Southern region of Brazil, from March 2020 to June 2021. The population studied was composed of 1,017 subjects and a minimal sample of 392 for this analysis was selected in a simple random manner, adopting a confidence level of 95% for a bilateral distribution of the sampling error, a statistical power of 80%, as well as a margin of error of 5%.

The inclusion criteria consisted in age equal to or older than 18 years-old, indication of hospital admission and diagnostic of COVID-19. Pregnant women were excluded. The data collection team was previously trained, and an operational manual was prepared to guide and standardize data collection, as this score is not commonly applied in the institution. Measurement included: a) social-demographical variables (age, gender, marital status and skin color stated in the admission; b) clinical variables of the

patient (existence of previous clinical conditions), variables related to hospital admission (medical unit where the patient was admitted, medical specialty at the moment of admission, need for transfer, time elapsed between admission and transfer, hospitalization time, total and type of complaint at admission, total and types of symptoms suggesting COVID-19, final outcome of the admission and hospital readmission); variables related to NEWS 2 – BR at admission and transfer.

The score value is calculated by the sum of the score assigned to each item (oxygen saturation, heart rate, systolic blood pressure, respiratory rate, temperature, use of auxiliary oxygen and level of awareness) ranging from 0 to 20. The NEWS 2 score generates a recommendation to the assistance team to monitor vital signs: "0" = minimum at every 12 hours, "total 1-4" = minimum at every 4-6 hours, "3 in a single parameter" = minimum at every hour, "total of 5 or more" = minimum at every hour and "total of 7 or more" = continuous monitoring of vital signs.[12-13]

Data was collected from the patients' electronic health record, transcribed to an Excel spreadsheet and assessed regarding inconsistencies in the records. The analysis of data was performed with the Statistical Package for the Social Sciences (SPSS), version 21.0. Data was analyzed through descriptive statistics, and absolute and relative frequencies were used for the categorical variables, and for central tendency and variability measurements were used for the continuous numerical variables. When data was identified as asymmetrical by the Kolmogorov-Smirnov test, the results were described with median and range. Inferential analysis was carried out with analytical statistics, through the Pearson chi-squared test or Fisher test, with a significance level of 5% and the accuracy was tested by analysis of are on the ROC curve.

Evaluation of the product between sensitivity and specificity, describing the three highest values among them, was applied to measure the optimal cut-off point for death outcome. The accuracy of these points was, then, evaluated in order to obtain the cut-off point with a significance assessment through the Pearson chi-squared test, Kappa test and McNemar test.

Guaranteeing the quality and transparency of writing, Strengthening the reporting of observational studies in epidemiology (STROBE) was used.[14] This study is part of a larger project named "Validation of NEWS 2 – Brazilian version in hospitalized

adults". The research was conducted according to the ethical standards required by Resolutions no. 466/2012 of the National Health Council of the Ministry of Health, receiving Term of Consent and approval from the Ethics Committee of the institution under CAAE no. 36022020.0.0000 and opinion number 4.199.937 on August 7th, 2020. The Term of Commitment for Use of Data was adopted for research development, according to the regulation of the institution, and the provisions of the Data Protection General Law were followed, ensuring data confidentiality.

Results

The study sample was composed of 400 patients. Social-demographical, clinical and hospitalization variables are presented in Table 1. The median age of the patients was 61 years, with range from 20 to 102 years. A median of 2 (0 to 7) complaints was reported to the nurse responsible for the Risk Rating (RR) of the institution at admission. A median of 2 (0 to 7) symptoms of COVID-19 was described in the evolution of admission to hospitalization. Regarding the total hospitalization time, the median was 7.45 (0 to 50) days.

Table 1 - Distribution of social-demographical and clinical variables of hospitalized patients with COVID-19 (n=400), Porto Alegre, RS, Brazil, 2020-2021

(to be continued)

Social-Demographical and Clinical Variables	n	%
Age		
18-61 years	202	50.5
62 years old or older	198	49.5
Genre		
Female	200	50.0
Male	200	50.0
Skin color		
White	353	88.2
Black	36	9.0

Brown	11	2.8
Marital status		
Married/Common-Law Marriage	185	46.2
Single	118	29.5
Widow	60	15.0
Divorced	37	9.3
Complaints mentioned at admission		
Up to 2	218	54.5
Between 3 and 7	182	45.5
Complaints mentioned at admission (with cut-off point of 10%)		
Dyspnea	218	54.5
Fever	113	28.2
Cough	107	26.8
Positive diagnostic for COVID-19	61	15.3
Prior health history		
Between 3 and 7 comorbidities	175	43.8
Up to two comorbidities	166	41.5
No prior disease history (healthy)	59	14.8
Comorbidities (with cut-off point of 10%)		
Hypertension	224	56.0
Diabetes	126	31.5
Cardiopathy	85	21.3
Dyslipidemia	52	13.0
Hypothyroidism/Hyperthyroidism	44	11.0
Chronic Kidney Disease	42	10.5
Obesity	41	10.3
Total hospitalization time		
Up to 7 days	189	47.2
8 days or more	211	52.8

Admission of patients happened at the Emergency Room in 370 (92.5%) cases, at the Patient Care Unit for 19 (4.7%) patients, at the Intensive Care Unit (ICU) for 8 (2.0%) patients and at the Surgery Room for 3 (0.8%) patients. Due to the pandemic scenario and the internal routines of the hospital, admission of patients from other hospitals or Emergency Care Units was in other units, with no need to go through the Emergency Room. Among those, 369 (92.2%) were transferred to other units of the institution of lower of higher complexity and the time between admission and transfer (n=369) was of "up to one day" for 325 (88.0%) patients.

The NEWS 2 – BR score, at the moment of admission, for the sample had a median of 5 points, with a range from 0 to 21 points. At the moment of transfer, the median was 4 with a range from 0 to 21 points. Among the patients who were not transferred, 11 (2.7%) evolved to death still in the Emergency Room, 4 (1%) were discharged directly from that care unit, 11 (2.7%) were admitted directly in the Patient Care Unit and 5 (1.2%) in the ICU. Data related to NEWS 2 – BR at the moment of admission and transfer, as well as the outcomes, are presented in Table 2.

Table 2 - Distribution of the NEWS 2 – BR score at admission and transfer and outcomes presented by hospitalized patients with COVID-19 (n=400), Porto Alegre, RS, Brazil, 2020-2021

(to be continued)

Variables of NEWS 2 – BR and Outcomes	n	%
NEWS 2 – BR Score - Admission		
Score 0 (monitoring at every 12 hours)	23	5.8
Score 1-4 (monitoring between 4 and 6 hours)	162	40.5
Score 3 in a single parameter (hourly monitoring)	9	2.2
Score >5 (hourly monitoring)	78	19.5
Score >7 (continuous monitoring)	128	32.0
NEWS 2 – BR Score - Transfer (n=369)		
Score 0 (monitoring at every 12 hours)	28	7.6
Score 1-4 (monitoring between 4 and 6 hours)	171	46.3

Score 3 in a single parameter (hourly monitoring)	62	16.9
Score >5 (hourly monitoring)	2	0.5
Score >7 (continuous monitoring)	106	28.7
Final Outcome		
High	267	66.7
Death	126	31.5
Transfer to another institution	6	1.5
Evasion	1	0.3
Readmission (n = 274)		
Yes	18	6.6
No	256	93.4

NEWS 2 – BR: National Early Warning Score 2 – Brazilian version.

The results of the association of monitoring indications, according to the scores of NEWS 2 – BR at admission and transfer, and the social-demographical and clinical variables are in Tables 3 and 4. It is noticeable the association between hospitalization time up to seven days with lower scores at admission, as well as hospitalization time of eight days or more with higher scores of NEWS 2 – BR. The outcome of hospital discharge was associated to lower scores of NEWS 2 – BR at admission, while higher scores were associated to the outcome of death.

Table 3 - Associations between monitoring indications of the NEWS 2 – Brazilian version (NEWS 2 – BR) score at admission and social-demographical and clinical variables and outcomes of hospitalized patients with COVID-19 (n=400). Porto Alegre, RS, Brazil, 2020-2021

Variables	NEWS 2 – BRScore at Admission					p value
	0‡	1-4§	3 in a single parameter||	>5||	>7¶	
	n (%)	n (%)	n (%)	n (%)	n (%)	
Age						
18-61 years	12 (5.9)	94 (46.5)	3 (1.5)	33 (16.3)	60 (29.7)	0.109†
62 years old or older	11 (5.6)	68 (34.3)	6 (3.0)	45 (22.0)	68 (34.3)	
Sex						
Female	10 (5.0)	87 (43.5)	3 (1.5)	43 (21.5)	57 (28.5)	0.334†
Male	13 (6.5)	75 (37.5)	6 (3.0)	35 (17.5)	71 (35.5)	
Complaints mentioned at admission						
Up to 2 complaints	14 (6.4)	83 (38.1)	6 (2.8)	39 (17.9)	76 (34.9)	0.488†
3 to 7 complaints	9 (4.9)	79 (43.4)	3 (1.6)	39 (21.4)	52 (28.6)	
Prior Comorbidities						
No prior health history and up to two comorbidities	14 (6.2)	94 (41.8)	4 (1.8)	45 (20.0)	68 (30.2)	0.831†
Between 3 and 7 comorbidities	9 (5.1)	68 (38.9)	5 (2.9)	33 (18.9)	60 (34.3)	
COVID-19 symptoms						
Asymptomatic or up to two symptoms	15 (6.6)	88 (38.4)	7 (3.1)	43 (18.8)	76 (33.2)	0.576†
Between 3 and 7 symptoms	8 (4.7)	74 (43.3)	2 (1.2)	35 (20.5)	52 (30.4)	
Total hospitalization time						
Up to 7 days	15 (7.9)*	100 (52.9)*	4 (2.1)	24 (12.7)	46 (24.3)	<0.001†
8 days or more	8 (3.8)	62 (29.4)	5 (2.4)	54 (25.6)*	82 (38.9)*	
Outcome						
Hospital discharge	20 (7.5)*	136 (50.9)*	8 (3.0)*	55 (20.6)	48 (18.0)	
Death	1 (0.8)	22 (17.5)	1 (0.8)	23 (18.3)	79 (62.7)*	<0.001†
Transference	1 (1.2)*	4 (66.7)*	-	-	1 (16.7)	
Evasion	1 (100.0)*	-	-	-	-	

*statistically significant association; †*Fisher's Exact Test*; ‡Monitoring every 12 hours; §Monitoring between 4 and 6 hours; ||Monitoring every hour; ¶Continuous monitoring.

At transfer, there was an association between the scores of 1-4 and age up to 61 years and highest scores (>7) with age of 62 years or more. Lower scores (0 or 1-4) at transfer were associated to shorter hospitalization time, as well as to a discharge outcome, while higher scores were associated to death and longer hospitalization time.

Table 4 - Associations between monitoring indications of the NEWS 2 – BRazilian version (NEWS 2 – BR) score at transfer and social-demographical and clinical variables and outcomes of hospitalized patients with COVID-19 (n=369). Porto Alegre, RS, Brazil, 2020-2021

Variables	NEWS 2 – BR Score at Transfer					p value
	0‡	1-4§	3 in a single parameter||	>5||	>7¶	
	n (%)	n (%)	n (%)	n (%)	n (%)	
Age						
Up to 61 years old	16 (8.6)	98 (52.4)*	1 (0.5)	32 (17.1)	40 (21.4)	0.021†
62 years old or older	12 (6.6)	73 (40.1)	1 (0.5)	30 (16.5)	66 (36.3)*	
Sex						
Female	14 (7.7)	94 (51.6)	-	31 (17.0)	43 (23.6)	0.108†
Male	14 (7.5)	77 (41.2)	2 (1.1)	31 (16.6)	63 (33.7)	
Complaints mentioned at admission						
Up to 2 complaints	15 (7.6)	90 (45.5)	2 (1.0)	33 (16.7)	58 (29.3)	0.873†
3 to 7 complaints	13 (7.6)	81 (47.4)	-	29 (17.0)	48 (28.1)	
Prior Comorbidities						
No prior health history and up to two comorbidities	13 (6.2)	107 (51.2)	1 (0.5)	38 (18.2)	50 (23.9)	0.064†
Between 3 and 7 comorbidities	15 (9.4)	64 (40.0)	1 (0.6)	24 (15.0)	56 (35.0)	
COVID-19 symptoms						
Asymptomatic or up to two symptoms	16 (7.7)	97 (46.6)	2 (1.0)	31 (14.9)	62 (29.8)	0.696†
Between 3 and 7 symptoms	12 (7.5)	74 (46.0)	-	31 (19.3)	44 (27.3)	
Total hospitalization time						
Up to 7 days	20 (11.6)*	91 (2.3)*	1 (0.6)	25 (14.5)	36 (20.8)	<0.001†
8 days or more	8 (4.1)	80 (40.8)	1 (0.5)	37 (18.9)*	70 (35.7)*	
Outcome						
Hospital discharge	25 (9.9)*	141 (55.7)*	2 (0.8)*	45 (17.8)	40 (15.8)	<0.001†
Death	3 (2.8)	25 (22.9)	-	17 (15.6)	64 (58.7)*	
Transference	-	4 (66.7)*	-	-	2 (33.3)	
Evasion	-	1 (100.0)*	-	-	-	

*statistically significant association; †*Fisher's Exact Test*; ‡Monitoring every 12 hours; §Monitoring between 4 and 6 hours; ||Monitoring every hour; ¶Continuous monitoring.

The predictive validity of NEWS 2 – BRfor the death outcome was established with the analysis of ROC curve (AUC), obtaining an accuracy of 0.776 at admission and 0.772 at transfer, with a confidence interval of 95%. Data is presented in Table 1.

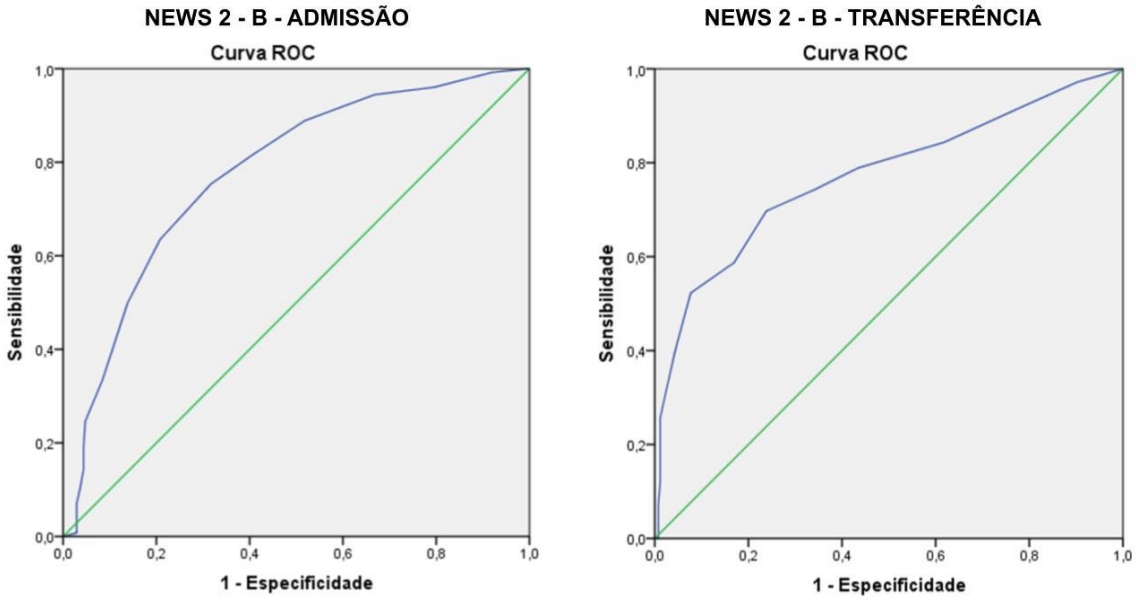

Figure 1 - ROC curve graphic for the NEWS 2 – Brazilian version score at admission and at transfer related to the death outcome. Porto Alegre, RS, Brazil, 2020-2021

The optimal cut-off point for the death outcome was defined at the score of six (6), measured after accuracy assessment with significance in the Pearson chi-squared test ($p<0.001$) and Kappa test ($p<0.001$) and no statistical significance in the McNemar test ($p=0.324$).

Discussion

The results found indicate that the profile with the highest severity among admitted patients with COVID-19 was associated to unfavorable outcomes, showing the capability of prediction of death by the NEWS 2 – BR score. Such data, added to the lack of any other Brazilian validation of the score in that population, encourage its inclusion in the assessment of patients suffering from COVID-19, especially in the hospital and emergency environment.

The social-demographical variables presented were similar to others found in academic literature. The median age and gender distribution were similar to data of other research.[15-19] It was noticed, in Brazil, a high proportion of comorbid elderly suffering from that disease, being described as a higher risk profile for more severe cases of the disease,[20-21] data also found in this study. Mortality had similar data to the other national sample,[20] but higher than that identified in developed countries.[6,11,15,17-19,22]

The median of 2 points in the NEWS 2 score at admission of patients suffering from COVID-19 was identified in a population in India,[23] presenting a range from 0 to 6 points, showing similarity to this study. The data found in that study showed that the highest NEWS 2 scores were associated to death, while the lowest scores were associated to the discharge outcome,[23] which also occurred in the application of the NEWS 2 - BR in the same population, in the Brazilian scenario. Such information corroborate the importance of applying that score in the admission of patients, associated to other tools of Risk Rating, and in the decision-making regarding assignment and/or transfer to units with higher or lower monitoring frequency. In face of the need for fast identification of patients with higher risk of clinical deterioration, the score adds to a safer care process.

In international scenarios, the ROC curve values for occurrence of unfavorable outcomes have shown higher accuracy than that found in this Brazilian investigation, being 0.809 in China,[24] 0.813 in India,[25] 0.822 in Norway,[26] 0.82 in the Netherlands,[27] 0.87 in Italy,[12] and 0882 in England,[28] corroborating the international recommendations to use the score to assess the severity in that profile of patients. Nevertheless, with an accuracy of 0.776 at admission, the Brazilian data are still similar to the Chinese data.[24]

The cut-off point of 6 at admission and transfer indicates an hourly monitoring, which would be performed in critical and semi-critical units in Brazil. However, it is known that such type of unit is not a reality in the domestic scenario. An alternative, in such cases, would be the stabilization of patients in the Emergency Room for later referral to Patient Care Units where the assessment periodicity is usually of 6 hours or once at every shift (morning, afternoon and night). The NEWS 2 – BR has important characteristics for assessment of clinical patients suffering from COVID-19, as it includes oxygen saturation and use of auxiliary oxygen in its components.[12] Although it is widely

applied in Europe, the score needs greater visibility in the Brazilian scenario and research such as this study broaden that process.

Similar data regarding the cut-off point has been found in other studies, presenting a NEWS 2 ≥5 score at admission as statistically associated to the prediction of severe disease.[6,7,23] Cut-off values identical to those presented in that population (NEWS 2 ≥6) have also been found in other investigations and indicated as a predictor of severe events for such patient profile.[13,22,26] Other findings suggest that NEWS 2 ≥7 scores would be associated to the need for mechanical ventilation,[29] however, such data has not been analyzed at this moment.

It is worth mentioning, as limitations, the assessment of patients prior to the creation and availability of vaccines in the Brazilian scenario, which could characterize a more severe profile of those patients at admission. Furthermore, the use of data collected from health records and the lack of assessment of overcrowding of medical units in critical periods of the pandemic. It is suggested that further investigations, including the evaluation of changes in the virus and pathology behavior, should be carried out.

However, the findings presented bring important results in the assessment and assistance of patients suffering from COVID-19, as the more severe the patients, the greater the need to place them in areas of critical assistance and/or monitoring. It is believed that such findings corroborate other domestic and international studies previously mentioned and advance, in the sense of presenting evidence regarding the use of NEWS 2 – BR as an early warning score that may indicate to healthcare teams and hospital managers the monitoring periodicity/need. Furthermore, it proves that NEWS 2 – BR may serve as a reference for decision-making regarding the transfer and resource planning. Such decisions surely impact directly the sequence of events, treatments and care and may contribute to the safety of patients suffering from COVID-19 during the hospitalization and, perhaps, contribute to reduce hospital mortality.

Conclusion

The study shows that NEWS 2 – BR is a valid early warning score to predict outcomes in the population suffering from COVID-19. It was possible to prove that lower

score values at admission and transfer are associated to hospital discharge, while higher values are associated to death, with a cut-off point of NEWS 2 – BR ≥ 6 points for prediction of mortality. The results show that, with data measured daily in the assistance routine of Brazilian hospitals, it is possible to predict outcomes and, thus, benefit the care provided.

In scenarios such as the COVID-19 pandemic, marked by overcrowding of healthcare institutions and the need for fast intervention, the NEWS 2 – BR presented good results, becoming an important tool. Such findings enable to indicate that the NEWS 2 – BR should be included in the assessment process of patients in emergency rooms and other care units, and that it should be used for early identification of clinical deterioration, contributing to the decision-making regarding the transfer of patients and phasing of their monitoring.

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Authorship Contributions

1 – Ana Paula Amestoy de Oliveira
Corresponding Author
Nurse, Master - anapamestoy@gmail.com
Conception and development of the research and/or writing the manuscript, review and approval of the final version.

2 – Andressa Golembieski Machado
Nurse - andressa.machado99@edu.pucrs.br
Conception and development of the research and/or writing the manuscript.

3 – Giovana Rossi Usevicius
Nurse, Specialist - giovana.usevicius@acad.pucrs.br
Conception and development of the research and/or writing the manuscript.

4 – Janete de Souza Urbanetto
Nurse, PhD - jurbanetto@pucrs.br
Conception and development of the research and/or writing the manuscript, review and approval of the final version.

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