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Predictive Performance of Rapid Scoring Scales in Intensive Care Patients with COVID-19

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Summary

COVID-19 remains one of the most significant causes of hospital admissions and deaths, frequently associated with septic complications. Reliable and simple prognostic tools are required to identify patients at high risk of developing sepsis and death early on.

Aim of the study. To evaluate the prognostic ability of the REMS, NEWS, NEWS2, qSOFA, and SIRS criteria in predicting sepsis, septic shock, and mortality in patients with COVID-19.

Materials and methods. A retrospective study was performed on 870 patients with confirmed COVID-19 who were hospitalized in anesthesiology and intensive care units. REMS, NEWS, NEWS2, qSOFA, and SIRS scores were calculated for each patient upon admission. The predictive ability of the scales was evaluated using ROC analysis, temporal associations were assessed using the Cox proportional hazards model, and the cumulative risk of outcome was assessed using the Kaplan–Meier method.

Results. The REMS scale demonstrated satisfactory predictive ability for mortality and septic shock (AUC = 0.780 and 0.724, respectively) and unsatisfactory for sepsis (AUC = 0.677), $p < 0.0001$. The NEWS, NEWS2, qSOFA, and SIRS scales showed unsatisfactory results for all outcomes. The Kaplan–Meier analysis showed that patients with high REMS scores developed sepsis or septic shock earlier and had shorter survival ($p < 0.0001$). The Cox model identified REMS as the scale with the highest risk ratio (HR 1.215; 95% CI 1.178–1.254) and concordance index (C = 0.656).

Conclusion. The REMS, NEWS, NEWS2, qSOFA, and SIRS rapid scales have a statistically significant prognostic value, but only the REMS provides a satisfactory accuracy in predicting septic shock and death in patients with COVID-19. The study was limited by its single-center and retrospective design.

Keywords: COVID-19 mortality risk; rapid scales; REMS; NEWS; NEWS2; qSOFA; SIRS criteria; sepsis; septic shock

Conflict of interest. The authors declare no conflict of interest.

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Introduction

According to the World Health Organization, about 404 000 deaths related to SARS-CoV-2 (coronavirus 2-related severe acute respiratory syndrome) were registered in the Russian Federation at the end of December 2025 [1]. Although the COVID-19 pandemic had actually ended by the end of 2025, and COVID-19 infection incidence had decreased, sepsis and septic shock complicated by multiple organ failure remain common in patients with severe COVID-19 [2]. Despite high mortality rates among patients with these complications [3–5], there are still no simple and validated tools for early prediction of sepsis and septic shock in patients with COVID-19 in the Russian Federation.

The world literature describes the widespread use of early warning scores, i. e., rapid scoring systems/scales (RSS) such as the quick Sequential Organ Failure Assessment (qSOFA) [6, 7], National Early Warning Score (NEWS) and NEWS2 [8, 9], Rapid Emergency Medicine Score (REMS) [10], and Systemic Inflammatory Response (SIRS) criteria [11] for rapid assessment of disease severity in critically ill patients. However, RSS comparative prognostic performance in patients with COVID-19, not only in relation to sepsis and/or septic shock, but also in relation to mortality, has not been sufficiently studied. This necessitates a comparative analysis of several rapid scoring systems in the same cohort of patients and comparison of their diagnostic characteristics.

In this regard, the aim was to compare the prognostic value of the REMS, NEWS, NEWS2, qSOFA scoring systems and criteria for predicting the development of sepsis, septic shock, and in-hospital mortality in emergency department patients with COVID-19, and to build a proportional hazards model to assess the potential interdependence between score numbers and time to development of an adverse outcome.

Materials and Methods

A retrospective observational study was conducted using data from electronic medical records (EMR) of patients who were hospitalized between April 2020 and January 2022 in the Department of Anesthesiology and Intensive Care /Emergency Department (ICU/ED) of the Krasnodar Clinical Hospital No. 2. The study was approved by the local ethics committee (protocol No. 104 dated 22.10.2021).

Totally 986 patients data were analyzed, 116 were excluded according to the exclusion criteria. For the final analysis, the data of 870 patients were used, of which 492 (56.6%) died, 516 (59.3%) developed sepsis, and 429 (49.3%) developed septic shock.

Verification of SARS-CoV-2 infection (ICD-10 code U07.1) was based on recorded diagnosis confirmed by positive PCR tests in patients' EMR (according to Rospotrebnadzor). The outcomes were recorded based on the date of the event in the EMR. If a lower respiratory tract infection (COVID-19-associated pneumonia) was recorded in patient's EMR, it was considered as potential cause of sepsis or septic shock. The diagnoses were used as they were reported by attending physicians, without retrospective reclassification.

The study included patients over the age of 18 who were admitted ICU/ED with confirmed or suspected diagnosis of coronavirus infection at the time of admission. Patients were excluded from the study if necessary for analysis information lacked in their medical records (physical and laboratory parameters, and outcome data); if they had hematological diseases; if they had surgery (except for tracheostomy) prior to admission; if they had malignant neoplasms (MN); if they were part of the pre-mortality cohort; if they were receiving programmable hemodialysis; if they had CHF stage 2B or higher; if they were in the acute phase of stroke or traumatic brain injury; and if they were on mechanical ventilation at the time of admission to ICU/ED.

Out of total 870 patients analyzed with median age of 66.0 (55.0–75.0) years 414 (47.6%) were men. All patients were managed according to the temporary guidelines of the Ministry of Health of the Russian Federation [12] and the methodological recommendations of the Federation of Anesthesiologists-Reanimatologists of Russia (FAR) [13].

The study database included demographic (gender and age) data, records of sepsis, septic shock and SARS-CoV-2 infection diagnoses, patients outcome data (discharge from the hospital or death), and info on other clinical parameters necessary for implementing the qSOFA, NEWS, NEWS2, REMS, and SIRS RSS. The scores were calculated retrospectively based on clinical data recorded in the first minutes of ICU/ED admission.

Nonparametric methods were used for statistical data analysis due to the non-normal distribution of most quantitative variables (according to the Shapiro–Wilk test). Quantitative variables were presented as median and interquartile range (*Me* (*Q1*; *Q3*); qualitative variables were presented as absolute values (*n*) and percentages.

Quantitative variables were compared using the Mann–Whitney test. Categorical variables were compared using the χ^2 test; Fisher's exact test was used for small expected frequencies.

The predictive performance of the REMS, NEWS, NEWS2, qSOFA scoring systems, and SIRS was evaluated using ROC analysis to determine the area under the curve (AUC), 95% confidence interval (95% CI), sensitivity, specificity, and Youden index (J) to identify the optimal threshold value. According to the commonly accepted Hosmer–Lemeshow classification [14], the predictive power was assessed as follows:

- as unsatisfactory at AUROC $<$ 0.7;
- satisfactory at AUROC = 0.7–0.8;
- good at AUROC = 0.8–0.9;
- excellent at AUROC $>$ 0.9.

Sensitivity or specificity values of $\geqslant$0.90 were considered high, of 0.80–0.89 — satisfactory, and $<$0.80 were considered moderate or low.

Cumulative risk and time to adverse outcomes (sepsis, septic shock, death) were assessed using the Kaplan–Meier method with log rank test to compare curves. To clarify the effect of score number on different RSS on the risk of adverse outcome, the Cox proportional hazards model was used with the calculation of hazards ratios (HR) and 95% CI. The proportional hazards (PH) assumption was tested using the Schoenfeld residue test. Due to detected violation of PH assumption for the REMS scoring system, the Cox model with the time-dependent REMS effect was used.

Patients were stratified according to the threshold values of the RSS, determined by the ROC analysis.

Statistical significance was accepted at $p < 0.05$. The data were processed using the MedCalc 20.027 program (MedCalc Software Ltd., Belgium). R version 4.5.1 was used to test the proportional hazards assumption using Cox regression.

The Results of the Study

The patient selection scheme is presented in Fig. 1.

Table 1 presents a comparison of baseline parameters analyzed in the rapid clinical scoring systems for surviving and non-surviving patients.

Patients who died were, on average, older than the survivors, more often had impaired consciousness, higher respiratory rate, and lower pulse oximetry values, indicating the need in oxygen support. Sepsis and septic shock were more common in non-survivors.

Results of ROC-analysis of the mortality, sepsis and septic shock prediction.

ROC-analysis results of the rapid scoring systems performance in mortality prediction are presented in Table 2.1.

The REMS scoring system demonstrated a satisfactory predictive power (AUC 0.780; 95% CI 0.751–0.807, $p<0.0001$). The optimal threshold value (cut-off) was >4 scores with a satisfactory sensitivity of 81.1% and a low specificity of 61.5% (Youden J index 0.425).

The predictive performance of the NEWS (AUC 0.678), NEWS2 (AUC 0.678), qSOFA (AUC 0.618) scoring systems, and SIRS (AUC 0.578) was unsatisfactory.

The results of the ROC analysis of RSS performance in prediction of sepsis are presented in Table 2.2.

All RSS showed unsatisfactory accuracy in prediction of sepsis.

The results of the ROC analysis of rapid scoring systems performance in prediction of septic shock are presented in Table 2.3.

The REMS showed the highest area under the ROC curve (AUC 0.724; 95% CI 0.693–0.754, $p<0.001$]), demonstrating the best combination of moderate sensitivity (79.75%) and low specificity (52.9%).

The NEWS (AUC=0.642), NEWS2 (AUC=0.639), qSOFA (AUC=0.592), and SIRS (AUC=0.574) RSS showed poor predictive ability.

The comparative ROC curves of the rapid scoring systems in predicting outcomes are presented in Fig. 2. REMS had statistically significant differences in AUROC compared to the other rapid scoring systems ($p<0.001$).

The analysis of survival data: the Kaplan–Meier method.

Kaplan–Meier analysis was performed only for the REMS due to unsatisfactory discrimination capacity of other rapid scoring systems.

For Kaplan–Meier survival analysis, patients were stratified into high- and low-risk groups according to RSS thresholds for different outcomes determined by ROC analysis.

For REMS, the cutoff point was >4 for all outcomes; 325 (37.4%) patients were in the low-risk group, and 545 (62.6%) were in the high-risk group.

The time-to-endpoint/event (TTE) analysis was conducted within the entire hospital stay. The length of follow up (FUP) for each patient was defined as the interval from admission to the occurrence of specific event (death, sepsis, or septic shock), or until discharge from the hospital, after which the case was considered as a censored observation. The maximum FUP corresponded to duration of hospital stay for the patient with the longest stay. The achievement of 100% cumulative probability on the Kaplan–Meier curves reflected the fact that by the end of FUP, all patients under FUP had experienced an event, and did not indicate universal mortality or total complication development.

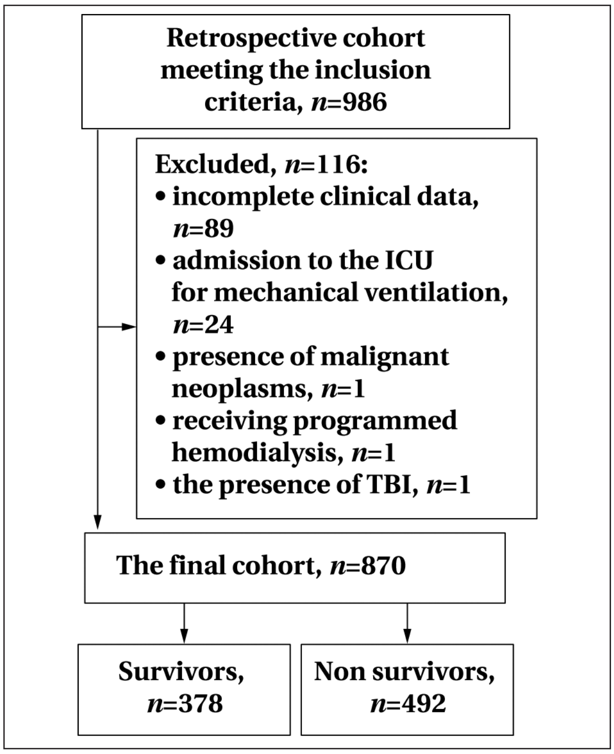

Fig. 1. Patient selection scheme.

Kaplan–Meier analysis for the REMS scoring system showed statistically significant differences for all events (Table 3, Fig. 3).

For all events, there were statistically significant differences between high-risk and low-risk patients ($p<0.0001$). The median time to event was statistically significantly shorter in high-risk patients.

Results of univariate Cox regression analysis.

The Cox proportional hazards analysis was also performed only for the REMS.

The results of the analysis (Table 4) showed that REMS demonstrated a statistically significant association for all events: HR 1.215 for death, HR 1.154 for sepsis, and HR 1.214 for septic shock ($p<0.0001$ in all cases).

In the time-dependent covariate model, the REMS interaction with time did not reach statistical significance for mortality ($p=0.112$), indicating that there was no significant temporal modification of the effect. The effect decreased over time for sepsis

Table 1. Characteristics of patients upon admission to the ICU/ED.

Parameters	Parameters value			*p*
	All patients, *n*=870	Survivors, *n*=378	Non–survivors, *n*=492	
Age, y, *Me* (*IQR*)	66.0 (55.0–75.0)	57.0 (39.3–68.0)	71.0 (64.0–79.0)	<0.0001*
Mortality, *n* (%)	492 (56.6)			
Systolic BP, mm Hg *Me* (*IQR*)	125.0 (120.0–130.0)	125.0 (120.0–130.0)	126.5 (120.0–131.0)	0.5202
Diastolic BP, mm Hg *Me* (*IQR*)	80.0 (70.0–80.0)	79.0 (70.0–80.0)	80.0 (70.0–80.0)	0.9080
Median BP, mm Hg *Me* (*IQR*)	93.0 (87.8–97.0)	93.0 (87.0–97.0)	93 (88.0–97.0)	0.5110
HR, bpm, *Me* (*IQR*)	82.0 (78.0–90.3)	81.0 (77.0–90.0)	82.0 (78.0–95.0)	0.1974
RR/ min, *Me* (*IQR*)	19.0 (18.0–20.0)	18.0 (18.0–20.0)	19.0 (18.0–21.0)	0.0001*
SpO_2, %, *Me* (*IQR*)	94.0 (88.0–96.0)	95.0 (92.3–97.0)	93.0 (85.0–96.0)	<0.0001*
Body temper., °C, *Me* (*IQR*)	37.2 (36.7–37.8)	37.1 (36.7–37.7)	37.2 (36.7–37.8)	0.6112
GCS, scores. *Me* (*IQR*)	15 (15–15)	15 (15–15)	15 (14–15)	<0.0001*
Oxygen therapy, *n* (%)	489 (56.2)	167 (43.3)	322 (66.1)	<0.0001*
Sepsis, *n* (%)	516 (59.3)	91 (24.1)	425 (86.4)	<0.0001*
Septic shock, *n* (%)	429 (49.3)	8 (2.1)	421 (85.6)	<0.0001*

Note. BP — blood pressure; HR — heart rate; RR — respiratory rate; GCS — Glasgow Coma Scale. For tables 1, 3: *Me* — median; *IQR* — interquartile range. * — $p<0.05$ according to the Fisher exact test for qualitative indicators and the Mann–Whitney test for quantitative indicators

Table 2.1. ROC analysis of in-hospital mortality prediction.

Scoring system	AUC (95% CI)	Cut-off	Sensitivity, %	Specificity, %	Youden J index	*p*
REMS	0.780 (0.751–0.807)	>4	81.07	61.46	0.4253	<0.0001
NEWS	0.678 (0.646–0.709)	>7	54.12	73.96	0.2807	<0.0001
NEWS2	0.678 (0.646–0.709)	>6	62.96	66.15	0.2911	<0.0001
qSOFA	0.618 (0.584–0.650)	>0	44.03	76.82	0.2086	<0.0001
SIRS	0.578 (0.544–0.611)	>1	41.56	71.09	0.1266	<0.0001

Note. For tables 2.1–2.3: AUC — area under curve; cut-off point with the highest Youden J index value.

Table 2.2. ROC analysis of sepsis prediction

Scoring system	AUC (95% CI)	Cut-off	Sensitivity, %	Specificity, %	Youden J index	*p*
REMS	0.677 (0.645–0.708)	>4	73.39	53.63	0.2702	<0.0001
NEWS	0.613 (0.580–0.646)	>5	69.47	47.49	0.1696	<0.0001
NEWS2	0.608 (0.575–0.641)	>6	57.34	60.06	0.1739	<0.0001
qSOFA	0.579 (0.545–0.612)	>0	40.12	72.91	0.1302	<0.0001
SIRS	0.583 (0.549–0.616)	>1	41.68	72.07	0.1375	<0.0001

Table. 2.3. ROC analysis of septic shock prediction.

Scoring system	AUC (95% CI)	Cut-off	Sensitivity, %	Specificity, %	Youden J index	*p*
REMS	0.724 (0.693–0.754)	>4	79.75	52.90	0.3266	<0.0001
NEWS	0.642 (0.609–0.674)	>7	53.33	68.39	0.2172	<0.0001
NEWS2	0.639 (0.606–0.671)	>6	62.72	60.86	0.2358	<0.0001
qSOFA	0.592 (0.558–0.624)	>1	18.77	96.13	0.1489	<0.0001
SIRS	0.574 (0.541–0.607)	>1	42.22	69.46	0.1168	<0.0001

(HR 0.937 [95% CI 0.904–0.972]) and septic shock (HR 0.961 [95% CI 0.926–0.997]).

Discussion

The analysis confirmed the predictive value of REMS for assessing events in patients with COVID-19, including in-hospital mortality, sepsis, and septic shock. According to the ROC analysis, the REMS scoring system showed the highest AUC for all three endpoints, indicating its best discriminatory capacity in the study cohort. NEWS, NEWS2, qSOFA, and SIRS demonstrated low AUC values, reflecting their limited value for risk stratification in the context of COVID-19.

The results obtained are consistent with previously published studies. In the works of Vedovati et al. [15] and Tsai et al. [16], REMS showed similar values (AUC 0.793 and 0.773, respectively) in predicting mortality. Similar results were obtained by Kamal et al. [17], where a combined endpoint (severe pneumonia, ARDS, sepsis, and septic shock) was evaluated, with an AUC of 0.765, which is close to the data presented in the study.

The NEWS and NEWS2 rapid scoring systems demonstrated low predictive power. This is consistent with the results of J. Alencar et al. [18] and S. Accordino [19], who obtained AUC<0.7 for NEWS when predicting mortality in patients with COVID-19,

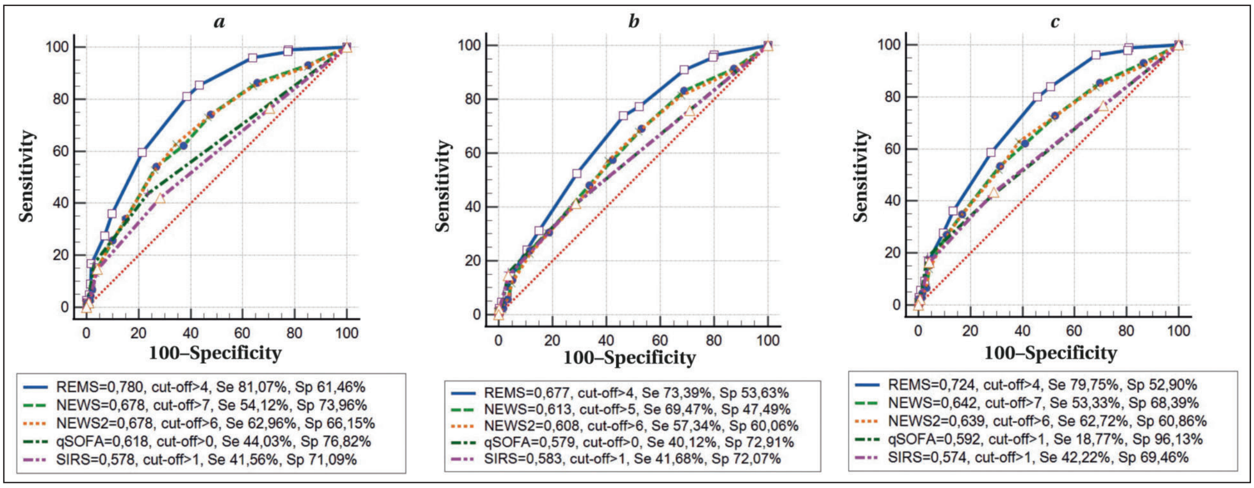

Fig. 2. Comparative ROC curves of the rapid scoring systems in prediction of: (*a*) death; (*b*) sepsis; (*c*) septic shock.
Cut-off — is the point with the highest Youden J index; Se — sensitivity; Sp — specificity.

Table 3. Kaplan-Meier analysis of cumulative probability of outcomes (REMS).

Event	χ^2	*p*	HR (95% CI)	Median time, days, *Me* (IQR)	
				low risk	high risk
Death	95.50	<0.0001	2.57 (2.13–3.10)	16 (15–21)	9 (8–10)
Sepsis	45.71	<0.0001	1.89 (1.57–2.27)	15 (14–16)	10 (9–11)
Septic shock	73.01	<0.0001	2.42 (1.97–2.96)	18 (16–21)	11 (10–13)

Note. χ^2 is the value of the log-rank test for comparing survival curves; HR is the hazards ratio calculated using the Cox model.

Table. 4. Results of univariate Cox regression analysis (REMS).

Outcome	χ^2	*p*	HR (95% CI)	C (95% CI)
Death	143.69	<0.0001	1.215 (1.178–1.254)	0.656 (0.630–0.681)
Sepsis	77.75	<0.0001	1.154 (1.118–1.191)	0.611 (0.585–0.637)
Septic shock	122.72	<0.0001	1.214 (1.174–1.256)	0.651 (0.624–0.678)

Note. χ^2 is the value of the chi-square criterion for the general model; HR is the hazards ratio; C-index is the Harrell's concordance index; 95% CI is the confidence interval

and the data of L. J. Scott et al. [20] and P. A. G. Aristizabal et al. [21], who also obtained unsatisfactory results (AUC 0.65 and 0.68, respectively) when evaluating NEWS2 for predicting mortality.

To our knowledge, there are currently no articles with a separate assessment of the predictive power of NEWS and NEWS2 in relation to development of sepsis or septic shock. However, M. Kamal et al. [17] evaluated NEWS2 as a predictor of severe disease (severe pneumonia, ARDS, sepsis, and septic shock), obtaining an AUC of 0.739. However, the sample size was limited ($n=219$), so the results of this study should be interpreted with caution.

For qSOFA and SIRS, the obtained results (AUC 0.58–0.62) also correspond to the published data. J. Alencar et al. [18] reported low accuracy of qSOFA and SIRS in predicting 30-day mortality (AUC 0.55 and 0.58, respectively). In the study by M. Kamal et al. [17] qSOFA AUC equaled 0.671 in prediction of severe disease (severe pneumonia, ARDS, sepsis, and septic shock),

For the first time, the REMS was evaluated as a risk stratification tool in the analysis of time to adverse outcome in patients with COVID-19. It was found that stratification of patients into low (⩽4 scores) and high (>4 scores) risk groups using REMS scoring system was associated with statistically significant differences in the time to adverse events, which was confirmed using the Kaplan–Meier method.

Unlike previously published studies [22], which mainly applied survival analysis methods to individual physiological parameters included in the REMS scoring system, the present study used the total REMS score as an integral prognostic indicator in the TTE analysis.

The Kaplan-Meier analysis data were consistent with the Cox regression analysis, which showed that REMS had the highest hazard ratio (HR = 1.215; 95% CI 1.178–1.254) and the highest concordance index (C = 0.656). This confirms the steady relationship between the severity of illness expressed by REMS and the probability of adverse events. However, in the analysis of time to death, sepsis and septic shock, the proportional hazards assumption for the REMS was violated. To correctly assess the effect of REMS, a Cox model with a time-dependent covariate was used, taking into account that REMS influence on the risk evolves over time. The prognostic value of REMS for sepsis and septic shock was highest in the early stages of hospital stay and gradually decreased over time, highlighting its high clinical significance for early identification of patients at high risk of adverse events. For mortality, the temporal dependence of the REMS effect did not reach statistical significance.

It should be noted that the results of this retrospective study largely agree with the results of earlier published by our group meta-analysis [23], where the REMS, NEWS, NEWS2, qSOFA rapid scoring systems and the SIRS criteria showed similar performance in predicting in-hospital mortality (AUC 0.808; 0.782; 0.749; 0.722 and 0.662, respectively) and adverse events (AUC 0.733; 0.778; 0.778, 0.662, and 0.607, respectively), however, the quality of GRADE evidence for all rapid scoring systems was low or very low due to high risks of systematic error, possible publication bias, or high heterogeneity. However, only the REMS scoring system had moderate evidence quality due to its strong effect (AUC for mortality of 0.82), low risk of bias, and lack of publication bias.

The advantage of REMS is probably due to its comprehensive nature: the scoring system takes into account not only physiological parameters (respiratory rate, heart rate, blood pressure, level of consciousness and saturation), but also age — an independent predictor of mortality in COVID-19. Thus, REMS reflects both the severity of the systemic inflammatory response and the reserve capacity of the body.

The unsatisfactory predictive power of NEWS, NEWS2, qSOFA, and SIRS is likely due to deviation from their intended use. NEWS and NEWS2 were primarily designed for early detection of disease worsening in hospitalized patients, while qSOFA and SIRS are focused on screening for sepsis rather than predicting outcomes in critically ill patients. It should be mentioned that the assessment of the qSOFA prognostic significance for identifying patients at higher risk of developing or already experiencing sepsis or septic shock has a methodological limitation associated with the partial overlap of the qSOFA predictors with the clinical criteria used to establish these complications, which may lead to biased estimates of prognostic accuracy. Despite this limitation, the analysis of the qSOFA predictive power for sepsis and septic shock appears to be clinically relevant, as this RSS was initially proposed as a tool for early identification of patients with infection who are at increased risk of adverse outcomes.

It is important to note that in the current study, the prognostic characteristics of NEWS, NEWS2, qSOFA, and SIRS were lower than in several publications from the early stages of the COVID-19 pandemic and in our previous meta-analysis [23]. This may be due to several factors. Firstly, the study included only a cohort of ED patients with high incidence of sepsis, septic shock, and high mortality rate, while numerous early studies analyzed more

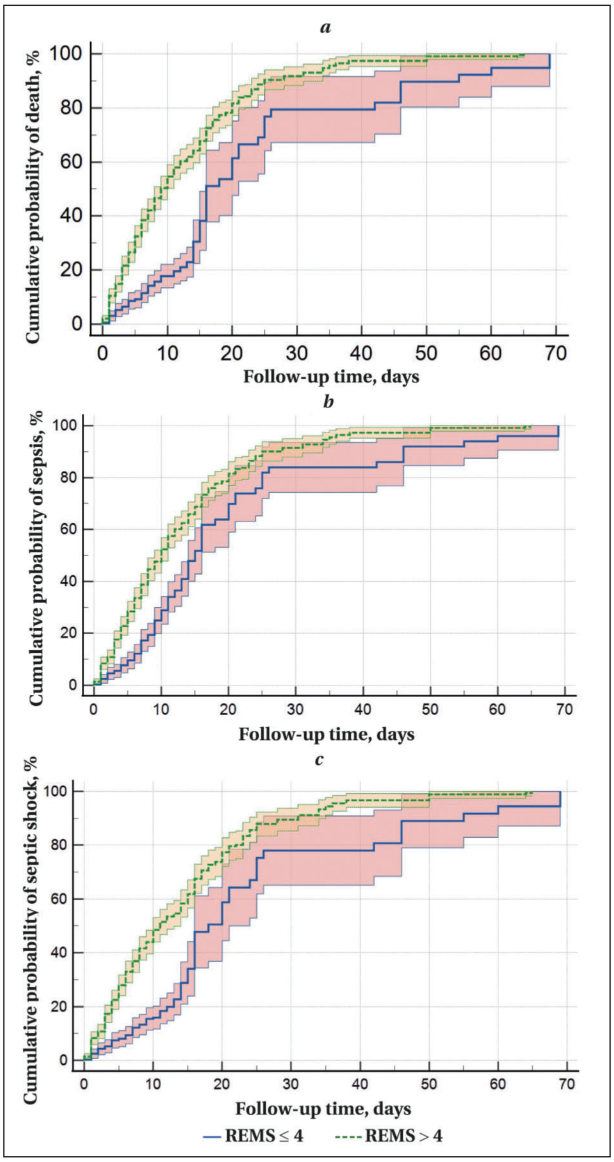

Fig. 3. Kaplan-Meier curves for mortality (*a*); sepsis (*b*); and septic shock (*c*).

heterogeneous hospital cohorts. In the cohort of initially severely ill and clinically homogeneous patient population, the discriminatory capacity of universal rapid scoring systems naturally decreases. Secondly, studies in the early stages of COVID-19 pandemic were conducted in different clinical and epidemiological situation, with different structure of hospitalized patients, different treatment strategies, and a lack of experience in managing this patient population, making it difficult to directly compare AUC values. Thirdly, some of the early publications reported combined endpoints that included admission to the intensive care unit, respiratory failure, mechanical ventilation, or other adverse events, whereas the current study focused on specific adverse clinical events. Finally, some of the high scores reported in earlier studies should be interpreted with caution, as the quality of evidence for most of the RSS remained low or very low due to significant heterogeneity, the risk of bias, and potential publication bias [23].

It is worth noting that the inclusion of the NEWS, NEWS2, qSOFA scoring systems and SIRS in the analysis of mortality prediction was due to their widespread use in real clinical practice as rapid tools for initial assessment of disease severity and risk stratification. During the pandemic, these RSS were often used at the pre-hospital stage, in admission departments, and for triage, making it clinically relevant to evaluate their predictive capacity in relation to the most severe endpoint, which is mortality. Thus, inclusion of these scoring systems in the study had a comparative goal of their performance evaluation, i. e., determining the extent to which widely used rapid scoring tools retain their discriminatory capacity in a cohort of severely ill COVID-19 patients admitted to ICU/ ED.

The results obtained are consistent with the current data that REMS is a universal tool capable of assessing the risk of death and complications in a wide range of critically ill patients. The use of REMS in clinical practice can improve the accuracy of early risk stratification in patients with COVID-19 and facilitate the timely initiation of intensive care.

The study has several limitations. Its retrospective nature may contribute to systematic errors in data collection, and its single-center design limits the generalizability of the results. Additionally, there is a lack of external validation, which requires confirmation of the findings in independent samples. Nevertheless, the use of three independent statistical approaches (ROC analysis, survival analysis, and Cox regression) ensured high consistency and statistical significance of the obtained data. It is important to note that the study sample consisted of ICU/ ED patients, yielding high incidence of fatal outcomes, sepsis, and septic shock. Therefore, the results obtained characterize the predictive value of the studied rapid scoring systems in the population of hospitalized severely ill patients, and cannot be directly extrapolated to a broader population of patients with COVID-19.

In general, the results confirm that the REMS is the most accurate tool for predicting in-hospital mortality and septic complications in patients with COVID-19, while NEWS and NEWS2 are suitable for dynamic monitoring, and qSOFA and SIRS can be used as auxiliary screening tools at the pre-hospital and early hospital stages.

Conclusion

The REMS, NEWS, NEWS2, qSOFA rapid scoring systems, and SIRS have a statistically significant value for prediction of sepsis, septic shock and in-hospital mortality in patients with COVID-19.

Only the REMS scoring system showed satisfactory accuracy for predicting mortality and septic shock in patients with COVID-19.

The NEWS, NEWS2, qSOFA scoring systems, and SIRS have unsatisfactory predictive power, and cannot be recommended for stratifying the severity of illness in patients with COVID-19, and for predicting adverse events when used as tools for primary risk stratification upon admission. However, these scoring systems are valuable for dynamic monitoring of patients' condition.

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