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Comparison of the validity of APACHE II, SOFA, and SAPS II scoring systems with EWS and modified SOFA (MSOFA) as predictors of mortality and length of stay in ICU patients at Wahidin Sudirohusodo Hospital

Fuad Widianto[1], Ari Santri Palinrungi[1,2], Faisal Muchtar[1,2], Syamsul Hilal Salam[1,2], Muhammad Rum[1], Andi Adil[1,2]

Abstract

***Background*: Intensive Care Units (ICUs) are vital for critically ill patients, yet face high mortality rates (27.6% in Indonesia) and significant costs, necessitating efficient resource allocation. To improve patient care and resource utilization, scoring systems such as the Acute Physiology and Chronic Health Evaluation II (APACHE II), Sequential Organ Failure Assessment (SOFA), Simplified Acute Physiology Score II (SAPS II), Early Warning Scores (EWS), and Modified SOFA (MSOFA) are used to assess illness severity and predict outcomes. This research at Wahidin Sudirohusodo Hospital aimed to validate the predictive power of these scores for mortality and length of stay in intensive care unit (ICU) patients, ultimately enhancing critical care quality, and informing admission criteria.**

***Methods*: This retrospective study employed a diagnostic and longitudinal cross-sectional design, analyzing data from 210 ICU patients admitted to Dr. Wahidin Sudirohusodo Hospital in Makassar between January 2023 and January 2024. The dataset included EWS, APACHE II, SAPS II, SOFA, and MSOFA scores. Numerical variables were summarized as mean±standard deviation. Receiver operating characteristic (ROC) curves were used to assess diagnostic accuracy (AUC, cut-off values, sensitivity, specificity), while Spearman's Rho was employed for correlation analysis, and the Kruskal-Wallis test for comparative analysis.**

***Results*: While APACHE II, SAPS II, SOFA, EWS, and MSOFA scores generally predicted mortality and ICU length of stay, EWS was less accurate, particularly for long-term predictions, though combining it with other scores improved the results. APACHE II excelled in predicting long-term mortality, SAPS II for 2-7 day mortality, and SOFA was strong across all time frames. MSOFA was the most accurate for predicting very short-term mortality (≤1 day) and showed the strongest correlation with length of hospital stay.**

***Conclusion*: Various scoring systems, including APACHE II, SAPS II, SOFA, EWS, and MSOFA, have been shown to be valid in predicting patient mortality and ICU length of stay. While EWS has lower predictive ability, particularly for medium and long-term mortality, combining it with other scores could improve accuracy. Specifically, MSOFA demonstrated the best performance in predicting short-term mortality (≤1 day) and has the strongest correlation with length of stay. SOFA was also an excellent predictor across all mortality timeframes, while APACHE II was most accurate for long-term.**

Keywords: Intensive Care Unit, Early Warning Scores, Acute Physiology and Chronic Health Evaluation II, Simplified Acute Physiology Score, Sequential Organ Failure Assessment, Modified SOFA.

Address for correspondence:
Fuad Widianto
Department of Anesthesiology, Intensive Care, and Pain Management, Faculty of Medicine, Hasanuddin University, Makassar, South Sulawesi, Indonesia
Email: fuad.widianto@gmail.com

[1.] Department of Anesthesiology, Intensive Care, and Pain Management, Faculty of Medicine, Hasanuddin University, Makassar, South Sulawesi, Indonesia
[2.] Department of Anesthesiology, Intensive Care, and Pain Management, Dr. Wahidin Sudirohusodo Hospital, Makassar, South Sulawesi, Indonesia

Introduction

The global average ICU mortality rate is 16.2%, but it varies significantly between countries (ranging from 8% to 26.2%) due to factors like infrastructure, staffing, training, and reasons for intensive care unit (ICU) admission. In the United States, the average is 8-19%, while North America, Oceania, Asia, and Europe report lower rates (9.3-18.7%). In contrast, South America, the Middle East, and Africa show higher ICU mortality rates. (1)

Early Warning Scores

Early Warning Scores (EWS) are a simple, bedside tool developed in 1997 to monitor vital signs (respiration rate, oxygen saturation, temperature, blood pressure, heart rate, and alert, verbal, pain, and unresponsive [AVPU] consciousness level) and identify acute deterioration in patients. EWS helps trigger timely intervention from skilled medical teams (like Critical Care Outreach Services), improving patient outcomes in conditions such as sepsis or stroke by facilitating prompt and adequate treatment. Higher EWS scores indicate a need for more advanced care or transfer to higher-acuity units, such as the ICU or high care unit (HCU). An increased EWS indicates patient deterioration, predicting the need for intensive care and mortality risk. Early identification via EWS, especially high scores (≥9), can potentially prevent deaths, with research showing ICU mortality up to 74% in high-risk groups. (2-4)

Acute Physiology and Chronic Health Evaluation II

Acute Physiology and Chronic Health Evaluation II (APACHE II) is a scoring system used in the ICU to assess disease severity and predict mortality. This score comprises 12 physiological variables, patient age, and chronic conditions, all of which are calculated within the first 24 hours of admission. While generally accurate in predicting mortality (with 75.9% sensitivity and 87.4% specificity at a 16.5 cut-off, where a 1-point increase in score raises the mortality risk by 10%), some studies have noted its limitations in handling complex comorbidities. Nonetheless, APACHE II remains a crucial tool for monitoring critical patient prognosis and enhancing ICU care standards. (5-7)

Simplified Acute Physiology Score

Simplified Acute Physiology Score II (SAPS II), launched in 1993, is a statistical modeling system designed to predict mortality in ICU patients. Developed from a dataset of 13,152 patients, SAPS II utilizes 17 variables (12 physiological, age, type of admission, and three underlying diseases) calculated from the worst values within the first 24 hours. Scores range from 0 to 163, with scores over 24 indicating a higher risk of death. SAPS II demonstrates high accuracy in predicting mortality, boasting an area under the receiver operating characteristic (ROC) curve (AUC) of 0.942, 87.3% sensitivity, and 89.6% specificity at a cut-off of 23.5. Studies suggest that SAPS II is slightly more accurate than APACHE II. For sepsis mortality prediction, SAPS II (AUC=0.981) outperforms APACHE II (AUC=0.978) and SOFA (AUC=0.911). However, for ICU prognosis, a combination of factors should still be considered. (8-10)

Sequential Organ Failure Assessment

Sequential Organ Failure Assessment (SOFA) is a scoring system designed to assess the severity of organ dysfunction in critically ill patients, particularly those with suspected infections. While not initially created to predict mortality, it correlates strongly with patient outcomes. SOFA considers six organ systems (cardiovascular, coagulation, hepatic, respiratory, renal, and neurological) with scores ranging from 0 to 4 for each, providing a total score. A SOFA score with a cut-off of 6.5 shows good sensitivity (73.33%) and specificity (84.38%) for mortality, with scores over 7 indicating a high risk of death. However, SOFA's reliance on detailed medical and laboratory data can make it less efficient and cost-effective. Despite this, it remains a valuable tool, with studies showing its effectiveness in predicting hospital mortality, comparable to the SAPS II, which aids in crucial ICU admission and treatment decisions. (11,12)

Modified SOFA

Modified SOFA (MSOFA) was developed to address the limitations of SOFA outside the ICU, utilizing simpler and more accessible clinical parameters, such as oxygen saturation and daily urine output, instead of the partial pressure of oxygen (PaO2)/fraction of inspired oxygen (FiO2) ratio and serum creatinine. This makes MSOFA highly adaptable for various clinical settings, including emergency departments and hospital wards, particularly in resource-limited environments. Studies show MSOFA's predictive ability for mortality in septic patients is comparable to SOFA, even with its simplified parameters. It effectively detects significant organ failure, a key determinant of mortality risk, with sensitivities ranging from 65-75% and specificities up to 80-85% for 28-day mortality. MSOFA also predicts long-term survival (up to 90 days post-treatment) and is positively correlated with longer ICU and overall hospital stays, indicating its utility

in estimating treatment duration and required interventions. Its high sensitivity in detecting organ failure, especially in multi-organ dysfunction, makes it more reliable than the quick SOFA in both ICU and non-ICU settings. MSOFA's ease of implementation across various clinical environments, along with its ability to integrate into early warning systems, makes it a powerful tool for identifying high-risk septic patients and improving patient outcomes without requiring advanced laboratory facilities. (13)

Methods

This study utilized a retrospective diagnostic and longitudinal cross-sectional design, conducted in the ICU of Dr. Wahidin Sudirohusodo Hospital, Makassar, from January 2023 to January 2024. The sample size was determined using the nomogram technique by Harry King, yielding 210 patient data records. All data were screened based on mortality, EWS, APACHE II, SAPS II, SOFA, and Palliative Performance Scale scores, as well as gender, age, comorbidities, cancer, mechanical ventilation, and sepsis status. Data were collected and statistically analyzed. Numerical variables are presented as mean±standard deviation. Diagnostic accuracy was assessed using ROC curves to determine the AUC and cut-off values. The predictive ability of APACHE II, SOFA, SAPS II, EWS, and MSOFA scores for mortality was evaluated using sensitivity and specificity tests. The correlation between these scoring systems and the length of stay (LOS) was analyzed using Spearman's rho test, while the comparison of LOS based on score categories was performed using the Kruskal-Wallis test. Finally, the mortality rate and length of ICU stay for combinations of EWS with APACHE II, SAPS II, SOFA, and MSOFA scores in deceased patients will be presented as percentages.

Result and discussion

This research evaluated the predictive power of various scoring systems (APACHE II, SAPS II, SOFA, EWS, and MSOFA) for mortality and length of ICU stay. It covered patient demographics, score distribution, and a comprehensive analysis of each score's accuracy (AUC, sensitivity, specificity) and its correlation with patient outcomes across different timeframes. A key highlight was the consistent finding that EWS performed poorly as a standalone predictor but significantly improved accuracy when combined with other, more complex scores, underscoring its role as an initial monitoring tool for clinical deterioration. The study also clearly demonstrated that higher scores across all systems were associated with a longer LOS in the ICU.

Table 1 indicates that among the 210 studied patients, the average age was 60 years (median 62, interquartile range [IQR] 50-75 years), showing a fairly wide age range. The majority of patients were male (57.1%) and admitted post-surgery (65%). The most common diagnosis was sepsis (40.5%). The overall ICU mortality rate was 20%, with most patients (80%) surviving. Regarding the LOS, the majority of patients (57.1%) stayed for 2-7 days, while 33.3% had longer stays (8-30 days), and 9.5% stayed for less than 1 day.

Table 2 summarizes the disease severity and organ dysfunction scores for ICU patients. The average APACHE II score was 23 (median 19), SOFA 8 (median 7), SAPS II 40 (median 38), EWS 5 (median 5), and MSOFA 6 (median 6). The median and IQR provided insights into the score distribution, indicating the variation in severity levels among patients.

The ROC curve (**Figure 1**) demonstrates that MSOFA, SOFA, and APACHE II were excellent at predicting ICU patient mortality within ≤1 day, as evidenced by their sharply curved plots and large AUCs. Conversely, EWS showed poor predictive performance for this timeframe, with its curve approximating randomness.

In **Figure 2**, the ROC curves indicate that SOFA, SAPS II, and APACHE II remained accurate predictors of mortality for ICU patients on days 2 to 7 of admission. Their sharp ascent towards the top-left confirmed strong performance. Conversely, EWS showed poor accuracy, approximating random prediction, and was, thus, not recommended for this period.

Figure 3 shows ROC curves that illustrate the varied performance of scoring systems in predicting medium-term ICU mortality (days 8 to 30). Curves that sharply bent towards the upper left indicated strong predictive capabilities. In contrast, those that approached or fell below the diagonal line suggested limited accuracy in differentiating patient outcomes during this extended hospital stay.

The AUC values in **Table 3** demonstrate the predictive capabilities of the scores in determining ICU patient mortality across different timeframes. For ≤1-day mortality, MSOFA score (AUC 0.90), SOFA score (AUC 0.88), and APACHE II score (AUC 0.85) were the best predictors. EWS showed the lowest performance with an AUC of 0.68. For 2–7-day mortality, the SOFA score (AUC 0.87) was the top predictor, followed by the SAPS II score (AUC 0.83) and the APACHE II score (AUC 0.82). Again, EWS had a very low AUC (0.50), equivalent to a random guess. For 8–30-day mortality, the

APACHE II score (AUC 0.89) ranked highest, followed by the SOFA score (AUC 0.85) and the SAPS II score (AUC 0.83). EWS consistently performed the worst (AUC 0.45), even falling below the level of random chance. Overall, the APACHE II score and SOFA score consistently demonstrated high accuracy in predicting mortality across all time categories, whereas the EWS score consistently proved inadequate as an ICU mortality prediction tool.

Table 4 presents the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of various scoring systems (APACHE II, SOFA, SAPS II, EWS, and MSOFA) in predicting patient mortality across different timeframes. For ≤1-day mortality, MSOFA score demonstrated the best performance with 93.3% sensitivity and 98.8% specificity, resulting in high PPV (87.5%) and NPV (99.4%). SOFA and APACHE II also showed good results, while EWS had the lowest sensitivity and PPV. For 2–7-day mortality, MSOFA score again excelled with 94.1% sensitivity and 98.8% specificity, alongside excellent PPV (88.9%) and NPV (99.4%). Other systems like SOFA, APACHE II, and SAPS II scores performed well, while the EWS score remained the lowest in sensitivity and PPV. Regarding 8–30-day mortality, both SOFA and MSOFA scores performed exceptionally well, each with 90% sensitivity and 99.4% specificity, yielding high PPV (90%) and NPV (99.4%). APACHE II and SAPS II scores also showed high accuracy, but the EWS score once again presented the lowest sensitivity and PPV.

Table 5 presents the correlation analysis between various scoring systems (APACHE II, SOFA, SAPS II, EWS, and MSOFA) and the length of ICU stay. All scores showed a positive correlation, meaning higher scores were associated with longer ICU stays. MSOFA score (p=0.75) and SOFA score (p=0.70) exhibited the strongest positive correlations, followed by APACHE II score (p=0.65) and SAPS II score (p=0.60), which had moderate correlations. EWS score (p=0.30) showed the weakest positive correlation. This indicated that MSOFA and SOFA scores were the strongest predictors of ICU LOS, while the EWS score had a lower predictive ability.

Table 6 of this study presents a comparison of ICU LOS based on categorized scores from APACHE II, SAPS II, SOFA, EWS, and MSOFA. A Kruskal-Wallis test was used to determine significant differences in median LOS across score categories. Consistently, the median LOS increased with higher score categories across all assessment systems, indicating that patients with higher scores tended to have longer stays in the ICU. These differences were statistically significant ($p<0.001$) for all systems.

Specifically:

- APACHE II: Median LOS increased from 3 days (low score: 0-15) to 12 days (high score: >25).
- SAPS II: Median LOS increased from 4 days (low score: 0-30) to 13 days (high score: >45).
- SOFA: Median LOS increased from 3 days (low score: 0-6) to 11 days (high score: >12).
- MSOFA: Median LOS increased from 3 days (low score: 0-4) to 10 days (high score: >8).
- EWS: Median LOS increased from 2 days (low score: 0-2) to 9 days (high score: >4).

These findings demonstrated a clear relationship between higher scores on these assessment systems and a longer ICU stay. This information could assist clinicians in estimating patient LOS based on their initial scoring.

Analysis of **Tables 7-10** consistently shows a direct relationship between increasing EWS categories and higher mortality rates when combined with other scoring systems (APACHE II, SAPS II, SOFA, and MSOFA). Specifically, high EWS scores combined with high scores from other systems resulted in the highest mortality. Conversely, even with high scores from APACHE II, SAPS II, SOFA, or MSOFA, a low EWS category tended to correlate with lower mortality, underscoring the value of EWS as an indicator of early clinical deterioration. This suggests that combining EWS with more complex physiological scoring systems significantly improves the accuracy of mortality prediction in ICU patients, emphasizing EWS's crucial role as an initial monitoring tool.

Analysis of **Tables 11-14** shows that the average LOS generally increases with higher EWS score categories and higher categories of other scoring systems (APACHE II, SAPS II, SOFA, MSOFA). Patients with a combination of high scores from both EWS and other assessment tools typically experience the longest average length of hospital stays.

Limitations

Based on the limitations of this study, it is recommended to conduct a multi-center prospective study with a larger sample size and broader clinical variables, in order to improve the external validity and accuracy of the prediction model. The testing of the MSOFA and SOFA scores in various clinical settings, as well as the integration of EWS as an initial screening tool with advanced scoring systems, requires further development. In addition, the evaluation of long-term outcomes of post-ICU

patients is important to assess the sustainability of the effectiveness of prediction.

Conclusion

APACHE II, SAPS II, SOFA, EWS, and MSOFA scores are valid and accurate in predicting mortality and length of ICU stay in patients. However, SOFA and MSOFA consistently show the best performance. The APACHE II score excels in predicting long-term mortality, whereas the SAPS II score is more accurate for mortality within 2-7 days. SOFA score is an excellent predictor across all mortality timeframes, and MSOFA score is best-suited for ≤1-day mortality, with the strongest correlation to LOS. EWS score has the weakest predictive ability, but combining EWS with other scores significantly improves mortality prediction accuracy, especially when both scores are high.

Table 1. General characteristics of patients

Characteristic	Category	Count (n=210)	Percentage (%)
Age (years)	Mean±SD	60±15	-
	Median (IQR)	62 (50-75)	-
Gender	Male	120	57.1
	Female	90	42.9
Reason for admission	Post surgical	136	65.0
	Non surgical	74	35.0
Diagnosis	Sepsis	85	40.5
	Non sepsis	40	19.0
	Trauma/accident	30	14.3
	Other	55	26.2
ICU mortality	Deceased	42	20.0
	Alive	168	80.0
Length of ICU stay (days)	≤1 day	20	9.5
	2-7 days	120	57.1
	8-30 days	70	33.3

Legend: SD=standard deviation; IQR=interquartile range; ICU=intensive care unit.

Table 2. Scoring characteristics

Score	Category	Value
APACHE II	Mean±SD	23±7
	Median (IQR)	19 (15-25)
SOFA	Mean±SD	8±4
	Median (IQR)	7 (5-10)
SAPS II	Mean±SD	40±12
	Median (IQR)	38 (30-50)
EWS	Mean±SD	5±2
	Median (IQR)	5 (4-6)
MSOFA	Mean±SD	6±3
	Median (IQR)	6 (4-8)

Legend: APACHE II=Acute Physiology and Chronic Health Evaluation II; SD=standard deviation; IQR=interquartile range; SOFA=Sequential Organ Failure Assessment; SAPS II=Simplified Acute Physiology Score II; EWS=Early Warning Scores; MSOFA=modified SOFA.

Table 3. Results of ROC curve analysis on the assessment of APACHE II, SOFA, SAPS II, EWS, and MSOFA scores as predictors of mortality

Mortality timeframe	Scoring system	AUC	95% CI for AUC	Cut-off value
≤1 day	APACHE II	0.85	0.75-0.94	20-30
	SOFA	0.88	0.78-0.97	8-12
	SAPS II	0.82	0.72-0.91	40-45
	EWS	0.68	0.74-0.85	≥5
	MSOFA	0.90	0.80-0.98	8-12
2-7 days	APACHE II	0.82	0.72-0.91	18-25
	SOFA	0.87	0.77-0.96	6-10
	SAPS II	0.83	0.73-0.92	35-45
	EWS	0.50	0.43-0.66	≥3
	MSOFA	0.80	0.70-0.89	6-10
8-30 days	APACHE II	0.89	0.79-0.98	15-20
	SOFA	0.85	0.75-0.94	4-8
	SAPS II	0.83	0.73-0.92	30-40
	EWS	0.45	0.38-0.58	≥2
	MSOFA	0.81	0.75-0.90	4-8

Legend: ROC=receiver operating characteristic; APACHE II=Acute Physiology and Chronic Health Evaluation II; SOFA=Sequential Organ Failure Assessment; SAPS II=Simplified Acute Physiology Score II; EWS=Early Warning Scores; MSOFA=modified SOFA; AUC=area under the ROC curve; CI=confidence interval.

Table 4. Sensitivity and specificity of APACHE II, SOFA, SAPS II, EWS, and MSOFA scores as predictors of mortality

Timeframe	Score	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
≤1 day	APACHE II	80	98.2	80	98.2
	SOFA	86.7	97.6	76.5	98.8
	SAPS II	73.3	97	68.8	97.6
	EWS	66.7	96.4	62.5	97
	MSOFA	93.3	98.8	87.5	99.4
2-7 days	APACHE II	82.4	97.6	77.8	98.2
	SOFA	88.2	98.2	83.3	98.8
	SAPS II	76.5	96.4	68.4	97.6
	EWS	70.6	95.8	63.2	97
	MSOFA	94.1	98.8	88.9	99.4
8-30 days	APACHE II	80	98.8	80	98.8
	SOFA	90	99.4	90	99.4
	SAPS II	70	98.2	70	98.2
	EWS	60	97.6	60	97.6
	MSOFA	90	99.4	90	99.4

Legend: APACHE II=Acute Physiology and Chronic Health Evaluation II; SOFA=Sequential Organ Failure Assessment; SAPS II=Simplified Acute Physiology Score II; EWS=Early Warning Scores; MSOFA=modified SOFA; PPV=positive predictive value; NPV=negative predictive value.

Table 5. Correlation between the assessment system and LOS

Scoring system	Spearman's rho correlation (ρ)	Interpretation
APACHE II	0.65	Moderate-to-strong positive correlation
SAPS II	0.60	Moderate positive correlation
SOFA	0.70	Strong positive correlation
EWS	0.30	Weak positive correlation
MSOFA	0.75	Strong positive correlation

Legend: LOS=length of stay; APACHE II=Acute Physiology and Chronic Health Evaluation II; SAPS II=Simplified Acute Physiology Score II; SOFA=Sequential Organ Failure Assessment; EWS=Early Warning Scores; MSOFA=modified SOFA.

Table 6. Comparison of the length of hospitalization based on score category

Scoring system	Score category	Number of patients (n=210)	Median LOS (days)	H-value	df	p-value
APACHE II	Low (0-15)	70	3	25.42	2	0.001*
	Moderate (16-25)	88	7			
	High (>25)	52	12			
SAPS II	Low (0-30)	65	4	30.15	2	<0.001*
	Moderate (31-45)	85	8			
	High (>45)	60	13			
SOFA	Low (0-6)	75	3	28.76	2	<0.001*
	Moderate (7-12)	73	7			
	High (>12)	62	11			
EWS	Low (0-2)	90	2	18.90	2	<0.001*
	Moderate (3-4)	70	5			
	High (>4)	50	9			
MSOFA	Low (0-4)	80	3	22.50	2	<0.001*
	Moderate (5-8)	69	6			
	High (>8)	61	10			

Legend: LOS=length of stay; df=degrees of freedom; APACHE II=Acute Physiology and Chronic Health Evaluation II; SAPS II=Simplified Acute Physiology Score II; SOFA=Sequential Organ Failure Assessment; EWS=Early Warning Scores; MSOFA=modified SOFA.
*Significant in the Kruskal-Wallis test.

Table 7. Combined mortality rate of EWS and APACHE II

EWS category	APACHE II category	Number of patients	Number deceased	Mortality rate (%)
Low	Low	35	1	2.9
Low	Moderate	20	2	10
Low	High	5	1	20
Moderate	Low	25	3	12
Moderate	Moderate	30	8	26.7
Moderate	High	15	7	46.7
High	Low	5	2	40
High	Moderate	13	10	76.9
High	High	62	8	93.5
Total		210	42	20

Legend: EWS=Early Warning Scores; APACHE II=Acute Physiology and Chronic Health Evaluation II.

Table 8. Combined mortality rate of EWS and SAPS II

EWS category	SAPS II category	Number of patients	Number deceased	Mortality rate (%)
Low	Low	30	1	3.3
Low	Moderate	25	3	12
Low	High	5	2	40
Moderate	Low	20	2	10
Moderate	Moderate	35	10	28.6
Moderate	High	15	8	53.3
High	Low	10	3	30
High	Moderate	25	13	52
High	High	45	20	44.4
Total		210	42	20

Legend: EWS=Early Warning Scores; SAPS II=Simplified Acute Physiology Score II.

Table 9. Combined mortality rate of EWS and SOFA

EWS category	SOFA category	Number of patients	Number deceased	Mortality rate (%)
Low	Low	40	1	2.5
Low	Moderate	15	2	13.3
Low	High	5	1	20
Moderate	Low	25	2	8
Moderate	Moderate	30	9	30
Moderate	High	15	8	53.3
High	Low	5	3	60
High	Moderate	20	15	75
High	High	55	21	38.2
Total		210	42	20

Legend: EWS=Early Warning Scores; SOFA=Sequential Organ Failure Assessment.

Table 10. Mortality rate of EWS and MSOFA combination

EWS category	MSOFA category	Number of patients	Number deceased	Mortality rate (%)
Low	Low	45	1	2.2
Low	Moderate	15	1	6.7
Low	High	5	1	20
Moderate	Low	20	2	10
Moderate	Moderate	30	8	26.7
Moderate	High	20	10	50
High	Low	5	3	60
High	Moderate	15	12	80
High	High	55	24	43.6
Total		210	42	20

Legend: EWS=Early Warning Scores; MSOFA=modified Sequential Organ Failure Assessment.

Table 11. Combination of EWS and APACHE II on average LOS

EWS category	APACHE II category	Number of patients	Average LOS (days)
Low	Low	35	3
Low	Moderate	20	5
Low	High	5	7
Moderate	Low	25	4
Moderate	Moderate	30	6
Moderate	High	15	10
High	Low	5	6
High	Moderate	13	9
High	High	62	13
Total		210	

Legend: EWS=Early Warning Scores; APACHE II=Acute Physiology and Chronic Health Evaluation II; LOS=length of stay.

Table 12. Combination of EWS and SAPS II on average LOS

EWS category	SAPS II category	Number of patients	Average LOS (days)
Low	Low	30	3
Low	Moderate	25	5
Low	High	5	7
Moderate	Low	20	4
Moderate	Moderate	35	7
Moderate	High	15	10
High	Low	10	6
High	Moderate	25	9
High	High	45	13
Total		210	

Legend: EWS=Early Warning Scores; SAPS II=Simplified Acute Physiology Score II; LOS=length of stay.

Table 13. Combination of EWS and SOFA on average LOS

EWS category	SOFA category	Number of patients	Average LOS (days)
Low	Low	40	2.8
Low	Moderate	15	4.5
Low	High	5	6.5
Moderate	Low	25	3.8
Moderate	Moderate	30	6.5
Moderate	High	15	9.5
High	Low	5	5.5
High	Moderate	20	9
High	High	55	11.5
Total		210	

Legend: EWS=Early Warning Scores; SOFA=Sequential Organ Failure Assessment; LOS=length of stay.

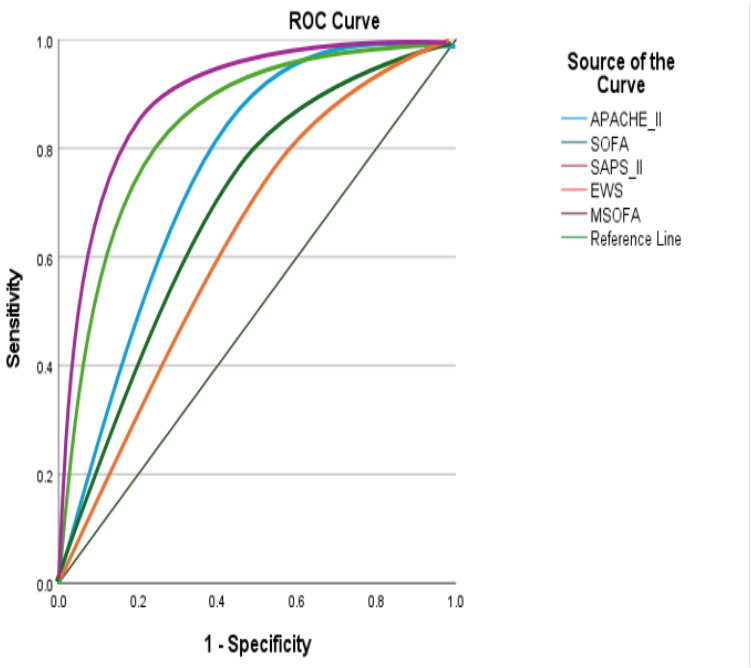
Table 14. Combination of EWS and MSOFA on average LOS

EWS category	MSOFA category	Number of patients	Average LOS (days)
Low	Low	45	2.6
Low	Moderate	15	4.2
Low	High	5	6.2
Moderate	Low	20	3.6
Moderate	Moderate	30	6.2
Moderate	High	20	9.2
High	Low	5	5.2
High	Moderate	15	8.8
High	High	55	11.8
Total		210	

Legend: EWS=Early Warning Scores; MSOFA=modified Sequential Organ Failure Assessment; LOS=length of stay.

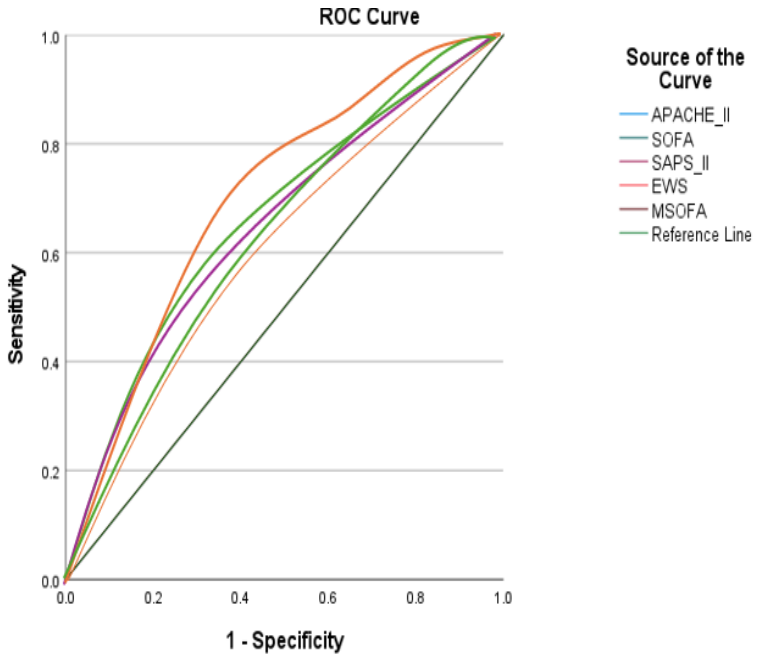
Category assumptions:
- EWS: Low: 0-2, Moderate: 3-4, High: ≥5
- APACHE II: Low: 0-15, Moderate: 16-25, High: >25
- SAPS II: Low: 0-30, Moderate: 31-45, High: >45
- SOFA: Low: 0-6, Moderate: 7-12, High: >12
- MSOFA: Low: 0-4, Moderate: 5-8, High: >8

Figure 1. ROC curve in the assessment of APACHE II, SOFA, SAPS II, EWS, MSOFA scores as predictors of mortality in the time range ≤1 day



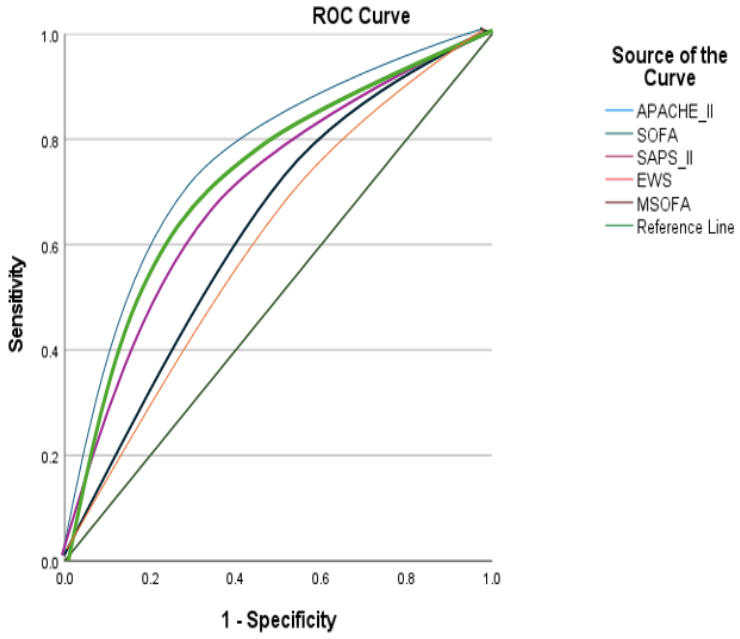
Legend: ROC=receiver operating characteristic; APACHE II=Acute Physiology and Chronic Health Evaluation II; SOFA=Sequential Organ Failure Assessment; SAPS II=Simplified Acute Physiology Score II; EWS=Early Warning Scores; MSOFA=modified SOFA.

Figure 2. ROC curve in the assessment of APACHE II, SOFA, SAPS II, EWS, MSOFA scores as predictors of mortality in the time range 2-7 days



Legend: ROC=receiver operating characteristic; APACHE II=Acute Physiology and Chronic Health Evaluation II; SOFA=Sequential Organ Failure Assessment; SAPS II=Simplified Acute Physiology Score II; EWS=Early Warning Scores; MSOFA=modified SOFA.

Figure 3. ROC curve in the assessment of APACHE II, SOFA, SAPS II, EWS, MSOFA scores as predictors of mortality in the time range 8-30 days



Legend: ROC=receiver operating characteristic; APACHE II=Acute Physiology and Chronic Health Evaluation II; SOFA=Sequential Organ Failure Assessment; SAPS II=Simplified Acute Physiology Score II; EWS=Early Warning Scores; MSOFA=modified SOFA.

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