Validity of three scoring systems in assessing the severity and outcome in Al-Abbassia Chest Hospital Respiratory Intensive Care Unit patients

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Background ICU scoring systems allowed an assessment of the severity of disease and death prediction. As ICU populations, investigations and management were changed, scoring systems should be updated.

Aim The aim of this study was to evaluate three scoring systems in predicting outcome in Al-Abbassia Chest Hospital Respiratory ICU patients in 6 months.

Patients and methods It was conducted on newly admitted cases in Al-Abbassia Respiratory ICU from July 2016 till January 2017. All patients were evaluated on admission and after 48 h by Acute Physiology and Chronic Health Evaluation IV (APACHE IV), Sequential Organ Failure Assessment (SOFA), and Simplified Acute Physiology Score II (SAPS II).

Results APACHE IV and SAPS II scores were significantly higher between dead than alive patients on admission and after 48 h, but were not able to predict death in ICU. SOFA score was insignificantly higher on admission and after 48 h between nonsurvivors. None of the three scores could predict the length of stay in ICU.

Conclusion APACHE IV and SAPS II scores were better than SOFA score as they were significantly higher between nonsurvivors but not to the extent to predict mortality or length of stay.

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Keywords: Acute Physiology and Chronic Health Evaluation IV, critical illness, Sequential Organ Failure Assessment, Simplified Acute Physiology Score II

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Introduction

Critical illness is any disease which results in physiological instability ending with disability or death in hours [1]. Assessment of the illness severity is essential for ICU death prediction [2]. ICU patients have different diseases [3]. Variable factors could increase death including age, severity of the disease, comorbidities, for example, malignancy [4]. ICU scoring systems derive a numerical value. They quantify the severity of illness [5]. Classification presented by Le Gall [6] assumes that most scores are calculated on admission, for example, Acute Physiology and Chronic Health Evaluation (APACHE), Simplified Acute Physiology Score (SAPS). Others are repetitive, for example, Sequential Organ Failure Assessment (SOFA).

The APACHE score is the most applied score [4]. The APACHE IV could predict mortality and stay in ICUs depending on several factors [7]. APACHE IV predicts ICU death more than APACHE III [8]. SOFA score on ICU admission is a good prognosis predictor [9]. The SAPS II was described in 1993 by Jean-Roger Le Gall *et al*. [10] based on the European-North American Study (ENAS) database 17. It was developedin a large sample of 110 hospitals in Europe and 27 hospitals in North America. It is a favorable discriminator for admission to ICU [11].

Patients and methods

This study was done on newly admitted cases in Al-Abbassia Respiratory ICU (RICU) during 6 months from July 2016 till January 2017. Three hundred and fifty patients were admitted to RICU. After excluding admissions due to nonrespiratory diseases, patients who died within the first 48 h, and postarrest new admissions who did not regain their conscious, only 130 patients diagnosed as Chronic obstructive pulmonarydisease (COPD) exacerbations, asthma exacerbations, pneumonia, tuberculosis (TB), pulmonary embolism, obese hypoventilation, empyema, and pneumothorax were studied.

Patients were subjected to full history, examination, chest radiography, routine laboratory tests including complete blood picture, bleeding profile, liver function, kidney functions, and random blood glucose level, sputum examination for acid fast bacilli, and sputum culture and sensitivity.

All patients were evaluated on admission and after 48 h by using APACHE IV, SAPS II, and SOFA scores to

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evaluate these scores regarding prediction of length of stay and mortality rate in the RICU.

For APACHE IV score, data were entered including the following:

(1) Age, temperature, vital signs, mechanical ventilation, FiO_2, PaO_2, $PaCO_2$, arterial pH, random blood sugar.
(2) Serum Na+, urine output, serum creatinine, blood urea, serum albumin, total bilirubin, hematocrit, white blood cell.
(3) Coma scale: eyes, verbal, motor.
(4) Chronic health conditions including chronic renal failure, hemodialysis, AIDS.

For SAPS II score, the data required were age, vital signs, mechanical ventilation or CPAP, PaO_2, FiO_2, urine output, BUN, NA, K, HCO_3, bilirubin, white blood cell, and comorbidities, for example, hematologic malignancy.

Mortality prediction percentage was calculated using this equation:

$$\text{Logit} = -7.7631 + 0.0737 \times \text{score} + 0.9971 \times \ln(\text{score} + 1)\ \text{mortality} = \text{elogit1} + \text{elogit}.$$

For SOFA score, the data required were FiO_2, PaO_2, mechanical ventilation, platelets, bilirubin, Glasgow coma scale, mean arterial blood pressure, vasopressors, serum creatinine, and urine output.

Statistical methods

The data were coded, tabulated, and statistically analyzed using IBM SPSS, version 22.0 (SPSS Inc., Chicago, Illinois, USA).

Descriptive statistics were done for quantitative data as minimum and maximum range with mean±SD for quantitative normally distributed data, but it was done for qualitative one as number and percentage.

Inferential analyses were done for quantitative variables using independent t-test in cases of two independent groups with normally distributed data. In qualitative data, inferential analyses for independent variables were done using χ^2-test for differences between proportions and Fisher's exact test for variables with small expected numbers. Correlations were done using Pearson's correlation for numerical normally distributed data, and using Spearman's ρ test for qualitative data. Receiver operating characteristic curve was used for evaluating different scores to differentiate between groups. Linear regression model was used to get independent factors affecting certain conditions. A P value less than 0.050 is significant, otherwise it is nonsignificant.

Diagnostic characteristics were calculated as follows:

$$\text{Sensitivity} = \frac{\text{True positive test}}{\text{Total positive golden}} \times 100,$$

$$\text{Specificity} = \frac{\text{True negative test}}{\text{Total negative golden}} \times 100,$$

$$\text{Predictive positive value} = \frac{\text{True positive test}}{\text{Total positive test}} \times 100,$$

$$\text{Predictive negative value} = \frac{\text{True negative test}}{\text{Total negative test}} \times 100,$$

$$\text{Likelihood ratio+} = \frac{\text{Sensitivity}}{1 - \text{specificity}},$$

$$\text{Likelihood-} = \frac{1 - \text{sensitivity}}{\text{Specificity}},$$

$$\text{Diagnostic accuracy} = \frac{\text{True positive test} + \text{true negative test}}{\text{Total cases}} \times 100.$$

Results were then tabulated and statistically analyzed using SPSS.

Results

The age group of the patients ranged from 15 to 83 years old. Ninety-two of them were men and 38 were women. Mortality rate among the studied cases was 52% (75% men and 25% women). Thirty-nine of the patients were diagnosed as COPD, 59 patients of pneumonia, 15 patients of TB, five were of interstitial lung disease, and four were suffering from bronchial asthma (Table 1 and Fig. 1).

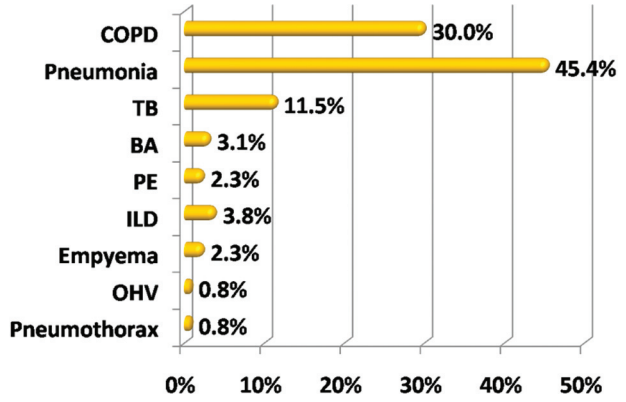
APACHE IV, SOFA, and SAPS II scores were applied to all the patients on admission showing a mean score of 76.6, 4.8, and 37.7, respectively. After 48 h, scores were reapplied again. The mean scores were 62.8, 4.8, and 33.3, respectively. The mortality rate among the studied cases was 52% (Tables 2–4 and Fig. 2).

Table 1 Demographic characteristics and comorbidities of the studied cases (*N*=130)

Variables	*n* (%)
Age [mean±SD (range)] (years)	53.6±15.9 (15.0–86.0)
Sex	
Male	92 (70.8)
Female	38 (29.2)
Smoking	45 (34.6)
Addiction	14 (10.8)
DM	15 (11.5)
Hypertension	16 (12.3)
IHD	15 (11.5)
HIV	4 (3.1)
HCV	3 (2.3)
Cancer (larynx, lymphoma)	2 (1.2)

DM, diabetes mellitus; HCV, hepatitis C virus; IHD, ischemic heart disease.

Figure 1



Diagnosis among the studied cases.

There was no significant statistical difference between dead and alive patients regarding age, sex, smoking status, addiction, comorbidities (diabetes mellitus, hypertension, ischemic heart disease, HIV, hepatitis C virus, and outcome of the patients (Table 5).

No significant statistical difference was observed between dead and alive patients regarding their diagnosis. 29.4% of COPD patients, 48.5% of pneumonia patients, and 8.8% of TB patients did not survive. APACHE IV and SAPS II scores were significantly higher between nonsurvivors than survivors on admission and after 48 h, but could not predict death among studied cases. *P* values of APACHE IV and SAPS II on admission were 0.008 and 0.001, respectively. Area under the curve (AUC) were 0.62 and 0.66, respectively. After 48 h *P* values of both of them were 0.001. AUC were 0.76 and 0.82, respectively. SOFA score showed nonsignificant statistical difference between dead and alive patients on admission and after 48 h. AUC on admission was 0.54 and after 48 h it was 0.64 (Tables 6–8).

Table 2 Clinical scores at admission among the studied cases (*N*=130)

Variables	Mean±SD
APACHE score	76.6±31.5 (2.0–185.0)
APACHE mortality	29.1±24.2 (2.0–96.0)
APACHE stay	5.3±1.7 (1.4–10.0)
APACHE–SAPS score	63.3±29.3 (5.0–160.0)
SAPS II score	37.7±17.4 (9.0–92.0)
SAPS II mortality	27.3±27.0 (0.8–97.0)
SOFA score	4.8±2.4 (1.0–11.0)
SOFA mortality [*n* (%)]	
<10.0	99 (76.2)
15.0–20.0	25 (19.2)
40.0–50.0	6 (4.6)

APACHE, Acute Physiology and Chronic Health Evaluation; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment.

Table 3 Clinical scores 48 h after admission among the studied cases (*N*=130)

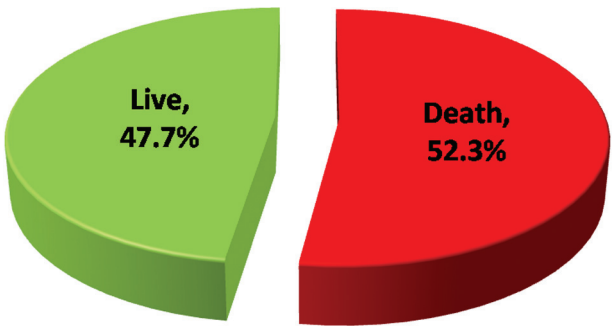
Variables	Mean±SD (range)
APACHE IV score	62.8±23.2 (23.0–150.0)
APACHEIV mortality	22.0±20.7 (0.6–90.0)
APACHE IV stay	6.0±2.5 (1.8–25.3)
APACHE IV–SAPS score	49.9±20.4 (4.0–128.0)
SAPS II score	33.3±14.2 (13.0–77.0)
SAPS II mortality	20.6±21.1 (1.5–90.5)
SOFA score	4.8±2.6 (1.0–13.0)
SOFA mortality [*n* (%)]	
<10.0	102 (78.5)
15.0–20.0	18 (13.8)
40.0–50.0	10 (7.7)

APACHE, Acute Physiology and Chronic Health Evaluation; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment.

Table 4 Outcome among the studied cases (*N*=30)

Findings	Mean±SD (range)
Stay length (days)	7.5±5.7 (2.0–33.0)
Death [*n* (%)]	68 (52.3)

Figure 2



Death among the studied cases.

APACHE IV score on admission and after 48 h showed negative correlation with stay at RICU (Tables 9 and 10 and Figs. 3 and 4). On admission,

Table 5 Comparison between dead and alive cases regarding demographic characteristics and comorbidities

Variables	Died (*N*=68) [*n* (%)]	Lived (*N*=62) [*n* (%)]	*P*
Age (mean±SD) (years)	54.5±16.7	52.7±15.0	0.522[a]
Sex			
Male	51 (75.0)	41 (66.1)	0.267[b]
Female	17 (25.0)	21 (33.9)	
Smoking	23 (33.8)	22 (35.5)	0.842[b]
Addiction	6 (8.8)	8 (12.9)	0.454[b]
DM	8 (11.8)	7 (11.3)	0.933[b]
Hypertension	9 (13.2)	7 (11.3)	0.736[b]
IHD	10 (14.7)	5 (8.1)	0.236[b]
HIV	3 (4.4)	1 (1.6)	0.621[c]
HCV	1 (1.5)	2 (3.2)	0.605[c]
Cancer	2 (2.9)	0 (0.0)	0.497[c]

DM, diabetes mellitus; HCV, hepatitis C virus; IHD, ischemic heart disease; [a]Independent *t*-test; [b]χ^2-Test; [c]Fisher's exact test.

Table 6 Comparison between dead and alive cases regarding diagnosis

Variables	Died (*N*=68) [*n* (%)]	Lived (*N*=62) [*n* (%)]	*P*
COPD	20 (29.4)	19 (30.6)	0.830[a]
Pneumonia	33 (48.5)	26 (41.9)	
TB	6 (8.8)	9 (14.5)	
BA	1 (1.5)	3 (4.8)	
PE	2 (2.9)	1 (1.6)	
ILD	3 (4.4)	2 (3.2)	
Empyema	2 (2.9)	1 (1.6)	
OHV	1 (1.5)	0 (0.0)	
Pneumothorax	0 (0.0)	1 (1.6)	

BA, bronchial asthma; COPD, chronic obstructive pulmonary disease; ILD, interstitial lung disease; OHV, obese hypoventilation; PE, pulmonary embolism; TB, tuberculosis; [a]Fisher's exact test.

Table 7 Comparison between dead and alive cases regarding clinical scores at admission among the studied cases

Variables	Died (*N*=68)	Lived (*N*=62)	*P*
APACHE IV score	83.5±33.6	68.9±27.4	**0.008**a*
APACHE IV mortality	34.0±27.1	23.8±19.4	**0.016**[a,*]
APACHE IV stay	5.4±1.6	5.2±1.9	0.372[a]
APACHE IV–SAPS score	67.6±33.8	58.5±22.9	0.078[a]
SAPS II score	42.6±18.5	32.3±14.4	<**0.001**[a,*]
SAPS II mortality	34.2±29.9	19.6±21.0	**0.002**[a,*]
SOFA score	5.0±2.4	4.6±2.3	0.372[a]
SOFA mortality [*n* (%)]			
<10.0	53 (77.9)	46 (74.2)	0.564[b]
15.0–20.0	11 (16.2)	14 (22.6)	
40.0–50.0	4 (5.9)	2 (3.2)	

APACHE, Acute Physiology and Chronic Health Evaluation; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; [a]Independent *t*-test; [b]Fisher's exact test; *Significant. Bold values are significant.

different scores showed nonsignificant differences between dead and alive COPD cases. After 48 h APACHE IV and SAPS II showed significant

Table 8 Comparison between dead and alive cases regarding clinical scores 48 h after admission among the studied cases

Variables	Died (*N*=68)	Alive (*N*=62)	*P*
APACHE IV score	72.8±24.6	51.9±15.5	<0.001[a,*]
APACHE IV mortality	30.2±23.3	13.0±12.2	<0.001[a,*]
APACHE IV stay	6.8±2.8	5.1±1.8	<0.001[a,*]
APACHE IV–SAPS score	57.1±22.4	42.0±14.2	<0.001[a,*]
SAPS II score	41.0±13.9	25.1±9.1	<0.001[a,*]
SAPS II mortality	30.9±23.6	9.4±9.2	<0.001[a,*]
SOFA score	5.4±2.6	4.2±2.5	0.011[a,*]
SOFA mortality [*n* (%)]			
<10.0	49 (72.1)	53 (85.5)	0.068[b]
15.0–20.0	14 (20.6)	4 (6.5)	
40.0–50.0	5 (7.4)	5 (8.1)	
Stay length (days)	7.9±6.3	7.1±4.9	0.423[a]

APACHE, Acute Physiology and Chronic Health Evaluation; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment.; [a]Independent *t*-test; [b]Fisher's exact test; *Significant.

Table 9 Correlation between length of stay and other scores

Variables	R^2	*P*
Age	–0.035	0.690
At admission		
APACHE IV score	–0.257[a]	0.003*
APACHE IV mortality	–0.145[a]	0.099
APACHE IV stay	–0.014[a]	0.871
APACHE IV–SAPS score	–0.188[a]	0.033*
SAPS II score	–0.122[a]	0.168
SAPS II mortality	–0.080[a]	0.364
SOFA score	–0.066[a]	0.458
SOFA mortality	–0.085[b]	0.336
48 h		
APACHE IV score	–0.200[a]	0.023*
APACHE IV mortality	–0.150[a]	0.088
APACHE IV stay	–0.004[a]	0.963
APACHE IV–SAPS score	–0.178[a]	0.043*
SAP II score	–0.075[a]	0.402
SAP II mortality	–0.047[a]	0.594
SOFA score	–0.011[a]	0.900
SOFA mortality	–0.065[b]	0.465

APACHE, Acute Physiology and Chronic Health Evaluation; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; [a]Pearson's correlation; [b]Spearman's correlation; *Significant.

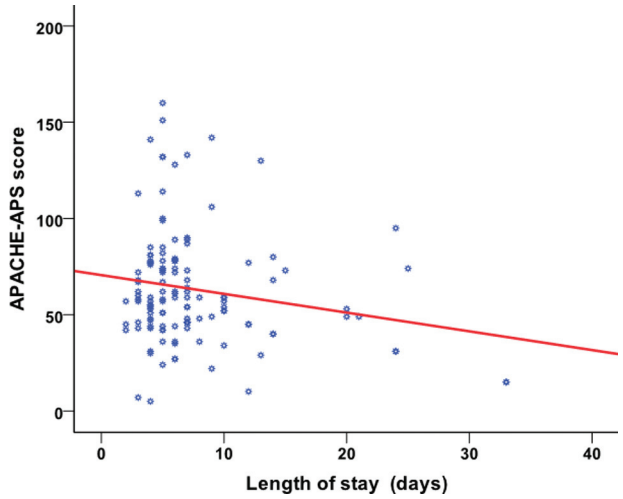
difference between alive and dead cases, but still could not predict mortality after 48 h; *P* values were 0.024 and 0.001 for APACHE IV and SAPS II score (Table 11). Regarding pneumonia, only SAPS II showed significant increase on admission (*P*=0.029). But after 48 h APACHE IV and SAPS II showed significant increase (*P*=0.001 of APACHE IV and SAPS II) among dead cases. None of them could predict mortality (Table 12). Different scores showed nonsignificant correlation between dead and alive TB cases and could not predict mortality

Table 10 Diagnostic performance of scores predicting death among the studied cases

Time	Factors	AUC	SE	*P*	95% CI
Admission	APACHE IV score	0.625	0.049	0.015*	0.529–0.722
	APACHE IV mortality	0.597	0.050	0.059	0.500–0.695
	APACHE IV–SAPS score	0.558	0.051	0.258	0.500–0.658
	SAPS II score	0.664	0.048	<0.001*	0.571–0.758
	SAPS II mortality	0.657	0.048	0.002*	0.563–0.751
	SOFA score	0.541	0.052	0.429	0.500–0.642
	SOFA mortality	0.519	0.051	0.717	0.500–0.582
48 h	APACHE IV score	0.763	0.042	<0.001*	0.680–0.847
	APACHE IV mortality	0.750	0.042	<0.001*	0.667–0.833
	APACHEIV–SAPS score	0.708	0.046	<0.001*	0.619–0.798
	SAPS II score	0.827	0.035	<0.001*	0.757–0.896
	SAPS II mortality	0.819	0.036	<0.001*	0.748–0.890
	SOFA score	0.644	0.049	0.005*	0.548–0.740
	SOFA mortality	0.557	0.051	0.265	0.500–0.657

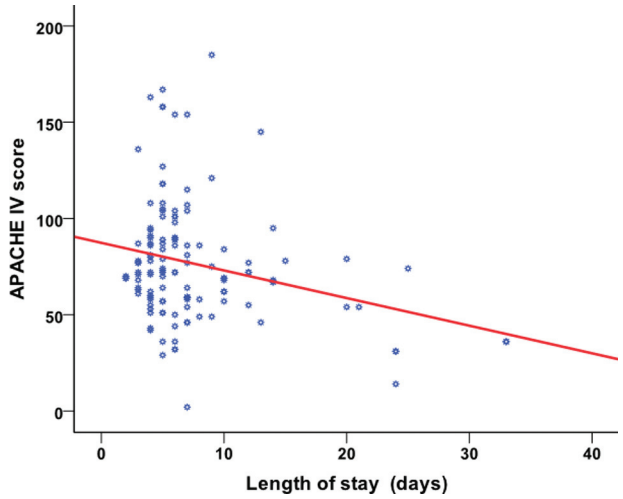
APACHE, Acute Physiology and Chronic Health Evaluation; AUC, area under the curve; CI, confidence interval; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; *Significant.

Figure 3



Correlation between length of stay and admission APACHE score. APACHE, Acute Physiology and Chronic Health Evaluation.

Figure 4



Correlation between length of stay and admission APACHE–SAPS score. APACHE, Acute Physiology and Chronic Health Evaluation; SAPS, acute physiology score.

(Table 13). Different scores had significant models for length of stay among COPD, pneumonia, and TB cases but could not predict length of stay (Tables 14–17).

Discussion

This prospective cohort study was conducted in the ICU at Al-Abbassia Chest Hospital. Three hundred and fifty patients were admitted between June 2016 and January 2017. Only 130 patients were included in the study. The patients' age group ranged from 15 to 83 years old. Ninety-two of them were men and 38 were females. The mortality rate among studied cases was 52% (75% men and 25% women). Thirty-nine of the patients were diagnosed as COPD, 59 patients had pneumonia, 15 patients had TB, five were having interstitial lung disease and four were having bronchial asthma.

APACHE IV, SOFA and SAPS II score were applied to all the patients on admission revealing a mean score of 76.6, 4.8, and 37.7, respectively. After 48 h, the scores were reapplied again. Mean scores were 62.8, 4.8, and 33.3, respectively. The mortality rate among the studied cases was 52%.

The present study showed no significant difference between dead and alive cases regarding demographic characteristics and comorbidities including diabetes mellitus (11.5%), hypertension (12.3%), ischemic heart disease (11.5%), and HIV (3.1). The present study concluded limited number of elderly patients (only 32 patients). That may affect the result.

This was against Neilson *et al.* [12] in a study conducted in Singapore about mortality in the

Table 11 Diagnostic performance of scores predicting death among chronic obstructive pulmonary disease cases

Time	Factors	AUC	SE	*P*	95% CI
Admission	APACHE IV score	0.534	0.094	0.715	0.500–0.719
	APACHE IV mortality	0.542	0.094	0.653	0.500–0.727
	APACHE IV–SAPS score	0.501	0.095	0.989	0.500–0.687
	SAPS II score	0.621	0.093	0.196	0.500–0.803
	SAPS II mortality	0.620	0.093	0.201	0.500–0.802
	SOFA score	0.550	0.093	0.593	0.500–0.733
	SOFA mortality	0.509	0.094	0.922	0.500–0.693
48 h	APACHE IV score	0.712	0.087	0.024*	0.541–0.883
	APACHE IV mortality	0.717	0.083	0.020*	0.555–0.879
	APACHE IV–APS score	0.632	0.091	0.160	0.500–0.810
	SAPS II score	0.811	0.069	<0.001*	0.675–0.946
	SAPS II mortality	0.808	0.070	<0.001*	0.671–0.944
	SOFA score	0.676	0.087	0.060	0.506–0.847
	SOFA mortality	0.563	0.093	0.500	0.500–0.745

APACHE, Acute Physiology and Chronic Health Evaluation; AUC, area under the curve; CI, confidence interval; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; *Significant.

Table 12 Diagnostic performance of scores predicting death among pneumonia cases

Time	Factors	AUC	SE	*P*	95% CI
Admission	APACHE IV score	0.636	0.073	0.074	0.500–0.779
	APACHE IV mortality	0.593	0.074	0.225	0.500–0.738
	APACHE IV–SAPS score	0.600	0.074	0.189	0.500–0.745
	SAPS II score	0.667	0.070	0.029*	0.529–0.805
	SAPS II mortality	0.671	0.070	0.025*	0.533–0.808
	SOFA score	0.528	0.078	0.714	0.500–0.681
	SOFA mortality	0.528	0.077	0.714	0.500–0.622
48 h	APACHE IV score	0.800	0.057	<0.001*	0.689–0.910
	APACHE IV mortality	0.767	0.061	<0.001*	0.648–0.886
	APACHE IV–SAPS score	0.740	0.064	0.002*	0.615–0.865
	SAPS II score	0.783	0.058	<0.001*	0.669–0.898
	SAPS II mortality	0.783	0.059	<0.001*	0.668–0.897
	SOFA score	0.625	0.074	0.101	0.500–0.770
	SOFA mortality	0.586	0.075	0.262	0.500–0.732

APACHE, Acute Physiology and Chronic Health Evaluation; AUC, area under the curve; CI, confidence interval; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; *Significant.

elderly in the ICU. It demonstrated that the ICU death increased with advancing age. It was conducted on elderly patients in the ICU [12].

Regarding diagnosis, our study showed no significant difference between dead and alive cases regarding diagnosis. Against that was a study on the 2596 patients confirmed that fewer patients died in the surgical group in ICU than in the nonsurgical group [13].

In the present study, died cases had significantly higher APACHE IV score and SAPS II score (on admission and after 48 h) than alive cases; SOFA score was nonsignificant among studied cases. This was correlated with a study done about predictive efficacy of APACHE IV in medical ICU, neurological ICU, and surgical ICU. It showed that APACHE IV can be used as a good predictor of mortality among all ICU patients [8]. In a study about SOFA score in Amsterdam. It disagreed and illustrated that SOFA score on admission was good as the SAPS score in predicting death in ICUs. For a better performance, he suggested the combination of other scores on admission, for example, the APACHE IV score [14].

The current study demonstrated that there were negative correlations between length of stay and APACHE IV score and APACHE IV–SAPS score (on admission and after 48 h). Kramer and Zimmerman [15] agreed with that after studying early prediction of long stay in 831 ICUs. They claimed that patients with an ICU stay of at least 5 days had high SAPS and APACHE IV score on admission. Chattopadhyay and Chatterjee [7] conducted a study against that and provided that APACHE IV could not predict ICU stay in severe sepsis patients. But the results were affected by management of cases.

This study illustrated that only APACHE IV and SAPS II scores (on admission and after 48 h) had significant, but not valuable performance in predicting mortality rate. Parajuli *et al.* [16] studied the evaluation of APACHE II and APACHE IV to predict ICU mortality in tertiary level teaching hospital. He agreed and concluded that

APACHE IV score increased significantly with increasing the mortality rate. APACHE IV was superior to APACHE II [16]. In Iran a study was done in 2017 on 82 critically ill patients about comparing APACHE II and SAPS II scores in the ICU. It agreed with us. It showed that they were significant [17]. A study was done in Korea including 1314 patients disagreed and showed that the APACHE IV overestimated mortality. It was done in surgical intensive care unit (SICU). Different categories of patient might led to that difference [18]. Keegan *et al.* [13] disagreed with his study about APACHE III, APACHE IV, SAPS III, and mortality predictor model (MPM) 0 III and resuscitation. Different ICUs were included in his study. He demonstrated that the overall performance was best for APACHE IV. However, the single-center nature made that result not reliable [13].

Table 13 Diagnostic performance of scores predicting death among tuberculosis cases

Time	Factors	AUC	SE	*P*	95% CI
Admission	APACHE IV score	0.653	0.153	0.396	0.500–0.952
	APACHE IV mortality	0.611	0.158	0.537	0.500–0.921
	APACHE IV–SAPS score	0.681	0.170	0.316	0.500–0.671
	SAPS II score	0.514	0.202	0.939	0.500–0.909
	SAPS II mortality	0.514	0.202	0.939	0.500–0.909
	SOFA score	0.708	0.149	0.247	0.500–1.000
	SOFA mortality	0.542	0.190	0.817	0.500–0.913
48 h	APACHE IV score	0.681	0.193	0.589	0.500–0.781
	APACHE IV mortality	0.681	0.155	0.487	0.500–0.679
	APACHE IV–SAPS score	0.500	0.183	1.000	0.500–0.859
	SAPS II score	0.778	0.173	0.123	0.500–1.000
	SAPS II mortality	0.778	0.173	0.123	0.500–1.000
	SOFA score	0.681	0.169	0.700	0.500–0.763
	SOFA mortality	0.681	0.172	0.758	0.500–0.782

APACHE, Acute Physiology and Chronic Health Evaluation; AUC, area under the curve; CI, confidence interval; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; *Significant.

Against that was a study done by Granholm *et al.* [19] about SAPS II and the SOFA scores in the ICU. He revealed that SAPS II was better than SOFA. SAPS II's was less a predictor than other new severity scores. Desa *et al.* [20] disagreed and showed that SAPS II was a good discriminator but it over predicted death.

In this study, different scores had no significant valuable diagnostic performance in predicting death among COPD cases on admission but APACHE IV score and SAPS II score after 48 h are significant but not valuable performance. To our knowledge, there was no study done discussing the relationship between these scores and COPD patients in ICU, but a study done in 1996 on APACHE II score and COPD patients admitted in ward agreed with us [21].

Regarding pneumonia, this study showed that different scores had no significant valuable diagnostic performance in predicting death among pneumonia cases. SAPS II score, on admission and APACHE IV score, SAPS II score after 48 h were significant but not of valuable performance. This was correlated with the study done on patients with severe sepsis and septic shock in India. It showed that APACHE IV underestimated death while SAPS II had overestimated it. So, none of them

Table 14 Regression models of scores in predicting length of stay among the studied cases

Scores	β	SE	*P*	95% CI	R^2
Admission					
APACHE IV score	0.078	0.007	<0.001*	0.063–0.092	0.466
APACHE IV stay	1.281	0.097	<0.001*	1.090–1.473	0.577
APACHE IV–SAPS score	0.092	0.009	<0.001*	0.075–0.109	0.462
SAPS II score	0.158	0.014	<0.001*	0.130–0.186	0.486
SOFA score	1.233	0.110	<0.001*	1.016–1.450	0.494
48 h					
APACHE IV score	0.100	0.009	<0.001*	0.083–0.117	0.505
APACHE IV stay	1.064	0.086	<0.001*	0.894–1.234	0.543
APACHE IV–SAPS score	0.123	0.011	<0.001*	0.101–0.144	0.493
SAPS II score	0.187	0.016	<0.001*	0.155–0.219	0.516
SOFA score	1.205	0.108	<0.001*	0.991–1.419	0.490

APACHE, Acute Physiology and Chronic Health Evaluation; AUC, area under the curve; CI, confidence interval; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; *Significant.

Table 15 Regression models for scores in predicting length of stay among chronic obstructive pulmonary disease cases

Scores	β	SE	*P*	95% CI	R^2
Admission					
APACHE IV score	0.082	0.013	<0.001*	0.057–0.108	0.526
APACHE IV stay	1.559	0.189	<0.001*	1.177–1.941	0.642
APACHE IV–SAPS score	0.095	0.016	<0.001*	0.063–0.128	0.476
SAPS II score	0.157	0.024	<0.001*	0.108–0.206	0.527
SOFA score	1.140	0.173	<0.001*	0.790–1.490	0.534
48 h					
APACHE IV score	0.098	0.016	<0.001*	0.066–0.129	0.510
APACHE IV stay	0.999	0.168	<0.001*	0.659–1.338	0.483
APACHE IV–SAPS score	0.120	0.021	<0.001*	0.077–0.163	0.457
SAPS II score	0.210	0.031	<0.001*	0.148–0.272	0.554
SOFA score	1.207	0.178	<0.001*	0.847–1.567	0.548

APACHE, Acute Physiology and Chronic Health Evaluation; AUC, area under the curve; CI, confidence interval; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; *Significant.

Table 16 Regression models for scores in predicting length of stay among pneumonia cases

Scores	β	SE	*P*	95% CI	R^2
Admission					
APACHE IV score	0.076	0.012	<0.001*	0.052–0.100	0.411
APACHE IV stay	1.276	0.151	<0.001*	0.975–1.578	0.553
APACHE IV–SAPS score	0.093	0.014	<0.001*	0.065–0.120	0.433
SAPS II score	0.164	0.023	<0.001*	0.118–0.210	0.469
SOFA score	1.337	0.191	<0.001*	0.956–1.719	0.459
48 h					
APACHE IV score	0.105	0.014	<0.001*	0.076–0.134	0.479
APACHE IV stay	1.123	0.133	<0.001*	0.857–1.389	0.551
APACHE IV–SAPS score	0.129	0.018	<0.001*	0.093–0.165	0.474
SAPS II score	0.185	0.024	<0.001*	0.137–0.233	0.507
SOFA score	1.247	0.183	<0.001*	0.880–1.613	0.445

APACHE, Acute Physiology and Chronic Health Evaluation; AUC, area under the curve; CI, confidence interval; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; *Significant.

Table 17 Regression models for scores in predicting length of stay among tuberculosis cases

Scores	β	SE	*P*	95% CI	R^2
Admission					
APACHE IV score	0.073	0.012	<0.001*	0.048–0.097	0.736
APACHE IV stay	0.963	0.099	<0.001*	0.751–1.175	0.871
APACHE IV–SAPS score	0.091	0.013	<0.001*	0.063–0.119	0.772
SAPS II score	0.139	0.029	<0.001*	0.077–0.201	0.623
SOFA score	0.963	0.154	<0.001*	0.632–1.293	0.736
48 h					
APACHE IV score	0.088	0.011	<0.001*	0.064–0.111	0.817
APACHE IV stay	0.976	0.088	<0.001*	0.788–1.164	0.898
APACHE IV–SAPS score	0.102	0.011	<0.001*	0.077–0.126	0.852
SAPS II score	0.176	0.034	<0.001*	0.103–0.250	0.696
SOFA score	0.863	0.169	<0.001*	0.501–1.225	0.651

APACHE, Acute Physiology and Chronic Health Evaluation; AUC, area under the curve; CI, confidence interval; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; *Significant.

could predict mortality [22]. Another study was done on adult respiratory distress syndrome (ARDS) patients in Saudi Arabia agreed with the results. It showed that SAPS II and SOFA scores gave significantly different severity scores and mortality prediction in survivors compared with nonsurvivors among ICU patients with ARDS. However, their accuracy in predicting the actual mortality was limited [2].

This was against a study done in 2013 in Pakistan about APACHE II and APACHE IV in predicting death in acute lung injury and ARDS. Kamal *et al.* [23] claimed that APACHE IV was a good predictor in these

patients. This difference might be due to more critical and limited numbers of patients enrolled in this study. Kamal *et al.* [23] enrolled 47 of mechanically ventilated ARDS patients.

In this study, it was illustrated that different scores had no significant valuable diagnostic performance in predicting death among TB cases. Koegelenberg *et al.* [24] study about severity scores in critically ill TB patients agreed with us. He demonstrated that the APACHE II score could not predict death in these patients. It was calculated 1 day after admission, so it is not a practical [24]. Rollas *et al.* [25] study in 2015 disagreed after studying TB in the ICU on 16 patients. He confirmed that death increased in patients with high SOFA scores. Limited number of the studied patient might lead to different results [25].

This study showed that different scores had significant but not valuable predicting models for length of stay among the studied cases. Verburg *et al.* [26] agreed with that in his study. He claimed that no score could predict unexpectedly long stay in the ICU. Against that was Yamin *et al.* [8] he confirmed that the APACHE IV showed good prediction for stay and death in the ICU as an overall view but not with sepsis patients. Different categories of the studied patient might have affected the results [8].

Different scores had significant but not valuable predicting models for length of stay among COPD cases that was demonstrated in this study. Goel *et al.* [21] agreed with that in his study and suggested combination with other scores for better prediction. According to this study, different scores had significant but not valuable predicting models for length of stay among pneumonia cases. Chattopadhyay and Chatterjee [7] agreed with that after conducting a study in the USA. They used the data of 2006–2008 for that study. It confirmed that APACHE IV could not predict ICU stay in severe sepsis cases and underestimated it. That might be affected by policies of patient admission, accommodation, and management [7].

This study showed that different scores had significant but not valuable predicting models for length of stay among the TB cases. To our knowledge, there were no studies discussing that.

A study was done on 60 patients in Serbia on the assessment of scoring systems in the ICU. It confirmed that APACHE II, SAPS II scores on admission, and SOFA score after 1 week were significant predictors of consequences [27].

Conclusion

APACHE IV and SAPS II scores were significantly higher between nonsurvivors on admission and after 48 h of admission with COPD and pneumonia patients, but they could not predict neither mortality nor length of stay accurately.

APACHE IV and SAPS II scores were better than the SOFA score, which was nonsignificant among all studied cases on admission and after 48 h and could not predict mortality or length of stay among patients.

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Conflicts of interest

There are no conflicts of interest.

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