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ORIGINAL ARTICLE

Evaluation of the predictive value of mortality scoring systems for intubation need in ischemic stroke patients: A prospective study

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ABSTRACT

Objectives: This study aimed to evaluate the prognostic accuracy of mortality scores for predicting the requirement of endotracheal intubation in ischemic stroke patients admitted to the intensive care unit.

Patients and methods: The prospective study examined 53 patients followed up in the stroke intensive care unit after ischemic stroke between June 2021 and April 2023. Patients were grouped as either intubated or not-intubated within the first seven days. Patients younger than 18 years of age and those with hemorrhagic stroke, late admission, insufficient data, or early discharge were excluded. The APACHE II (Acute Physiology and Chronic Health Evaluation), SAPS II (Simplified Acute Physiology Score), and SOFA (Sequential Organ Failure Assessment) scores measured at 24, 36, and 48 h were used to assess mortality rates. The National Institutes of Health Stroke Scale score was used to assess stroke severity, and the modified Rankin Scale was used to assess independent survival.

Results: Forty patients (19 males, 21 females; median age: 72 [64.2-79.5] years) were not intubated within the first seven days, while 13 (8 males, 5 females; median age: 76 [70.5-83.0] years) required intubation. There were no significant differences in demographic data or comorbidities between the two groups. Intubated patients exhibited increased levels of inflammatory markers and mortality scores at 24, 36, and 48 h following intubation. Only the APACHE II score at 24 h was identified as a significant independent risk factor for intubation (odds ratio=2.36, p=0.037), with an optimal threshold of 9.5 identified by receiver operating characteristic analysis (area under the curve=0.828).

Conclusion: The study identified that the APACHE II score, measured 24 h after admission, could reliably predict that ischemic stroke patients in the intensive care unit would require intubation within the first week. This discovery fills a significant gap, as present instruments estimate mortality but not the specific need for ventilation. These results emphasize the need for broader research into the development of improved predictive systems.

Keywords: APACHE II, critical care, endotracheal intubation, prospective study, SAPS II, SOFA, stroke.

Stroke is not only the leading cause of mortality and morbidity worldwide but also constitutes the majority of admissions to neurology intensive care units (ICU). In the USA, approximately 795,000 new or recurrent stroke cases occur every year, and 87% of these are acute ischemic stroke cases.[1] About 15 to 20% of all patients admitted to the stroke unit require intensive care.[2] The most common extracerebral complication in stroke patients followed in intensive care is respiratory failure, with mechanical ventilation needs varying between 5 and 8%.[3] Patients requiring mechanical ventilation stay longer in the hospital due to sedatives, analgesics, and ventilator-associated pneumonia. Moreover, the need for mechanical ventilation is an independent indicator of poor prognosis, with a mortality rate varying between 40 and 80%.[4-8]

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In intensive care patients, scoring systems are frequently used to determine the severity of the disease, the response to the treatment given, expected death rates, and intensive care performance. These systems consist of two main parts: prognostic systems that predict mortality and organ failure systems that evaluate morbidity. The APACHE II (Acute Physiology and Chronic Health Evaluation), SAPS II (Simplified Acute Physiology Score) are the most commonly used scales for predicting mortality based on data collected within the first 24 h for patients followed in ICU. The leading scale used to predict organ failure with recurring measurements in patients in intensive care is SOFA (Sequential Organ Failure Assessment). Although these scales are designed solely as predictors of mortality and morbidity, their use has been increasing with studies conducted.[9,10]

The need for mechanical ventilation in ischemic stroke patients is a pressing issue due to prolonged hospital stays and increased mortality rates. The absence of a system to predict the need for mechanical ventilation is one of the major shortcomings in finding solutions. With this in mind, this study aimed to evaluate the success of mortality scoring systems (SAPS II, APACHE II, and SOFA) in predicting the need for endotracheal intubation within the first seven days in patients admitted to the ICU due to ischemic stroke.

PATIENTS AND METHODS

The prospective study examined patients diagnosed with acute ischemic stroke who were admitted to the stroke ICU of Necmettin Erbakan University Meram Faculty of Medicine between June 2021 and April 2023 and either underwent endotracheal intubation within the first seven days or did not require intubation. All patients were monitored by the neurology intensive care team in a tertiary stroke ICU. The exclusion criteria were as follows: *(i)* patients under the age of 18; *(ii)* patients presenting with hemorrhagic stroke; *(iii)* patients who did not present to the hospital within the first 24 h; *(iv)* patients who were admitted after being intubated in another center; *(v)* patients with insufficient data (due to the ICU and the team taking care of COVID-19 patients during the COVID-19 pandemic, adequate data could not be provided); *(vi)* patients discharged from intensive care within the first two days. A written informed consent was obtained from each patient. The study protocol was approved by the Necmettin Erbakan University Meram Faculty of Medicine Non-Drug and Non-Medical Device Research Ethics Committee (date: 23.10.2020, no: 2020/2864). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Demographic data and comorbidities were obtained from the patients themselves, their relatives, or by reviewing their medical records. Laboratory data were obtained from the hospital information system. The severity of illness and mortality risk were assessed using the APACHE II, SAPS II, and SOFA scores, measured at 24, 36, and 48 h after ICU admission.

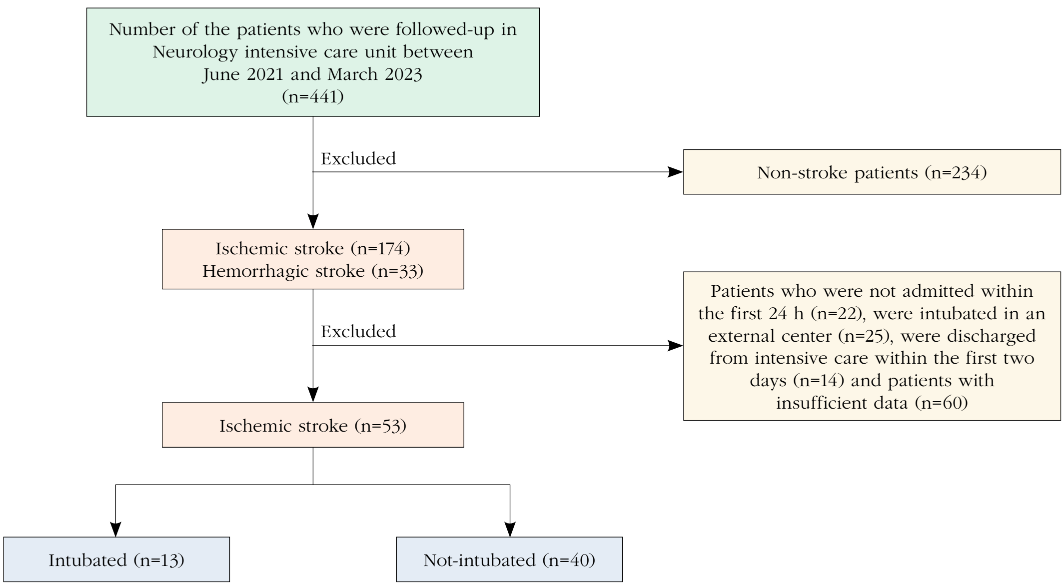


Figure 1. Patient recruitment flowchart.

TABLE 1
General data of the cases

	Not-intubated (n=40)				Intubated (n=13)				
	n	%	Median	IQR	n	%	Median	IQR	*p*
Demographics									
Age (year)			72	64.2-79.5			76	70.5-83.0	0.300†
Sex									
Female	21	52.5					5	38.5	0.379‡
Comorbidities									
Hypertension	28	70			11	84.6			0.299‡
Diabetes mellitus	12	30			6	46.2			0.285‡
Hyperlipidemia	8	20			5	38.5			0.179‡
Cardiovascular diseases	13	32.5			9	69.2			0.885‡
Atrial fibrillation	5	12.5			3	23.1			0.355‡
Cerebrovascular disease history	3	7.5			2	15.4			0.398‡
Transient ischemic attack	1	2.5			0	0			0.565‡
Smoking	14	35			4	30.8			0.780‡
Admission severity scores									
GCS			15	13-15			11	9.5-12.5	**<0.001†**
NIHSS			8	4-14			15	14-20	**<0.001†**
mRS			4	3-4			4	4-5	**0.019†**
Admission labs									
White blood cell (10^9/L)			9.3	7.2-10.5			8.3	7.1-15.8	0.741†
Lymphocyte (10^9/L)			1.4	0.9-2.4			1.6	0.9-2.8	0.702†
Neutrophil (10^9/L)			6.3	5.4-7.9			5.7	4.1-12.2	0.885†
Hemoglobin (g/L)			13.4	11.9-14.6			13.4	12-15	0.934†
Hematocrit (%)			41.4	36.8-44.2			42.7	39.8-47.2	0.182†
Platelet count (10^9/L)			228	203-284			242	202-298	0.951†
Urea (mg/dL)			36.5	29.5-47			44	34-65.5	0.277†
Creatinine (mmol/L)			1	0.8-1.1			0.8	0.7-1.3	0.748†
Uric acid (mg/dL)			4.7	3.9-5.6			6.5	4.1-8.3	0.076†
Alanine transaminase (U/L)			14	10.2-20.2			19	9-17	0.315†
Aspartate transaminase (U/L)			17.7	14.2-21.8			19	15.5-23.5	0.495†
Sodium (mmol/L)			138	137-139			138	136-139.5	0.637†
Potassium (mmol/L)			4.3	4-4.5			4.3	3.8-4.6	0.641†
Calcium (mmol/L)			8.9	8.6-9.2			9.2	8.6-9.4	0.576†
Serum glucose (mg/dL)			135	113-180			140	98-176	0.577†
C-reactive protein (mg/L)			4.3	1.5-8.9			13	1.7-16.5	0.148†
Serum albumin (g/dL)			40	38-42			40	35-43	0.892†
Red cell distribution width (%)			13.9	13-15			14.1	13.4-15	0.780†
Mean platelet volume (fL)			10.5	9.7-11.2			10.1	9.8-10.8	0.555†
Neutrophil/lymphocyte			3.9	2.0-7.9			4.1	2.2-7.6	0.877†
Platelet/lymphocyte			147	100-258			134	92-266	0.951†

TABLE 1
Continued

	Not-intubated (n=40)				Intubated (n=13)				
	n	%	Median	IQR	n	%	Median	IQR	*p*
Labs at 24th h									
White blood cell (10^9/L)			9.9	8.4-11.9			13.8	10.4-21.7	**0.003†**
Lymphocyte (10^9/L)			1.1	0.8-1.8			0.9	0.7-1.5	0.357†
Neutrophil (10^9/L)			8.2	6.5-9.9			12.5	10.8-23.1	**<0.001†**
Hemoglobin (g/L)			12.6	11.2-14.4			12.6	11.9-14.3	0.756†
Hematocrit (%)			38.5	34.3-43.0			40.3	36.9-43.7	0.182†
Platelet count (10^9/L)			227	192-272			260	229-287	0.112†
Urea (mg/dL)			30.5	25.2-39.0			42.0	30.5-72.0	**0.029†**
Creatinine (mmol/L)			0.8	0.7-1.0			0.9	0.6-1.4	0.656†
Serum glucose (mg/dL)			129	119-185			156	112-184	0.620†
C-reactive protein (mg/L)			20	8.2-50.5			48	21-110	**0.014†**
Red cell distribution width (%)			13.8	13.1-15.0			14.4	13.6-15.0	0.444†
Mean platelet volume (fL)			10.6	9.9-11.5			10.3	9.9-11.3	0.671†
Neutrophil/lymphocyte			6.2	4.6-9.2			13.8	8.1-24.1	**<0.001†**
Platelet/lymphocyte			169	125-259			273	143-345	0.231†
Labs at 36th h									
White blood cell (10^9/L)			10.0	8.1-12.1			13.1	9.7-19.6	**0.034†**
Lymphocyte (10^9/L)			1.3	0.9-2.0			0.8	0.4-1.3	**0.040†**
Neutrophil (10^9/L)			7.5	6.0-9.6			12.0	7.1-16.6	**0.009†**
Hemoglobin (g/L)			12.7	11.5-14.4			12.2	11.0-14.2	0.602†
Hematocrit (%)			38.9	36.0-44.0			39.3	36.2-43.3	0.965†
Platelet count (10^9/L)			225	175-284			213	193-293	0.641†
Urea (mg/dL)			32	29-40			46	30-63	0.085†
Creatinine (mmol/L)			0.8	0.70-0.95			1.03	0.8-1.6	**0.043†**
Serum glucose (mg/dL)			126	104-156			170	125-203	**0.027†**
C-reactive protein (mg/L)			21	11.2-48.2			79	17-130	**0.024†**
Red cell distribution width (%)			13.8	13.1-15.4			14.4	13.7-15.5	0.328†
Mean platelet volume (fL)			10.5	9.8-11.6			10.8	9.6-11.5	0.657†
Neutrophil/lymphocyte			5.3	3.6-8.4			12.5	6.8-32.2	**0.003†**
Platelet/lymphocyte			139	110-207			232	151-262	**0.052†**
Labs at 48th h									
White blood cell (10^9/L)			8.9	7.4-10.4			15	11.8-19.1	**<0.001†**
Lymphocyte (10^9/L)			1.4	1.0-1.8			0.9	0.8-1.6	0.065†
Neutrophil (10^9/L)			6.3	5.2-8.3			13	8.8-16.2	**<0.001†**
Hemoglobin (g/L)			12.1	11.2-14.1			11.8	9.2-12.9	0.327†
Hematocrit (%)			37.8	34.7-44.0			39	32.0-40.7	0.965†
Platelet count (10^9/L)			217	182-260			243	193-280	0.399†
Urea (mg/dL)			37	30.5-47.0			63	44.5-95.0	**<0.001†**
Creatinine (mmol/L)			0.8	0.7-0.9			1	0.8-2.8	**0.035†**
Serum glucose (mg/dL)			122	99-158			190	123-220	**0.022†**
C-reactive protein (mg/L)			34	15-71			97	52-174	**0.008†**
Red cell distribution width (%)			13.8	13.0-14.8			14.1	13.2-15.0	0.326†
Mean platelet volume (fL)			10.6	10.0-11.5			10.8	9.7-11.0	0.891†
Neutrophil/lymphocyte			4.3	3.1-6.0			12.6	4.2-18.4	**0.020†**
Platelet/lymphocyte			145	121-192			270	127-319	0.056†

TABLE 1
Continued

	Not-intubated (n=40)				Intubated (n=13)				
	n	%	Median	IQR	n	%	Median	IQR	*p*
TOAST									
Cardioembolism	11§	27.5			0	0			0.098‡
Large-artery atherosclerosis	15§	37.5			6§	46.2			
Undetermined etiology	14§	35			7§	53.8			
Acute treatment									
tPA	14	35			4	30.8			0.780‡
Mechanical thrombectomy	7	17.5			7	53.8			**0.010‡**
tPA + mechanical thrombectomy	2	5			2	15.4			0.218‡
Admission and follow-up information									
Application time to the hospital (h)			4.4	3.6			7.3	6.0	**0.030‡**
Intensive care hospitalization period (days)			5.0	2.0-14.0			11.0	3.2-52.2	0.103‡

IQR: Interquartile range; GCS: Glasgow Coma Scale; NIHSS: National Institutes of Health Stroke Scale; mRS: Modified Rankin Scale; TOAST: Trial of Org 10172 in Acute Stroke Treatment; tPA: Tissue plasminogen activator; † Mann-Whitney U test; ‡ Chi-square or Fisher exact test; § No significant difference between data.

The APACHE II score includes various physiological measurements, laboratory values, and patient information regarding chronic health conditions, with scores ranging from 0 to 71. Higher scores indicate a higher risk of mortality and more severe illness.[11]

The SAPS II evaluates the severity of illness based on 17 variables, including physiological variables, age, type of admission, and underlying diseases, with scores ranging from 0 to 163. Higher scores indicate a higher risk of mortality and more severe illness.[12]

The SOFA score measures the degree of organ dysfunction in six organ systems: respiratory, cardiovascular, hepatic, coagulation, renal, and neurological. Scores range from 0 to 24. Each organ system is scored from 0 to 4, with higher scores indicating more severe organ failure.[13]

At admission, the patients were assessed using the Glasgow Coma Scale (GCS), National Institutes of Health Stroke Scale (NIHSS), and modified Rankin Scale (mRS). The GCS was used to assess the level of consciousness, ranging from 3 (deep coma or death) to 15 (fully awake).[14] The NIHSS was used to determine the severity of stroke, ranging from 0 (no stroke symptoms) to 42 (most severe).[15] The mRS was used to assess the degree of disability or dependence in daily activities after the stroke, ranging from 0 (no symptoms) to 6 (death).[16] Scores were measured using the MDCalc website (https://www.mdcalc.com).

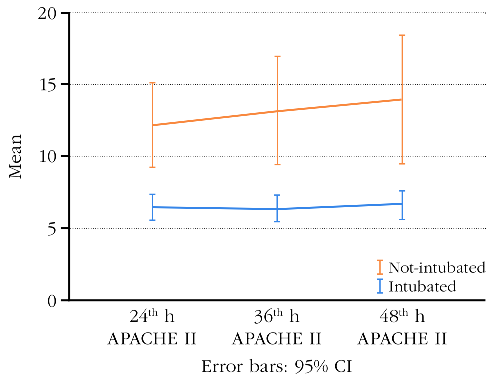
The TOAST (Trial of ORG 10172 in Acute Stroke Treatment) classification was used to categorize the etiology of ischemic stroke into the following categories: large artery atherosclerosis, cardioembolism, small artery occlusion, stroke of other determined cause, and stroke of undetermined cause.[17]

Statistical analysis

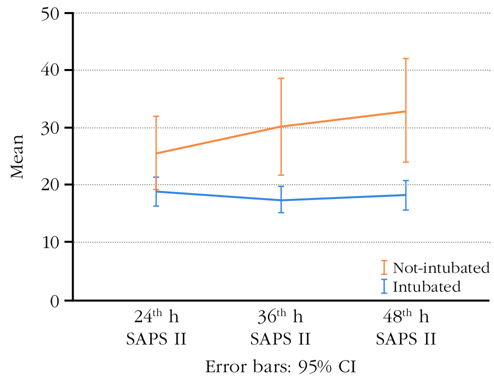
Data were analyzed using IBM SPSS version 25.0 software (IBM Corp., Armonk, NY, USA). In the descriptive statistics of the data, median, first and third quartiles, minimum, and maximum were used. The Mann-Whitney U test was used for quantitative variables. The chi-square test was used for the analysis of qualitative data. Logistic regression analysis was employed to determine independent predictors of intubation. Variables with a probability value <0.10 in univariate analysis and those of clinical significance were selected for the models. A receiver operating characteristic analysis was utilized to determine cutoff values and measure predictive power for mortality scores. The cutoff value was determined according to Youden's J statistic. A p-value <0.05 was considered statistically significant when comparing groups.

RESULTS

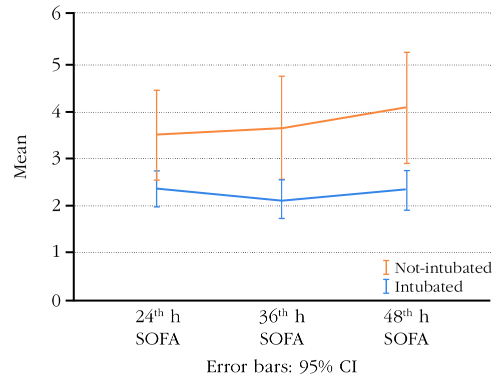
Out of the 53 patients included in the study, 13 (8 males, 5 females; median age: 76 [70.5-83.0] years) were endotracheally intubated within the



	Not-intubated (n=40)		Intubated (n=13)		
Mortality scores	Median	IQR	Median	IQR	*p*
24th APACHE II	6	5-8	15	9-16.5	**<0.001†**
36th APACHE II	6	5-8	13	8.7-18.0	**<0.001†**
48th APACHE II	6	5-8	14.5	8.2-18.7	**<0.001†**
p value	0.573‡		0.178‡		



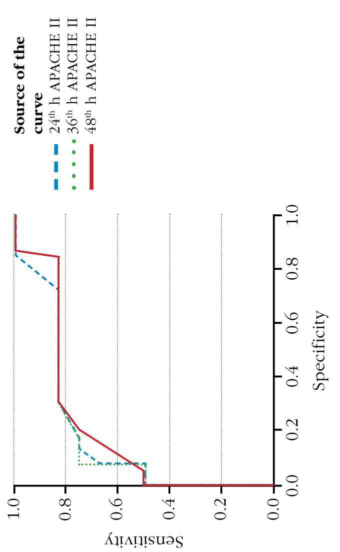
	Not-intubated (n=40)		Intubated (n=13)		
Mortality scores	Median	IQR	Median	IQR	*p*
24th SAPS II	18	15-23	25	19-29	**0.042†**
36th SAPS II	16	12-23	28	21.0-43.7	**0.003†**
48th SAPS II	17	15-22.5	29	22.7-48.4	**0.002†**
p value	**0.032‡**		**0.010‡**		



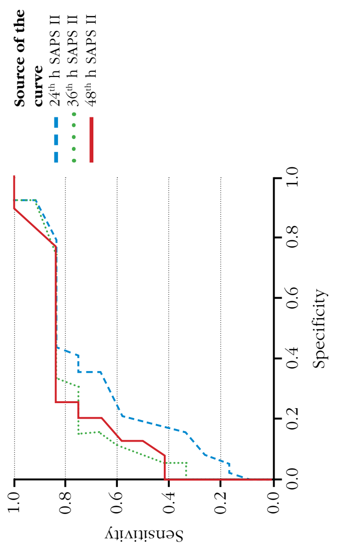
	Not-intubated (n=40)		Intubated (n=13)		
Mortality scores	Median	IQR	Median	IQR	*p*
24th SOFA	2	2-3	3	3-4	**0.020†**
36th SOFA	2	1-3	3	2.2-4.7	**0.006†**
48th SOFA	2	2-3	4	2.5-5	**0.006†**
p value	**0.046‡**		**0.032‡**		

Figure 2. Data for APACHE II, SAPS II, and SOFA at 24, 36, and 48 h.

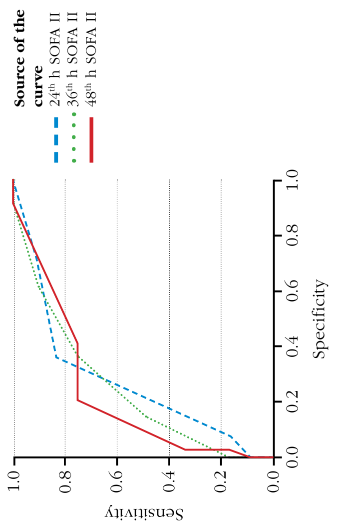
IQR: Interquartile range; APECHE II: Acute Physiology and Chronic Health Evaluation II; SAPS II: Simplified Acute Physiology Score II; SOFA: Sequential Organ Failure Assessment Score; † Mann-Whitney U test; Friedman test.



	AUC	95% CI	p	Cut-off value	Sensitivity (%)	Specificity (%)
24th h APACHE II	0.828	0.663-0.993	**0.001**	9.5	75	97
36th h APACHE II	0.817	0.637-0.997	**0.001**	10.5	75	92
48th h APACHE II	0.803	0.624-0.983	**0.002**	8.5	75	80



	AUC	95% CI	p	Cut-off value	Sensitivity (%)	Specificity (%)
24th h SAPS II	0.700	0.517-0.883	**0.038**	24.5	58	80
36th h SAPS II	0.786	0.603-0.969	**0.003**	23.5	75	85
48th h SAPS II	0.790	0.615-0.964	**0.003**	21.5	83	74



	AUC	95% CI	p	Cut-off value	Sensitivity (%)	Specificity (%)
24th h SOFA II	0.734	0.574-0.894	**0.015**	2.5	83	64
36th h SOFA II	0.760	0.604-0.915	**0.007**	2.5	75	64
48th h SOFA II	0.781	0.615-0.947	**0.003**	3.5	75	80

Figure 3. Receiver operating characteristic analysis and cutoff value of the 24-h APACHE II score for predicting intubation in the first seven days.

AUC: Area under the curve; CI: Confidence interval; APECHE II: Acute Physiology and Chronic Health Evaluation II; SAPS II: Simplified Acute Physiology Score II; SOFA: Sequential Organ Failure Assessment Score.

first seven days, while 40 (19 males, 21 females; median age: 72 [64.2-79.5] years) were not. There was no significant difference between the intubated and not-intubated groups in terms of age, sex, comorbidities, and the hemogram, liver function tests, kidney function tests, and acute phase reactants taken upon hospital admission (Table 1). The GCS score (15 [13-15] *vs.* 11 [9.5-12.5], p<0.001) measured at the time of hospital admission, the mRS score (4 [3-4] *vs.* 4 [4-5], p=0.019), and the NIHSS score (8 [4-14] *vs.* 15 [14-20], p<0.001) were significantly higher in the intubated patients compared to not-intubated patients. Repeated laboratory measurements at 24, 36, and 48 h showed that white blood cells, neutrophils, glucose, C-reactive protein, neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, and kidney function values related to inflammation were significantly higher in the intubated group (Table 1).

The ICU scores measured at 24, 36, and 48 h, namely APACHE II, SAPS II, and SOFA scores, were significantly higher in patients who were intubated. In repeated measurements, while there was no significant increase in the APACHE II score in intubated patients, it was found that SAPS II and SOFA scores significantly increased (Figure 2).

In the receiver operating characteristic analysis, when comparing the success of predicting endotracheal intubation in the first seven days based on the mortality scoring measurements at 24, 36, and 48 h, the APACHE II score measured at 24 h (area under the curve [AUC]: 0.828; cutoff value: 9.5; sensitivity: 75%; specificity: 87%; p=0.001) had the highest success rate. This was followed by the APACHE II score measured at 36 h (AUC=0.817, cutoff value=10.5; sensitivity: 75%; specificity: 92%; p=0.001) and 48 h (AUC=0.803, cutoff value=8.5; sensitivity: 75%; specificity: 80%; p=0.003; Figure 3).

In the multivariate logistic regression analysis, only the APACHE II score measured at 24 h was identified as an independent risk factor (odds ratio=2.36, 95% confidence interval 1.051-5.301, p=0.037; Table 2).

DISCUSSION

In this study, it was determined that the APACHE II score measured at 24 h had a high prediction success for endotracheal intubation within the first seven days in patients hospitalized in the neurology ICU due to ischemic stroke, and according to logistic regression analysis, it was an independent risk factor.

TABLE 2
The effect of the variables examined in the multivariate analysis on the risk of intubation in the first seven days

		95% CI		
	OR	Upper	Lower	*p*
24th APACHE II*	2.36	1.051	5.301	**0.037**†

CI: Confidence interval; OR: Odds ratio; † Multivariate cox regression analysis; * Only significant data were reported.

The APACHE was the first intensive care scale created and consisted of 34 physiological parameters. The number of physiological evaluations was reduced to 12, and with the addition of age, chronic disease information, and the GCS score for neurological evaluation, the APACHE II scoring system was established. Although APACHE II has a satisfactory prediction in many patient groups, it has not been successful in patients with coronary artery disease, patients undergoing bypass surgery, and patients with burn.[9,11] In a study by Bian et al.[18] on the mortality prediction of APACHE II in patients in neurology ICU, high APACHE II scores were associated with high mortality rates; the mortality prediction increased in patients with scores >10. In a study by Su et al.,[19] it was determined that the APACHE II score was applicable for ischemic stroke, hemorrhagic stroke, and neurological infections in neurology intensive care patients but not for other neurological diseases. Other studies also confirmed the success of APACHE II in mortality prediction in both ischemic and hemorrhagic stroke patients.[20,21] Although APACHE II is successful in predicting mortality in patients with ischemic stroke, there are not enough studies regarding its prediction of the need for mechanical ventilation. In a study by Safavi et al.[22] in a third-level ICU, it was found that APACHE II predicted the need for mechanical ventilation with 90% sensitivity and 30% specificity at a cutoff value of 12 in a study of 180 patients, including five patients with cerebrovascular disease. In a retrospective study by Kozak et al.,[23] the APACHE II score was significantly higher in patients with ischemic stroke who needed mechanical ventilation. In our study, APACHE II scores measured at 24, 36, and 48 h successfully predicted the need for mechanical ventilation in the first seven days. The measurement at 24 h had the highest AUC value. On admission, mRS, NIHSS, GCS, and follow-up mortality scores were significantly higher in intubated patients; however, according to the multivariate logistic regression analysis, only the APACHE II score measured at 24 h was determined as an independent risk factor for intubation need. For each 1-point increase in the APACHE II score, the odds ratio increased by 2.36, and the prediction of intubation had a sensitivity of 76.9% and a specificity of 87.5% at a cutoff value of 9.5. This study showed that while mRS, NIHSS, and GCS scores were indicators of poor prognosis for ischemic stroke, they were not risk factors for predicting intubation.

The SAPS II, along with 12 physiological variables similar to those in APACHE II, takes into account a total of 17 variables, including age, mode of admission to intensive care, and underlying disease. Each variable is scored within different point ranges. Together with APACHE II, it is one of the most widely used scoring systems worldwide.[9] It was determined that a SAPS II >22 was an independent risk factor for the need for intensive care in patients with acute ischemic stroke.[24] Furthermore, in a study by Moon et al.[20] on the prediction of mortality scores for stroke patients, it was found that SAPS II was a better predictor for ischemic stroke patients, while APACHE II was a better predictor for hemorrhagic stroke patients. In a retrospective study by Kozak et al.,[23] which evaluated the prediction of intubation needs within the first seven days by mortality scores, both SAPS II and APACHE II scores were found to be significant for predicting intubation needs, with the SAPS II score being more predictive than APACHE II. However, in the multivariate analysis, only SAPS II was found to be an independent risk factor for intubation needs. In our prospective study, both SAPS II and APACHE II were identified as predictors for the need for mechanical ventilation, with APACHE II being more successful than SAPS II.

Initially used to evaluate organ failure due to sepsis, the SOFA has later been used to assess organ failure in cases without sepsis.[13] Although it is primarily used to predict morbidity rather than mortality, it has also shown success in predicting mortality. The SOFA system, based on the consecutive measurements of six organ systems, did not achieve sufficient predictive accuracy for mortalities that occurred before the onset of multiple organ failure.[25] A study demonstrated that the SOFA score could be used to predict mortality in patients with ischemic stroke.[26] However, there are few studies on the use of the SOFA score to predict the need for mechanical ventilation in stroke patients. In a retrospective study conducted by Kozak et al.,[23] the SOFA score was found to be more successful in predicting the need for mechanical ventilation compared to APACHE II and SAPS II. However, in our prospective study, SOFA was less successful in predicting the need for a mechanical ventilator compared to SAPS II and APACHE II. The emergence of the need for mechanical ventilation before the onset of multiple organ failure was thought to be the main reason for the lower success of the SOFA score in our study compared to the other two systems.

The limitation of this study was that it was conducted at a single center and involved a small number of patients.

In conclusion, while there are many scoring systems available for predicting mortality in patients admitted to the ICU, there is insufficient research on predicting the need for intubation in ischemic stroke patients, which is associated with longer hospital stays and higher mortality rates. This study addressed this issue and paved the way for future research in this area.

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REFERENCES

1. Tsao CW, Aday AW, Almarzooq ZI, Alonso A, Beaton AZ, Bittencourt MS, et al. Heart disease and stroke statistics-2022 update: A report from the American Heart Association. Circulation 2022;145:e153-639. doi: 10.1161/CIR.0000000000001052.
2. Kortelainen S, Curtze S, Martinez-Majander N, Raj R, Skrifvars MB. Acute ischemic stroke in a university hospital intensive care unit: 1-year costs and outcome. Acta Anaesthesiol Scand 2022;66:516-25. doi: 10.1111/aas.14037.
3. Lahiri S, Mayer SA, Fink ME, Lord AS, Rosengart A, Mangat HS, et al. Mechanical ventilation for acute stroke: A multi-state population-based study. Neurocrit Care 2015;23:28-32. doi: 10.1007/s12028-014-0082-9.
4. Bösel J. Use and timing of tracheostomy after severe stroke. Stroke 2017;48:2638-43. doi: 10.1161/STROKEAHA.117.017794.
5. Venkatasubba Rao CP, Suarez JI. Management of stroke in the neurocritical care unit. Continuum (Minneap Minn) 2018;24:1658-82. doi: 10.1212/CON.0000000000000670.
6. Isokuortti H, Virta JJ, Curtze S, Tiainen M. One-year survival of ischemic stroke patients requiring mechanical ventilation. Neurocrit Care 2023;39:348-56. doi: 10.1007/s12028-023-01674-9.
7. Sonneville R, Mazighi M, Collet M, Gayat E, Degos V, Duranteau J, et al. One-year outcomes in patients with acute stroke requiring mechanical ventilation. Stroke 2023;54:2328-37. doi: 10.1161/STROKEAHA.123.042910.
8. Ding J, Ma X, Huang W, Yue C, Xu G, Wang Y, et al. Validation and refinement of a predictive nomogram using artificial intelligence: Assessing in-hospital mortality in patients with large hemispheric cerebral infarction. Front Neurol 2024;15:1398142. doi: 10.3389/fneur.2024.1398142. .
9. Rapsang AG, Shyam DC. Scoring systems in the intensive care unit: A compendium. Indian J Crit Care Med 2014;18:220-8. doi: 10.4103/0972-5229.130573.
10. Shahi S, Paneru H, Ojha R, Karn R, Rajbhandari R, Gajurel BP. SOFA and APACHE II scoring systems for predicting outcome of neurological patients admitted in a tertiary hospital intensive care unit. Ann Med Surg (Lond) 2024;86:1895-1900. doi: 10.1097/MS9.0000000000001734.
11. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: A severity of disease classification system. Crit Care Med 1985;13:818-29.
12. Le Gall JR, Lemeshow S, Saulnier F. A new Simplified Acute Physiology Score (SAPS II) based on a European/North American multicenter study. JAMA 1993;270:2957-63. doi: 10.1001/jama.270.24.2957.
13. Vincent JL, Moreno R, Takala J, Willatts S, De Mendonça A, Bruining H, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the working group on sepsis-related problems of the European Society of intensive care medicine. Intensive Care Med 1996;22:707-10. doi: 10.1007/BF01709751.
14. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. Lancet 1974;2:81-4. doi: 10.1016/s0140-6736(74)91639-0.
15. Brott T, Adams HP Jr, Olinger CP, Marler JR, Barsan WG, Biller J, et al. Measurements of acute cerebral infarction: A clinical examination scale. Stroke 1989;20:864-70. doi: 10.1161/01.str.20.7.864.
16. Rankin J. Cerebral vascular accidents in patients over the age of 60. II. Prognosis. Scott Med J 1957;2:200-15. doi: 10.1177/003693305700200504.

17. Adams HP Jr, Bendixen BH, Kappelle LJ, Biller J, Love BB, Gordon DL, et al. Classification of subtype of acute ischemic stroke. Definitions for use in a multicenter clinical trial. TOAST. Trial of Org 10172 in Acute Stroke Treatment. Stroke 1993;24:35-41. doi: 10.1161/01.str.24.1.35.
18. Bian Y, Zhang P, Xiong Y, Xu F, Zhu S, Tang Z, et al. Application of the APACHE II score to assess the condition of patients with critical neurological diseases. Acta Neurol Belg 2015;115:651-6. doi: 10.1007/s13760-014-0420-x.
19. Su YY, Li X, Li SJ, Luo R, Ding JP, Wang L, et al. Predicting hospital mortality using APACHE II scores in neurocritically ill patients: A prospective study. J Neurol 2009;256:1427-33. doi: 10.1007/s00415-009-5129-z.
20. Moon BH, Park SK, Jang DK, Jang KS, Kim JT, Han YM. Use of APACHE II and SAPS II to predict mortality for hemorrhagic and ischemic stroke patients. J Clin Neurosci 2015;22:111-5. doi: 10.1016/j.jocn.2014.05.031.
21. Huang Y, Chen J, Zhong S, Yuan J. Role of APACHE II scoring system in the prediction of severity and outcome of acute intracerebral hemorrhage. Int J Neurosci 2016;126:1020-4. doi: 10.3109/00207454.2015.1099099.
22. Safavi M, Honarmand A. Comparison of infection probability score, APACHE II, and APACHE III scoring systems in predicting need for ventilator and ventilation duration in critically ill patients. Arch Iran Med 2007;10:354-360.
23. Kozak HH, Buğrul A, Tol F. Akut iskemik inmenin erken döneminde mortalite skorları ve inflamatuar belirteçler mekanik ventilasyon ihtiyacını öngörebilir. Türk Beyin Damar Hast Derg 2022;28:141-8. doi: 10.5505/tbdhd.2022.33255
24. Faigle R, Marsh EB, Llinas RH, Urrutia VC, Gottesman RF. ICAT: A simple score predicting critical care needs after thrombolysis in stroke patients. Crit Care 2016;20:26. doi: 10.1186/s13054-016-1195-7.
25. Raschke RA, Agarwal S, Rangan P, Heise CW, Curry SC. Discriminant accuracy of the SOFA score for determining the probable mortality of patients with COVID-19 pneumonia requiring mechanical ventilation. JAMA 2021;325:1469-70. doi: 10.1001/jama.2021.1545.
26. Qin W, Zhang X, Yang L, Li Y, Yang S, Li X, et al. Predictive value of the Sequential Organ Failure Assessment (SOFA) score for prognosis in patients with severe acute ischemic stroke: A retrospective study. J Int Med Res 2020;48:300060520950103. doi: 10.1177/0300060520950103.