ORIGINAL ARTICLE

A NEW PROGNOSTIC SCALE IN ISCHEMIC STROKE: THE SELCUK SCORE

Turkish Journal of Geriatrics
DOI: 10.29400/tjgeri.2024.374
2024; 27(1):11−20

Cihat ÖZGÜNCÜ[1]
Şerefnur ÖZTÜRK[2]
Fettah EREN[2]
Muslu Kazım KOREZ[3]
Recep AYGÜL[2]
Ahmet Hakan EKMEKCİ[2]
Haluk GÜMÜŞ[2]
Gökhan ÖZDEMİR[1]
Ali ÜNLÜ[4]
Alaattin NAYMAN[5]
Süeda Ecem YILMAZ[2]
Sevde TEKNECİ[2]
Azer MAMMADLİ[2]

CORRESPONDANCE

[1]Cihat ÖZGÜNCÜ

Phone : +905393073537
e-mail : cihatozguncu@gmail.com

Received : Nov 29, 2024
Accepted : Feb 11, 2024

[1] Konya City Hospital, Neurology Clinic, Konya, Turkey

[2] Selcuk University, Faculty of Medicine, Department of Neurology, Konya, Turkey

[3] Selcuk University, Faculty of Medicine, Department of Biostatistics, Konya, Turkey

[4] Selcuk University, Faculty of Medicine, Department of Medical Biochemistry, Konya, Turkey

[5] Selcuk University, Faculty of Medicine, Department of Radiology, Konya, Turkey

Abstract

Introduction: The incidence of stroke is increasing worldwide; thus, prognostic scales with higher predictive values are becoming more important. We aimed to develop a new, simple and useful prognostic scale with high predictive power to predict stroke prognosis.

Materials and Method: The blood samples, imaging data, and clinical parameters of 1697 stroke patients were analyzed retrospectively to evaluate hospital mortality. Binary logistic regression analysis was applied, and appropriate parameters were determined. The Hosmer-Lemeshow test was used for the calibration, and internal validation was applied to the model. Comparisons were performed using the Totaled Health Risks in Vascular Events score and Ling et al. scores (2019), which were evaluated.

Results: Level of consciousness, length of hospital stay, albumin level, National Institutes of Health Stroke Scale score, lesion volume, periventricular hypodensity, and age were the most significant preevaluation parameters. The sensitivity and specificity of the model in predicting mortality were 83.6% (78.4–88%) and 81.2% (79.1–83.2%), respectively. The area under the curve for our developed model was 0.884 (0.868–0.899) ($p<0.001$). This value was higher than the Totaled Health Risks in Vascular Events score of 0.822 (0.803–0.840) and Ling et al. score (2019) of 0.864 (0.847–0.880) in the literature.

Conclusions: The novel Selcuk scoring system, has a better predictive power than other well-known scales used to evaluate mortality. Although the system was proven to be accurate by internal validation, it should be tested in different environments. After further clinical validation studies, our model is anticipated to be useful and promising in clinical daily practice.

Keywords: Mortality; Prognosis; Stroke; Risk Factor; Geriatrics.

INTRODUCTION

A significant portion of the patient burden in neurology and intensive care units (ICUs) mainly consists of stroke patients, most of whom are from the geriatric population. It is the clinician's responsibility to evaluate the severity of the clinical condition, approach the challenge in terms of acute treatment, investigate the risk factors, provide an appropriate medication to minimize the risk of recurrent stroke, and discharge the patient as soon as possible.During the acute and post-acute treatment process, especially patients and their relatives expect to acquire prompt information from health-care providers. The physician's past experience is used to evaluate the condition, but it may not always be easy to predict the current state, severity, and future state of the clinical syndrome. At the same time, personal assessments may not always be objective in making decisions. In the Clinician Judgment vs Risk Score to Predict Stroke Outcomes (JURaSSiC) study, where clinicians evaluated patients to estimate the incidence rates of death and disability, and only 16.9% of the estimations matched the facts (1). In an environment where patients and their relatives expect accurate and easily accessible information from physicians and plan the next treatment modalities, the importance of scales that can reevaluate patients and predict their prognosis becomes more evident.

In the present study, our aim was developing a unique prognostic scale that can be used to predict stroke prognosis, especially in elderly patients. We achieved this by retrospectively evaluating patients treated for stroke in our clinic, where the study was conducted. Thus, we chose to call the scale "the Selcuk score."

METHODS

The present study, which had a retrospective and cross-sectional design, was conducted in the Department of Neurology, Faculty of Medicine, Selcuk University. Approval was obtained from the Local Ethics Committee for Clinical Researches of Selcuk University before the study (approval number: 2020-473). Patients older than 18 years who were admitted to the hospital with the diagnosis of acute stroke between 2016 and 2020 were included and evaluated in the study. Patients with a diagnosis of head trauma, subarachnoid hemorrhage, subdural or epidural hematoma, and sinus vein thrombosis were excluded from the study. Of the 2030 patients enrolled, 188 had transient ischemic attacks and 145 had parenchymal hemorrhages. The study was conducted with 1697 ischemic stroke patients.

The date of admission, age and gender, dates of discharge or exitus, and the length of hospital stay were recorded. Comorbid conditions such as diabetes mellitus (DM), hypertension (HT), history of coronary artery disease (CAD) and/or exposure to any coronary intervention, malignancy, chronic renal failure (CRF) and/or undergoing dialysis treatment, dementia, smoking status, atrial fibrillation (AF), and previous stroke history were determined through the patients' hospital records and the etiological examination performed during hospitalization.

In the first examination, the state of consciousness, Vulpian sign, muscle strength in the upper and lower extremities, presence of cranial nerve involvement, speech status, Glasgow coma scale (GCS) scores, National Institutes of Health Stroke Scale (NIHSS) score, and the modified Rankin score (mRS) were evaluated. Cranial computed tomography (CT) and diffusion magnetic resonance imaging (MRI) tests were performed to determine the localization and size of the lesions. The formula (largest diameter × number of slices × slice thickness/2) was used to calculate the volume of the lesion, which reveals the diffusion restriction in the cerebrum and cerebellum. Stroke lesions with an average volume of <5 cm^3 were considered small, those between 5 and 15 cm^3 were considered medium-sized, and those >15 cm^3 were regarded as large stroke lesions. In the brain stem, however,

while stroke lesions < 1 cm^3 were classified as small, those between 1 to 1.5 cm^3 and >1.5 cm^3 were accepted to be medium- and large-volume stroke lesions. The presence of periventricular hypodensity and carotid artery stenosis were evaluated using CT angiography, carotid and vertebral artery Doppler ultrasonography, MRI angiography, and digital subtraction angiography. The patients' blood samples drawn at the time of hospitalization were also analyzed. The reference values for blood glucose level (mg/dL), leukocyte count (K/μL), and levels of hemoglobin (g/dL), creatinine (mg/dL), urea (K/μL), C-reactive protein (CRP; mg/L), and albumin (g/dL) were recorded. The type of recanalization treatment administered to the patients due to the indications and the time the treatment was started were also recorded. Whether the complications were systemic or related to the central nervous system (CNS), the subtype of CNS complications, the need for intensive care and ventilation support, and the requirement for a decompressive craniectomy operation were determined. The Trial of Org 10172 in Acute Stroke Treatment (TOAST) (2), which was etiologically evaluated during hospitalization, was specified, and the mRS, GCS score, Glasgow outcome scale (GOS) score, and NIHSS score were recorded at discharge.

Statistical Analysis

All statistical analyses were performed using R-3.6.0 for Statistical Computing for Windows (https://www.r-project.org) program. Before the analyses, the normality of the data was checked with the Shapiro-Wilk normality test and Q-Q graphs, and the homogeneity of the variances was checked using the Levene test. The parameters with an extremely skewed distribution to the right were analyzed by applying a logarithmic transformation. Numerical data were expressed as mean ± standard deviation (SD) for the variables with normal distribution, as a geometric mean (95% confidence interval [CI]) for the parameters with logarithmic transformation, and as median (interquartile range [IQR]) for those without logarithmic transformation. Categorical data were presented as frequency (n) and percentile (%). The independent-sample *t* test, Welch *t* test, Mann-Whitney *U* test, or Yuen (robust) independent-sample test were used to compare the numerical parameters related to mortality status. The Pearson chi-square, Yates continuity corrected chi-square, or Fisher exact chi-square test was used to compare the categorical variables. For the primary purpose of the study, binary logistic regression was performed using univariate and multivariate analyses to develop a new scoring system based on the risk model for mortality. Possible independent risk factors were determined by investigating the effects of blood parameters, demographic characteristics, and clinical findings related to mortality in the univariate binary logistic regressions. In the univariate binary logistic regression analysis, significant candidate independent risk factors of mortality were modeled together, and using the stepwise variable selection method, the insignificant variables were removed from the model. Therefore, a novel risk model that predicts mortality during hospitalization was created for patients with ischemic stroke. The coefficients in the multivariate binary logistic regression model were used to calculate the new risk score. The scores were obtained by rounding the regression coefficients to the nearest value.

In addition, to show that the variables in this new risk model are indeed significant parameters for classifying mortality, the patients were classified as either exitus or survivors under the algorithm of the gradient boosting classification. Twenty percent of the data were used for testing, whereas 80% were utilized for training; however, 20% of the 80% for training were used for validation in the gradient boosting algorithm. The results of the gradient boosting classification algorithm were presented as the values of precision, recall, F1 measurement, and area under curve (AUC). The variables used in the risk model were also shown to be significant.

The calibration of the newly created risk model was checked with the Hosmer-Lemeshow test, and the discrimination was checked by evaluating the area under the ROC curve.

On the other hand, the diagnostic performance of the newly developed risk scoring system in predicting mortality was calculated in terms of sensitivity, specificity, and positive (PPV) and negative predictive values (NPV)and compared with those in the literature that were determined using the DeLong method (3). The sensitivity and specificity values of the risk scores were compared using the McNemar test, and PPVs and NPVs were compared with the weighted generalized statistical test scores (4). Missing data were excluded from the analysis, and in evaluating the statistical tests, a significance level of 5% was considered.

RESULTS

A total of 1697 patients, including 913 men (53.8%) and 784 women (46.2%), were enrolled in the present study, with a mean age of 66.92 ± 14.16 years (range, 19–98 years). Whereas 1447 (85.26%) of the patients were discharged, 250 (14.73%) died in the hospital. The baseline information of all patients is shown in Table 1. The results of the binary logistic regression analysis of the risk factors of poor prognosis in patients with acute ischemic stroke (AIS) are shown in Table 2.

As a result of the multiple logistic regression analysis, nine candidate markers were identified for the proposed model in the estimation of the mortality risk and calculated as in Table 3.

In terms of statistical significance, 0.5 point was assigned for each of urea level (>44 mg/dL), age (≥70 years), and periventricular hypodensity. However, 1 point was assigned for each of consciousness (somnolence, lethargy, and coma), speech (dysphasia and aphasia), hospital stay (≥14 days), and albumin level (<3.5 g/dL). One and 2 points were assigned for NIHSSs between 10–19 and ≥20. For medium and large volume stroke lesions, 0.5 and 1 point were assigned. Therefore, a new prediction model with a total score of 8.5 points was achieved. The ROC curve analysis was performed to compare the diagnostic performance of the Selcuk score, which we developed in our study, with those of the THRIVE (5) and Ling et al. scores (6), and the findings from the comparisons are indicated in Figure 1. The findings from the ROC curve analysis, sensitivity, specificity, cutoff value, PPV, and NPV of the Selcuk, THRIVE (5), and Ling et al. (6) scores are summarized in Table 4. The AUC value of the Selcuk score was significantly higher than those of the other models investigated in the study.

DISCUSSION

AIS is a common disease that can lead to serious consequences. Stroke is one of the most important causes of morbidity and mortality, especially in the geriatric age group, as age is the most important factor that increases the prevalence of stroke. Researchers have been trying to define prognostic factors related to AIS for years, which include stroke severity (7), localization of the lesion and volume (8), stroke etiology (9), acute treatment method, certain blood parameters (10), need for intensive care during hospitalization, and the development of complications (11). Although these factors may individually affect patient prognosis, the estimation accuracy of the scales created by combining several of these factors is likely to increase.

Although researchers have developed numerous scaling systems for assessing stroke prognosis, many healthcare professionals still do not widely use them. Several reasons explain why scales are not applied in daily practice, including the complex scoring system of the scale, the physician's inability to remember the scoring easily, the need for complex imaging and examinations, and the requirement for an expert's opinion or a specialist's examination. Owing to our country's current health

Table 1. Evaluation of demographic and clinical features, clinical imaging and laboratory findings of patients with acute ischemic stroke

Parameters		All patients n=1697	Survivors n=1447	Exitus n=250	p-value
Age (years)	≥70	825 (48.62%)	653 (45.13%)	172 (68.80%)	<0.001 [a]
Gender	Male	913 (53.80%)	808 (55.84%)	105 (42.00%)	<0.001 [a]
Number of hospitalization days	≥14	425 (25.04%)	325 (22.46%)	100 (40%)	<0.001 [a]
Recurrent stroke	Yes	456 (26.87%)	382 (26.40%)	74 (29.60%)	0.292 [a]
DM	Yes	641 (37.77%)	540 (37.32%)	101 (40.40%)	0.353 [a]
Hypertension	Yes	1029 (60.64%)	873 (60.33%)	156 (62.40%)	0.537 [a]
History of cardiac disease	Yes	483 (28.46%)	385 (26.61%)	98 (39.20%)	<0.001 [a]
Malignancy	Yes	110 (6.48%)	91 (6.29%)	19 (7.60%)	0.437a
CKD/dialysis	Yes	78 (4.60%)	56 (3.87%)	22 (8.80%)	<0.001 [a]
Dementia	Yes	66 (3.89%)	45 (3.11%)	21 (8.40%)	<0.001 [a]
AF	Yes	361 (21.27 %)	300 (20.73%)	61 (24.40%)	0.191 [a]
Stroke volume	Small	1030 (60.73%)	980 (67.73%)	50 (20.00%)	<0.001 [a]
	Medium	347 (20.45%)	289 (19.97%)	58 (23.20%)	
	Large	320 (18.86%)	178 (12.30%)	142 (56.80%)	
Periventricular hypodensity	Yes	646 (38.07%)	529 (36.56%)	117 (46.80%)	0.002 [a]
Rate of carotid stenosis	≥50	284 (19.67%)	254 (19.00%)	30 (28.04%)	0.024 [a]
Level of consciousness	Somnolence, lethargy, coma	221 (13.02%)	81 (5.60%)	140 (56.00%)	<0.001 [a]
Vulpian sign	Yes	178 (10.49%)	93 (6.43%)	85 (34.00%)	<0.001 [a]
Speech	Dysphasia-aphasia	1018 (59.99%)	783 (54.11%)	235 (94.00%)	<0.001 [a]
NIHSS	<10	1210 (71.34%)	1162 (80.36%)	48 (19.20%)	<0.001 [a]
	≥10-19	368 (21.70%)	250 (17.29%)	118 (47.20%)	
	≥20	118 (15.50%)	34 (2.35%)	84 (33.60%)	
ICU	Yes	734 (43.25%)	484 (33.45%)	250 (100.00%)	<0.001 [a]
Recanalization procedure	None	1351 (79.61%)	1194 (82.52%)	157 (62.80%)	<0.001 [a]
	IV tPA	147 (8.66%)	115 (7.95%)	32 (12.80%)	0.012 [a]
	IA tPA	36 (2.12%)	28 (1.94%)	8 (3.20%)	0.200 [a]
	Thrombectomy	94 (5.54%)	70 (4.84%)	24 (9.60%)	<0.002 [a]
	IV tPA+thrombectomy	69 (4.07%)	40 (2.76%)	29 (11.60%)	<0.001 [a]
CNS complications	Yes	154 (9.07%)	55 (3.80%)	99 (39.60%)	<0.001 [a]
Systemic complications	Yes	260 (15.3%)	117 (8.1%)	143 (57.2%)	<0.001 [a]
Decompressive craniectomy	Yes	52 (3.06%)	9 (0.62%)	43 (17.20%)	<0.001 [a]
Blood glucose			126 (104-175)	142 (110-215)	<0.001[b]
Log- creatinine			0.86 (0.86-0.87)	0.97 (0.94-0.99)	<0.001 [c]
Albumin			3.42±0.51	2.95±0.64	<0.001[e]
Log-CRP			17.83 (4.59-69.31)	48.55 (13.02-181.05)	<0.001[d]
Log-urea			39.55 (26.14-39.22)	51.10 (32.26-80.95)	<0.001[d]
CRP/albumin			6.64 (2.35-21.39)	24.13 (6.24-57.57)	<0.001[b]
Hg			13.47±1.96	12.78±2.21	<0.001 [d]
Log-WBC			8.77 (8.70-8.85)	10.03 (9.80-10.26)	<0.001[c]

[a]: Data were presented as numbers (n) and percentages (%). A p-value was calculated by Pearson chi-square test.[b]: Mann Whitney U test, [c]: Yuen test, [d]: student t-test, [e]: Welch t-test was applied. AF: Atrial fibrillation, CKD: Chronic Kidney Disease, CNS: Central nervous system, CRP: C-Reactive protein, DM: Diabetes mellitus, Hg: Hemoglobin, ICU: Intensive care unit, NIHSS: National Institutes of Health Stroke Scale, WBC: White blood count, IV: Intravenous, IA: Intraarterial, tPA: tissue plasminogen activator

Table 2. Mortality risk ratios of risk factors in acute ischemic stroke

Parameters		OR (%95 CI)	p-value
Age (years)	≥70	2.681 (2.013 - 3.572)	<0.001
Gender	Female	1.746 (1.331 - 2.291)	<0.001
Number of hospitalization days	≥14	2.302 (1.737 - 3.050)	<0.001
Recurrent stroke	Yes	1.172 (0.872 - 1.575)	0.292
DM	Yes	1.139 (0.866 - 1.498)	0.354
Hypertension	Yes	1.091 (0.827 - 1.439)	0.537
History of cardiac disease	Yes	1.778 (1.345 - 2.352)	<0.001
Malignancy	Yes	1.226 (0.733 - 2.049)	0.438
CKD/dialysis	Yes	2.397 (1.435 - 4.002)	<0.001
Dementia	Yes	2.857 (1.671 - 4.885)	<0.001
AF	Yes	1.234 (0.900 - 1.691)	0.191
Stroke volume	Small	Reference	
	Medium	3.934 (2.636 - 5.870)	<0.001
	Large	15.636 (10.912 - 22.404)	<0.001
Periventricular hypodensity	Yes	1.527(1.165 - 2.001)	0.002
Rate of carotid stenosis	≥50	1.661 (1.066 - 2.588)	0.025
Level of consciousness	Somnolence, lethargy, coma	21.464 (15.345 - 30.021)	<0.001
Vulpian sign	Yes	7.500 (5.362 - 10.491)	<0.001
Speech	Dysphasia-aphasia	13.286 (7.804 - 22.619)	<0.001
NIHSS (categorized)	<10	Reference	
	≥10-19	11.426 (7.954 - 16.415)	<0.001
	≥20	59.809 (36.568 - 97.821)	<0.001
Recanalization procedure	None	Reference	
	IV tPa	2.116(1.383 - 3.239)	<0.001
	IA tPA	2.173 (1.383 - 3.239)	0.058
	Thrombectomy	2.607(1.593 - 4.267)	<0.001
	IV tPA+thrombectomy	5.514(3.324 - 9.147)	<0.001
CNS complications	Yes	16.593(11.463 - 24.021)	<0.001
Decompressive craniectomy	Yes	33.191 (15.946 - 69.085)	<0.001

Data were presented at 95% confidence intervals (CI). A p-value was calculated by logistic regression analysis. AF: Atrial fibrillation, CKD: Chronic Kidney Disease, CNS: Central nervous system, DM: Diabetes mellitus, NIHSS: National Institutes of Health Stroke Scale; OR: Odds ratio, IV: Intravenous, IA: Intraarterial, tPA: tissue plasminogen activator

Table 3. Results of multivariate logistic regression analysis for the mortality prediction model

Parameters	Estimates	SE	*p*-value	OR (%95 CI)	Wald	VIF	Tolerance	Score
Level of consciousness						1.318	0.758	
Conscious or confused	[Reference]							
Somnolence, Lethargy or Coma	1.10000	0.249	<.001	3.004 (1.845–4.891)	19.564			1
Speech						1.090	0.917	
Normal	[Reference]							
Dysphasia – Aphasia	1.13381	0.309	<.001	3.107 (1.697–5.689)	13.503			1
Number of hospitalization days						1.121	0.892	
<14 days	[Reference]							
≥ 14 days	0.77589	0.205	<.001	2.172 (1.453–3.248)	14.295			1
Albumin (g/dL)						1.061	0.943	
≥ 3.5	[Reference]							
< 3.5	1.00292	0.195	<.001	2.726 (1.861–3.993)	26.515			1
Urea (mg/dL)						1.037	0.964	
≤ 44	[Reference]							
>44	0.52895	0.184	.004	1.697 (1.181–2.438)	8.191			0.5
NIHSS						1.227	0.815	
< 10	[Reference]							
10 – 19	1.24730	0.246	<.001	3.481 (2.147–5.643)	25.596			1
≥ 20	1.93459	0.372	<.001	6.921 (3.337–14.355)	27.016			2
Stroke volume						1.115	0.897	
Small	[Reference]							
Middle	0.52213	0.253	.040	1.685 (1.025–2.771)	4.234			0.5
Large	1.14366	0.258	<.001	3.138 (1.889–5.211)	19.533			1
Periventricular hypodensity						1.125	0.889	
No	[Reference]							
Yes	0.42297	0.205	.036	1.526 (1.027–2.268)	4.379			0.5
Age (years)						1.121	0.892	
< 70	[Reference]							
≥ 70	0.52372	0.206	.011	1.688 (1.127–2.528)	6.455			0.5

Model Fit Measures	**Pseudo R^2 (Coefficient of determination)**
AIC (Akaike Information Criteria) = 878.81	McFadden's R^2 = 0.397
BIC (Bayesian Information Criteria) = 944.05	Cox & Snell's R^2 = 0.283
χ^2=563.66, p<.001	Nagelkerke's R^2 = 0.500
Deviance = 854.81	Tjur R^2 = 0.412

AIC: Akaike information criteria, BIC: Bayesian information criteria, CI: Confidence interval, NIHSS: National Institutes of Health Stroke Scale, OR: Odds ratio, R2: Coefficient of determination, SE: Standard Error, VIF: Variance inflation factor,

Table 4. Comparisons of The Selcuk Score recommended to predict hospital mortality in patients with acute ischemic stroke with predicting performances of THRIVE and Ling et al. (2019) scores

	Selcuk Score	THRIVE	Ling et al. (2019)
ROC Analysis Results			
AUC (%95 CI)	0.884 (0.868–0.899)≠	0.822 (0.803–0.840)	0.864 (0.847–0.880)
p-value	<.001	<.001	<.001
Cut-off value	>3	>3	>3
AUC Comparison		*p*<.001	*p*=.035
Statistical Diagnostic Measures			
Sensitivity (%)	83.6 (78.4–88)	75.2 (69.4–80.4)	74.8 (68.9–80.1)
Specificity (%)	81.2 (79.1–83.2)	79.1 (76.9–81.2)	84.8 (82.8–86.6)
PPV	43.5 (40.5–46.4)	38.4 (35.5–41.3)	45.9 (42.5–49.5)
NPV	96.6 (95.6–97.4)	94.9 (93.7–95.8)	95.1 (94–96)

≠Demonstrates the significant difference between Selcuk score and THRIVE score (p<.001). AUC: Area under curve, CI: Confidence interval, NPV: Negative predictive value, PPV: Positive predictive value

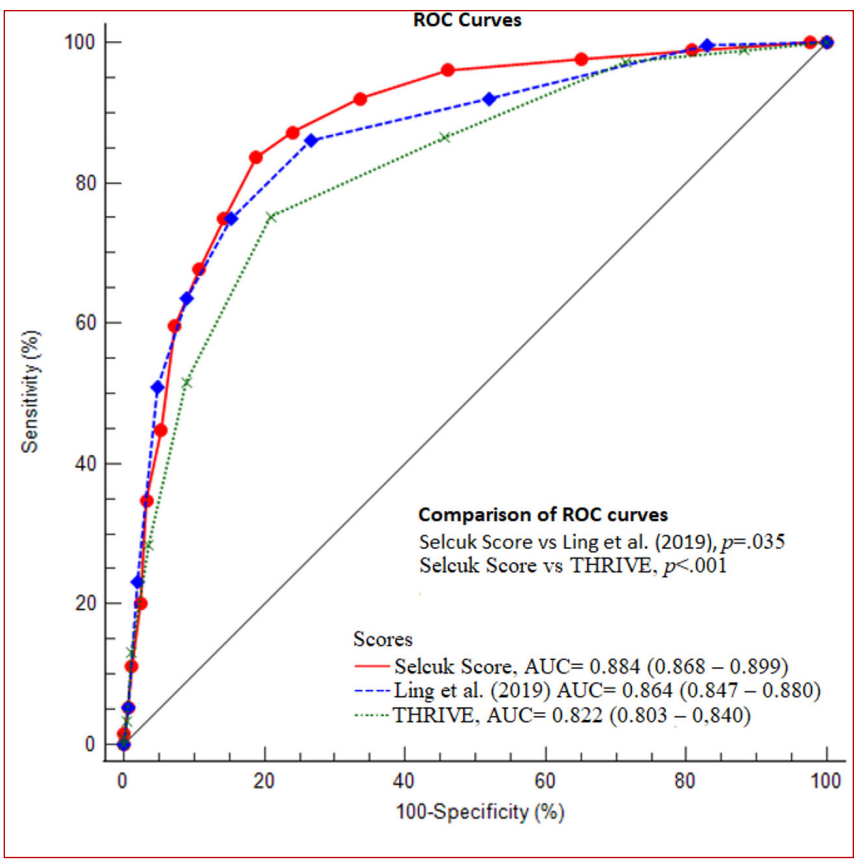

Figure 1. Comparison of the prediction performances of the scoring systems.

and automation infrastructures, advanced referral system, easy access to treatment by specialist physicians, and advanced imaging opportunities, we consider that the Selcuk scoring system we developed will become easier to use.

On the basis of the comparisons between our study findings and those reported in the literature, our study shows similar incidence rates of stroke according to sex. Moreover, our patients experienced stroke at an earlier age, as different from the outcomes of the studies. According to the literature, the most common comorbidity was hypertension (6, 10, 12-14).

The literature has reported the development of several prognostic scales specific to conditions such as intravenous tissue plasminogen activator (tPA), thrombectomy, and intraarterial tPA. Such procedures may provide dramatic improvements in patients' clinical condition and lead to the development of complications and unexpected deteriorations, making it difficult to predict prognosis. Scoring modalities such as the Acute Stroke Registry and Analysis of Lausanne (ASTRAL) score, the PLAN score (preadmission comorbidities, level of consciousness, age, and neurological deficit), and the Bologna Outcome Algorithm for Stroke (BOAS) were not compared with our scoring system in terms of prediction performance because acute treatment approaches were excluded in these scoring systems (13, 15, 16). We consider our study to be intriguing and outstanding because we included all patients with ischemic stroke, including those receiving acute treatment.

The parameters such as age (6, 10, 12-16), state of consciousness (6, 13, 16), NIHSS (6, 16), stroke lesion size (15), and dysphasia (13) included in the Selcuk score have also been evaluated in other scores. However, to our knowledge, no study has included and investigated length of hospital stay, presence of periventricular hypodensity, and albumin and urea levels as significant components together. Our study has the potential to contribute to the field of prognostic prediction in terms of revealing that different parameters can also be involved in the prediction of prognosis.

The present study has several limitations. First, it was planned as a retrospective and cross-sectional study. Second, we couldn't evaluate national and geographical characteristics because we used data from a single center. Therefore, our study findings cannot be applied to populations from other regions. The evaluation of serum markers in the study might have been affected by many clinical and structural conditions, and we were unable to assess the long-term prognostic factors (in the third and sixth months, or first year) and causes of mortality. As data obtained on hospital admission were examined, no dynamic variabilities in neurological deficits that might have developed in the patient and affected the prognosis could be evaluated in the study. Owing to this dynamic process, stroke prognosis is not easy to predict, and unpredictable results may occur not only in the Selcuk score but also in all prognostic scales owing to patients displaying such a clinical course. Therefore, prognostic scales should not be replaced with clinical observation and evaluation. Although prognostic scores for both ischemic and hemorrhagic stroke have been reported in the literature, the Selcuk scoring system includes only patients with AIS. We have shown using internal validation methods that the scale we developed is valid. However, the validity of the Selcuk score should also be tested in different populations using prospective validation clinical studies.

CONCLUSION

The Selcuk score was developed to standardize the clinical prediction of prognosis in stroke patients. It is the first prognostic score to be developed for ischemic stroke in our country. We consider that the Selcuk score can significantly support clinicians in the prognostic evaluation of patients with AIS and in managing the disease process.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

REFERENCES

1. Saposnik G, Cote R, Mamdani M, et al. JURaSSiC: accuracy of clinician vs risk score prediction of ischemic stroke outcomes. Neurology 2013;81:448-55. (DOI: 10.1212/WNL.0b013e31829d874e)
2. Adams HP Jr., Bendixen BH, Kappelle LJ, 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)
3. DeLong ER, DeLong DM, Clarke-Pearson DL. Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach. Biometrics 1988;44:837-45.
4. Kosinski AS. A weighted generalized score statistic for comparison of predictive values of diagnostic tests. Stat Med 2013;32:964-77. (DOI: 10.1002/sim.5587)
5. Chen W, Liu G, Fang J, et al. External validation of the totaled health risks in vascular events score to predict functional outcome and mortality in patients entered into the China National Stroke Registry. J Stroke Cerebrovasc Dis 2016;25:2331-7. (DOI: 10.1016/j.jstrokecerebrovasdis.2016.03.021)
6. Ling X, Shen B, Li K, Si L, Yang X. Development of a prediction model for 1-year poor prognosis in patients with acute ischemic stroke. J Investig Med 2019;67:957-63. (DOI: 10.1136/jim-2018-000883)
7. Weimar C, König IR, Kraywinkel K, Ziegler A, Diener HC. Age and National Institutes of Health Stroke Scale Score within 6 hours after onset are accurate predictors of outcome after cerebral ischemia: development and external validation of prognostic models. Stroke 2004;35:158-62. (DOI: 10.1161/01.STR.0000106761.94985.8B)
8. Baird AE, Dambrosia J, Janket S, et al. A three-item scale for the early prediction of stroke recovery. Lancet 2001;357:2095-9. (DOI: 10.1016/s0140-6736(00)05183-7)
9. Petty GW, Brown RD, Jr., Whisnant JP, et al. Ischemic stroke subtypes: a population-based study of functional outcome, survival, and recurrence. Stroke 2000;31:1062-8. (DOI: 10.1161/01.str.31.5.1062)
10. Desilles JP, Meseguer E, Labreuche J, et al. Diabetes mellitus, admission glucose, and outcomes after stroke thrombolysis: a registry and systematic review. Stroke 2013;44:1915-23. (DOI: 10.1161/STROKEAHA.111.000813)
11. Meisel KM, Thabet AM, Josephson SA. Acute care of ischemic stroke patients in the hospital. Semin Neurol 2015;35:629-37. (DOI: 10.1055/s-0035-1564301)
12. Smith EE, Shobha N, Dai D, et al. Risk score for in-hospital ischemic stroke mortality derived and validated within the Get With the Guidelines-Stroke Program. Circulation 2010;122:1496-504. (DOI: 10.1161/CIRCULATIONAHA.109.932822)
13. O'Donnell MJ, Fang J, D'Uva C, et al. The PLAN score: a bedside prediction rule for death and severe disability following acute ischemic stroke. Arch Intern Med 2012;172:1548-56. (DOI: 10.1001/2013.jamainternmed.30)
14. Saposnik G, Kapral MK, Liu Y, et al. IScore: a risk score to predict death early after hospitalization for an acute ischemic stroke. Circulation 2011;123:739-49. (DOI: 10.1161/CIRCULATIONAHA.110.983353)
15. Muscari A, Puddu GM, Santoro N, Zoli M. A simple scoring system for outcome prediction of ischemic stroke. Acta Neurol Scand 2011;124:334-42. (DOI: 10.1111/j.1600-0404.2010.01479.x)
16. Ntaios G, Faouzi M, Ferrari J, et al. An integer-based score to predict functional outcome in acute ischemic stroke: the ASTRAL score. Neurology 2012;78:1916-22. (DOI: 10.1212/WNL.0b013e318259e221)