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Original Paper

The Kurashiki Prehospital Stroke Scale Is a Prehospital Scale That Can Predict Long-Term Outcome of Patients with Acute Cerebral Ischemia

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Key Words
Acute stroke outcome · Emergency care · Kurashiki Prehospital Stroke Scale · Prehospital stroke care · Thrombolysis

Abstract
Background and Purpose: Our aim was to confirm the clinical relationship between the Kurashiki Prehospital Stroke Scale (KPSS) scored by paramedics and favorable outcomes in patients with modified Rankin scale (mRS) scores of 0–1 assessed 3 months after symptom onset. ***Methods:*** We enrolled patients with acute stroke and transient ischemic attack showing symptoms on admission. Paramedics transferred patients to our hospital after estimating stroke severity using the KPSS. After categorizing patients into either the mRS 0–1 group (favorable outcome) or the mRS 2–6 group (no favorable outcome), we compared the background data between the two groups. We assessed KPSS scores predictive of a favorable outcome. Multivariate regression modeling was conducted to identify factors independently associated with a favorable outcome. ***Results:*** The study cohort comprised 147 patients with a premorbid status of mRS 0–1: 69 patients (47%) of them were in the mRS 0–1 group and 78 (53%) in the mRS 2–6 group at the follow-up 3 months after symptom onset. The median KPSS score was lower in the mRS 0–1 group than in the mRS 2–6 group (1 vs. 4, $p < 0.001$). After classifying the 147 patients into KPSS tertiles with thresholds of 2 and 4, the frequency of mRS 0–1 gradually decreased with increasing KPSS score (lower KPSS, 67.2%; middle KPSS, 47.6%, and higher KPSS, 21.3%; $p < 0.001$). KPSS score <3 was able to predict a favorable outcome with 67% sensitivity and 71% specificity, and independently associated with mRS 0–1 (odds ratio, 3.0; 95% confidence interval, 1.2–7.3; $p = 0.015$). ***Conclusion:*** KPSS score <3 apparently presents a reasonable cutoff for predicting a favorable outcome in patients with acute cerebral ischemia.

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Introduction

Since the approval of intravenous tissue plasminogen activator (IV t-PA) for ischemic stroke treatment in the United States [1], stroke care has become highly time dependent. To broaden the eligibility of patients for IV t-PA, transportation by ambulance supported by emergency medical services (EMS) is needed to minimize the duration from symptom onset to hospital arrival and decrease the time to physical examination on admission [2]. As half of the patients with signs or symptoms of acute stroke access initial medical care using an ambulance [3], appropriate identification of acute stroke by EMS paramedics possibly increases the number of patients who may benefit from IV t-PA.

To immediately transport the patient to the closest and most appropriate facility, specifically for stroke bypass surgery, two types of prehospital stroke scales are required in the field: a scale for identifying stroke and a scale for assessing stroke severity. While novel stroke screening instruments for identifying possible stroke patients (e.g. the Los Angeles Prehospital Stroke Screen and the Cincinnati Prehospital Stroke Screen) have already been used in onset scenes [4, 5], prehospital stroke severity scales (PSSSs) have gained wide attention over the last decade. PSSSs representing basic modifications of the full 15-variable National Institutes of Health Stroke Scale (NIHSS) include the Los Angeles Motor Scale (LAMS), a shortened version of the NIHSS (sNIHSS), a simple 3-item stroke scale (3-ISS), and the Kurashiki Prehospital Stroke Scale (KPSS; table 1) [6–9]. The KPSS comprises four items: level of consciousness; disturbance of consciousness; motor weakness, and language. Scores for the KPSS range from 0 to 13, with the maximum (13 points) representing the most severe symptoms [6]. As paramedics are able to decide on appropriate transportation in accordance with stroke severity, estimating not only the possibility but also the severity of stroke will be more practical for prehospital stroke care [10]. Indeed, when stroke neurologists assessed stroke severity using PSSSs (e.g. LAMS, sNIHSS, and 3-ISS), these PSSSs were able to predict the presence of arterial occlusion [9, 11] and long-term outcome [7, 8], as well as NIHSS. However, the question of whether these assessments using PSSSs have been realistically verified in the prehospital setting remains. Our aim was thus to clarify the relationship between the KPSS score recorded by paramedics and outcome 3 months after symptom onset.

Subjects and Methods

The study cohort comprised consecutive patients with ischemic stroke or transient ischemic attack with symptoms on admission who were transferred to our facility within 24 h of onset between May 2007 and April 2010. The following clinical background data of all patients were collected: (1) age and gender; (2) past history; (3) duration from onset to admission; (4) NIHSS score evaluated by stroke neurologists on admission; (5) KPSS score evaluated by paramedics prior to or during transportation; (6) presence of proximal arterial occlusion and infarct size assessed by neuroimaging using computed tomography or magnetic resonance images immediately after admission; (7) use of IV t-PA; (8) premorbid status, and (9) outcome 3 months after onset.

The four items in the KPSS (level of consciousness; disturbance of consciousness; motor weakness, and language) were chosen and modified based on the full NIHSS. In accordance with the prehospital stroke care recommendations of the Japanese Society for Emergency Medicine, immediately after paramedics arrived at the scene, the condition of the patient suspected of suffering a stroke was evaluated [12]. When ischemic stroke or transient ischemic attack was considered possible, neurological severity was assessed using the KPSS [12]. Before transferring the patients to our facility, the paramedics provided precise information

Table 1. Kurashiki Prehospital Stroke Scale

	Scoring (total disorder: 13 points)	
Level of consciousness		
Check level of consciousness		
Alert	normal: 0 points	
Arousal by stimulation	1 point	
No response	2 points	
Consciousness disturbance		
Ask patient's name		
Correct	normal: 0 points	
Incorrect	1 point	
Motor weakness (kinetic paralysis)		
Ask the patient to close eyes, raise arms to the front with palms down (with gestures)	*right hand*	*left hand*
Able to keep arms raised in parallel	normal: 0 points	normal: 0 points
Able to raise arms but not to keep them in position so that they go downward	1 point	1 point
Unable to raise arms	2 points	2 points
Instruct the patient to close eyes, raise legs from the bed to the front with gestures	*right leg*	*left leg*
Able to keep legs raised in parallel	normal: 0 points	normal: 0 points
Able to raise legs but not to keep them in position so that they go downward	1 point	1 point
Unable to raise legs	2 points	2 points
Language		
Ask the patient to say 'It's fine today' repeatedly		
Able to clearly say it repeatedly	normal: 0 points	
Either unclear (slurred) or abnormal	1 point	
Silent, unable to understand linguistically	2 points	
Total	.... points	

to the staff in the emergency room. In most cases, stroke neurologists were already provided with information on the patient, including vital signs (blood pressure, heart rate, respiratory rate, and oxygen saturation), time of symptom onset, situation of the onset location, past patient history, and the KPSS score. The NIHSS score was determined by stroke neurologists on arrival of the patient at our hospital.

To achieve a precise diagnosis, we performed diffusion-weighted magnetic resonance imaging and angiography, and carotid duplex ultrasonography immediately after admission, if no contraindications were present. A large infarct was diagnosed if more than one third of the territory of the middle cerebral artery (MCA) was affected on initial diffusion-weighted imaging [13]. Proximal arterial occlusion was defined as occlusion of the main trunk of the intra- and/or extracranial artery and the corresponding symptoms. Patients diagnosed with hyper-acute stroke received IV t-PA according to previously published criteria, if eligible [13]. Outcome 3 months after onset was determined using the modified Rankin scale (mRS). A favorable outcome was defined as mRS 0 or 1. All study protocols were approved by the Institutional Review Board of the Kawasaki Medical School (No. 587).

Analysis

After identifying cases with premorbid status mRS 0–1, we classified patients into two groups according to the postmorbid status 3 months after onset: patients in the mRS 0–1 group had a favorable outcome and those in the mRS 2–6 group had no favorable outcome. We then categorized all patients into KPSS tertiles, in order to estimate the proportion of

Table 2. Clinical background data of ischemic stroke patients in mRS 0–1 and mRS 2–6 groups

	mRS 0–1 group (n = 69)	mRS 2–6 group (n = 69)	p value
Median age (IQR), years	70 (60–76)	75 (66–83)	0.007
Males, n (%)	51 (73.9)	44 (56.4)	0.038
Past history, n (%)			
Hypertension	43 (62.3)	54 (69.2)	0.389
Diabetes mellitus	17 (24.6)	18 (23.1)	0.848
Hyperlipidemia	17 (24.6)	22 (28.2)	0.709
Smoking	39 (56.6)	38 (48.7)	0.409
Atrial fibrillation	13 (18.8)	21 (26.9)	0.327
Ischemic stroke	7 (10.1)	11 (14.1)	0.615
Time from onset to admission ≤3 h, n (%)	43 (62.3)	40 (51.3)	0.187
Median NIHSS (IQR)	2 (1–4)	11 (5–18)	<0.001
Median KPSS (IQR)	1 (0–3)	4 (2–9)	<0.001
KPSS <3, n (%)	46 (66.7)	23 (29.5)	<0.001
Infarct area of MCA >1/3	5/62 (8.1)	19/67 (28.4)	0.003
Proximal arterial occlusion, n (%)	17 (24.6)	45 (57.7)	<0.001
Median blood glucose (IQR), mg/dl	130 (107–152)	137 (113–167)	0.261
IV t-PA, n/cases within 3 h of onset (%)	8/43 (18.6)	27/40 (67.5)	<0.001

IQR = Interquartile range.

patients with mRS 0–1 in each tertile. The cutoff KPSS score for mRS 0–1 was then calculated by plotting sensitivity and specificity curves, and background data were compared between mRS 0–1 and mRS 2–6 groups. Significant trends were examined using the χ^2 test and the Mann-Whitney U test. Variables showing values of $p < 0.1$ in univariate analyses and well-known variables related to stroke prognosis (age, atrial fibrillation, blood glucose level on admission, and baseline neuroimaging) [14–16] were considered as potential explanatory variables. Multivariate logistic regression analyses were then conducted to estimate factors independently associated with mRS 0–1. Correlations between KPSS and NIHSS scores were analyzed using Spearman's rank correlation. Statistical analyses were performed using PASW statistics (version 18.0) software (SPSS, Chicago, Ill., USA). Values of $p < 0.05$ were considered significant.

Results

A total of 238 consecutive patients with ischemic stroke or symptomatic transient ischemic attack on admission (median age, 75 years; 139 men, 99 women; median NIHSS score, 6) were transferred to our hospital. Regarding the premorbid status, 147 of the 238 patients (61.8%) were mRS 0–1 prior to stroke onset. In these patients, an excellent correlation was evident between KPSS and NIHSS scores (R = 0.728, $p < 0.001$).

We classified these 147 patients into two groups (table 2): the mRS 0–1 group (n = 69; median age, 70 years; 51 men, 18 women) and the mRS 2–6 group (n = 78; median age, 75 years; 44 men, 34 women). The mRS 0–1 group was significantly younger than the mRS 2–6 group (p = 0.007). Median NIHSS score was higher in the mRS 2–6 group than in the mRS 0–1 group (11 vs. 2, respectively; $p < 0.001$).

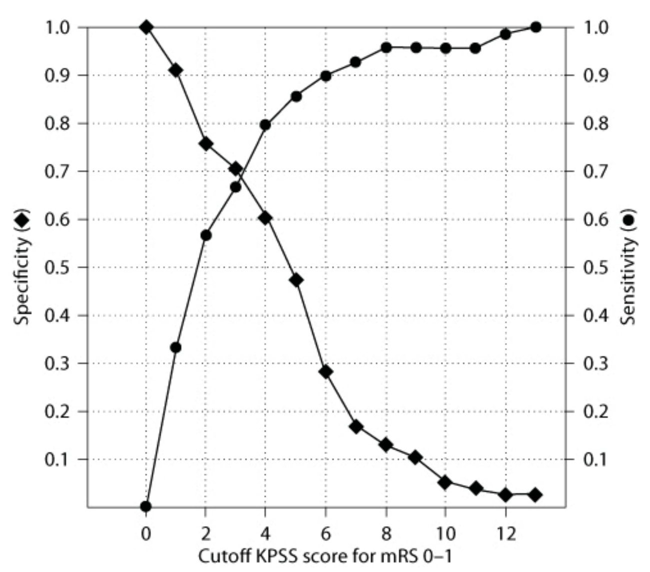

Fig. 1. Cutoff KPSS score for mRS 0–1 plotted on a sensitivity-specificity curve.

Regarding the KPSS score, after categorizing all 147 cases in KPSS tertiles using thresholds scores of 2 and 4, we compared the proportion of patients with mRS 0–1 among KPSS tertiles. Patients with mRS 0–1 assessed 3 months after onset comprised 39 of 58 patients (67.2%) in the lower KPSS tertile (KPSS <2), 20 of 42 patients (47.6%) in the middle KPSS tertile, and 10 of 47 patients (21.3%) in the higher KPSS tertile ($p < 0.001$). Patients with lower KPSS achieved more favorable outcomes than those with higher KPSS.

Comparing background data between mRS 0–1 and 2–6 groups again, the KPSS score was significantly lower in the mRS 0–1 group (median KPSS; 1 vs. 4, $p < 0.001$, table 2). The cutoff KPSS score for predicting mRS 0–1 at 3 months after onset was 3, with a sensitivity of 67% and a specificity of 71% (fig. 1). Patients with KPSS <3 were more frequently in the mRS 0–1 group than in the mRS 2–6 group (66.7 vs. 29.5%, $p < 0.001$; table 2). Concerning the infarct area in patients showing ischemic lesions in the territory of the MCA, patients with a large infarct were more often in the mRS 2–6 group (28.4%) than in the mRS 0–1 group (8.1%, $p = 0.003$). IV rt-PA was administered to 8 of 43 patients (18.6%) with hyper-acute ischemic stroke in the mRS 0–1 group and 27 of 40 patients (67.5%) in the mRS 2–6 group ($p < 0.001$).

Factors associated with mRS 0–1 were analyzed using multivariate logistic regression analysis. NIHSS score was considered a confounding factor and excluded from analysis. The only factor independently associated with mRS 0–1 was KPSS <3 (odds ratio, 3.0; 95% confidence interval, 1.2–7.3, $p = 0.015$; fig. 2).

Discussion

The present results confirmed good validity for the initial KPSS score in predicting clinical outcome 3 months after symptom onset, which was assessed using the mRS to quantify functional activities and global handicap of daily living. These findings are supportive of the

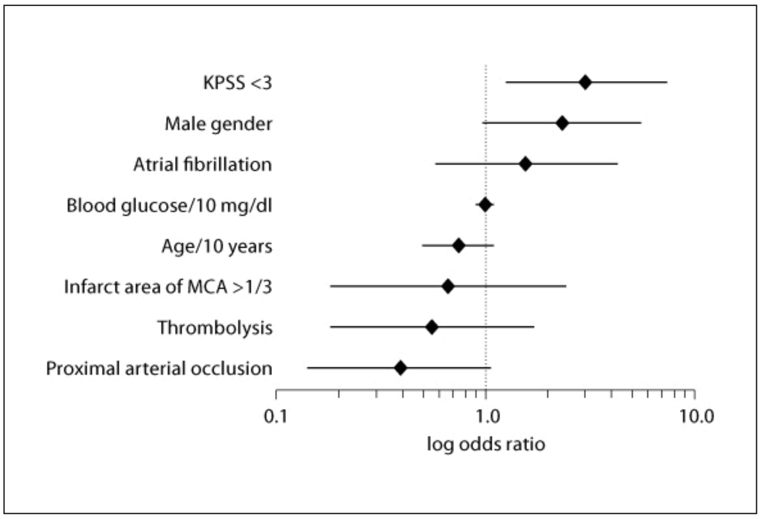

Fig. 2. A forest plot diagram showing factors for mRS 0–1 at 3 months after symptom onset in a multivariate logistic regression model.

previous finding that the LAMS correlates with functional outcome at 3 months as well as the full NIHSS [7]. The reason for this relationship may be as follows. First, clinical prognosis of stroke patients was strongly associated with initial stroke severity, which is generally assessed using the NIHSS [17]. Indeed, because an excellent correlation was evident between KPSS and NIHSS scores in our series, KPSS score <3 should be considered as a factor independently associated with a favorable outcome 3 months after onset.

Our assessment of stroke severity was performed in a straightforward manner by paramedics in the prehospital field. Actually, the KPSS, LAMS, sNIHSS, and 3-ISS are simple scoring systems [7–9], but results from previous investigations might have been influenced by the setting (field in the present study vs. emergency room in the other three studies) or examiner (paramedics in this study vs. physicians in other studies). We thus consider that this examination using the KPSS in a realistic situation should be sufficiently robust to confirm the potential for PSSSs.

What is the essential information for assessing possible stroke patients as having mild or severe symptoms in prehospital scenarios? Two applications should be outlined in this regard. First, when neurological symptoms deteriorate during transportation, an urgent and precise diagnosis in a stroke center is required to assess and rescue vulnerable brain tissue. Patients with a PSSS possibly indicating large artery occlusion may sometimes be best transferred directly to a comprehensive stroke center where endovascular recanalization interventions may be available [9]. The KPSS will thus allow adequate decision-making and transport in prehospital settings. Furthermore, pretreatment evaluation of stroke severity using the KPSS may predict long-term outcomes of stroke patients and has great potential as an important initial value for prehospital clinical research. Although we have no supporting data for this issue from previous studies, one proposal is that a certified assessment of pretreatment stroke severity will be a future requirement for prehospital stroke clinical treatment trials investigating the development of adequate transportation systems.

An important limitation of this study was the analysis of only a single dichotomized outcome using mRS. Then, substantial interrater variability of mRS measurement may be present because we are unable to conduct a structured assessment tool in order to reduce mRS variability. To confirm the utility of the KPSS in a Japanese prehospital setting, prospective, multicenter trials should be extensively conducted.

In conclusion, the KPSS shows promise as an excellent tool enabling paramedics to quantify stroke severity in the prehospital setting. Prehospital assessment of stroke severity using the KPSS may help to predict a favorable outcome in acute cerebral ischemia.

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Disclosure Statement

The authors have no competing interest to report.

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