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Predicting independent walking ability using the Simplified Stroke Rehabilitation Assessment of Movement, Berg Balance Scale, and Barthel Index for Activities of Daily Living in individuals post-stroke: an observational preliminary study

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Abstract

Introduction. The purpose of this study was to determine cut scores to predict independent ambulation for the Simplified Stroke Rehabilitation Assessment of Movement (S-STREAM), Berg Balance Scale (BBS), Barthel Index (BI) for Activities of Daily Living for patients with time after stroke up to 1 year. The study's second goal was to establish statistical dependence between the tests the S-STREAM, BBS, BI, and the Functional Ambulation Category (FAC).

Methods. Cohort observational retrospective pilot study by design. Twenty-four people who suffered a stroke within the past year were enrolled in the study. The FAC was used to classify patients into independent walking and non-walking groups (scores 0–2 are non-walking patients, scores 4–5 are independent walking patients). Receiver operating characteristic (ROC) curve analysis was performed for the S-STREAM, BBS, BI selected according to the multiple logistic regression analysis with dichotomy on groups independent walking patients and not.

Results. ROC analysis of scores at admission were used to determine cut scores for the independent waking ability for each of the listed measures. The cut score for S-STREAM was 19 points, for BBS was 27 points and for BI was 65 points. Based on this analysis it appears there is sufficient evidence to conclude a significant linear relationship between all tests the S-STREAM, BBS, BI, and FAC.

Conclusions. In patients who were ambulators, less than one year post stroke, this pilot study established a cut score for standardized assessment tools S-STREAM, BBS, BI for Activities of Daily Living.

Key words: simplified stroke rehabilitation assessment of movement, Berg balance scale, Barthel index for activities of daily living, functional ambulation category

Introduction

An essential component of a physical therapist's clinical practice is the use of standardized scales to assess the patient's condition and to prognosticate potential outcomes after a stroke. The Academy of Neurologic Physical Therapy's STROKEdge task force has prepared a set of guidelines [1] for using clinical tools for patient assessment after stroke. The only scale that has a Highly Recommended grade for all five practice settings: acute care hospital, in-patient rehabilitation, home health, skilled nursing facility, and out-patient, as well as by acuity level, is the Stroke Rehabilitation Assessment of Movement (STREAM) [2]. STREAM is a measure of voluntary movement and basic mobility [3]. A simplified version of this scale – Simplified Stroke Rehabilitation Assessment of Movement (S-STREAM), consists of 3 subscales: upper-limb movements, lower-limb movements, and mobility and has points from 0 to 35. Hsueh et al. [4] demonstrated high Rasch reliability, unidimensionality, and concurrent validity of S-STREAM with STREAM in stroke patients.

Clinical tools have limitations in their interpretation and need to establish minimal detectable changes and cut score values to increase the information content of instruments. Set cut scores have been suggested for the internal categorization of these instruments [5]. Cut scores for clinical assessment tools can be helpful to comprehensively assess a patient, set realistic goals for an intervention, make decisions about an intervention strategy, and help guide the physical therapist in other clinical situations. A common question/concern of individuals who have suffered a stroke is their potential for independent walking. Defining cut scores for ambulatory potential would prove to be a valuable clinical decision-making tool for the physical therapist.

Several studies have evaluated the ability to walk independently in a group of patients after a stroke; for example, Jenkin et al. [6] compared several clinical assessment tools to determine which admission clinical assessments could best predict independent walking at discharge. The best results were demonstrated by the Berg Balance Scale (BBS); a score of 14 or more at admission was associated with higher odds of achieving independent walking at discharge. Makizako et al. [7] established that BBS scores ≥ 13 among inpatients after their first stroke in a rehabilitation facility were the optimal cut scores for predicting a Functional Independence Measure walking level of 6 or 7.

The creators of the BBS scale also interpreted the results in terms of the patient's independent walking [8]: 41–56 = independent, 21–40 = walking with assistance, and 0–20 = wheelchair-bound.

Many clinical assessment tools have been developed to classify ambulation ability. Kollen et al. [9] used Functional Ambulation Categories (FAC), and independent gait was classi-

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fied into the present (FAC > or = 4) or absent (FAC < 4). In a critical review, done by Kwah and Herbert [10], the definition of independent walking was determined to be a score of ≥ 4/5 on the FAC. In our study, we used the same classification as Kwah and Herbert [10].

In a study, Wandel et al. [11] found the Barthel Index (BI) for Activities of Daily Living on admission was the only significant predictive value independent walking factor. The mean admission BI was 50 in the walking group versus 3 in the non-walking group. Age, gender, lesion side, total Scandinavian Stroke Scale score, and comorbidities had no predictive value.

The purpose of this study was to establish a cut score for independent ambulation for the S-STREAM, BBS, and BI for Activities of Daily Living in a population within one year of stroke. We used the FAC to classify patients into independent walking and non-walking groups. Patients who were assessed at 4 and 5 points belonged to the group of independent walking. Patients who were rated 0, 1, and 2 were in the non-walker group. We excluded patients who scored 3 points on the FAC from the analysis of the definition of the cut score because their gait was dependent on supervision and included their results in the analysis of statistical dependence between the tests.

The study's second goal was to establish statistical dependence between the tests S-STREAM, BBS, BI, and FAC. Suttiwong et al. [12] established a significant correlation between STREAM and FAC.

Subjects and methods

Subjects

Inclusion criteria: Male or female stroke patients over the age of 17 with confirmation of stroke by neuroimaging, understanding instructions, and time after stroke up to 1 year.

Subjects were excluded if they had aphasia that would have interfered with the participant's ability to understand and comply with study procedures or complete stroke assessments, dementia, ataxia, localization of stroke in the cerebellum or vertebrobasilar insufficiency, orthopaedic problems that affected the ability to walk before the stroke, and time after stroke more than 1 year.

During the study period, 60 stroke patients were admitted to the rehabilitation department. Only 29 patients met the criteria for inclusion in the study: 19 patients had problems with understanding commands or severe cognitive impairment, making it impossible to correctly assess, and 12 patients had a stroke more than one year ago. The FAC scale was used to classify patients as independent walkers, and non-walking patients who scored 3 on the FAC were excluded from the analysis (Figure 1). Five patients who were rated at 3 points were included in the analysis to determine the correlation between all tests.

Study design

Cohort observational retrospective pilot study by design. Consenting and data collection were completed at the Department of Rehabilitation of Patients with Consequences of Diseases and Injuries of the Nervous System.

The study was conducted in The Kyiv Regional Clinical Hospital, Department of Rehabilitation of Patients with Consequences of Diseases and Injuries of the Nervous System from January 1, 2020, to March 20, 2020. Unfortunately, data collection was planned for a calendar year. At the end of March 2020, the Department of Rehabilitation was closed and re-profiled into an infectious department to help patients with COVID-19. This affected a small sample of patients.

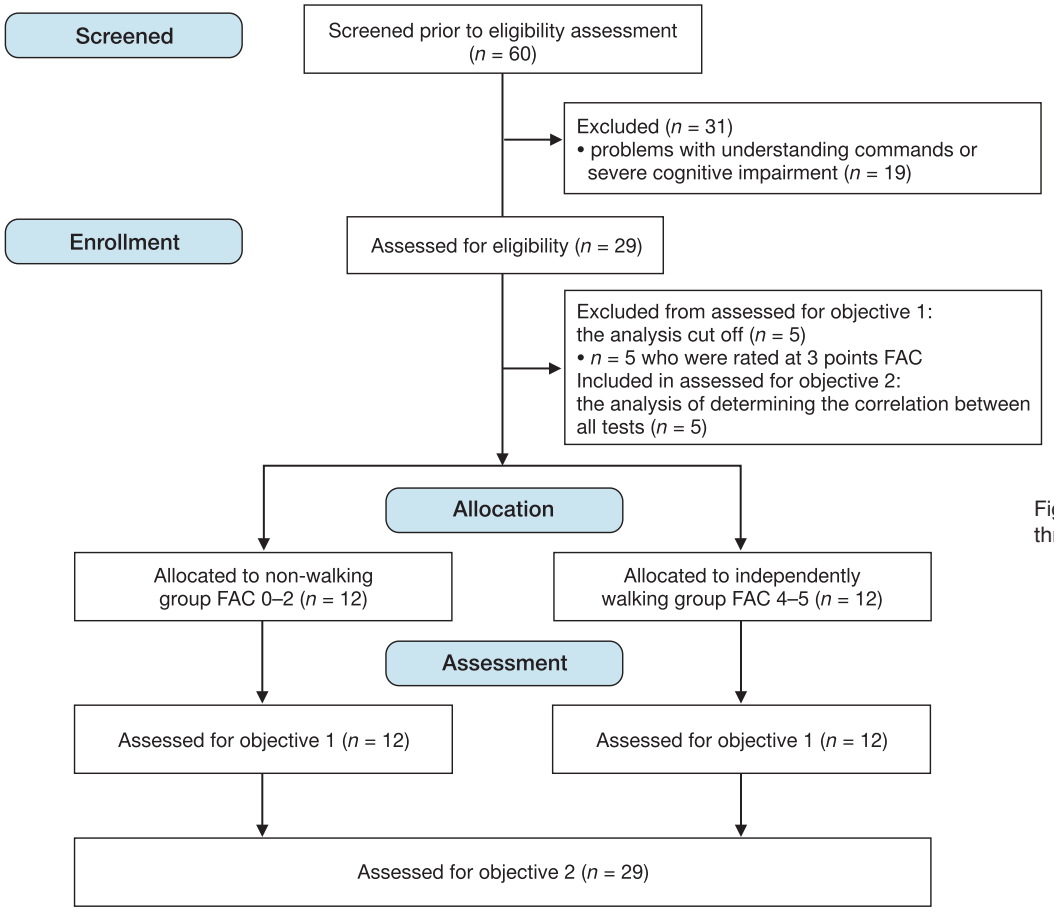

Figure 1. Flow of participants through each stage

Assessment

All therapists had more than 3 years of clinical experience. Physical therapists and occupational therapists received specialized training to ensure consistency in the assessments. All patients signed informed consent. Patients underwent a neurological evaluation by both a physical therapist and an occupational therapist within 24 hours after admission. The physical therapist performed the S-STREAM, BBS, and FAC. The occupational therapist conducted the Montreal Cognitive Assessment (MoCA) and BI for Activities of Daily Living. The results of the patient's examination at discharge were entered into a medical record filled out by the therapist and, within 3 days after discharge, were submitted to the senior physical therapist, who was collecting data, signed and submitted by the case manager.

Statistical analysis

Receiver operating characteristic (ROC) curve analysis was performed for the S-STREAM, BBS, and BI selected according to the multiple logistic regression analysis. The area under the curve (AUC), sensitivity, and specificity were calculated for the cut score. This analysis draws a plot of sensitivity (true positive rate) by 1-specificity (false positive rate) for every test value by dichotomizing patients into independently walking or non-ambulatory abilities. Statistical analyses were performed using SPSS 26.0.1 statistical software. A p-value ≤ 0.05 was considered to be statistically significant.

Since the sample size was small, the Mann–Whitney U-test was used to identify differences between groups. The nominal data were compared using Pearson's chi-squared tests (χ^2). The statistical dependence between the tests was measured using a nonparametric Spearman's rank correlation coefficient.

Results

Subject characteristics

Twenty-four people (mean age: 58.1 ± 9.2) with stroke up to a year were part of the final analysis (Table 1). A comparison of groups of patients found that there were no differences except for age (p = 0.04; Mann–Whitney U-test); patients in the independent walking group were older.

ROC analysis

The ROC curves demonstrated that the AUCs for the S-STREAM were 0.965 in distinguishing between independent walkers and non-walkers, respectively. An AUC of 0.8 has been stated to represent a reasonably powerful model [6]. The AUC for the BBS and BI was 1.000 (perfect diagnostic ability); this value indicated these tests provide an excellent discriminative score for the patients with independent walking in similar samples (Figure 2).

Table 1. Groups characteristic

Parameters	Groups		p-value
	non-walking group FAC 0–2	independently walking group FAC 4–5	
Gender, male/female [n (%)]	11/1 (91.7/8.3)	11/1 (91.7/8.3)	p = 0.000 (χ^2)
Age (years), mean ± SD Rage	53.3 ± 10.4 48–85	63.7 ± 10.8 46–69	p = 0.04 (Mann–Whitney U-test)
Time after stroke (day), mean ± SD Range	79.72 ± 53.03 15–153	76.17 ± 60.14 12–255	p = 1.00 (Mann–Whitney U-test)
Type of stroke, ischemic/hemorrhagic [n (%)]	9/3 (75/25)	10/2 (83.3/16.7)	p = 0.25 (χ^2)
Montreal Cognitive Assessment, median; 95% CI	18.5; 13.01 to 21.06	19.5; 12.16 to 22.1	p = 0.63 (Mann–Whitney U-test)
Number of patients	12	12	

FAC – Functional Ambulation Category, 95% CI – 95% confidence intervals

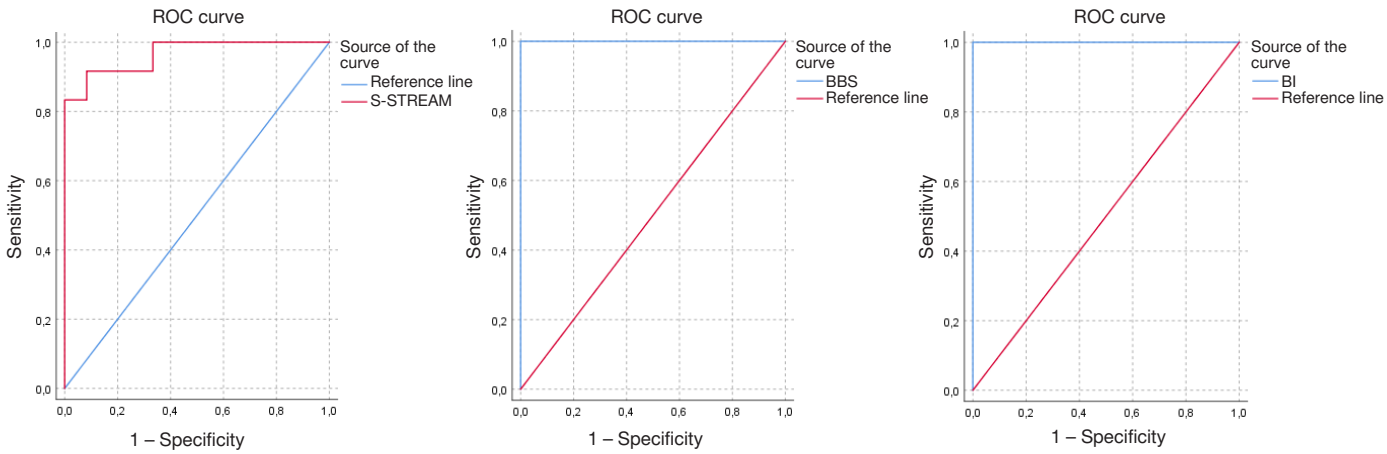

Figure 2. Receiver operating characteristic (ROC) curves and area under the curve (AUC) for independent walkers and non-walking patients after stroke for S-STREAM (2A) all independent walkers compared with non-walkers, AUC 0.965; for BBS – AUC 1.000 (2B); for BI – AUC 1.000 (2C), (n = 24)

Table 2. ROC analysis

Parameters	Rehabilitation assessment tools		
	Simplified Stroke Rehabilitation Assessment of Movement	Berg Balance Scale	Barthel Index for Activities of Daily Living
Independently walking if greater than or equal to	19	27	65
Sensitivity	0.917	1.000	1.000
1 – Specificity	0.083	1.000	1.000
Area under the ROC curve	0.965	1.000	1.000
SE[a]	0.033	0.000	0.000

[a] under the nonparametric assumption

Table 3. Correlations Spearman's rho

Rehabilitation assessment tools		Simplified Stroke Rehabilitation Assessment of Movement	Berg Balance Scale	Barthel Index for Activities of Daily Living	Functional ambulation category
Simplified Stroke Rehabilitation Assessment of Movement	correlation coefficient	1.000	0.800**	0.782**	0.847**
	sig. (2-tailed)	.	0.000	0.000	0.000
	n	29	29	29	29
Berg Balance Scale	correlation coefficient	0.800**	1.000	0.881**	0.902**
	sig. (2-tailed)	0.000	.	0.000	0.000
	n	29	29	29	29
Barthel Index for Activities of Daily Living	correlation coefficient	0.782**	0.881**	1.000	0.920**
	sig. (2-tailed)	0.000	0.000	.	0.000
	n	29	29	29	29
Functional ambulation category	correlation coefficient	0.847**	0.902**	0.920**	1.000
	sig. (2-tailed)	0.000	0.000	0.000	.
	n	29	29	29	29

** correlation is significant at the 0.01 level (2-tailed)

The cut score for independently walking patients for S-STREAM was 19 points, for BBS was 27 points, and for BI for Daily Living Activities was 65 points (Table 2).

Our second goal was to determine the statistical dependence between tests S-STREAM, BBS, BI, and FAC. We used Spearman's correlation coefficient to identify the dependence. In addition to 24 patients with scores of 0, 1, 2, 4, and 5 by FAC, we included 5 patients with a score of 3 by FAC in the analysis. The final sample size for identifying the statistical dependence between tests was 29 patients after stroke up to one year.

As shown in Table 3, all three scales have a strong positive correlation among themselves in patients after stroke up to one year. There is sufficient evidence to conclude there is a significant linear relationship between tests S-STREAM, BBS, BI, and FAC because the correlation coefficients are significantly different from zero.

Discussion

In the present study, when the total S-STREAM score of post-stroke patients up to one year at admission was ≥ 19 points (as the cut score drawn from the study), the patient is likely to be walking independently. The performed statistical analysis demonstrated an excellent sensitivity of the clinical tool S-STREAM for determining the patient's walking independence after a stroke, which was 96%. The sensitivity for the tests BBS and BI were 100%.

The few studies that have been conducted using BBS to identify patients after stroke with independent walking show varied results. Makizako et al. [7] found that admissions to the department with a BBS greater than 13 correlated to a better outcome; however, the results of our study and other studies have shown different indicators.

In a previous study by Louie and Eng [13], BBS was a significant predictor of regaining unassisted ambulation and found that a BBS cut score of 29 on admission predicts that an individual will achieve community walking speed. The results of our study demonstrate that in the group of independently walking patients up to a year post-stroke, the cut score for the BBS was 27 points.

Uyttenboogaart et al. [14] demonstrated, for a group of patients with acute stroke, assessed on a modified Rankin scale at 3 points, a cut score of 75 points on the BI. The results of our study demonstrate that in the group of independently walking patients up to a year post-stroke, the cut score for the BI was 65 points.

Suttiwong et al. [12] also found that STREAM was significantly correlated with FAC, which was also confirmed in our study with S-STREAM and FAC.

The use of this cut score to predict the ambulatory ability provides additional information to the physical therapist for clinical decision-making. The United Kingdom's National Institute for Health and Care Excellence quality standard for stroke patients [15] states that it takes an average of 5 days to set rehabilitation goals from the moment the patient is admitted to the department.

The cut scores should be used cautiously, which can only serve as a guide and not a dogma for decision-making.

Limitations

Due to the COVID-19 pandemic and the re-profiling of the rehabilitation department to the infectious department, data collection had to be completed ahead of time, which affected a small number of participants.

Conclusions

In patients who were ambulators, less than one year post-stroke, this pilot study established a cut score for the standardized assessment tools: S-STREAM, BBS, and BI for Activities of Daily Living. Scores of the S-STREAM, BBS, and BI may be predictive of independent ambulatory potential based on the findings in this pilot study: S-STREAM was 19 points, BBS was 27 points, and BI for Activities of Daily Living was 65 points.

This pilot study demonstrates that there is a significant linear relationship between the clinical assessment tools: S-STREAM, BBS, BI, and FAC.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the ethics committee of the Kyiv Regional Clinical Hospital of the Kyiv Regional Council and retrospectively registered on clinicaltrials.gov (No.: NCT05259215).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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