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Assessment of the Influence of Physical Impairments on Activities in Persons With Stroke

Young-keun Woo, Ph.D., P.T.
Dept. of Physical Therapy, College of Alternative Medicine, Jeonju University

Abstract

The aim of this study was to analyze the relationship between physical impairments and daily activities on the basis of the outcome measurements in stroke patients. Seventy-six stroke patients participated in this study. Two physical therapists evaluated 3 clinical common measurements, i.e., the Fugl-Meyer Assessment (FMA), the Berg Balance Scale (BBS), and the Functional Independence Measure (FIM). Multiple regression analysis was used, as the dependent variables were the BBS and FIM; the independent variables were post-stroke duration, FMA of Upper Extremity (FMU), and FMA of Lower Extremity (FML). In the regression equation of the BBS, the coefficient of determination (R^2) was .383, and the FML was found to be the most important variable for determining the BBS score. In the regression equation of the FIM, R^2 was .531, and the FML was found to be the most important variable for determining the FIM. These results suggest that there is a need to determine the function of activities on the basis of the physical impairments of stroke patients. More variable measurement tools on the levels of body function and structure, as well as activity limitations are required.

Key Words: Berg balance scale; Fugl-Meyer assessment; Functional Independence Measures; International classification of functioning, disability, and health; Stroke.

Introduction

Outcome measure is an important component in determining rehabilitative effectiveness (van der Putten et al, 1999). In accordance with those of the patients, professionals consider improvement of rehabilitation outcomes and goal setting to be important for outcome measure (Soberg et al, 2008). Selecting outcome measures in stroke patients is a difficult process due to the variability in etiologies, symptoms, severity, and the possibility of spontaneous recovery after stroke (Barak and Duncan, 2006). Incorporation of a health and disability framework for clinical outcome measures in stroke survivors such as that of the International Classification of Functioning, Disability, and Health (ICF) can be applied (Barak and Duncan, 2006). The ICF presents a multidimensional perspective on function and may be applied both in the analysis of disability and in the setting of rehabilitation goals (Soberg, 2008). It could provide a common language for the explanation of human function through outcomes measured at 3 levels, namely, body structure or function, activities, and participants. Therefore, multidisciplinary responsibility and coordination within interventions is necessary for clinicians (Steiner et al, 2002). The ICF check-list is the most efficient of tools but evaluation requires much time due to the high number of categories and list components.

Clinical measures provide a simple and convenient method for identifying problems and reducing the time spent in clinics. Recently, a few studies have suggested that classification of popular outcome measures tools using ICF would be useful in stroke rehabilitation (Barak and Duncan, 2006; Salter et al, 2005). In these studies, the Fugl-Meyer Assessment

Corresponding author: Young-keun Woo ykwoo92@naver.com

(FMA) was used to assess the motor function of body structure (impairments), Functional Independence Measure (FIM) was applied for daily life activities on the activities level, and the Berg Balance Scale (BBS) was applied for balancing ability on the activities level. The FMA is based on Brunnstrom's stages of recovery, which are assumed and divided into a few domains in detail. This assessment includes an evaluation of muscle tone, range of motion, tendon reflexes, and the performance of voluntary movements of the affected arm (Fugl-Meyer et al, 1975). The BBS is used to assess the balance of elderly individuals and monitors change over time, and is used in stroke rehabilitation (Carr and Shepherd, 2010). In addition, the FIM is a widely used measurement tool for the severity of disability in daily life for neurologic patients. It was designed to assess the degree of assistance required by a person with disability to perform daily activities.

Soberg et al (2008) concluded that most patient goals focus on activities and participation, but physical therapists mainly focus on body structure and function. Therefore, the aim of this study was to analyze the relationship between the outcome measures of physical impairments and daily activities in stroke patients. Moreover, we aimed to propose better ideas for goals of rehabilitation in stroke patients through the physical impairments-participants relationship.

Methods

Participants

Seventy-six stroke patients participated in this study. Data collection was performed in the out-/in-patient physical therapy for adult rehabilitation unit in rehabilitation hospitals located in Seoul, Korea. The subjects' general characteristics are listed in Table 1. The following inclusion criteria were used: a medically confirmed diagnosis of stroke and the ability to communicate with evaluators. Patients were excluded from the study if they had a history of any other neurologic, orthopedic, and psychological disorders that would affect their ambulatory or balancing ability, or any cognitive deficits that precluded support for the procedures of this study.

Clinical Measurements

To investigate the influence of impairments on activities based on outcome measures in stroke patients, 3 common clinical measurements (FMA, BBS, and FIM) were evaluated by 2 physical therapists. Outcome measurements for stroke patients were assessed at all 3 levels as described in the ICF (Barak and Duncan, 2006; Carr and Shepherd, 2003; Salter et al, 2005; WHO, 2001): body functions and structures (impairments), activities (limitation), and participation (restriction). The

Table 1. General characteristics of the participants of this study (N=76)

Characteristics	Mean±SD
Age (year)	56.2±14.3
Height (㎝)	164.8±9.9
Weight (㎏)	64.3±11.3
Gender (Male / Female)	50/26
Affected Side (Left / Right)	36/40
Post-stroke duration (month)	15.2±23.8
FML[a]	23.2±5.8
FMU[b]	42.9±18.8
BBS[c]	38.8±11.3
FIM[d]	107.1±12.2

[a]Fugl-Meyer Assessment of Lower Extremity, [b]Fugl-Meyer Assessment of Upper Extremity, [c]Berg Balance Scale, [d]Functional Independence Measure.

ICF is the World Health Organization's (WHO) framework for health and disability.

Of the clinical measurement scores in this study, the FMA was used to identify range of motion, tendon reflex, and voluntary movements of the affected arm and leg at the body structures and function levels of the upper and lower extremities (Fugl-Meyer et al, 1975; Salter et al, 2005). The BBS was used to identify postural control, balance, and self-care, while the FIM was used to evaluate communication and social cognition at the activity limitation level.

The FMA (upper and lower extremity) is used as an adaptation of Brunnstrom's hemiplegia classification, using an ordinal-level scoring system in which each detail is rated with a score: 0=cannot be performed, 1=can be partly performed, and 2=can be performed faultlessly. The total score ranges from 0 to 66 for the upper extremity, and from 0 to 34 for the lower extremity. In this study, we used both the upper and lower extremity sub-tests. Inter-rater reliability as reported in an FMA-related study with 37 stroke patients was .99, and test-retest reliability was .97 (Platz et al, 2005).

The BBS is a test commonly used to assess the performance of postural and balance control while sitting and standing in older persons and individuals with neurological disorders. The scale consists of 14 items and has a maximum possible score of 56 points. It also uses an ordinal-level scoring system in which each detail is rated: 0 being the lowest and 4 being the highest level of function. Test-retest reliability as reported in stroke survivors was .99 (Berg et al, 1995).

The FIM assesses physical and cognitive disability, which focuses on the activity of daily living. In addition, the FIM is used to measure the patient's progress and to assess rehabilitation outcomes. Measurement consists of 18 items (13 physical items and 5 cognitive items) and has a possible score range of 18-126 points. Higher scores indicate more independence in the activities of daily life, and the FIM uses an ordinal-level scoring system in which each detail is rated: 1=total assistance, 2~4=maximal to minimal assistance, 5=supervision, and 6~7=modified to complete independence. Inter-rater reliability was reported as .95, and test-retest reliability was .95 (Ottenbacher et al, 1996).

Statistical Analysis

Descriptive analysis was used to describe characteristics such as age, height, weight, post-stroke duration, FMA and BBS scores, and FIM; frequency analysis was used for gender and the affected side in paraplegia or paresis in stroke patients. Multiple regression analysis was used to determine relationships in outcome measures between the level of activity and body function and structure. Since the dependent variables were BBS and FIM, the predictor variables were post-stroke duration, the Fugl-Meyer Assessment of Upper Extremity (FMU) score, and the Fugl-Meyer Assessment of Lower Extremity (FML) score. A significance level of $\alpha<.05$ was adopted. Data analyses were performed using SPSS version 18.0.

Results

Multiple Regression Analysis for Berg Balance Scale and Functional Independence Measures

The equations to calculate the FMA score and post-stroke duration on the FIM and BBS by multiple regression analysis were shown in Table 2. Table 2 showed the regression equation for calculating the predicted BBS and FIM score using the FMA and post-stroke duration. In the regression equation of the BBS, the coefficient of determination (R^2) was .383, the regression constant was 10.685, and the regression coefficient was 1.219 for the FML. As shown in Table 3, the FML was the most important variable for determining the BBS score. In addition, the FMU and post-stroke duration were not significant in the prediction of the BBS score ($p=.37$ and $p=.47$ respectively; $\alpha=.05$). In the regression

Table 2. The equations for FMA and post-stroke duration on the BBS and FIM by multiple regression analysis (N=76)

Outcome Measures	Regression equation	R^2	p
BBS[a]	(10.685)+(1.219×FML[c])	.383	<.05
FIM[b]	(71.086)+(1.565×FML)	.531	<.05

[a]Berg Balance Scale, [b]Functional Independence Measure, [c]Fugl-Meyer Assessment of Lower Extremity.

Table 3. Output for multiple regression analyses for the prediction of the BBS score and FIM from the FMU, FML, and post-stroke duration (N=76)

BBS[a]	Standardized coefficient (β)	p	FIM[b]	Standardized coefficient (β)	p
R^2=.383, F=44.76, p<.05			R^2=.531, F=81.39, p<.05		
FMU[c]	-.125	.37	FMU	.113	.35
FML[d]	.619	<.05	FML	.728	<.05
Post-stroke duration	-.069	.47	Post-stroke duration	.119	.15

[a]Berg Balance Scale, [b]Functional Independence Measure, [c]Fugl-Meyer Assessment of Upper Extremity, [d]Fugl-Meyer Assessment of Lower Extremity.

Table 4. The equations for FMA on the BBS and FIM within 12 months post-stroke duration by multiple regression analysis (N=53)

Outcome Measures	Regression equation	R^2	p
BBS[a]	(10.590)+(1.233×FML[c])	.356	<.05
FIM[b]	(67.753)+(1.682×FML)	.527	<.05

[a]Berg Balance Scale, [b]Functional Independence Measure, [c]Fugl-Meyer Assessment of Lower Extremity.

Table 5. Output for multiple regression analyses for the prediction of the BBS score and FIM from the FMU, FML within 12 months post-stroke (N=53)

BBS[a]	Standardized coefficient (β)	p	FIM[b]	Standardized coefficient (β)	p
R^2=.356, F=27.70, p<.05			R^2=.527, F=55.79, p<.05		
FMU[c]	-.029	.88	FMU	.241	.13
FML[d]	.597	<.05	FML	.726	<.05
Post-stroke duration	.062	.60	Post-stroke duration	.091	.37

[a]Berg Balance Scale, [b]Functional Independence Measure, [c]Fugl-Meyer Assessment of Upper Extremity, [d]Fugl-Meyer Assessment of Lower Extremity.

equation of the FIM, R^2 was .531, the regression constant was 71.086, and the regression coefficient was 1.565 for the FML. As shown in Table 3, the FML was the most important variable for determining FIM. Furthermore, the FMU and post-stroke duration were not significant in the prediction of FIM (p=.35 and p=.15 respectively; α=.05).

In Tables 4 and 5, the results of multiple regression analyses for post-stroke duration within 12 months were shown. In the regression equation of the

Table 6. The equations for the FMA on the BBS and FIM over 12 months post-stroke duration by multiple regression analysis (N=23)

Outcome Measures	Regression equation	R^2	p
BBS[a]	(11.481)+(1.155×FML[c])	.431	<.05
FIM[b]	(76.397)+(1.382×FML)	.582	<.05

[a]Berg Balance Scale, [b]Functional Independence Measure, [c]Fugl-Meyer Assessment of Lower Extremity.

Table 7. Output for multiple regression analysis for the prediction of the BBS score and FIM from the FMU and FML over 12 months post-stroke (N=23)

BBS[a]	Standardized coefficient (β)	p	FIM[b]	Standardized coefficient (β)	p
R^2=.431, F=15.18, p<.05			R^2=.582, F=27.85, p<.05		
FMU[c]	-.289	.20	FMU	-.158	.42
FML[d]	.657	<.05	FML	.763	<.05
Post-stroke duration	-.147	.41	Post-stroke duration	.161	.29

[a]Berg Balance Scale, [b]Functional Independence Measure, [c]Fugl-Meyer Assessment of Upper Extremity, [d]Fugl-Meyer Assessment of Lower Extremity.

BBS, R^2 was .356, the regression constant was 10.590, and the regression coefficient was 1.233 for the FML. As shown in Table 5, the FML was the most important variable for determining the BBS score. Additionally, the FMU and post-stroke duration were not significant in the prediction of the BBS score (p=.88 and p=.60 respectively; α=.05). In the regression equation of the FIM, R^2 was .527, the regression constant was 67.753, and the regression coefficient was 1.682 for the FML. As shown in Table 5, the FML was the most important variable for determining the FIM. Furthermore, the FMU and post-stroke duration were not significant in the prediction of FIM (p=.13 and p=.37 respectively; α=.05).

In Tables 6 and 7, the results of multiple regression analyses for post-stroke duration over 12 months were shown. In the regression equation of the BBS, R^2 was .431, the regression constant was 11.481, and the regression coefficient was 1.155 for the FML. As shown in Table 7, the FML was the most important variable for predicting the BBS score. In addition, the FMU and post-stroke duration were not significant in the prediction of the BBS score (p=.20 and p=.41 respectively; α=.05). In the regression equation of the FIM, R^2 was .582, the regression constant was 76.397, and the regression coefficient was 1.382 for the FML. As shown in Table 7, the FML was the most important variable for determining the FIM. Furthermore, the FMU and post-stroke duration were not significant in the prediction of the FIM (p=.42 and p=.29 respectively; α=.05).

Discussion

The purpose of this study was to propose ideas to predict activities on the basis of the physical abilities and daily activities of stroke patients using outcome measurement tools with common clinical assessments, including the FMA, BBS, and FIM. The results of our study revealed several significant findings. Firstly, the result of this study showed that have 38% for the prediction of the BBS score of the information by FML on physical impairments to predict activities in stroke patients. Secondly, the result of this study showed that have 53% for the prediction of the FIM score of the information by FML on physical impairments to predict activities in stroke patients. These percentages in stroke patients indicate that they were not affected by post-stroke duration within and over 12 months or by the FMU score.

A fundamental issue in any clinical setting concerns how the levels of functional activity are measured in subjects, and stroke is no exception. The BBS is widely used to assess balancing ability in stroke patients; it contains 14 components for balance evaluation. All components were required for function of the lower extremity and both static and dynamic balance, but the FML is based only on lower extremities for predicting BBS scores. These results suggested that the FML is not a sufficiently predictive variable for balancing ability. Beninato et al (2009) suggested that the ICF is a useful framework for selecting clinical measures relative to fall history, but multiple regression analysis of our study showed that the FMU and post-stroke duration did not significantly impact the predictions of the BBS and FIM scores. This is because the BBS is not characteristic of the motor components used during balancing activity, and other components for evaluating balance exist, such as visual and proprioceptive stimuli. Therefore, the BBS is based on different levels of measurement of activity and impairment. Physical impairments should not be generalized or correlated with the levels of function calculated by 2 different levels of measurement tools.

The FIM is widely used for assessing the activity of daily living in stroke patients. Murtezani et al (2009) reported that physical impairment has an impact on the reintegration of stroke patients into the community. Improving the physical state means that quality of life is also improved, and stroke patients are easily reintegrated into the community. The FMA is the most common tool for evaluating physical impairment in stroke patients. Following multiple regression analysis of the FMA and FIM in this study, the FML score indicated moderate predictors for the FIM scores, although the FML contains no components for assessing cognitive status in stroke patients. Strengthening the significance of this result is the fact that the FML clarifies the FIM score if there is no cognitive information; however, the weakness of this result is that the FIM is not reflected or explained by upper extremity physical impairments in stroke patients.

One reason for the lower predictor variables between the FMA, FIM, and BBS is that they demonstrated that only one physical impairment measure was insufficient to clarify the activity or balancing ability of stroke patients. The main limitations to the BBS that it may not be suitable for the evaluation of active elderly persons, and no common interpretation exists for BBS scores except those of border scores for fall risk and decreased sensitivity in early-stage stroke patients (Mao et al, 2002; Nakamura et al, 1999; Wee et al, 2003). Moreover, one of the greatest limitations of FIM tools for stroke is that there might be no precise scoring range for each item (Salter et al, 2005). Selecting a combination of assessments within the ICF model may be a critical factor for improving the accuracy of outcome measures in stroke patients. Yates et al (2002) have shown that combining measures on the basis of body function and structure may improve their sensitivity compared to applying them individually to stroke patients. In addition, the outcome measurements for stroke must consider the study and intervention types, and whether the outcome measured for focuses on activity limitation during rehabilitation. As discussed earlier, the individuals who participated in this study were measured with only 1 physical impairment tool and for activity of daily life or balance. Therefore, the results cannot be generalized to the measures of daily life activity or balancing ability of stroke patients. Physical impairments may reduce participation in daily activities for community-dwelling stroke patients, ultimately affecting their quality of life. Further studies could analyze the influence of physical impairments on activities using more variable measurement tools on levels of both body function and of structure, and activity limitations.

Conclusion

This study aimed to identify the outcome measures in relation with measurement of impairment and activities in stroke patients. The FMA, BBS, and FIM score of 76 stroke patients were measured by 2 physical therapists. The results suggest that the FML is the most important variable for predicting the balancing ability on the basis of the BBS score and daily activities on the basis of the FML in stroke patients. However, it was not a strong clarification of the influence of physical impairments on activity limitation. Therefore, there is a need to analyze the influence of physical impairments on activities using more variable measurement tools on levels both of body function and of structure, and activity limitations.

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