Stroke from Prospective Acute Inpatient Rehabilitation Data: Functional Outcomes Using the Functional Independence Measure

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Objectives: Stroke is a second leading cause of mortality and results often to severely lasting disability in worldwide. We studied the long-term effects of rehabilitation after stroke as a key factor in improving the quality of life, due to the reason that Mongolia has one of highest rates of ischemic heart disease. The aim of this study was to evaluate functional outcomes of all patients admitted to an inpatient rehabilitation unit in a tertiary hospital using Functional Independence Measure (FIM), and analyze factors that are associated significantly with progression of discharge functional scores and higher functional gains. **Methods:** In this longitudinal study over a two-month period, functional data for 104 patients admitted consecutively to the Stroke Center at Third State Central Hospital inpatient rehabilitation unit in Mongolia were charted into a custom designed rehabilitation database. The primary outcome measures were the discharge total FIM scores, FIM gain and FIM efficiency. Multiple linear regression analysis were used to identify independent variables associated with better discharge FIM scores and FIM gain. **Results:** The mean age was 56.3 ± 11.6 years and 55.7% of the patients were male. Ischemic stroke (28.8%) followed by hemorrhagic stroke (71.2%) were more common diagnoses. The average rehabilitation length of stay was 9.3 ± 2.2 days. The mean admission total FIM score was 42.3 ± 20.7 and the mean discharge total FIM score was 61.3 ± 24.6, with this gain being highly significant (P < 0.001). The mean FIM gain was 18.6 ± 17.4 and FIM efficiency was 2.1 ± 1.0 points per day. Factors associated with better functional outcomes were higher admission motor and cognitive FIM scores, male gender and a longer rehabilitation length of stay. **Conclusions:** The FIM is an easy-to-use, standardized and robust general measure of functional disability. The total FIM scores of all patients, participated in this study, significantly improved. Moreover, longer rehabilitation LOS resulted in a negative effect on discharge FIM scores. To our knowledge, this study is the first study that examines the stroke rehabilitation using FIM scores as the primary outcome measure in Mongolia.

Keywords: Functional Independence Measure, Rehabilitation, Ischemic and Hemorrhagic Stroke

Introduction

Stroke often leads to serious, life-long disability and impairment in adults, associated with physical and behavioral disorders, which is an emotionally and financial burden to their families [1]. An estimated 17 million people suffer each year from strokes, out of which 6 million die. Further, 10% of stroke survivors recover completely, 25% are partially disabled, 40% suffer mild to moderate disability, while 10% are left permanently disabled and require institutional nursing care [2]. In Mongolia, every year statistical data reports of morbidity and mortality show that young adults account for approximately 20-26% of all stroke patients as opposed to only 10-13% in Western countries [3].

In rehabilitation medicine, numerous research has been performed in recent years with the aim towards better clinical care as well as reduction of disability [4, 5]. Despite major advances in detecting stroke causes, risk factors and stroke prevention strategies, many unanswered questions remain concerning the treatment issues. Well-designed rehabilitation to improve outcome and quality of life often relies on multidisciplinary patient management to deliver integrated care rather than rehabilitation in general medical wards [4]. The stroke-related death decrease results from increasing efforts in acute stroke management as well as placing more demand on more effective therapies for the rising number of older people with disability from stroke in developed countries in upcoming years, which in turn results in growth of cost for rehabilitation [3]. The reason for the increasing number of rehabilitation facilities with a larger array of therapeutic options and subspecialty programs is that each country offers different rehabilitation services in order to solve the problems in the reimbursement system. This includes case-mix and functional-related group systems for the classification of diseases as well as payment systems which may be prospective, per diem or per episode [6-10].

The most important elements of the rehabilitation service system include the development of the basic data set and the well-standardized outcome measures applicable to a wide variety of rehabilitation conditions. This, in turn, assists clinicians in prognostication as well as rehabilitation cohorts in order to establish quality standards and effective planning of the economic and rehabilitation resources [11]. In areas, such as United States, Australia, and continental Europe where the practice of rehabilitation medicine is well developed, databases specific to rehabilitation outcomes often meet important needs. The United States National Model Systems Spinal Cord Injury and Traumatic Brain Injury Rehabilitation databases are examples of such multicentre registries that maintain a minimum data set and utilize the Functional Independence Measure (FIM) as the common primary functional outcome measure [12,13]. Because of its advantages such as the capability of comparing functional outcomes by diagnosis, maintaining internationally coordinating centers for large FIM database, FIM is also the most widely used general measure of disability in North America and Australia, and is increasingly being adopted by Asian countries with developed rehabilitation facilities such as Japan and Taiwan [1,14-19]. The FIM has undergone continuous reviews and refinements to maintain standards, relevance, as well as accreditation for clinicians.

There is limited available evidence for baseline rehabilitation demographics and outcomes in Mongolia. It has been considered that the reason for the data infrequency is that after discharge from the hospital, patients often do not receive continuous rehabilitation treatment in their community. While it is always important to focus on the social, cultural as well as healthcare potentials, there are still gaps in the rehabilitation services of hospitals, and outpatient locations for measuring functional outcomes. Therefore, the aim of this paper was to prospectively evaluate functional outcomes of stroke patients admitted to a Stroke Center at the State Central Hospital III inpatient rehabilitation unit by using the FIM as the primary outcome measure. We also aimed to investigate the long-term effects of rehabilitation after stroke as a key factor in improving the quality of life.

Materials and Methods

Subjects
Matched with inclusion criteria, a total of 104 patients with a primary diagnosis of stroke hospitalized at the Stroke Center of the State Central Hospital III between March 2019 and May 2019, participated in this study.

Inclusion criteria
The admission criteria to the rehabilitation unit is (1) age 15 or older, (2) presence of impairments or disabilities which may benefit from a comprehensive inpatient rehabilitation program

regardless of diagnosis, (3) patient who have the potential to participate in a goal-oriented rehabilitation program and (4) sufficient medical stability to participate in a rehabilitation setting. Rehabilitation Medicine specialists select patients for rehabilitation during consultation rounds and coordinate the transfer of appropriate candidates from the acute referring units.

Instrument

The functional independence measure (FIM) is the primary functional outcome measure used in our facility and database, and is collected prospectively at admission (AFIM) and discharge (DFIM). The FIM is a widely used standardized functional outcome measure in medical rehabilitation. It consists of 13 motor and 5 cognitive items, with established content and construct validity, sensitivity and inter-rater reliability for the measurement of general functional ability across a wide range of rehabilitation conditions [14]. Motor items include disability assessment in feeding, grooming, dressing, toileting and mobility. Cognitive items assess communication, social interaction, problem-solving and memory. Scores range from 1 (totally dependent) to 7 (totally independent) for each of the 18 items, with a maximum score of 126 indicating total functional independence. The FIM gain is the difference between DFIM and AFIM scores and measures functional improvement. The FIM efficiency is the FIM gain divided by the length of stay (LOS), and measures the rate of functional improvement [1]. All physicians, nurses and therapists who perform FIM assessments are trained and accredited in FIM scoring.

Measurement

A multidisciplinary team led by a rehabilitation physician assesses and scores the FIM within 72 hours of admission to and discharge from our unit. All patients go through a comprehensive rehabilitation program, which includes medical and nursing care, physical therapy, and occupational therapy. Speech or language therapies and medical social work interventions are arranged where appropriate. Patients received approximately 2 to 3 hours of therapy per day. Weekly multidisciplinary staff meetings are conducted to assess progress, review functional goals, plan further therapies and formulate discharge plans.

Statistical analysis

The Student's t-test was used to assess differences in group means. The Chi-square test was carried out to examine patterns between categorical variables. Moreover, the paired t-test was used for repeated measurements as in Table 2. We performed multiple linear regression analyses to identify independent clinical variables associated with the discharge total FIM score and FIM gain. The independent variables chosen were based on prior literature review as well as a consensus among the authors. This included age, gender and the length of stay (LOS). The variables were then entered simultaneously into the linear regression models. In both of these linear models, assessments for violation of assumptions were made, including analyses of normality of the residuals and linearity of the continuous variables. The adjusted R^2 was calculated for these models to assess whether they were good predictors of the discharge FIM score and FIM gain. Before regression analyses, we carried out correlation analysis to detect multi-collinearity. Unless otherwise indicated, statistical analyses performed were parametric when groups were compared and a P value of <0.05 was considered statistically significant. The SPSS version 24 software (SPSS Inc., Chicago, IL, USA) was used for statistical analysis.

Ethical statement

The study was approved by the Research Ethics Committee of the Mongolian National University of Medical Sciences) (No13-03/1A). All patients provided written informed consent before participating in the study.

Results

Out of 104 participants, 58 (55.7%) were males and 30 (28.8%) suffered from an ischemic stroke. The average age of the participants was 56.3 ± 11.6 years.

Table 1. General characteristics of the study population

| Variables | Stroke | | | P-value |
	Ischemic (n=30)	Hemorrhage (n=74)	Total (n=104)	
	Mean ± SD	Mean ± SD	Mean ± SD	
Age	61.5 ± 9.9	54.2 ± 13.9	56. 3 ± 13.3	0.003
Length of Stay	9.2 ± 1.4	9.4 ± 2.4	9.3 ± 2.2	0.000
FIM Admission	41.4 ± 19.2	42.6 ± 21.5	42.2 ± 20.8	0.000
FIM Discharge	58.1 ± 23.3	62.6 ± 24.9	61.3 ± 24.5	0.000
FIM Gain	1.9 ± 2.1	2.2 ± 2.1	18.8 ± 17.2	0.074
	N (%)	N (%)	N (%)	
Gender				
Male	18 (60)	40 (54.1)	58 (55.8)	0.737
Female	12 (40)	34 (45.9)	46 (44.2)	
Hypertension				
Yes	25 (83.3)	60 (81.1)	85 (81.7)	0.534
No	5 (16.7	14 (18.9)	19 (18.3)	
Alcohol				
Yes	17 (56.7)	27 (36.5)	44 (42.3)	0.095
No	13 (43.3)	47 (63.5)	60 (57.7)	
Smoke				
Yes	17 (56.7)	29 (39.2)	46 (44.2)	0.159
No	13 (43.3)	45 (60.8)	58 (55.7)	
Diabetes				
Yes	7 (23.3)	11 (14.9)	18 (17.3)	0.223
No	23 (76.7)	63 (85.1)	86 (82.7)	

The study group was admitted and received early post-stroke rehabilitation treatment by a multidisciplinary rehabilitation team according to the Guideline for Stroke Rehabilitation for two months in a row.

The mean admission total FIM score was 42.3 ± 20.7 and the mean discharge total FIM score was 61.3 ± 24.6. This gain in FIM scores is highly significant (P < .001). There were also highly significant gains in motor and cognitive FIM scores (Table 1). The mean FIM gain was 18.6 ± 17.4 and the FIM efficiency was 2.1 ± 2.1 points/day.

Table 2. FIM Scores of All Patients in Our Cohort

Variables	Admission Mean ± SD	Discharge Mean ± SD	P-value*
Total FIM Scores	42.3 ± 20.7	61.3 ± 24.6	<0.001
Motor FIM Scores	26.7 ± 16.6	42.4 ± 20.1	<0.001
Cognitive FIM Scores	15.5 ± 7.3	20.5 ± 7.7	<0.001

FIM: Functional Independence Measure (range from 18, most disability to 126, no disability) *paired t-test

Table 2 shows total FIM scores of the admission and discharge as well as the FIM sub scores by ischemic and hemorrhage stroke groups. Both ischemic or hemorrhage group patients improved significantly (p < .01) during rehabilitation.

It was observed that the motor FIM scores increased by 13.0 points in the ischemia group and 16.8 points in the hemorrhage group. Subsequently, cognitive FIM scores improved 4.4 and 5.36 points, respectively.

Table 3. FIM scores of patients categorized by stroke in rehabilitation

Variables	Stroke		
	Ischemic (n = 30)	Hemorrhage (n = 74)	Total (n = 104)
Primary FIM Outcome Measures	Mean ± SD	Mean ± SD	Mean ± SD
Admission Total FIM	41.4 ± 19.2	42.7 ± 21.4	42.4 ± 20.8
Discharge Total FIM	58.1 ± 23.3	62.6 ± 25.1	61.4 ± 24.6
P-value*	< 0.01	< 0.01	< 0.001
FIM Motor Scores			
Admission Motor FIM	26.1 ± 16.7	26.9 ± 16.7	26.7 ± 16.7
Discharge Motor FIM	39.1 ± 19.2	43.7 ± 20.4	42.4 ± 20.14
P-value*	< 0.01	< 0.01	< 0.001
FIM Cognitive Scores			
Admission Cognitive FIM	15.5 ± 5.5	15.5 ± 7.9	15.5 ± 7.3
Discharge Cognitive FIM	19.9 ± 6.3	20.86 ± 8.2	20.6 ± 7.7
P-value*	< 0.01	< 0.01	< 0.001
Derivate FIM Scores			
FIM Gain‡	16.7 ± 18.0	19.4 ± 17.1	18.6 ± 17.4
FIM Efficiency§	1.8 ± 2.1	2.1 ± 2.1	2.1 ± 2.1

Functional Independence Measure (range from 18, most disability to 126, no disability)
All scores are mean ± SD; *Paired t-test; ‡ Discharge Total FIM-Admission Total FIM; § FIM Gain divided by length of stay in rehabilitation

Table 3 represents the total discharge FIM multiple linear regression analysis model scores (adjusted $R^2 = 0.61$). The factors with the highest impact on the discharge total FIM scores were the admission motor FIM scores ($\beta = 0.66$) and the admission cognitive FIM scores ($\beta = 0.57$) in the univariate model. Factors associated with a higher discharge total FIM score were higher admission motor and cognitive FIM scores, and male gender in the univariate model, while cognitive FIM scores, male gender as well as older age were higher in multivariate analysis. In both models, the factor for a lower discharge total FIM score was shorter rehabilitation LOS.

Table 4. Correlation analysis

Variables	Age	Admission FIM Score	Discharge FIM Score	FIM Gain	Admission Motor FIM Score	Admission Cognitive FIM Score	LOS
Age	1						
Admission FIM Score	0.07	1					
Discharge FIM Score	0.08	0.21	1				
FIM Gain	0.02	- 0.17	0.23	1			
Admission Motor FIM Score	0.06	0.34	0.15	- 0.19	1		
Admission Cognitive FIM Scores	0.02	0.12	0.37	- 0.00	0.24	1	
LOS	- 0.07	-0.04	- 0.25	- 0.29	0.01	- 0.15	1

LOS: Length of Stay

Table 4 shows correlation analysis between dependent and independent variables. The outcome of correlation analysis showed that there are positive correlations between admission cognitive FIM scores and discharge FIM scores (r = 0.37), as well as admission motor FIM scores and discharge motor FIM scores (r = 0.34). Regarding other variables, this analysis revealed weak correlations.

Table 5. Multiple linear regression analysis model on total discharge FIM scores

Variables	B*	SE	βt	P-value	VIF
Admission Motor FIM Scores	- 0.44	0.88	- 0.37	0.617	1.38
Admission Cognitive FIM Scores	1.16	0.87	0.79	0.189	1.29
Male	1.64	0.89	0.49	0.068	1.11
Age	5.31	3.45	0.11	0.128	1.01
Length of stay in rehabilitation	- 0.38	0.13	- 0.19	0.005	1.05

FIM: Functional Independence Measure; SE: Standard Error; VIF: Variance Inflation Factor; Adjusted R^2 = 0.61; *Unstandardized coefficient; †Standardized coefficient

Further, in tables 5 and 6, factors associated with a higher FIM gain were male gender, a longer rehabilitation LOS in the multivariate model, while cognitive FIM scores, male gender and older age showed higher FIM gain in multivariate analysis. In both models, motor FIM scores had the lowest FIM gain (-0.37 and -1.72, respectively). Moreover, the regression between the dependent variables and independent variables demonstrated VIP values less than 10, providing an initial indication that there was not multicollinearity.

Table 6. Multiple linear regression analysis model on total discharge FIM gain

Variables	B*	SE	βt	P-value	VIF
Admission Motor FIM Scores	-1.44	0.88	-1.72	0.003	1.38
Admission Cognitive FIM Scores	1.16	0.88	1.12	0.105	1.29
Male	1.64	0.89	0.69	0.189	1.11
Age	5.31	3.46	0.15	0.068	1.00
Length of stay in rehabilitation	-0.38	0.13	-0.28	0.128	1.05

FIM: Functional Independence Measure; SE:Standard Error; VIF: Variance Inflation Factor; Adjusted R^2 = 0.38; *Unstandardized coefficient; †Standardized coefficient

Discussion

According to the statistics, stroke is one of the five leading cause of mortality in Mongolia, and among young adults, accounts for 26% of all stroke patients. The high presence of ischemic heart disease in the Mongolian population probably represents a high vascular disease burden and associated co-morbidity, which impairs the recovery process during rehabilitation. Clinical reports and studies have shown that approximately 22.3% of the adult population of Mongolia reported a sedentary lifestyle, nearly 50% of the population is considered obese, and among adults aged 25-64 years over 40% are at a high risk for coronary atherosclerosis. There are three main types of stroke: transient ischemic attack, ischemic stroke and hemorrhagic stroke. Worldwide the most common type of stroke, accounting for 87% of all strokes, is ischemic stroke. However, in the case of the Mongolian population, the most dominant type is hemorrhagic stroke or intracerebral hemorrhage, which is the most disabling and deadly form of stroke. Due to being the least densely populated country in the world and lack of an integrated national healthcare registration system, we face numerous issues, in particular, management of rehabilitation community and welfare services.

Our present study provides important data on functional outcomes after inpatient rehabilitation for an ischemic and hemorrhagic stroke in Mongolia, which in turn allows us potentially to compare functional differences between diagnoses and across rehabilitation facilities. However, it is common knowledge that strokes are frequent in elderly. The average age of our patients was 56.3 years which is lower than the age cut-off for geriatric services in Mongolia (≥65 years) [20]. Compared to older adults, young patients are often employed at the time of their illness, care for dependents and have different risk factors such as financial stability and family responsibilities. With this approach, our present study showed the importance of inpatient rehabilitation programs on the functional outcomes of

stroke in order to improve the social and financial burden on the country in the long run [21]. Moreover, this rehabilitation cohort comprised diverse clinical conditions and several factors, which could have contributed to the differences in functional outcomes of the patients.

In our cohort study, the total FIM scores of all patients significantly improved by 19 points (p<.001). Further, FIM motor was markedly more effected than cognitive FIM in patients discharged to the community, with 10.7 scores higher (Table 1). As mentioned above, due to intracerebral hemorrhage, which is the most common case of the stroke in Mongolia, resulting in heavy locomotor deficits, high motor FIM scores in this study maybe an important threshold for community discharge of patients. As shown in Table 2, when the cohort analysis was categorized by stroke, FIM efficiency also was slightly higher (2.1 ± 2.1) in hemorrhage compared to the ischemic stroke (1.8 ± 2.1). Otherwise, rehabilitation improved functional outcomes for patients with disabilities regardless of whether ischemic or hemorrhagic stroke. Thus, it should be noted that further research is required on the evaluation of outcomes, as well as long-term follow up of patients after discharge from inpatient rehabilitation for the future effective planning of rehabilitation as well as national healthcare resources.

Univariate analysis showed significant associations among total discharge FIM scores, admission motor FIM (β=+0.66), admission cognitive FIM (β=+0.57), LOS in rehabilitation (β=-0.33), while in multivariate analysis, the LOS in rehabilitation was negatively associated with discharge FIM scores (Table 3). The important association that the severity of disability at admission best predicts is the discharge functional capacity which has been reported by numerous outcome studies in rehabilitation and is also true in our cohort. Further, admission cognitive FIM score with higher SE resulted in a weak association with discharge FIM scores compared to that of admission motor FIM scores. Interestingly, a longer rehabilitation LOS resulted in a negative effect on discharge FIM scores in both analysis (-0.33 and -0.19 respectively). Higher admission FIM scores can be the reason of this finding, which in turn, results to the shorter LOS and better likelihood of discharge to home.

Our study also confirmed that admission motor FIM scores in both univariate and multivariate analysis were negatively associated with total discharge FIM gain. However, in both cases, the actual absolute impact was quite small (B=-0.14 and

-1.44). The ceiling effects can explain the reason of this effect, where maximal scores masks subtle deficits. Previous studies in different population have revealed that older age and male sex was associated with total discharge FIM scores as well as gains. However, in our study, only univariate analysis showed positive correlation between the male sex and FIM gain.

As we mentioned, the population age with hemorrhagic stroke is much younger in Mongolia. The stroke burden in Mongolia is 4400/1000.000 people which is the highest in Asian countries. The average age of our study was 56.3 years old which is much younger when compared with a Singaporean study [22] and a Taiwan's study [16]. Moreover, our results revealed that LOS in rehabilitation was negatively associated with discharge FIM scores (Table 3). It was shown in a Singaporean study that there was positive correlation between discharge FIM and LOS. We explained this by the higher admission FIM scores. To our knowledge, this study is the first study that examines the stroke rehabilitation using FIM scores as the primary outcome measure in Mongolia.

Many studies have reported that the total discharge FIM scores strongly correlated with total FIM scores at the time of admission. Thus, the scores at the admission to rehabilitation can be an important prognostic factor that encourages the patient and family, because the majority of caregivers of disabled patients are family members. Moreover, these scores are also extremely helpful to optimize functional and social patient outcomes, for informing of the possibility of improvement as well as educating and counselling caregivers. On the other hand, it must be further emphasized that social and cultural factors always influence the functional outcome of a patient discharge.

There have been plenty of reviews and meta-analysis on complementary medicine in Asian countries. For example, some studies have demonstrated that acupuncture may improve pain and mood in stroke patients and results to better discharge FIM scores and FIM gain, while there are several analysis that show little or no benefit from acupuncture on motor recovery in stroke. Therefore, there is need in the future to study to attempt to account for these factors.

The limitation of our present study has inclusion bias. We selected only patients who were admitted to inpatient rehabilitation in our hospital. Thus, the findings in this study may not reflect the wide range of patients with disabilities who had preferences for rehabilitation at other facilities such as inpatient

rehabilitation units at other hospitals as well as community rehabilitation hospitals. Moreover, our present data was not large enough to provide adequate functional outcomes and LOS may have changed over three-month period of the study.

Conclusions

The FIM is an easy-to-use, standardized and robust general measure of functional disability. The total FIM scores of all patients, participated in this study, significantly improved. Moreover, longer rehabilitation LOS resulted in a negative effect on discharge FIM scores. To our knowledge, this study is the first study that examines the stroke rehabilitation using FIM scores as the primary outcome measure in Mongolia.

Conflict of Interest

The authors state no conflict of interest.

Acknowledgements

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