

Long-Term Rehabilitation Outcomes of Neurological Patients: A Multicenter Study

Donrueedee Srisupphaphon^{ID}, M.D.*, Pranee Lukkanapichonchut^{ID}, M.D.***, Nualpis Intaratep^{ID}, M.D.***, Vilai Kuptniratsaikul^{ID}, M.D.****

*Sirindhorn National Medical Rehabilitation Institute, Ministry of Public Health, Nonthaburi, Thailand, **Department of Rehabilitation Medicine, Ratchaburi Hospital, Ministry of Public Health, Ratchaburi, Thailand, ***Department of Rehabilitation Medicine, Maharat Nakhon Ratchasima Hospital, Ministry of Public Health, Nakhon Ratchasima, Thailand, ****Department of Rehabilitation Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand.

ABSTRACT

Objective: To evaluate functional outcomes in patients three years after rehabilitation and to identify factors significantly associated with improvement.

Materials and Methods: This prospective cohort study was carried out in nine tertiary centers to compare functional outcomes (Barthel Index; BI) at discharge with scores at three-year follow-up among various diagnoses and types of admissions. Related factors were evaluated for association with improvement in functional score.

Results: Three hundred and eighteen patients (mean age: 54 years; 60% male) were included. More than half of all patients suffered from a spinal cord injury. After three years, 35% of patients were still receiving physical therapy. Only those who were admitted for intensive rehabilitation showed significant improvement after three years. One hundred and ten patients or 35.8% showed significant improvement over time. A univariate analysis showed type of diagnosis, type of admission, onset to admission interval, BI at discharge, and presence of depression and complications at follow-up to be significantly associated with improvements in functional score in the follow-up period. Using a multivariate analysis, only the type of diagnosis, low BI at discharge, and absence of depression and complications at follow-up related to functional improvement.

Conclusion: One-third of patients had sustained functional improvements from rehabilitation three years after discharge. Participants admitted into intensive rehabilitation showed significant improvements in functional scores between discharge and follow-up. TBI diagnosis, low BI at discharge, absence of depression and complications at follow-up related to long-term functional improvement at the three-year mark.

Keywords: Rehabilitation; treatment outcome; inpatients; functions; multicenter study (Siriraj Med J 2022; 74: 562-569)

INTRODUCTION

One of the principal objectives of rehabilitation is to enhance a person's functional status so he/she can participate in normal activities of daily living and social activities, both of which contribute to a better quality of life. Studies from many countries, including a large multicenter trial and three dataset reviews, have

shown the effectiveness and efficiency of inpatient rehabilitation to facilitate improvement in or return of patient's normal level of function.¹⁻⁴ Several studies have reported factors that predict functional outcomes at discharge from rehabilitation, including age, onset to rehabilitation admission interval (OAI), length of stay (LOS), admission functional status, admission cognitive

Corresponding author: Vilai Kuptniratsaikul

E-mail: vilai.kup@mahidol.ac.th

Received 20 September 2021 Revised 22 May 2022 Accepted 23 May 2022

ORCID ID: <https://orcid.org/0000-0001-8348-0369>

<http://dx.doi.org/10.33192/Smj.2022.67>



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level, diagnosis, intensity of rehabilitation program, and certain characteristics of impairments.^{1-3,5,6} In order to achieve the ultimate goal of personal independence and social participation, functional performance needs to be retained long after rehabilitation.

Most studies explore long-term outcomes in stroke patients,⁷⁻⁹ but some also look at outcomes in patients with a traumatic brain injury.¹⁰⁻¹³ As such, functional measurement tools used to evaluate these two patient population groups vary substantially. Only a few studies compare a patient's functional status between rehabilitation discharge and long-term community outcome.⁹⁻¹¹

Factors reported as being significantly associated with long-term functional outcomes in brain injury patients include age, type of impairment, functional level during admission, functional level at discharge, ability to follow commands before discharge, duration of minimally conscious state, and diagnosis.^{8,10,11,13}

In Thailand, there are no rehabilitation units dedicated to a specific type of disorder. All patients in Thailand in need of functional restoration are admitted to general rehabilitation wards located mostly in general hospitals and university hospitals.¹⁴ Data relating to long-term functional outcomes after discharge from inpatient rehabilitation in Thailand is scarce. Accordingly, the aim of this study was to evaluate functional outcomes of patients with neurological conditions after three years of rehabilitation in Thailand, and to identify factors associated with functional outcomes.

MATERIALS AND METHODS

In 2012, two thousand and eighty-one patients from fourteen medical centers participated in a prospective multicenter study to investigate the effectiveness and efficiency of inpatient rehabilitation services in Thailand.¹⁴ Of those, nine centers agreed to participate in this three-year follow-up study of functional outcomes in patients admitted for inpatient rehabilitation. The ethical review committee of each participating center approved this multicenter study (Si: 393/2015). Patients aged above 18 admitted to inpatient rehabilitation facilities in 2012 were included. Those no longer having regular follow-up appointments were contacted via telephone to come back for a checkup. Written informed consent was given by all enrolled study participants.

Demographic and clinical data included age, gender, onset-to-admission interval (OAI), length of stay, marital status, diagnosis, requirements for caregiver, discharge location, and type of admission. Participants were examined by a rehabilitation physician for functional status using the Barthel Index (BI)¹⁵ at their three-year follow-up visit.

The BI ranges from 0-20, with a higher score indicating better functional status. The BI score at three-year follow-up was compared to the BI score at discharge among various diagnoses and types of admission. In addition, the number (%) of patients with different levels of disability severity was analyzed for association between discharge and three-year follow-up.

The type of admission was classified as either intensive or non-intensive rehabilitation. Patients admitted in the intensive program included people who could tolerate rehabilitation at least three hours per day, five days per week. Patients admitted in the non-intensive program satisfied one or more of the following criteria¹⁴: 1) patient could tolerate rehabilitation less than two hours per day; 2) admitted for investigation; 3) admitted so that their caregiver could receive training; and/or, 4) admitted to be treated for complications. Readmission after discharge from inpatient rehabilitation wards was also recorded. Complications were recorded as none or having complications, including pain, spasticity, shoulder subluxation, joint contracture, pressure ulcer, pneumonia, incontinence, dysphagia, and depression. Depression was evaluated using the Patient Health Questionnaire (PHQ-9) with a score greater than nine indicating depression.¹⁶

Statistical analysis

Demographic and clinical data was analyzed descriptively. A paired t-test was used to analyze changes in BI scores at discharge (BI_{DC}) and at three-year follow-up (BI_{FU}) among various diagnoses and types of admission. The McNemar's test was used to compare severity of disabilities at discharge and three-year follow-up. Factors related to changes in functional score were analyzed using the Student's t-test and one-way analysis of variance (ANOVA) for categorical data. The Pearson's and Spearman's rank correlation coefficient tests were applied for continuous data. All factors with a *p*-value of less than 0.10 in univariate analysis was included in a multiple linear regression analysis. A *p*-value of less than 0.05 was regarded as being statistically significant. All statistical analyses were performed using SPSS Statistics version 18 (SPSS, Inc., Chicago, IL, USA).

RESULTS

Among the 1,431 patients admitted to nine hospitals in Thailand in 2012, we were able to track 628 (43.89%). Of those, 109 had died, 201 declined to participate, and the remaining 318 patients were included in this study (Fig 1). Ninety-four patients were readmitted to the hospital after discharge in the three-year follow-up period, and approximately half of those had more than

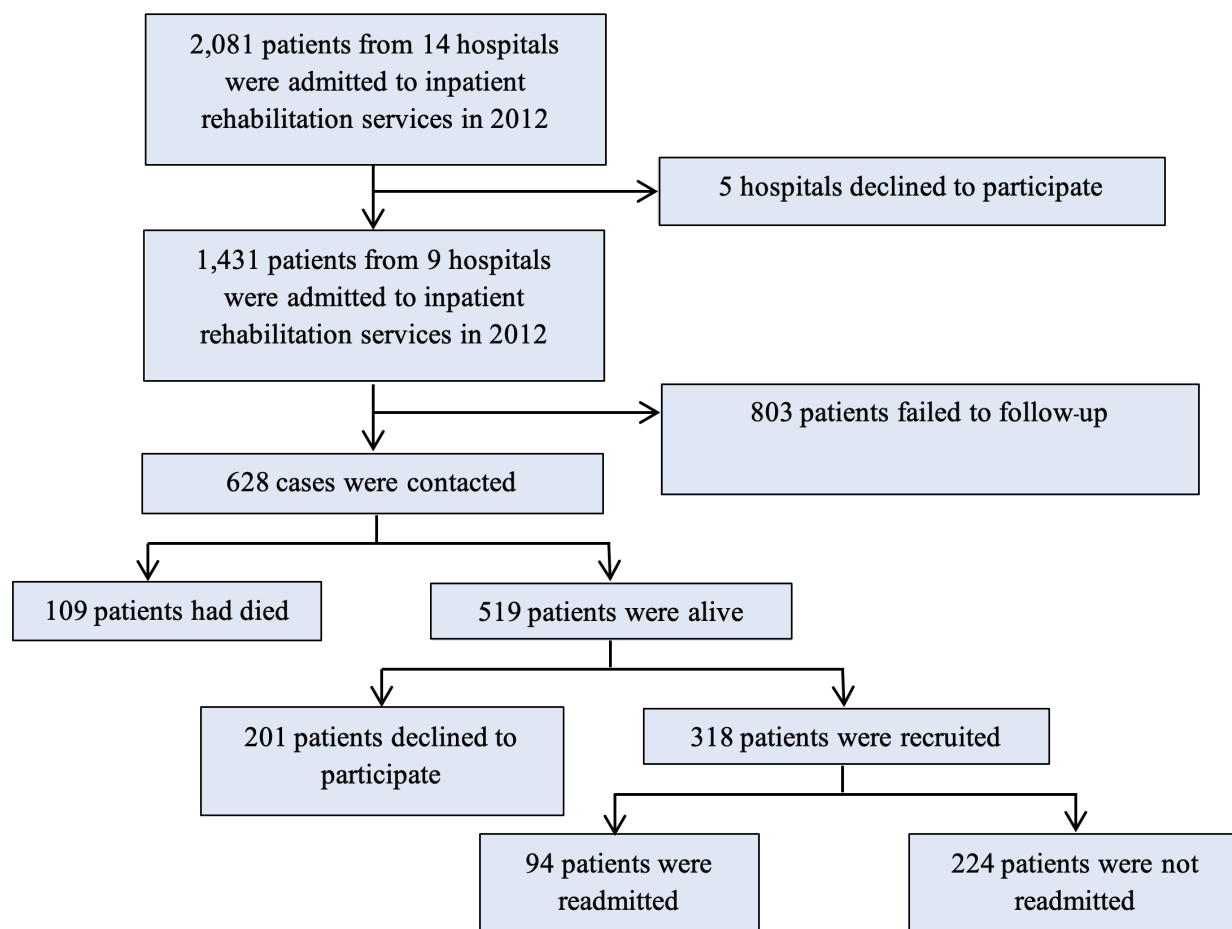


Fig 1. Flow diagram of study enrollment process

one admission due to complications. The majority of complications were urinary tract infection (UTI) and pressure ulcer, and a small number of patients had pneumonia, deconditioning, or recurrent stroke.

The average age of patients was 54, with 60% being male. More than half of all patients suffered from spinal cord injuries (SCI). Approximately 80% of study patients also required assistance from a caregiver. More than half (53.6%) of patients were admitted at some point in time for intensive rehabilitation (Table 1).

The Barthel Index (BI) compared type of diagnosis and type of admission at discharge and the follow-up period as shown in Table 2. The changes in BI score at follow-up and discharge revealed statistically significant improvements regarding stroke, SCI, and traumatic brain injury (TBI). Patients with TBI showed the greatest increase in functional score. In addition, only those who were admitted for intensive rehabilitation showed significant improvements at the three-year follow-up.

Association between functional score (BI) at discharge and at the three-year follow-up by severity of disability

is shown in Table 3. Almost half of all patients (46.3%) remained at the same level of ability, while 110 (35.8%) showed signs of improvement over time. Only 55 patients (17.9%) had functional deterioration at the three-year follow-up mark.

A univariate analysis revealed type of diagnosis ($p=0.039$), type of admission ($p=0.025$), onset-to-admission interval (OAI) ($p=0.034$), BI at discharge ($p<0.001$), presence of depression at follow-up ($p=0.015$), and presence of complications at follow-up periods ($p=0.059$) to be significantly associated with improvement in functional score at follow-up. A multivariate analysis identified four factors that were either negatively or positively associated with improvements in functional score at three-year follow-up. TBI diagnosis positively correlated with improvements in functional score at follow-up ($p=0.048$). A low BI score at discharge ($p<0.001$), presence of complications at follow-up ($p=0.011$), and presence of depression at follow-up ($p=0.023$) all negatively correlated with improvements in functional score at follow-up (Table 4).

TABLE 1. Demographics and clinical characteristics of study participants.

Characteristics	(N=318)
Age (years), mean \pm SD	54.0 \pm 18.5
Male gender, n (%)	191 (60.1%)
Onset-to-admission interval (months), median (min, max)	5.00 (0.03, 312.00)
Length of stay (days), median (min, max)	20 (1, 236)
Marital status: married (n=314), n (%)	98 (31.2%)
Need caregiver, n (%)	252 (79.2%)
Discharge location: home (n=309), n (%)	259 (83.8%)
Diagnosis (n=315), n (%)	
Stroke	80 (25.4%)
Spinal cord injury	168 (53.3%)
Traumatic brain injury	11 (3.5%)
Others	56 (17.8%)
Type of admission (n=304), n (%)	
Intensive rehabilitation	163 (53.6%)
Less-intensive rehabilitation	24 (7.9%)
Investigation	73 (24.0%)
Caregiver training	9 (3.0%)
Treatment of complications	11 (3.6%)
Others	24 (7.9%)

TABLE 2. Barthel Index compared between discharge and follow-up for type of diagnosis and type of admission.

Variables	n	BI discharge (mean \pm SD)	BI follow-up (mean \pm SD)	Change score (95% CI)	P-value [#]
Diagnosis					
Stroke	77	12.6 \pm 4.8	14.0 \pm 6.7	1.4 (0.4, 2.5)	0.007
SCI	163	11.6 \pm 5.4	12.4 \pm 5.6	0.8 (0.2, 1.5)	0.007
TBI	10	8.4 \pm 5.6	13.1 \pm 7.5	4.7 (2.5, 6.9)	0.001
Others	54	13.9 \pm 5.3	14.6 \pm 6.3	0.7 (-0.4, 1.9)	0.203
Type of admission					
Intensive rehab	163	12.1 \pm 4.9	13.7 \pm 6.4	1.6 (0.9, 2.3)	<0.001
Less-intensive rehab	24	8.0 \pm 5.0	8.8 \pm 5.7	0.8 (-1.1, 2.8)	0.383
Investigation	73	13.4 \pm 4.8	13.7 \pm 4.8	0.3 (-0.5, 1.1)	0.428
Caregiver training	9	3.1 \pm 4.0	3.8 \pm 5.3	0.7 (-3.6, 4.9)	0.728
Treat complications	11	13.6 \pm 2.7	14.8 \pm 4.3	1.2 (-1.4, 3.9)	0.308
Others	24	16.0 \pm 4.8	15.9 \pm 5.0	-0.1 (-0.9, 0.8)	0.919

A p-value <0.05 indicates statistical significance; [#]Paired t-test

Abbreviations: BI; Barthel Index, SCI; spinal cord injury, TBI; Traumatic brain injury

TABLE 3. Association between functional score at discharge and functional score at the three-year follow-up by severity of disability (N=307).

Severity of functional score (BI) at discharge n (%)	Severity of functional score (BI) at 3-year follow-up, n (%)				
	Very severely disabled (BI: 0-4)	Severely disabled (BI: 5-9)	Moderately disabled (BI: 10-14)	Mildly disabled (BI: 15-19)	Independent (BI: 20)
Very severely disabled (BI: 0-4)	25 (8.1%)	9 (2.9%)	2 (0.7%)	1 (0.3%)	0 (0.0%)
Severely disabled (BI: 5-9)	9 (2.9%)	13 (4.2%)	10 (3.3%)	14 (4.6%)	1 (0.3%)
Moderately disabled (BI: 10-14)	6 (2.0%)	13 (4.2%)	51 (16.6%)	33 (10.7%)	13 (4.2%)
Mild disabled (BI: 15-19)	0 (0.0%)	2 (0.7%)	17 (5.5%)	37 (12.1%)	27 (8.8%)
Independent (BI: 20)	0 (0.0%)	0 (0.0%)	0 (0.0%)	8 (2.6%)	16 (5.2%)

McNemar's test: p -value<0.001

Abbreviation: BI, Barthel Index

DISCUSSION

Three years after discharge from rehabilitation, our study found that one-third of all patients had sustained functional improvement, while almost half remained at the same level of disability, and one-fifth had functional deterioration. Wade and Hewer reported the outcomes at six months post-stroke and found that 65.7% of patients saw an improvement while the condition of 6.2% declined.¹⁷ Our results are in contrast against those in a study by Kuptniratsaikul, *et al.* who reported that 51.5% of patients had improved functional level while 12.8% saw a decline one year post-stroke.¹⁸ These studies confirm the natural course of functional recovery in which significant improvement occurs within 6-12 months, with a subsequent observed tendency of the patient's functional level to stabilize or decline thereafter. It is important to emphasize that in addition to our study which enrolled stroke patients (25.4%), we also enrolled patients with SCI (53.3%) and TBI (3.5%). More than 80% of participants were admitted with sub-acute neurological conditions and therefore, the course of recovery discussed here is probably applicable.

In addition to observed significant improvements in functional score at three-year follow-up, patients admitted

for intensive rehabilitation showed apparent sustainability of functional status, which is consistent with previous findings.^{14,19,20} Pattanasuwanna and Kuptniratsaikul performed a retrospective study in stroke patients admitted between 2010-2014 to investigate five-year outcomes,¹⁹ and Rinkaewkan and Kuptniratsaikul performed a retrospective study in patients admitted for SCI rehabilitation between 2006-2010.²⁰ Those studies revealed that stroke and SCI patients admitted for intensive rehabilitation had better functional improvements (change in BI score) than groups admitted for non-intensive rehabilitation. These differences may be due to the fact that patients admitted for intensive therapy were deemed able to tolerate a three-hour per day program. Taken together, these findings also confirm previously reported findings that intensive rehabilitation is effective for improving functional status in any disease.¹⁴

Regarding factors that significantly correlate with an improved Barthel Index score over time, our study found four. A multivariate analysis showed that diagnosis of TBI positively associated with improved BI at follow-up, low BI at discharge, and that presence of depression at follow-up, and presence of complications at follow-up negatively associated with improved BI. This result aligns

TABLE 4. Univariate and multivariate analysis for factors significantly associated with changes in Barthel Index score ($BI_{FU} - BI_{DC}$).

Factors	n	Univariate analysis		Multivariate analysis		
		Change in BI score	P-value	b	SE (b)	P-value
Age (years)	305	$r = -0.064$	0.268	-	-	-
Gender			0.838	-	-	-
Male	184	1.1 ± 4.2				
Female	123	1.2 ± 4.5				
Marital status			0.659	-	-	-
Single	95	1.1 ± 4.2				
Married	160	1.2 ± 4.5				
Divorced	48	0.6 ± 5.3				
Diagnosis			0.039			
Others	54	0.8 ± 4.3				
Stroke	77	1.5 ± 4.7		0.324	0.751	0.667
Spinal cord injury	163	0.9 ± 4.1		0.052	0.677	0.939
Traumatic brain injury	10	4.7 ± 3.0		3.052	1.558	0.048
Discharge location			0.639	-	-	-
Home	273	1.2 ± 4.4				
Nursing home/shelter	26	0.8 ± 3.5				
Type of admission			0.025			
Non-intensive	141	0.5 ± 3.8				
Intensive	163	1.6 ± 4.7		0.430	0.565	0.447
OAI	294	$r = -0.123$	0.034	-0.009	0.005	0.078
LOS	307	$r = 0.067$	0.243	-	-	-
BI at discharge	307	$r = -0.194$	0.001	-0.207	0.047	<0.001
Readmission during 3 years			0.143	-	-	-
Yes	90	0.5 ± 4.8				
No	217	1.3 ± 4.1				
Presence of depression _{FU}			0.015			
No	228	1.5 ± 4.3				
Yes	70	0.1 ± 3.7		-1.325	0.579	0.023
Presence of complications _{FU}			0.059			
No	49	2.2 ± 4.0				
Yes (any complications)	258	0.9 ± 4.4		-1.781	0.694	0.011

P-values <0.1 and <0.05 indicate statistical significance in univariate and multivariate analysis, respectively

Abbreviations: SE; standard error, OAI; onset-to-admission interval, LOS; length of stay, BI; Barthel Index, FU; follow up, DC; discharge

with those from a study by Katz, *et al.*,¹¹ which suggests that TBI patients have a better chance of recovery than non-TBI patients. The functional status at admission or discharge from rehabilitation has also been demonstrated to be an indicator of level of ability or disability in the long-term in many studies.^{8,10,11,21-24} As there is a variety of measurement tools being used, it is difficult to directly compare the results reported among studies.

Cognitive function is one factor that can predict functional outcomes at discharge from rehabilitation. Rehabilitation doctors do TMSE for cognitive function screening as a routine during inpatient service. In addition, only stroke patients with good potential are suitable for receiving rehabilitation program. That means they should have good co-operation, be able to follow command and retain 24-hour memory. These can represent fair to good cognitive function. Depression, another important factor, is one of our obstacles to rehabilitation program. It could affect co-operation and final outcomes. Every inpatient in rehabilitation ward was also screened for depression as a routine procedure. Other studies reported the fact that depression is an independent indicator of poor functional status in the long-run.^{18,25,26}

Concerning complications, Rinkaewkan and Kuptniratsaikul conducted a retrospective study in 201 SCI patients admitted to rehabilitation wards between 2006-2010. They found an absence of comorbidity and the ability to undertake an intensive rehabilitation program to be associated with increased functional score after rehabilitation.²⁰

Discharge to home is one of the final outcomes which represents successful rehabilitation program. Our country could not provide skilled nursing facilities like other western countries, so one of our goals is patients being discharged to home after receiving full rehabilitation program. In addition, some patients still had disabilities that needed help at discharge. Caregiver was a key person to help patients complete those functions at home. However, to minimize the burden of caregiver, they had to learn how to help patients independent before being discharged. Rehabilitation team should also concern burden of caregiver as well as patients' quality of life.^{27,28}

This study had some limitations such as the fact that only 318 of 1,431 patients from nine medical centers could be recruited, which is a relatively small study population. In contrast, a study conducted in the United States was able to collect rehabilitation outcome data of more than 200,000 patients in more than 300 rehabilitation centers over an eight-year period.^{29,30} In countries lacking long-term data collection systems like Thailand, the analyzed information is from a relatively small number of patient

records and from postal surveys, which are associated with low response rates.^{7,11-13} Moreover, it may be inferred that data from these two methods would probably reflect more well-disciplined patients that maintained contact with health care providers. It is also, therefore, possible that the health status and functional level of participants included in the present study would be better than the health status and functional level of participants who failed to follow-up. It should also be noted that funding limitations prevented the research team from visiting patients at their homes. Further complicating the patient recruitment process was that some patients lived in rural areas which are inconveniently far from a rehabilitation center, so many declined to participate. A further study with more participants would be helpful in confirming long-term functional outcome findings reported in this study.

CONCLUSION

More than one-third of patients had sustained improvements in functional level three years after discharge from inpatient rehabilitation. Participants admitted for intensive rehabilitation showed significant improvements in functional scores between discharge and three-year follow-up. A multivariate analysis revealed TBI diagnosis to be positively correlated, and low BI at discharge, presence of depression, and presence of complications at follow-up to be negatively correlated with long-term functional improvements.

ACKNOWLEDGEMENTS

We are grateful to all of the rehabilitation staff in the nine tertiary centers. We are also grateful to our patients and their families for their cooperation. The authors would like to thank Ms. Pimpagee Pornmusigawan for her assistance with the coordination of data collection, and Ms. Julaporn Poolium for statistical analyses.

Conflicts of interest: All authors declare no personal or professional conflicts of interest regarding any aspect of this study.

Sources of funding: Our study was supported by the Royal College of Physicians of Thailand and partly supported by the Faculty of Medicine Siriraj Hospital, Mahidol University.

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