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Inpatient Stroke Rehabilitation Outcomes in Korea Derived from the Korean Brain Rehabilitation Centers' Online Database System for the Years 2007 to 2011

Kyung-Lim Joa,[1] Tai-Ryoon Han,[2] Sung-Bom Pyun,[3] Ueon-Woo Rah,[4] Joo-Hyun Park,[5] Yun-Hee Kim,[6] Min-Ho Chun,[7] Nam-Jong Paik,[8] Seung-Don Yoo,[9] Sam-Gyu Lee,[10] Si-Woon Park,[11] Sung-Hun Im,[12] and Han-Young Jung[1]

Department of Physical & Rehabilitation Medicine, [1]School of Medicine, Inha University, Incheon; [2]Seoul National University College of Medicine, Seoul; [3]Korea University School of Medicine, Seoul; [4]Ajou University College of Medicine, Suwon; [5]The Catholic University of Korea School of Medicine, Seoul; [6]Sungkyunkwan University School of Medicine, Seoul; [7]University of Ulsan College of Medicine, Seoul; [8]Seoul National University College of Medicine, Seoul National University Bundang Hospital, Seongnam; [9]Kyung Hee University College of Medicine, Seoul; [10]Chonnam National University Medical School, Gwangju; [11]National Rehabilitation Center, Seoul; [12]The Catholic University of Korea School of Medicine, St. Vincent's Hospital, Suwon, Korea

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Address for Correspondence:
Han-Young Jung, MD
Department of Physical & Rehabilitation Medicine, School of Medicine, Inha University, 27 Inhang-ro, Jung-gu, Incheon 400-711, Korea
Tel: +82.32-890-2480, Fax: +82.32-890-2486
E-mail: rmjung@inha.ac.kr

The purpose of this report was to provide information for patients receiving inpatient rehabilitation after stroke and to identify the possible factors influencing functional outcome after inpatient rehabilitation. Stroke patients (n = 5,212) who were discharged from the Departments of Rehabilitation Medicine (RM) of university hospitals and rehabilitation hospitals from 2007 through 2011 were participants. Prevalence, age, transfer time after onset, length of stay (LOS), functional status at admission and discharge were analyzed. In all stroke subjects, cerebral infarctions (67%) were more common than hemorrhages. Cerebral infarctions in the middle cerebral artery territory were most common, while the basal ganglia and cerebral cortex were the most common areas for hemorrhagic stroke. The LOS decreased from 45 to 28 days. Transfer time after onset decreased from 44 to 30 days. Shorter transfer time after onset was correlated with better discharge functional status and shorter LOS. Initial functional status was correlated with discharge functional status. In ischemic stroke subtypes, cerebellar and brainstem strokes predicted better outcomes, while strokes with more than one territory predicted poorer outcomes with more disabilities. In hemorrhagic stroke subtypes, initial and discharge functional status was the lowest for cortical hemorrhages and highest for brainstem hemorrhages. This report shows that LOS and transfer time after onset has been decreased over time and initial functional status and shorter transfer after onset are predictors of better functional outcome at discharge.

Keywords: Stroke; Rehabilitation; Outcome; Database; Korea

INTRODUCTION

This article presents the outcome trend determined using the Korean Brain Rehabilitation Database (KBRD) V1.0 which includes information on stroke patients from 2007 through 2011. KBRD V1.0 was developed by the Korean Society of Neurorehabilitation (KSNR) in 2005, is an online system (http://www.kbrr.or.kr) for collection of demographic information and clinical data describing subjects with brain disorders. Analysis of brain disorder patients collected from 2009 was previously reported (1). The report included all brain disorders associated with stroke, traumatic brain injury, and brain tumors, but did not provide specific data regarding infarction and hemorrhage. Moreover, although stroke prevalence, length of stay (LOS), and modified Barthel index (MBI) efficiency have been reported, outcome of different stroke subtypes by vascular territories and locations have not described.

Here, we provide information for basic rehabilitation outcomes such as LOS, functional outcome changes after rehabilitation of stroke patients by infarction/hemorrhage classification and by vascular territories and locations. This report provides information from 2007 to 2011 and presents trends in rehabilitation outcomes over time while providing annual summaries. Our goal is to produce data that can serve as resources for rehabilitation researchers.

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MATERIALS AND METHODS

Subjects

A total of 46 hospitals across Korea participated in the KBRD, providing 5,572 records. These 46 hospitals represent approximately 67% of all rehabilitation facilities of university hospitals and rehabilitation hospitals in Korea. This report enrolled subjects between January 1, 2007 and December 31, 2011.

Inclusion criteria

We applied five basic criteria for cases to be included in this report: 1) the subject must have been receiving initial rehabilitation services (i.e., no persons were admitted for evaluation or readmission), 2) the records could not have missing data for key variables such as LOS and Korean version of modified Barthel Index (K-MBI), 3) the subject had to be between the ages of 7 and 105 yr at admission, 4) the duration from impairment onset to rehabilitation admission could not exceed 365 days and 5) the total LOS could not exceed 548 days (1.5 yr) (2).

Methods

Demographics and hospital information including age, sex, LOS, and transfer time after onset were analyzed. LOS is the total number of days spent in the rehabilitation facility. Interim days spent in an acute care setting were not included in this value. Transfer time after onset was quantified as the duration (in days) from date of onset to rehabilitation admission.

Information regarding functional status is based on the Korean version of the Modified Barthel Index (K-MBI) (3) and the Korean version of the Mini-Mental State Examination (K-MMSE) (4) for admission and discharge. Treatment outcome was measured by K-MBI gain and K-MBI efficiency. K-MBI gain is the difference between total K-MBI admission and total K-MBI discharge ratings. K-MBI efficiency, which refers to the average change in total K-MBI ratings per day, is calculated for each patient by subtracting K-MBI admission from K-MBI discharge ratings and then dividing by the LOS measured in days. K-MMSE gain and K-MMSE efficiency were measured by the same methods.

Statistical analysis

A *t*-test was employed for analysis of continuous variables, while a chi-square test was employed for categorical variables upon comparison of groups based on demographic data. For clinical and functional outcome data, analysis of covariance (ANCOVA) was used to report adjusted means for LOS, transfer time after onset, K-MBI, and K-MMSE after correction for age, gender between stroke groups (ischemic, hemorrhagic), ischemic territory groups, and hemorrhagic territory groups. A repeated-measures ANCOVA was used to assess the changes within-subject total K-MBI, K-MBI efficiency, and K-MMSE at admission and discharge and between-subjects categorized by stroke groups (ischemic, hemorrhagic), ischemic territory groups, and hemorrhagic territory groups. Differences in improvement in K-MBI and K-MMSE between brain stroke groups, ischemic groups, and hemorrhagic groups were analyzed with a test of interaction of each category and K-MBI and K-MMSE gain. Within the ANCOVA model, the post hoc Scheffe's test was administered to identify subsets of each category.

Multiple linear regression was performed to identify independent clinical variables associated with the discharge K-MBI, K-MBI gain, K-MBI efficiency and LOS. Independent variables consisted of age, sex, transfer time after onset, admission K-MBI, and admission K-MMSE. These variables were then entered simultaneously into the regression model. The aim of this regression analysis was to determine if knowledge of discharge K-MBI, K-MBI gain, K-MBI efficiency and LOS were significantly associated with the transfer time after onset, admission K-MBI and admission K-MMSE provided by the rest of the variables. The adjusted R^2 was calculated for this model to determine whether the independent variables were good predictors of discharge K-MBI, K-MBI gain, K-MBI efficiency and LOS. Probability values of < 0.05 were considered statistically significant. All analyses were conducted using SPSS statistical software, version 22 (SPSS Inc., Chicago, IL, USA).

Ethics statement

This study was approved by the institutional review board of Inha University Hospital (IRB No. IUH-IRB13-1627). Informed consent was waived for this study since it is an observational study and therefore presents no more than minimal risk to the subjects.

RESULTS

Demographics, lesion sites, and functional improvement data

A total of 5,212 of 5,572 patient records was analyzed for this study. A total of 360 records were excluded due to missing information. The records of 4,503 hospitalized subjects were taken from university hospitals, while 709 cases were from rehabilitation hospitals. Overall, 59.7% were male and 40.2% were female. Cerebral infarctions were more common (67%) than hemorrhages (33%) in all stroke subjects. Cerebral infarctions in the middle cerebral artery territory were most common, while the basal ganglia and cerebral cortex were the most common areas for hemorrhagic stroke. The average K-MBI at admission was 36.5, while this increased significantly to 54.6 at discharge. The average K-MMSE at admission was 19.0, while this increased to 21.4 on discharge (Table 1). Fig. 1 displays the trends for K-MBI gain and K-MBI efficiency over time, and it shows that K-MBI efficiency increased while K-MBI gain is relatively constant. Fig. 2 shows the trends for LOS and transfer time after onset over time and it shows that LOS decreased from 45 to 28 days and transfer time after onset decreased from 44 to 30 days.

Functional outcome according to general characteristics of subjects

There were significant correlations among the age of onset, time of transfer to the rehabilitation facility after onset, K-MBI at admission, K-MMSE at admission, and the K-MBI at discharge, K-MBI gain, and K-MBI efficiency (Table 2). Decreased transfer time after onset was correlated with improved discharge functional status and decreased LOS. A higher K-MBI and MMSE at admission were positively correlated with the discharge K-MBI, K-MBI gain, and K-MBI efficiency. K-MBI at admission was most closely correlated with K-MBI at discharge (Table 2).

Table 1. Demographic, lesion sites, and functional improvement data

Characteristics	No. (%) of patients
Number of subjects	5,212
Mean age (SD) (yr)	67.0 (14.1)
Sex (%)	
Male	59.7
Female	40.2
Lesions	
Infarction	3,529 (67)
ICA	193 (3.7)
MCA	2,219 (42.6)
PCA	298 (5.7)
ACA	222 (4.2)
Basilar	163 (3.1)
Vertebral	54 (1.0)
SCA	38 (0.7)
AICA	24 (0.5)
PICA	242 (4.6)
Others	76 (1.4)
Hemorrhage	1,683 (33)
Cortex	402 (7.7)
BG	671 (12.8)
Thalamus	333 (6.4)
Midbrain	30 (0.6)
Pons	80 (1.5)
Medulla	9 (0.2)
Cerebellum	88 (1.4)
Others	70 (1.3)
Admission K-MBI (SD)	36.2 (28.3)
Discharge K-MBI (SD)	54.2 (31.9)
K-MBI gain (SD)	18.0 (17.8)
K-MBI efficiency (SD)	0.7 (1.1)
Admission K-MMSE (SD)	19.6 (8.5)
Discharge K-MMSE (SD)	21.9 (7.8)
K-MMSE gain (SD)	2.4 (3.7)

SD, standard deviation; ICA, internal carotid artery; MCA, middle carotid artery; PCA, posterior carotid artery; ACA, anterior carotid artery; SCA, superior cerebellar artery; AICA, anterior inferior cerebellar artery; PICA, posterior inferior cerebellar artery; BG, basal ganglia; K-MBI, Korean version of modified Barthel index; K-MMSE, Korean mini mental state examination.

Comparison of ischemic stroke and hemorrhagic stroke

Cerebral infarction tended to increase with age, with most subjects being older than 75 yr at the time of stroke, while cerebral hemorrhages were most common between ages 45 and 64 yr (Table 3). Admission K-MBI and K-MMSE ratings were higher for ischemic strokes than for hemorrhagic strokes, while the gains of K-MBI and K-MMSE were higher in hemorrhagic strokes (Table 3). Median transfer time after onset was shorter for ischemic

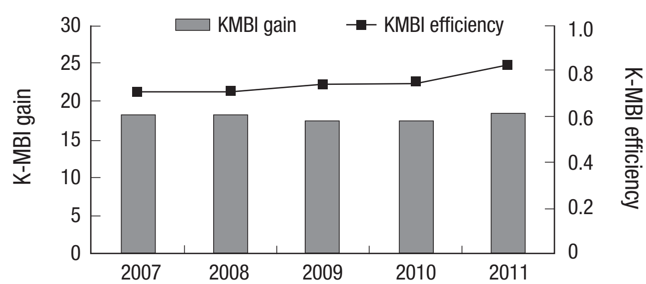

Fig. 1. Trends in K-MBI gain and K-MBI efficiency over time.

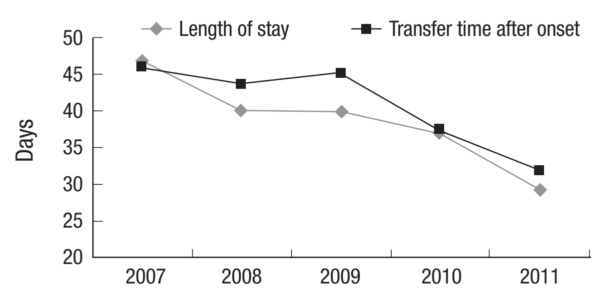

Fig. 2. Trends in transfer time after onset and length of stay over time.

Table 2. Functional outcome according to general characteristics of subjects

Characteristics	Discharge K-MBI		K-MBI gain		K-MBI efficiency		Length of stay	
	Coef. (s.e.)	*P* value	Coef. (s.e.)	*P* value	Coef. (s.e.)	*P* value	Coef. (s.e.)	*P* value
Sex								
Male (ref)								
Female	-0.527 (0.519)	0.309	-0.527 (0.519)	0.309	-0.021 (0.032)	0.519	-1.094 (1.140)	0.337
Age (yr)	-0.165 (0.018)	< 0.001	-0.165 (0.018)	< 0.001	-0.003 (0.001)	0.003	-0.038 (0.039)	0.334
Transfer time after onset	-0.278 (0.006)	< 0.001	-0.078 (0.006)	< 0.001	-0.005 (0.000)	< 0.001	0.364 (0.013)	< 0.001
Admission K-MBI	0.763 (0.011)	< 0.001	0.237 (0.011)	< 0.001	0.007 (0.001)	< 0.001	-0.047 (0.023)	0.047
Admission K-MMSE	0.237 (0.034)	< 0.001	0.237 (0.034)	< 0.001	0.013 (0.002)	< 0.001	-0.128 (0.075)	0.088
Adj. *R*-square	0.660		0.138		0.076		0.051	

K-MBI, Korean version of modified Barthel index; Coef. (s.e.), coefficient, (standard error); K-MMSE, Korean mini mental state examination.

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Table 3. Comparison of ischemic stroke and hemorrhagic stroke

Characteristics	Ischemic stroke	Hemorrhagic stroke	*P* value
Mean age (SD) (yr)	70.34 (13.01)	62.14 (14.28)	< 0.001
Age (yr), %			< 0.001
< 45	114 (3.7)	240 (11.4)	
45-64	708 (25.0)	897 (42.8)	
65-74	880 (28.2)	534 (25.4)	
≥ 75	1,340 (43.0)	427 (20.3)	
Sex (%)			0.023
Male	1,789 (57.4)	1,114 (53.1)	
Female	1,325 (42.5)	984 (46.9)	
Admission K-MBI	39.5 (28.0)	31.4 (28.0)	< 0.001
Discharge K-MBI	56.7 (30.8)	50.7 (33.2)	< 0.001
K-MBI gain	17.1 (16.3)	19.2 (19.7)	< 0.001
K-MBI efficiency	0.8 (1.2)	0.7 (0.9)	0.049
Admission K-MMSE	20.8 (7.9)	17.7 (8.8)	< 0.001
Discharge K-MMSE	22.6 (7.3)	20.8 (8.2)	< 0.001
K-MMSE gain	1.81 (3.07)	3.19 (4.32)	< 0.001
Median (mean) transfer time after onset (days)	19.0 (33.0)	35.0 (50.9)	< 0.001
Median (mean) length of stay (days)	25.0 (35.6)	29.0 (42.1)	< 0.001

SD, standard deviation; K-MBI, Korean version of modified Barthel index; K-MMSE, Korean mini mental state examination.

strokes than hemorrhagic strokes. The mean LOS of hemorrhagic strokes was longer than that of ischemic strokes (Table 3).

Functional outcome measures of patients with ischemic stroke in different vascular territories

Ischemic stroke was re-categorized into six vascular territories based on previously reported criteria in neuroanatomy, neurology, and rehabilitation literature (5, 6). Actually, previous reports agreed on seven lesion location categories; specifically, the anterior cerebral artery (ACA), middle cerebral artery (MCA), posterior cerebral artery (PCA), brain stem, cerebellar, small-vessel stroke, and strokes in more than one vascular territory (MVT). In our brain database (KBRD V1.0), there was no small vessel stroke category. This is because lacunar infarctions experience more favorable outcomes than other ischemic stroke subtypes (6). Therefore, most lacunar infarction patients were discharged without transfer to an RM department. Although lacunar infarctions can result from basilar or cerebellar arteries, if some lacunar infarction patients were transferred to a RM department, they were included in the MCA in our report. Post hoc analysis

Table 4. Functional outcome measures of subjects with ischemic stroke in different vascular territories

Characteristics	ACA (n = 138)	MCA (n = 1,700)	PCA (n = 300)	Brain stem (n = 405)	Cerebellar (n = 177)	> 1 Territory (n = 470)	*P*
Age	69.80 (70.12)	70.12 (13.12)	69.89 (13.25)	69.52 (12.91)	69.35 (13.12)	69.22 (13.12)	0.871†
Length of stay	34.39 (27.86)	37.49 (33.47)	25.90 (15.08)	26.27 (36.62)	24.33 (22.63)	35.20 (28.70)	< 0.001†
Transfer time after onset	34.79 (39.88)	35.40 (36.49)	30.73 (36.89)	28.40 (32.40)	26.93 (27.94)	44.00 (44.96)	< 0.001†
Admission K-MBI	32.93 (27.60)	34.50 (26.83)	39.51 (28.05)	45.27 (29.01)	53.15 (27.81)	32.86 (27.30)	< 0.001†
Discharge K-MBI	52.30 (33.60)	52.01 (30.53)	59.23 (31.51)	61.17 (32.16)	70.22 (27.21)	48.47 (31.85)	< 0.001†
K-MBI gain	19.37 (21.69)	17.51 (16.85)	19.72 (19.14)	15.89 (14.74)	17.06 (17.18)	15.62 (15.78)	0.133‡
K-MBI efficiency	0.85 (1.18)	0.73 (1.27)	0.82 (0.87)	0.87 (1.13)	0.92 (1.15)	0.69 (1.14)	0.313‡
Admission K-MMSE	18.79 (7.75)	18.77 (8.97)	20.43 (7.27)	22.60 (6.59)	22.72 (7.04)	18.49 (8.45)	< 0.001†
Discharge K-MMSE	21.56 (6.60)	20.61 (8.55)	22.53 (6.25)	23.77 (6.06)	24.35 (6.34)	20.72 (7.87)	< 0.001†
MMSE gain	2.77 (4.52)	1.92 (3.28)	2.09 (3.11)	1.18 (3.81)	1.63 (2.51)	2.28 (3.05)	0.015‡

> 1 territory: strokes occurring in more than one vascular territory. *All scores are reported as a mean (SD) and adjusted for age, gender; †ANCOVA with vascular territory group as a fixed factor; ‡Repeated-measures ANCOVA, test of interaction between magnitude of K-MBI improvements, K-MBI efficiency, and K-MMSE improvement from admission to discharge vascular territory group. ACA, anterior carotid artery; MCA, middle carotid artery; PCA, posterior carotid artery; K-MBI, Korean version of modified Barthel index; K-MMSE, Korean mini mental state examination.

Table 5. Functional outcome measures of subjects with hemorrhagic stroke in different brain areas

Characteristics	Supratentorial		Infratentorial	*F*	*P*
	Cortex	Subcortex	Brainstem		
Transfer time after onset	34.4	31.4	28.9	2.866	0.057†
Length of stay	34.7	29.4	31.7	4.904	0.008†
Admission K-MBI	33.2 (26.9)	41.8 (27.3)	47.6 (27.6)	37.403	< 0.001†
Discharge K-MBI	50.7 (30.7)	59.2 (29.1)	64.9 (29.2)	30.962	< 0.001†
K-MBI gain	17.5 (17.2)	17.3 (16.2)	17.2 (15.9)	0.049	0.952‡
K-MBI efficiency	0.8 (1.4)	0.75 (0.9)	0.87 (1.1)	2.243	0.106‡
Admission K-MMSE	18.9 (8.2)	21.6 (7.5)	23.9 (5.5)	50.825	< 0.001†
Discharge K-MMSE	20.7 (7.8)	23.47 (6.7)	25.33 (4.9)	50.705	< 0.001†
MMSE gain	1.9 (3.5)	1.9 (3.2)	1.3 (2.4)	4.333	0.013‡

All scores are reported as a mean (SD) and adjusted for age, gender; †ANCOVA with vascular territory group as a fixed factor; ‡Repeated-measures ANCOVA, test of interaction between magnitude of K-MBI improvements, K-MBI efficiency, and K-MMSE improvement from admission to discharge vascular territory group. K-MBI, Korean version of modified Barthel index; K-MMSE, Korean mini mental state examination.

within the ANCOVA model indicated that the transfer time after onset and LOS is longer for MVT infarctions. Strokes in MCA, MVT and ACA incurred a longer LOS than cerebellar, PCA, and brain stem strokes. Admission and discharge K-MBI of cerebellar and brain stem strokes was higher than those in other groups. PCA and brainstem strokes have a higher admission and discharge MMSE than those in other groups. MVT strokes had the lowest admission and discharge K-MBI and MMSE (Table 4).

Functional outcome measures of patients with hemorrhagic stroke in different brain areas

Hemorrhagic stroke was re-categorized into three different brain areas, the cortex, subcortex, and brainstem. Post hoc analysis within the ANCOVA model indicated that the LOS was longer for cortical hemorrhages than those of subcortical or brainstem hemorrhages. Initial and discharge K-MBI and K-MMSE were the lowest for cortical hemorrhages and highest for brainstem hemorrhages (Table 5).

DISCUSSION

This is a multi-year, multi-center report from the KBRD. A previous annual report of brain disorders for 2009 showed stroke prevalence, length of stay (LOS), and MBI efficiency. Because that report included all brain disorders of stroke, traumatic brain injury, and tumors, it did not show specific stroke outcome data. Here, we focus on stroke patients to present trends in rehabilitation outcomes over time. We applied five inclusion criteria for patient selection from database to analysis based on stroke patient outcome data analysis (2).

The mean LOS decreased over the study period, from 45 days in 2007 to 28 days in 2011 (Fig. 1). These reduced LOS suggest an improved efficacy of rehabilitation because K-MBI gain remained stable during the study period. As a result, the hospital bed turnover rate improved, leading to increased profits.

However, when compared to the LOS of the United States (17 days) (2), the 28 day LOS observed in the present study was still long. These differences may be attributed to differences in healthcare systems and cultural backgrounds between countries. Korean health insurance covers longer hospital stays for both acute care hospitals and rehabilitation hospitals, while the health insurance system of the United States may not cover longer stays (7). Additionally, scarcity of community rehabilitation services in Korea, including daycare centers and nursing homes, could have contributed to this difference (2). In a study of stroke outcome in Japan (8), the average transfer time after onset was 74 days and the average LOS was 115.8 days, which was longer than in the United States and Korea. Japan seems to have a similar hospital and community environment as that in Korea.

Higher scores of K-MBI and K-MMSE at admission were correlated with higher functional status at discharge. Admission K-MBI was the most predictable of discharge K-MBI scores, as in a previous stroke rehabilitation study (9). There have been studies of the impact of cognitive function on functional recovery during rehabilitation in patients with stroke (10, 11).

Decreased transfer time after onset was correlated with improved discharge functional status and decreased LOS. Decreased transfer time after onset means early and intensive rehabilitation. Rehabilitation is possible twice a day only after a patient is transferred to the RM department in Korea. Because early and intensive rehabilitation predicts good functional outcomes and faster recovery (12, 13), decreased transfer time after onset could attribute to the LOS. These results suggest that the sooner a patient with stroke starts rehabilitation, the better the outcome, and consequently the shorter the LOS. This is also supported by a previous study in the United States that showed fewer days from stroke onset to rehabilitation admission was associated with better functional outcomes at discharge and shorter LOS (14).

Comparison of functional outcomes of ischemic and hemorrhagic stroke showed that hemorrhagic stroke survivors had a poorer initial and discharge outcome, but experienced better functional gains during the rehabilitation admission period. This finding of faster recovery in hemorrhagic stroke is consistent with that of previous reports (15, 16). A suggested mechanism that may explain the faster recovery is as follows: hematoma formation and vasogenic edema may only displace tissue, and, as vasogenic edema and hematoma resolve, neurologic functions recover and functional status evaluated by K-MBI improves (16). Poorer initial functional status could have resulted in longer LOS and transfer time after onset. Here, delayed transfer time after onset could have attributed to longer LOS as well.

Functional outcome measures of patients with ischemic stroke in different vascular territories shows that strokes in MVT were the most debilitating because more vascular territories were involved. MCA and ACA infarctions also led to severe disability because of the multiple motor, cognitive, and behavioral impairments that are characteristic in these territories (17-19). Cerebellar strokes led to less disability, possibly because balance impairments are both less disabling and less well captured by the K-MBI than strength impairments (20). Because cognition is preserved in brainstem infarction, admission and discharge K-MMSE were higher in such cases. One United States hospital registry report with 2,213 patients stated that MVT, MCA, and ACA infarctions yielded significantly lower admission and discharge totals and cognitive functional independence measure (FIM) scores than other stroke groups (21). Severe stroke in MCA, MVT and ACA incurred a longer LOS and transfer time after onset than cerebellar, PCA, and brain stem strokes. Initial severe stroke could have resulted in delayed transfer to RM department and consequently resulting in longer LOS.

Functional outcome measures of patients with hemorrhagic

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stroke in different brain territories showed better functional outcome in the subcortex and brainstem than in the cortex. Strokes affecting the cerebral cortex classically present with deficits such as neglect, aphasia and hemianopia. Subcortical hemorrhages affect the small vessels deep in the brain, and typically present with purely motor hemiparesis affecting the face, arm, and leg (22). This difference may result in a longer LOS and poorer functional outcomes in cortical hemorrhages. Brainstem hemorrhages often impose devastating conditions that result in severe disability (12.7%), vegetative state (10.8%), or death (57.5%) (23). However, the prognosis has been reported to be highly dependent on the clinical severity at presentation. Because brainstem strokes do not usually affect language ability, if the lesion is not critical, the patient is able to participate more fully in rehabilitation therapy. Most deficits are motor-related, not cognitive (23). We suspect that massive brainstem hemorrhage patients were already died and therefore were not transferred to a RM department. Additionally, many of our subjects with brainstem hemorrhage could have mild impairment, resulting in better functional outcome.

It should be noted that this study was limited in that only patients with stroke requiring inpatient rehabilitation were included. Therefore, this sample does not represent the actual functional disability of each stroke subtype because those with little disability did not require inpatient rehabilitation.

The results of this study were as follows: in all stroke subjects, cerebral infarctions were more common (67%) than hemorrhages. Cerebral infarction in the middle cerebral artery territory was most common, while the basal ganglia and cerebral cortex were the most common areas for hemorrhages. Transfer time after onset decreased, as did the LOS. Initial functional status was correlated with discharge functional status. Decreased transfer time after onset was correlated with improved discharge functional status and decreased LOS. Hemorrhagic stroke presents worse initial and discharge functional status, but patients experience better functional gains during rehabilitation. In ischemic stroke subtypes, cerebellar and brainstem strokes have predictably better outcomes, while strokes with more than one territory have predictably poorer outcomes with more disabilities. In hemorrhagic stroke subtypes, initial and discharge functional status were the lowest for cortical hemorrhages and the highest for brainstem hemorrhages.

Based on the results of this study, consecutive investigations of the status of rehabilitation patients need to be conducted to provide useful information to practitioners. Such studies would provide a better understanding of the status of rehabilitation in Korea.

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DISCLOSURE

The authors have no conflicts of interest to disclose.

AUTHOR CONTRIBUTION

Conception and coordination of the study: Jung HY, Joa KL, Han TR. Design of ethical issues: Rah UW, Park JH, Kim YH, Chun MH. Acquisition of data: Yoo SD, Lee SG, Kim YH, Park SW. Data review: Park SW, Yoo SD, Jung HY, Joa KL. Statistical analysis: Im SH, Park NJ. Manuscript preparation: Joa KL, Jung HY, Pyun SB. Manuscript approval: all authors.

ORCID

Kyung-Lim Joa *http://orcid.org/0000-0002-3747-9831*
Tai-Ryoon Han *http://orcid.org/0000-0002-7532-9068*
Sung-Bom Pyun *http://orcid.org/0000-0002-3471-9692*
Ueon-Woo Rah *http://orcid.org/0000-0001-8062-7521*
Joo-Hyun Park *http://orcid.org/0000-0002-5585-5239*
Yun-Hee Kim *http://orcid.org/0000-0003-0101-6103*
Min-Ho Chun *http://orcid.org/0000-0002-2075-6820*
Nam-Jong Paik *http://orcid.org/0000-0001-5623-578X*
Seung-Don Yoo *http://orcid.org/0000-0003-0787-765X*
Sam-Gyu Lee *http://orcid.org/0000-0003-0091-231X*
Si-Woon Park *http://orcid.org/0000-0002-9295-7074*

Sung-Hun Im *http://orcid.org/0000-0002-1530-6120*
Han-Young Jung *http://orcid.org/0000-0003-1428-9821*

REFERENCES

1. Yang SN, Park SW, Jung HY, Rah UW, Kim YH, Chun MH, Paik NJ, Yoo SD, Pyun SB, Kim MW, et al. *Korean Brain Rehabilitation Registry for rehabilitation of persons with brain disorders: annual report in 2009. J Korean Med Sci 2012; 27: 691-6.*
2. Granger CV, Markello SJ, Graham JE, Deutsch A, Ottenbacher KJ. *The uniform data system for medical rehabilitation: report of patients with stroke discharged from comprehensive medical programs in 2000-2007. Am J Phys Med Rehabil 2009; 88: 961-72.*
3. Jung HY, Park BK, Shin HS, Kang YK, Pyun SB, Paik NJ, Kim SH, Kim TH, Han TR. *Development of the Korean version of Modified Barthel Index (K-MBI): multi-center study for subjects with stroke. J Korean Acad Rehabil Med 2007; 31: 283-97.*
4. Choi SH, Na DL, Kwon HM, Yoon SJ, Jeong JH, Ha CK. *The Korean version of the neuropsychiatric inventory: a scoring tool for neuropsychiatric disturbance in dementia patients. J Korean Med Sci 2000; 15: 609-15.*
5. Beninato M, Gill-Body KM, Salles S, Stark PC, Black-Schaffer RM, Stein J. *Determination of the minimal clinically important difference in the FIM instrument in patients with stroke. Arch Phys Med Rehabil 2006; 87: 32-9.*
6. Jackson C, Sudlow C. *Comparing risks of death and recurrent vascular events between lacunar and non-lacunar infarction. Brain 2005; 128: 2507-17.*
7. US Burden of Disease Collaborators. *The state of US health, 1990-2010: burden of diseases, injuries, and risk factors. JAMA 2013; 310: 591-608.*
8. Murakami M, Inouye M. *Stroke rehabilitation outcome study: a comparison of Japan with the United States. Am J Phys Med Rehabil 2002; 81: 279-82.*
9. Shah S, Vanclay F, Cooper B. *Predicting discharge status at commencement of stroke rehabilitation. Stroke 1989; 20: 766-9.*
10. Denti L, Agosti M, Franceschini M. *Outcome predictors of rehabilitation for first stroke in the elderly. Eur J Phys Rehabil Med 2008; 44: 3-11.*
11. Oneş K, Yalçinkaya EY, BC. *T, Cağlar N. Effects of age, gender, and cognitive, functional and motor status on functional outcomes of stroke rehabilitation. NeuroRehabilitation 2009; 25: 241-9.*
12. Hu MH, Hsu SS, Yip PK, Jeng JS, Wang YH. *Early and intensive rehabilitation predicts good functional outcomes in patients admitted to the stroke intensive care unit. Disabil Rehabil 2010; 32: 1251-9.*
13. Salter K, Jutai J, Hartley M, Foley N, Bhogal S, Bayona N, Teasell R. *Impact of early vs delayed admission to rehabilitation on functional outcomes in persons with stroke. J Rehabil Med 2006; 38: 113-7.*
14. Maulden SA, Gassaway J, Horn SD, Smout RJ, DeJong G. *Timing of initiation of rehabilitation after stroke. Arch Phys Med Rehabil 2005; 86: S34-s40.*
15. Bhalla A, Wang Y, Rudd A, Wolfe CD. *Differences in outcome and predictors between ischemic and intracerebral hemorrhage: the South London Stroke Register. Stroke 2013; 44: 2174-81.*
16. Paolucci S, Antonucci G, Grasso MG, Bragoni M, Coiro P, De Angelis D, Fusco FR, Morelli D, Venturiero V, Troisi E, et al. *Functional outcome of ischemic and hemorrhagic stroke patients after inpatient rehabilitation: a matched comparison. Stroke 2003; 34: 2861-5.*
17. Cals N, Devuyst G, Afsar N, Karapanayiotides T, Bogousslavsky J. *Pure superficial posterior cerebral artery territory infarction in The Lausanne Stroke Registry. J Neurol 2002; 249: 855-61.*
18. Kumral E, Bayulkem G, Evyapan D, Yunten N. *Spectrum of anterior cerebral artery territory infarction: clinical and MRI findings. Eur J Neurol 2002; 9: 615-24.*
19. Heinsius T, Bogousslavsky J, Van Melle G. *Large infarcts in the middle cerebral artery territory. Etiology and outcome patterns. Neurology 1998; 50: 341-50.*
20. Kelly PJ, Stein J, Shafqat S, Eskey C, Doherty D, Chang Y, Kurina A, Furie KL. *Functional recovery after rehabilitation for cerebellar stroke. Stroke 2001; 32: 530-4.*
21. Ng YS, Stein J, Ning M, Black-Schaffer RM. *Comparison of clinical characteristics and functional outcomes of ischemic stroke in different vascular territories. Stroke 2007; 38: 2309-14.*
22. Lindgren A, Norrving B, Rudling O, Johansson BB. *Comparison of clinical and neuroradiological findings in first-ever stroke. A population-based study. Stroke 1994; 25: 1371-7.*
23. Takeuchi S, Suzuki G, Takasato Y, Masaoka H, Hayakawa T, Otani N, Yatsushige H, Shigeta K, Momose T, Wada K, et al. *Prognostic factors in patients with primary brainstem hemorrhage. Clin Neurol Neurosurg 2013; 115: 732-5.*

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