ORIGINAL ARTICLE

Clinical Profile and Predictors of Motor Function Improvement at Discharge following Inpatient Stroke Rehabilitation in a Public Rehabilitation Hospital

Pui Kei Chong[1], Nor Syazlin Nor Azmi[2], Nor Shafiqah Mohd Sharkawi[2], Hock Peng Koh[3]

[1] Department of Physiotherapy, Hospital Kuala Lumpur, Ministry of Health, Malaysia
[2] Physiotherapy Unit, Hospital Rehabilitasi Cheras, Ministry of Health, Malaysia
[3] Pharmacy Department, Hospital Kuala Lumpur, Ministry of Health, Malaysia

ABSTRACT

Background and Objectives: Data on the outcomes following inpatient stroke rehabilitation (ISR) in developing countries, including Malaysia, are scarce. This study aimed to assess the motor function outcomes among stroke patients following ISR in a rehabilitation hospital and identify the predictors affecting their motor function improvement. **Methods:** This retrospective observational study analysed data on stroke patients admitted to a rehabilitation hospital for ISR from January 2014 to December 2015. All patients received 60 minutes of physiotherapy sessions five times a week. Purposive sampling was used in this study. The Motor Assessment Scale (MAS) score was the primary outcome measure and assessed during admission and discharge. Linear regression analyses identified the predictors of MAS score improvement from the subjects' demographics and clinical characteristics. **Results:** 124 subjects were analysed with a mean age of 53.9 (SD=13.6) years, predominantly male (n=93, 75.0%), and the majority had an ischemic stroke (n=99, 79.8%). The median length of stay (LOS) was 30 (19.0–41.8) days. The majority of subjects had stroke onset to ISR admission interval (OAI) of <90days (n=77, 62.1%). Overall, the subjects' achieved a median MAS score improvement of 9 points (p<0.001). An equation to predict the MAS score improvement following ISR was derived: MAS score improvement = 5.273 + 0.114(LOS)+ 4.269(OAI <90days). **Conclusion:** ISR was able to improve stroke patients' motor function in our setting. The above-identified predictors can help guide ISR duration for stroke patients and highlight the importance of early enrolment into ISR before the late subacute stroke recovery phase.

Keywords: Inpatient stroke rehabilitation, stroke, physiotherapy, motor function, motor assessment scale, Malaysia

Corresponding Author:
Pui Kei Chong
Email: yukichong7707@gmail.com
Tel: +60169604100

INTRODUCTION

Stroke is a significant global health problem. Stroke was ranked the third killer and top ten hospitalisation causes in Malaysia (Department of Statistics Malaysia 2020). The number of stroke survivors increases due to advancements in medical care that reduce mortality during acute stroke episodes (Mohd Nordin et al., 2016). The years-lived post-stroke in most stroke survivors is at least five years, with the majority of them having continuous neurological deficits and requiring continuous rehabilitation (Brønnum-Hansen et al. 2001).

Stroke rehabilitation services are commonly delivered in the sub-acute phase once the stroke survivor is medically stable (Lindsay et al. 2016). Stroke rehabilitation constitutes the primary mode of therapy to improve quality of life and function outcomes following stroke by aiming to help stroke survivors achieve the maximum physical, functional and psychological recovery (Langhorne et al. 2011; Ng et al. 2013). In stroke rehabilitation, relearning of skills as before the stroke will be facilitated. Additionally, stroke survivors and their family members are trained to adapt and compensate for post-stroke deficits (Langhorne et al. 2011).

Inpatient stroke rehabilitation (ISR) is an essential stroke service under the Global Stroke Guideline and Action Plan by World Stroke Organization (Lindsay et al. 2016). ISR provides hospital-level care to stroke survivors who require intensive and interdisciplinary rehabilitation care under a physiatrist or physician (Winstein et al. 2016). Several guidelines have recommended enrolment in ISR for post-acute care (Burris 2017; Lindsay et al. 2018; NICE 2013; Sall et al. 2019). ISR has been shown to reduce mortality, length of inpatient stay and improve activity daily living (ADL) independence among stroke survivors

(Kollen et al. 2006). Additionally, stroke survivors enrolled in ISR for post-acute care have been shown to achieve higher functional gains than other facilities such as skilled nursing facilities (Chan et al. 2013). Generally, ISR is recommended for stroke survivors who are (1) too disabled to return home, (2) able to participate in therapy with adequate cognition and fitness, (3) require continuous medical rehabilitation and education by interdisciplinary rehabilitation professionals, and (4) have sufficient social support to return to home (Department of Health and Human Services 2012).

The outcomes on motor function of stroke survivors following ISR can be highly variable. Predicting clinical outcomes of stroke survivors receiving ISR at the time of admission is crucial as it has been shown to improve the efficiency of rehabilitation and improve therapists' confidence (Stinear et al. 2019). Similarly, estimating stroke survivors' future discharge outcomes by utilising the baseline clinical information during early enrolment in ISR would help clinicians design better-targeted treatment strategies with more realistic rehabilitation goals and anticipate the patient's assistive needs and discharge care plan (Harari et al. 2020).

Developing countries such as Singapore and Thailand had reported the positive outcomes of ISR on functional gains in stroke survivors (V Kuptniratsaikul et al. 2009; Ng et al. 2013; Suksathien et al. 2015). However, data on ISR outcomes in Malaysia is lacking. The data from other countries cannot be generalised into our local setting given the difference in ISR setting, health policy, practices and outcome measures used. In addition, information on the effects of length of stay (LOS) during ISR is needed as Malaysia is a country with subsidised healthcare. Thus, this study aimed to assess the motor function outcomes among stroke patients following ISR in a rehabilitation hospital and identify the predictors affecting their motor function improvement.

MATERIALS AND METHODS

Study design, setting and population

This retrospective observational study was conducted from October 2016 to October 2017 at Hospital Rehabilitasi Cheras (HRC) Kuala Lumpur, the first rehabilitation hospital in Southeast Asia. HRC was officially operated in March 2013. In HRC, the multidisciplinary stroke rehabilitation team consists of an interdisciplinary team that includes a physician, physiotherapist, occupational therapist, speech therapist, audiologist, pharmacist, nurses and dietician. Stroke survivors admitted to HRC were commonly referred from the acute hospital setting. Before admission, all referred stroke survivors were assessed and screened by a rehabilitation physician in the clinic. Upon admission, stroke survivors were initiated on rehabilitation treatment/program within 24 hours. The duration of each physiotherapy session was 60 minutes per day, five times a week.

Ethics approval

This study was approved by the National Medical Ethics & Research Committee (MREC), Ministry of Health, Malaysia (NMRR–16–2296–33394). Informed consent was waived due to the retrospective nature of the study. This study conformed to the principles outlined in the Declaration of Helsinki.

Inclusion criteria

This study's inclusion criteria were: (1) stroke survivors admitted to HRC for ISR from 01 January 2014 and discharged by 31 December 2015; and (2) stroke survivors with the first ISR admission.

Exclusion criteria

This study excluded stroke survivors with: (1) unplanned discharged or discharged at their own risk; and (2) incomplete data.

Data collection

Purposive sampling was used in this study. The admission and discharge lists of stroke survivors were extracted from patients' admission and discharge records. Medical records of stroke patients were traced from the Record Unit of HRC and were screened and reviewed based on eligibility criteria. All encounter stroke patients who fulfilled the inclusion criteria were recruited. Data such as age, gender, ethnicity, actual stroke diagnosis, type of stroke, sites of motor deficits, date of stroke onset, date of HRC admission and discharge, comorbidities, Motor Assessment Scale (MAS) score during HRC admission and on discharge, completion of ISR, and LOS were retrieved from the patients' medical record. The stroke onset to ISR admission interval (OAI) was categorised into <90 days (acute & early subacute), 90 – 180 days (late subacute) and >180 days (chronic) based on phases of stroke recovery (Bernhardt et al. 2017).

Assessment tool

The Motor Assessment Scale (MAS) is a standard assessment tool used in Malaysian public health facilities for stroke survivors. In this study, MAS was used to assess the stroke survivors' motor function in eight areas: rolling, lie to sit, balanced sitting, sit to stand, walking, upper arm function, hand movements, and advanced hand activities. All areas were assessed using a 7-scoring ranging from 0 to 6. The maximum score of 6 indicates the optimal motor function (Carr et al. 1985). All stroke survivors performed each task three times with the best performance recorded for final analyses. All item scores were summed to provide the final overall score. In acute stroke survivors, the MAS has excellent concurrent validity with the Fugl-Meyer Assessment (FMA) for all items, except sitting balance ($r = 0.96$, excluding tonus item) (Malouin et al., 1994). In addition, MAS has excellent inter-rater reliability (mean correlation $r = 0.95$) for both acute and chronic stroke survivors (Carr et al. 1985).

Statistical analysis

Data analysis was performed using the statistical package for social sciences (SPSS) for Windows version 26.0 (IBM Corp., Armonk, N.Y., USA). Descriptive analysis used to describe continuous data was expressed as mean and standard deviations (SD) or median and interquartile range (IQR) depending on

normality distribution, whereas categorical data were reported as counts and percentages. The linear regression models included subjects' demographics and clinical characteristics in determining predictors affecting the motor function progression (improvement of MAS score) among the stroke patients who received intensive ISR in HRC. We included variables with a p-value < 0.25 from the simple regression analysis in the multiple regression model to assess the independent predictors for MAS improvement. Results of regression models were presented as odds ratios with a 95% confidence interval. All statistical tests with a p-value of < 0.05 denote statistical significance.

RESULTS

Subjects' demographics and clinical profile

A total of 238 stroke survivors were discharged from the Physiotherapy Unit of HRC from January 2014 to December 2015. After screening, a total of 124 subjects were included in the final analyses (Figure 1).

The majority of the subjects were male (n = 93, 75.0%), Malay (n = 85, 68.5%) with a mean age of 53.9 (SD = 13.6) years. More than half of the subjects had an ischemic stroke (n=99, 79.8%) and motor deficit at the right side (n = 66, 53.2%). Also, most stroke patients admitted to HRC had stroke onset to admission interval of below 90 days (n = 77, 62.1%).

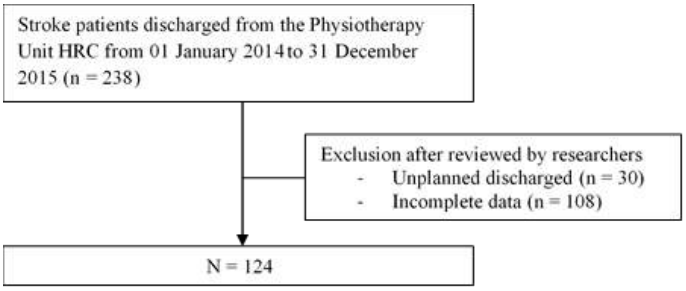

Figure 1: Study recruitment profile

MAS score changes at discharge

The median improvement of the MAS score achieved was 30 (19.0 – 41.8) (Table I). Overall, ISR in HRC significantly improved the motor function of stroke patients upon discharge (p < 0.001) (Table II).

Predictors of MAS score improvement

An equation to predict the improvement of MAS score for stroke patients who received intensive ISR: MAS score improvement = 5.273 + 0.114 (LOS) + 4.269 (OAI < 90 days), was derived from the multiple linear regression model (Table II). There were significant positive relationships between (1) LOS and MAS score improvement and (2) OAI < 90 days and MAS score improvement. When there was an increase in LOS by ten days, the MAS score improved by 1 point. Similarly, if stroke patients were admitted for intensive ISR within 90 days from the stroke onset, their MAS score improved by 4 points (Table III).

Table I: Subjects' demographics and clinical characteristics (n=124)

Variables	Frequency, n (%), mean (SD), or median (IQR)
Age, in years (mean (SD))	53.9 ± 13.6
Gender, n (%)	
Male	93 (75.0)
Female	31 (25.0)
Races, n (%)	
Malay	85 (68.5)
Chinese	24 (19.4)
Indian	12 (9.7)
Others	3 (2.4)
Motor deficit, n (%)	
Right	66 (53.2)
Left	46 (37.1)
Both sides	11 (8.9)
None	1 (0.8)
Stroke type, n (%)	
Ischemic	99 (79.8)
Haemorrhagic	20 (16.1)
Mixed	5 (4.0)
Chronic comorbidities, n (%)	
Hypertension	97 (78.2)
Diabetes mellitus	54 (43.5)
Ischemic heart disease	12 (9.7)
Dyslipidaemia	28 (22.6)
Recurrent stroke	5 (4.0)
Atrial fibrillation	3 (2.4)
Chronic kidney disease	4 (3.2)
Malignancy	4 (3.2)
Number of Chronic Comorbidities, n (%)	
0	15 (12.1)
1	27 (21.8)
2	41 (33.1)
3	30 (24.2)
4	9 (7.3)
5	2 (1.6)
Length of stay, days	
Median (IQR)	30 (19.0 – 41.8)
Range	5 – 89

Table II: Change of MAS score upon completion of intensive ISR among stroke patients

MAS score on admission Median (IQR)	MAS score upon discharge Median (IQR)	Z statistics	p-value[a]
17 (8 – 28)	26 (17 – 33)	-9.313	<0.001

[a] Wilcoxon signed-rank test

Table III: Simple and multiple linear regression analyses of the possible predictor for the improvement in MAS score

Predictor variables	MAS score Improvement					
	Simple linear regression			Multiple linear regression		
	b (95% CI)	t	P-value	b (95% CI)	t	P-value
Age	-0.018 ([-]0.092 – 0.056)	-0.480	0.632			
Male gender	0.376 ([-]1.951 – 2.703)	0.320	0.749			
Ischemic stroke	-0.319 ([-]2.831 – 2.193)	-0.023	0.802			
Hemorrhagic stroke	-0.519 ([-]3.258 – 2.220)	-0.375	0.708			
Mixed CVA	3.141 ([-]1.952 – 8.235)	1.221	0.224			
LOS	0.107 (0.047 – 0.167)	3.547	0.001	0.114 (0.059 – 0.169)	4.605	<0.001
Number of chronic comorbidities	-0.026 ([-]0.885 – 0.833)	-0.060	0.952			
OAI <90 days	4.068 (2.122 – 6.013)	4.139	<0.001	4.269 (2.434 – 6.104)	4.070	<0.001
OAI 90 - 180	-2.487 ([-]5.191 – 0.218)	-1.820	0.071			
OAI > 180 days	-3.646 ([-]6.000 – [-]1.293)	-3.067	0.003			

b = adjusted regression coefficient
Stepwise multiple linear regression method applied. Model assumptions are fulfilled.
No interaction and multicollinearity were detected.
Coefficient of determination, $r^2 = 0.216$

DISCUSSION

To our knowledge, this is the first study in Malaysia to assess the ISR outcomes in a rehabilitation hospital. This study provides an insight into the clinical profile and motor outcomes of stroke patients enrolled in ISR of a rehabilitation hospital. Also, this is the first Asian study reporting the predictors of MAS improvement among stroke patients enrolled in ISR. Our study findings suggested that ISR is beneficial to stroke patients, with early enrolment and a longer LOS improved stroke patients' MAS score better.

The mean age of stroke patients in this study is far younger than 62.5 years reported by the Malaysia National Stroke Registry (Abdul Aziz et al. 2017). Also, their mean age is younger than stroke patients reported in most Asian countries such as Indonesia, India, Thailand, Singapore and Japan (Abdul Aziz et al. 2017; Ling et al. 2020; Toyoda et al. 2019). Younger stroke survivors in our population is a concern as they might have greater social and economic consequences, such as returning to work (Crichton et al. 2012). Besides, the predominantly male stroke survivors in this study were consistent with the Malaysia National Stroke Registry (Abdul Aziz et al. 2017). Male gender is a known risk factor for stroke up to 75 years old (Rosamond et al. 2007). Various general and sex-specific risk factors such as pre-existing comorbidities, tobacco usage, alcohol consumptions, changes in testosterone level and others play a role in the higher incidence of stroke in males (Girijala et al. 2017).

Ischemic stroke was the commonest stroke type in this study, consistent with the Malaysia National Stroke Registry (Abdul Aziz et al. 2017). Additionally, this study found hypertension, diabetes, and hyperlipidaemia as the top three comorbidities among stroke survivors; all are modifiable risk factors for stroke (Boehme et al. 2017). It is crucial to note that hypertension is the most important modifiable risk factor for stroke, as there was a strong, direct, linear, and continuous relationship between blood pressure and stroke risk (Boehme et al. 2017). Similarly, diabetes mellitus increases the risk of stroke by two-fold, and stroke accounts for about 20% of deaths in diabetic patients (Boehme et al. 2017). The prevalence of hypertension, diabetes and hyperlipidaemia among Malaysians were high, with 8.1% (1.7 million) and 16.2% (3.4 million) of adults having three and two of these risk factors, respectively (Institute for Public Health 2020). Thus, the health authorities and individuals must prevent and control these non-communicable diseases to reduce the incidence of stroke.

Multiple studies and a network meta-analysis had shown the benefits of ISR where stroke patients who received organised inpatient care are more likely to be alive, living at home, independent in looking after themselves 1-year post-stroke, achieved optimal functional ability, and improved psychological status and quality of life (Vilai Kuptniratsaikul et al. 2009; Langhorne et al. 2020). Consistent with the literature, our study also found the positive finding that ISR in our rehabilitation hospital can effectively improve motor function among stroke survivors.

The mean LOS for ISR in this study was longer than 18 to 28 days reported in Singapore, Thailand and Australia, probably due to newly established settings and lack of guidelines on the optimum duration of ISR (Vilai Kuptniratsaikul et al. 2009; Ng et al. 2013; The Stroke Foundation 2020). The previous studies have found variable outcomes for the effect of LOS on functional outcomes. A study in Thailand has shown that stroke patients who had longer ISR LOS had a lower functional score (Barthel Index) at 1-year (Vilai Kuptniratsaikul et al. 2013). In another study, a longer ISR LOS was significantly associated with lower total and motor Functional Independence Measure (FIM) scores at discharge in moderate stroke patients. However, in severe stroke patients, a longer LOS is associated significantly with higher total FIM scores and more likely

to be discharged home (Horn et al. 2005). Our study has found a positive correlation where stroke patients with a longer ISR LOS predict a better motor function improvement at discharge. However, a longer LOS for stroke patients can increase the healthcare burden as Malaysia is a country that provides subsidised healthcare to its citizens. Thus, an optimal LOS needs to be identified to ensure a cost-effective rehabilitation therapy for stroke patients.

Time since stroke may affect how the brain re-organises itself due to its association to the remaining levels of neural plasticity (Cramer 2008). Following the central nervous system reorganisation, the resulting neurophysiological processes, for example, cortical excitability and interhemispheric inhibition during task-oriented interventions, may affect motor function improvement (Cramer 2008; Takechi et al. 2014). Previous studies utilising an unstandardised duration of OAI (short OAI of < 20 days, medium OAI of 20 – 40 days, and long OAI of >40 days) had shown variable outcomes of ISR (Gagnon et al. 2006; Paolucci et al. 2000). Our study utilised a more recent definition of stroke recovery phases by where OAI of < 90 days include stroke patients with both acute and early subacute phases (Bernhardt et al. 2017). The positive predictive value of stroke patients with OAI < 90 days in this study was consistent with other studies (Gagnon et al. 2006; Horn et al. 2005; Vilai Kuptniratsaikul et al. 2013). On the contrary, one study found that only stroke patients with OAI < 20 days had significantly greater functional improvement, whereas stroke patients who joined ISR later were associated with poor functional improvement (Paolucci et al. 2000). Our study suggests that stroke patients should be referred early to receive ISR to achieve a better motor function improvement.

Increasing age is often associated with additional comorbidities and disabilities, impacting rehabilitation outcomes in stroke patients (Ween et al. 1996). However, the impact of age on stroke recovery remains inconclusive as there is conflicting evidence on the impact of age on functional outcomes, LOS, discharge destination, and mortality post-stroke (Teasell & Hussein 2018). In this study, age is not a predictor of MAS score improvement. Nevertheless, older stroke patients showed comparable improvements following rehabilitation and should be given equivalent priority in ISR (Luk et al. 2006).

A systematic review reported that females generally have worse functional outcomes than males in the long term after stroke, probably due to the differences in demographic, social, and medical histories (Gall et al. 2012). However, gender is not a predictor of motor function improvement following ISR in our study, in agreement with a more recent study where there was no significant difference between gender in achieving good functional outcomes (motor-FIM) (Scrutinio et al. 2020).

Brain injury and recovery mechanisms are different between ischemic and haemorrhagic stroke. The mechanisms of brain injury in ischemic stroke involve ischemia, inflammation and mass effect secondary to cerebral oedema (Deb et al. 2010). On the other hand, haemorrhagic stroke has additional toxic effects of lysed blood on the brain parenchyma and vasculature and the mass effect from the hematoma (Benowitz & Carmichael 2010). The data on the effect of ischemic and haemorrhagic stroke types on motor function improvement and functional outcomes during ISR is scarce. Although the available evidence was inconclusive, haemorrhagic stroke survivors were generally perceived to have better neurological and functional prognoses than ischemic stroke survivors (Perna & Temple 2015). One study had found that although there were no differences in discharge FIM or FIM improvement between stroke types, haemorrhagic stroke patients showed faster functional motor improvement and had shorter LOS (Chae et al. 1996). Similarly, our study found that stroke type did not predict motor function improvement during ISR.

The presence of comorbidities in stroke patients can considerably impact their frailty and functional impairment through organ-level impairments and pathophysiological changes (Fried & Guralnik 1997). Several studies have demonstrated the negative association between the numbers of comorbidities and functional outcomes post-stroke (Berlowitz et al. 2008; Jiang et al. 2020; Simić-Panić et al. 2018). However, there was no previous study that reported the impact of the number of comorbidities on MAS score. Our study found that the number of comorbidities in stroke patients did not affect their MAS score changes during ISR. However, different underlying comorbidities may impact the rehabilitation outcomes differently. For example, patients who were physically and/or cognitively frail pre-stroke due to their pre-existing comorbidities often have poorer cardiovascular and neuromuscular reserve due to lower pre-stroke physical activity and worse hemodynamic and collateralisation that impedes post-stroke functional recovery (Stroud et al. 2009). Some pre-existing comorbidities, such as dementia or previous stroke, can increase the risk of post-stroke cognitive decline that hinders neuropsychological adaption (Appelros et al. 2002). Due to the limited sample size, all comorbidities were not individually analysed and included in the multiple regression analysis in this study.

We acknowledged several limitations in this study. First, this study's retrospective observational nature may affect the data quality as the study primarily relies on the accuracy of documentation. Secondly, all subjects received ISR in a rehabilitation hospital. The outcomes of this study may not apply to other health facilities due to differences in settings and multidisciplinary involvement. Thirdly, there was unstandardized documentation in the medical records during the early establishment of the rehabilitation hospital. The lack of information on stroke severity and reperfusion intervention may affect the study outcomes. Furthermore, the individualised amount or intensity of mobility training received during ISR based on stroke patients' ability, tolerability, and endurance may affect their motor function outcomes. Lastly, this study involved

only subjects from one rehabilitation hospital in the urban capital city of Malaysia. Thus, the prevalence results obtained in this study may not represent all hospitals in Malaysia.

Nevertheless, this study's findings added knowledge on the motor function improvement in stroke patients who received ISR in a rehabilitation hospital. The identified predictors provide hints on the effects of ISR duration and early enrolment to ISR post-stroke. Future studies should include a larger sample size from multicentre of different regions that provide ISR and more outcomes measures.

CONCLUSION

ISR was able to improve stroke patients' motor function in our setting. The improvement of MAS score following ISR can be predicted by LOS and OAI. The identified predictors can help guide ISR duration for stroke patients and highlight the importance of early enrolment into ISR before the late subacute stroke recovery phase.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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