Research Report

Time between Stroke Onset and Rehabilitation: A Predictor of Mobility Recovery for Patients with Stroke in a Chinese Population

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ABSTRACT

Introduction: There is an axiom that the earlier a person with stroke receives rehabilitation intervention, the better rehabilitation outcome he/she may experience. The purpose of this pilot study was to examine if this axiom can be applied to a Chinese population. ***Method***: From June 1999 to June 2002, 92 patients from a hospital in Shanghai, China who qualified for the research were measured with the stroke rehabilitation assessment of movement. All data were analyzed with SPSS 13.0. ***Results***: The between-groups ANOVA and post hoc comparison revealed that patients receiving therapy intervention within the first 6 weeks after a stroke had better recovery than patients in other groups; within weeks 7 to 12 the mobility improvement prognosis seemed to be unreliable, an observation that could indicate that this might be a transitional time period. After 12 or more weeks post stroke, the rehabilitation outcome was incomplete and slower. ***Conclusions***: This study demonstrated that Chinese patients with stroke are similar to white patients in terms of post stroke time being a positive correlative factor for the outcome of rehabilitation intervention. Namely, there is a positive association between the time when rehabilitation is initiated after stroke and the level of mobility recovery in patients with stroke.

Keywords*: stroke recovery, outcome assessment, physical therapy.*

INTRODUCTION

Stroke occurs at all ages, but increases dramatically with age, almost doubling in every decade after the age of 55.[1] The incidence rate of stroke in China is 219/100,000 per year,[2] while in the United States it is approximately 249/100,000 per year (700,000 annually).[3] Of those who experience stroke in the U.S. 30-40% survive and suffer significant disability.[1]

The post stroke time (PST) is the time from the onset of a stroke to the time rehabilitation treatment commences. The PST is considered to be the strongest factor influencing the rehabilitation outcome of patients who have suffered from a stroke.[4-7] Increased PST is associated with poorer outcomes with regard to transfers to the bed, toilet, and tub; assistance in ambulation, degree of spasticity, and self-care abilities in household activities.[8] Many publications have indicated that early intervention therapy services are associated with improved functional outcomes after stroke.[4-6,9-12]

Early mobilization and aggressive rehabilitation are components of stroke care thought to contribute to improved outcomes.[10,11,13] However, there is no consensus on how the time course of the PST relates to the outcome of stroke rehabilitation. The optimal period for functional recovery after stroke has been reported to occur in a period ranging from 4-6 weeks[5,14] to 11-12 weeks.[15-17] Furthermore, although there are many publications, as mentioned above, that have indicated that early rehabilitation intervention results in better functional outcomes, these studies have all been conducted in predominantly white patients**.** However, there are only a few papers that describe how stroke patients from other races/ethnicities respond to early and late rehabilitation intervention. Horner et al[18] reported that there were no differences in inpatient rehabilitation outcomes between blacks and whites if they received rehabilitation early (within 3 days of PST), findings which were later replicated in Hispanic and black stroke patient populations[19] as well as in a mixed Asian patient population.[20] A paper from Bhandari et al[21] is the only study that included mixed Asian people and it was conducted in the United States instead of in Asia.

Our reasons for conducting this study are based on the following two considerations. (1) Research has indicated that there is an important genetic influence, that appears to follow ethnicity, on the occurrence and outcome of diseases.[21,22] Recently, this kind of influence has been further demonstrated in patients with stroke.[23] In a study by Wolfe et al,[23] black patients with stroke did have a survival advantage over white patients that was not explained by age, case mixture or other factors. It is likely that genetic influences might someday be considered highly relevant in the treatment and evaluation of a disease. It is important for us not to close our eyes to potential information that could benefit us later. (2). The current Chinese healthcare delivery system is a system that focuses on medical intervention more than on prevention.[24] Comparatively, risk prevention is emphasized much less than medical treatment in China.[2] Therefore, early medical intervention for patients with stroke is essential to the recovery of Chinese patients. However, due to the disparity between the rural and the urban areas, patients living in remote areas may not receive timely medical treatment.[24] Thus, a question is raised. How long after stroke can a Chinese patient requiring early rehabilitation be treated and still garner the benefits of early intervention? Answering this question will be beneficial for both medical professionals and their patients.

So far, to our knowledge, no study has been conducted in China to investigate if similarities exist between Chinese patients with stroke and patients of the white race in terms of the relationship between PST and recovery. Our study seeks to determine if there is variability in optimal PST due to the Chinese ethnicity and the healthcare delivery system in China. Understanding such optimal PST can provide a more concrete basis for stroke treatment specific to the Chinese population.

The purpose of this study was to investigate whether early rehabilitation intervention would enhance the level of mobility recovery in the Chinese population. An additional purpose was to attempt to answer the following three questions based on the results from this study and publications from others. First, does improvement occur in the upper extremity at the same pace as in the lower extremity? Second, can the axiom that states that earlier rehabilitation will lead to better recovery be applied to both patients with recurrent stroke and patients with first-ever stroke? Third, should the medical conditions of patients with stroke be stabilized before rehabilitation treatment is provided?

METHODOLOGY

From June 1999 to June 2002, with the approval of the local Research Ethics Committee, patients diagnosed with a cerebrovascular accident (CVA, or stroke) and admitted to the Department of Rehabilitation Medicine of Fudan University's ZhongShan Hospital in Shanghai, China, were assessed for qualification to participate in this study. The inclusion criteria were as follows: (1) diagnosis of cerebral hemorrhage or cerebral ischemic stroke based on the World Health Organization International Classification of Diseases, 9th revision clinical modification (ICD-9-CM); (2) first ever experience of stroke; (3) ability to follow verbal commands; (4) no bilateral upper and/or lower extremity deficits related to stroke; and (5) no major comorbid conditions that might interfere with mobility function or its assessment. All diagnoses of stroke in this study were confirmed with computed tomography (CT) or magnetic resonance imaging (MRI).

In this study, the stroke rehabilitation assessment of movement (STREAM) which was introduced in the late 1990s,[25] was used to measure the outcome of stroke rehabilitation. It consists of three subscales (upper extremity movement, lower extremity movement, and basic mobility) with high inter-rater reliabilities (r = 0.92 -0.96) for each subscale and the total scale.[26] STREAM has been used as a quick, simple, and reliable outcome measure of mobility function in clinical practice and research for evaluating the recovery of voluntary movement and basic mobility of patients who have experienced a stroke.[26-28] It has been correlated with the Barthel ADL Index (r = 0.81)[29] and with the Fugl-Meyer mobility assessment scale (r = 0.95).[26] When compared with the National Institute of Health Stroke Scale (NIHSS) and the Functional Independence Measure (FIM), which are not sensitive to changes in extremities,[30] STREAM, due to its design and construct (which include subscales and different testing positions) is more thorough and sensitive to mobility improvement.[25-27] Also, the STREAM shows better psychometric characteristics and thus is more highly recommended than the Rivermead Mobility Index for measuring mobility recovery in patients who suffer from stroke.[28]

One hundred fourteen patients were admitted with a diagnosis of stroke. Ninety-two qualified for this study based on the inclusion criteria. All patients were treated by two therapists certified in neurodevelopmental treatment (NDT) and experienced in using the STREAM. All patients received NDT as soon as their medical conditions stabilized (when no further sensory and mobility deficits had occurred within the last 24 hours). The stability of an individual's medical condition was determined by an examination performed 3-4 times within a 24 hour period by the nurses using a standard check list to assess neurological deficits (sensory, mobility, and mental deficits), blood pressure, temperature, glucose level and fluid and electrolyte balance.[31]

Scores for the STREAM were obtained from the affected side only.[25] Obtaining scores involved measuring voluntary movements of the shoulder, elbow, wrist, and hand (upper extremity – UE); and the hip, knee, and ankle (lower extremity – LE). Scoring also involved observing basic mobility (i.e. bed mobility, transfers, standing, and brief periods of gait). The completeness of functional recovery was measured by finding the difference in STREAM scores between admission and discharge. The efficiency (or quickness) of functional recovery was measured by dividing the difference in STREAM scores from admission to discharge by the total number of rehabilitation treatment days). Outcome measures (STREAM) were conducted one day before the NDT intervention and then every other week until a period of more than two weeks passed without a patient making further progress. The patient was then discharged from rehabilitation services. The determination of "no further progress" was based on STREAM scores showing that the latest scores were equal to or less than the patient's scores from two weeks previous. Before the study began, seven patients with stroke were recruited to test the inter-rater reliability between the two therapists who would be providing NDT interventions. The results showed high reliabilities in terms of sub-scores, total scores, and in the calculated completeness and efficiency of recovery (r ranges from 0.81 to 0.92).

In this study, the STREAM scores were collected and analyzed with the statistical software SPSS 13.0 to test if post stroke time related to mobility recovery. All of the cases were divided into three groups based on previously published research indicating that the optimal period for recovery was within the first 4-6 weeks[5,14] or within the first 12 weeks[15-17] following stroke. Prior to grouping, patients within their first 4 weeks of PST were compared with patients in their 5^{th}-6^{th} weeks of PST using STREAM. No statistically significant difference in STREAM scores was found between these two groups ($p > 0.05$). As a result, patients in their first 6 weeks of PST were placed in Group 1 (within 6 weeks, 0-42 days) for purposes of statistical analysis, while patients within weeks 7-12 (43-84 days) were in Group 2, and patients in their 13^{th} or greater week (≥ 85 days) were assigned to Group 3. Multiple one-way ANOVAs were used to compare these groups**.** Levene's test for homogeneity of variances (HOV) was performed before the post hoc analyses were conducted to determine if there were significant differences in STREAM scores among these three groups. Due to the violation of the assumption of HOV, Dunnett T3 was used in the post hoc analysis. The level of statistical significance was set at 0.05.

RESULTS

In this study, the average age of all subjects was 66.32 ± 11.78 (with an age range of 24-88 years old). The PST ranged from 1-540 days with the median of 31 days. The three subjects who had the shortest PST (24 hours or one day) received rehabilitation treatment as soon as their medical conditions were considered stable based on observation and examination within 24 hours of stroke onset. Subjects who did not arrive at the hospital 3 days after a stroke occurrence were asked why they could not make it to the hospital on the day of stroke onset. Two major reasons were financial insufficiency (19 out of a total of 92 patients), unavailable transportation (11/92), or both (31/92). The average number of inpatient rehabilitation treatment days was 32.59 ± 13.99 (with a range of 8-90 days). The baseline data of severity (STREAM scores on the day when NDT provision was initiated) were compared among the three groups before further data analysis could be processed. As seen in Table 1, there were no significant differences found for these comparisons (all $p > 0.05$).

Since subjects were divided into groups based on PST, group size varied among the groups. Group 1 had 56 subjects, Group 2 had 18 subjects, and Group 3 had 18 subjects. The means and standard deviations for each group are shown in Table 2.

A between groups analysis of variance was conducted to explore the impact of PST on levels of completeness of recovery (as measured by the STREAM score difference between pre- and post-treatment) There was a statistically significant difference in the LE [$F(2, 89)=3.3$, $p=0.04$], basic mobility (BM) [$F(2,89)=3.215$, $p=0.041$], and total body (TB) [$F(2,89)=3.76$, $p=0.027$] , but not in the UE [$F(2, 89)=1.446$, $p=0.241$) when pre- and post-treatment scores were compared. The effect sizes, calculated using partial eta squared, were 0.07, 0.067, 0.031, and 0.078 respectively. The impact of PST on the level of efficiency (quickness) of recovery, as measured by the STREAM score difference divided by treatment days, was also

Table 1. **Multiple Comparisons of Severity Using Baseline STREAM Scores**

		PST (days)	**N**	**Age**	**Baseline STREAM Scores**			
					UE	LE	BM	TB
Groups	G1	1-42	56	67.35±12.56	9.53±6.96	8.11±6.04	10.53±8.10	28.19±19.50
	G2	43-84	18	65.62±11.58	7.81±6.49	7.57±6.41	8.71±6.59	27.09±18.31
	G3	≥ 85	18	63.11±11.42	8.22±5.49	9.06±4.08	11.83±5.89	30.94±13.89
P Value*	G1 vs. G2			0.720	0.352	0.560	0.612	0.519
	G1 vs. G3			0.475	0.749	0.823	0.101	0.391
	G2 vs. G3			0.685	0.783	0.481	0.674	0.190

Table 2. **Descriptive Data**

	Completeness of Recovery (M ± SD)				**Efficiency of Recovery (M ± SD)**			
	UE	LE	BM	TB	UE	LE	BM	TB
G1	2.52 ± 2.68	3.59 ± 3.49	7.48±5.44	13.55 ± 9.64	0.09 ± 0.09	0.12 ± 0.12	0.29±0.27	0.50 ± ±0.39
G2	2.17 ± 2.55	2.67 ± 2.57	6.83±4.12	11.67 ± 7.80	0.07 ± 0.10	0.08 ± 0.10	0.22±0.22	0.38 ± 0.38
G3	2.23 ± 2.47	1.50 ± 1.58	6.71±2.34	7.28 ± 3.60	0.05 ± 0.05	0.06 ± 0.06	0.15±0.06	0.25 ± 0.12

M ± SD: mean ± standardized deviation; UE: upper extremity. LE: lower extremity. BM: basic mobility. TB: total body

UE: upper extremity. LE: lower extremity. BM: basic mobility. TB: total body. *Level of statistical significance at 0.05.

Table 3. **Results of Dunnett T3 (Non-Homogeneity) Test**

Location	Groups	P (completeness of recovery)		P (efficiency of recovery)	
		Group 2	Group 3	Group 2	Group 3
LE	Group 1	0.545	0.003*	0.358	0.013*
	Group 2		0.293		0.781
BM	Group 1	0.681	0.024*	0.418	0.043*
	Group 2		0.171		0.490
TB	Group 1	0.785	0.000*	0.599	0.000*
	Group 2		0.114		0.458

*significant difference between the hemorrhagic patients and the ischemic patients in terms of completeness of recovery in Group 2.
** significant difference between the hemorrhagic group and the ischemic group in terms of completeness of recovery among all patients.
***significant difference between the hemorrhagic group and the ischemic group in terms of efficiency of recovery among all patients.

Table 4. **Comparison of Ischemic and Hemorrhagic Stroke**

	Ischemic Stroke (n = 64)		Hemorrhagic Stroke (n = 28)	
	Completeness of Recovery	Efficiency of Recovery	Completeness of Recovery	Efficiency of Recovery
Group 1	13.37±9.24	0.47±0.41	16.46±10.29	0.61±0.32
Group 2	*8.20±6.36	0.32±0.40	*16.00±7.56	0.46±0.38
Group 3	7.09±3.75	0.26±0.12	7.57±3.60	0.24±0.11
Total	**10.81±8.37	***0.41±0.38	**14.57±9.06	***0.47±0.33

evaluated with a between groups analysis of variance. There was a marginal difference between pre- and post- treatment in the LE [F(2, 89)=2.91, p=0.06] and the BM [F(2,89)=2.543, p=0.074)], no difference in the UE [F(2,89)=1.711, p=0.187), and a significant difference in TB [F(2, 89)=3.475, p=0.03]. The effect sizes, also calculated using partial eta squared, were 0.061, 0.054, 0.037, and 0.072 respectively. Post hoc comparisons were performed with Dunnett's test on differences that approached or achieved statistical significance (LE, BM, and TB). As shown in Table 3, there was a statistically significant difference between Groups 1 and 3 regarding the completeness and efficiency of recovery for the LE, BM and TB (all p < 0.05) (Table 3). However, when Group 2 was compared with Groups 1 and 3, no statistically significant differences were identified (all $p > 0.05$).

Out of 92 subjects, 64 had ischemic stroke, and 28 had hemorrhagic stroke. Comparison between subgroups (the ischemic and hemorrhagic groups) without considering the post-stroke time revealed that in general patients with hemorrhagic stroke had more complete ($p = 0.006$) but not more efficient ($p = 0.393$) recovery of functional mobility than patients with ischemic stroke (Table 4).

Further comparisons of these two subgroups within Group 1, Group 2, and Group 3 demonstrated that within Groups 1 and 3 there were no significant differences (all $p > 0.05$) between the ischemic and hemorrhagic subgroups, while within Group 2, statistical significances were identified between the two subgroups in terms of LE, BM and TB (all $p < 0.03$), while there were no differences for the UE ($p > 0.05$).

Summary of Results

The time course of PST related primarily to the functional recovery of the LE, BM, and TB, but not the UE. Patients who started receiving rehabilitation treatment within the first 6 weeks following stroke (Group 1) showed quicker and much more effective LE, BM, and TB recovery. For patients who started rehabilitation interventions in weeks 7 to 12 of PST (Group 2), there was not enough of a statistical difference between their group and Group 1 to determine whether or not a similar extent of mobility improvement could be expected in the two groups. The functional recovery of those who started receiving rehabilitation treatment after 12 or more weeks of PST (Group 3), was less complete and slower than those who started treatment within the first 6 weeks of PST (Group 1). However, there was not a statistically significant difference between Group 3 and Group 2. Subjects with hemorrhagic stroke seemed to have better recovery than those with ischemic stroke. This was primarily seen when comparing the hemorrhagic and ischemic subgroups within Group 2.

DISCUSSION

Factors related to predicting the outcome of stroke rehabilitation have been investigated in the Chinese population within China.[32,33] However, to our knowledge, time between stroke and rehabilitation commencing has not yet been investigated as a predictive factor related to stroke in Chinese people; such studies have been conducted mainly in white, [8,9,11,12, 34] black,[18,19] Hispanic,[19,20] and mixed Asian patients.[20] In recent years, three studies[18-20] conducted in the United States found that there were no significant differences across races in terms of PST (the interval between stroke onset and admission to rehabilitation treatment[20]). In contrast to these studies conducted in non-white races, our study was conducted in Chinese people in China rather than in a mixed Asian population in the US. The results from our study also suggested that Chinese race might not be a factor influencing stroke recovery when early rehabilitation services are provided, which seem to be able to address the two considerations (described in the Introduction section of this article) related to our reasons for conducting this study. Chinese race as a possible "genetic" impact might not be a factor that influences the impact of PST on stroke recovery. The earlier a healthcare intervention (including rehabilitation treatment) is delivered to a patient with stroke, the better the patient may be able to recover.

Furthermore, according to the results from this study in the Chinese population, the best rehabilitation outcomes seemed to occur with interventions performed within the first 6 weeks of PST, a time period similar to that found to be optimal in Western society regardless of whether patients are white[5,14] or black.[18] This result suggests that PST might have similar value for stroke recovery in both Chinese and white patient populations. Since we did not include patients from other races in this study, we are unable to report whether or not Chinese stroke patients have better recovery than patients from other races.

This study is in agreement with the idea that patients with stroke have much better rehabilitation outcomes and much quicker mobility recovery if they receive rehabilitation treatment sooner after the onset of stroke. This information intimates that patients who receive rehabilitation intervention in the early weeks post-stroke might experience better recovery than those who receive delayed rehabilitation treatment. In terms of mobility recovery, the results of the current study correspond with results in previous studies showing whole body progress in functional activities in patients with stroke. [8,9,11,12,34] Our study shows that scores for Group 2 (from the 7^{th} to the 12^{th} week of PST) did not differ significantly from the scores from Groups 1 or 3. As a result, it is difficult to determine whether or not weeks 7 through 12 are a better time frame for beginning interventions than other time frames. The suggestion that the period from week 7 to week 12 of PST might be a critical time for recovery needs to be explored further.

In general, the current results from a Chinese population are in agreement with what others[14,15,35] have reported concerning rehabilitation outcomes.

Greater recovery was apparent when treatment started within 6 weeks of PST. This might suggest that within 6 weeks post stroke is a critical time to reshape the cortical circuit using timely training procedures, and might be the critical time for patients with stroke to reorganize a new set of responses to substitute for what has been irreversibly damaged by the stroke. Olsen[15] reported that after 12 weeks post-stroke, function for both the UE and LE would no longer be fully recovered. All of the above information implies that following a stroke, the more time that elapses without rehabilitation treatment, the less recovery the individual with the stroke will experience. Therefore, patients should receive early rehabilitation intervention as soon as their medical conditions stabilize.

Stroke subtype might influence functional recovery,[14] but as a single predictor stroke subtype might not be able to predict stroke rehabilitation outcome significantly.[27] However, if post stroke time and stroke subtype are considered together, patients with hemorrhagic stroke may have better recovery than patients with ischemic stroke under the condition that the baseline (severity) of these two subgroups are similar.[32] Our current study reveals that within Group 1 both subtype groups showed similar results. Differences in recovery completeness between the two subtype groups primarily occurred in the Group 2 time category (within 42 to 84 days after onset of first stroke) with more complete recovery in the hemorrhagic subgroup. These findings conform to previous studies but might still be inconclusive because the sample sizes within Group 2 (n = 18) and Group 3 (n = 18) were small. Further study with larger sample sizes in different PST categories may identify relative levels of recovery for ischemic subgroups versus hemorrhagic subgroups for given PST timeframes.

Based on the results of this study, the three questions that were posed in the introduction section of this paper might be answered in the following way. First, is the UE improved at the same pace as the LE? Both Olsen[15] and Jorgensen et al[35] reported that the LE showed more complete functional improvement than the UE. Vilensky et al[36] found that following a major unilateral cerebral ablation in primates, the hind limb recovered more rapidly than the forelimb. Based on our present study in a Chinese population, UE improvement was not certain and did not seem to be highly related to the time course of PST. Based on our results, compared with the UE, the LE might show quicker and more complete recovery than the UE within the first 6 weeks of PST. These results imply that the ability to achieve improvement in functional deficits of the UE and the LE might not be parallel following a stroke. The greater level of improvement in the LE compared to the UE might result from the greater demands placed on the LE than on the UE in daily activity. During normal activities of daily living, a patient cannot compensate for his/her affected LE, though he/she may compensate for the affected UE by using the unaffected UE.[7]

Second, there has been an axiom that the earlier a patient with stroke receives rehabilitation, the better recovery he/she may achieve. Is the axiom applicable to both patients with recurrent stroke and patients with first-ever stroke? Studies by Andrews et al[16], Paolucci et al,[10] and our current study recruited only subjects who had experienced a single stroke, while some others[6,34,35] recruited patients with both first ever and/or recurrent stroke for their studies of how PST influenced recovery outcomes. Results from all of these studies indicated that the type of stroke experience (first ever versus recurrent stroke) was not a factor that could affect the axiom. In either situation, early rehabilitation treatment would likely lead to better rehabilitation outcomes.

Third, should the medical conditions of patients with stroke be stabilized before rehabilitation treatment is provided? Some investigators[10] stated that early rehabilitation services could be provided to a person with a stroke even before the patient's medical condition stabilized. However, Maulden et al[34] pointed out that early rehabilitation intervention after stroke might harm vulnerable cells through oxidation and/or metabolic stress in concert with reperfusion injury. Some[1, 31] suggested that early rehabilitation intervention could be started within 72 hours post-stroke.

According to our study, intervention can be initiated after a patient's medical condition is stabilized, as determined by 24 hours of observation and examination. Medical conditions that should be observed and examined to determine their stability were described by Indredavik et al.[31] In our study, observation of patients' medical conditions continued even during and after the rehab intervention time. Adverse effects of rehabilitation intervention might affect the infarct size, which could be examined by CT or MRI. However, due to the relative convenience of physical examination, and because of financial constraints, constant use of CT or MRI is not suggested. Currently it seems that observation and examination of medical conditions (any symptoms and signs related to neurological changes) are recommended to minimize possible adverse effects of further infarct from rehab intervention.[37] Stabilizing a patient after a stroke includes treating the event and any medical conditions arising from the stroke.

CONCLUSION

Our data demonstrated a possible positive correlation between PST and recovery. We cannot yet establish a definite causative relationship between the two as other factors influencing both delayed rehabilitation and recovery could be involved. In our study, delayed rehabilitation mainly resulted from insufficient financial support. While PST as a causative factor cannot be assumed, there is evidence to suggest that it is at least a potential causative factor influencing rehabilitation outcomes. The results from this pilot study conducted in Chinese patients with stroke did not seem to differ specifically, in terms of functional recovery, from study results obtained in western societies. This indicates that race might not be a factor influencing rehabilitation outcome. These results may help clinicians who are treating Chinese patients with stroke to predict rehabilitation outcomes.

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