Original Paper

- Predictors of Participation in Supervised Therapy by Post-Stroke Patients in the Singapore Community: a One-Year Cohort Study

Predictors of Participation in Supervised Therapy by Post-Stroke Patients in the Singapore Community: a One-Year Cohort Study

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ABSTRACT

Introduction: To determine the relationship between participation in supervised and unsupervised therapy, and predictors of participation in supervised therapy during the first post-stroke year.

Materials & Methods:

Design: Prospective longitudinal study with interviews at admission, discharge, one month, six months and one year after discharge.

Setting: Two subacute inpatient rehabilitation units and the community after discharge in Singapore.

Participants: 215 subacute non-aphasic stroke patients.

Intervention: Participation rate in supervised therapy (at outpatient rehabilitation centres) and unsupervised therapy (at home) defined as proportion of time spent performing therapy as prescribed by the subacute hospital's multidisciplinary rehabilitation team at discharge.

Main Outcome Measure: Predictors of participation in supervised and unsupervised therapy.

Results: Patients who participated in supervised therapy (i.e. at an outpatient rehabilitation centre) >25% of the time recommended were more likely to participate in unsupervised therapy (i.e. at home) >75% of the time recommended at one, six and 12 months (crude odds ratio, OR = 4.41 [95%CI:2.09–10.17], 4.45 [95%CI:2.17–9.12], 6.93 [95%CI:2.60–18.48] respectively). Greater participation in supervised therapy at one and six months independently predicted greater participation in supervised therapy at six (adjusted OR=11.64 [95%CI:4.52-29.97]) and twelve months (adjusted OR=76.46 [95%CI:12.52-466.98]) respectively. Caregiver availability at six months independently predicted poorer participation in supervised therapy at 12 months.

Conclusion: Interventions to increase participation in supervised therapy in the first post-stroke year should focus on transition of care in the first month after discharge. Further studies are needed to understand why caregiver availability was associated with low participation in supervised therapy.

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INTRODUCTION

Research has found that in stroke survivors, supervision of post-discharge rehabilitation results in better functional recovery. In a randomised controlled trial by Olney et al.[1] which compared 10 weeks of supervised and unsupervised exercise for ambulatory stroke survivors, it was found that both forms of exercise resulted in better functional outcomes at one year. However, the supervised therapy group experienced better functional outcomes than the unsupervised therapy group. In a published prospective one-year cohort study of 215 stroke survivors in Singapore, Koh et al.[2] found that in post-stroke patients, continuation of supervised therapy (i.e. at an outpatient rehabilitation centre), as compared to unsupervised therapy (i.e. at home), at one and six months after discharge from inpatient rehabilitation was predictive of greater and faster functional recovery in the first post-stroke year. However, little is known about the predictors of participation in supervised therapy at different time-points after discharge from inpatient rehabilitation, and the relationship between participation in supervised and unsupervised therapy by stroke patients in their first post-stroke year.

With data from our previous Singapore study,[2] we analysed the cohort of stroke survivors who were discharged from subacute inpatient rehabilitation units and followed up for a year, to determine the relationship between participation in supervised and unsupervised therapy, and the predictors of participation in supervised therapy at one month, six months, and one year after discharge.

METHODS

Study Design

We recruited 215 stroke patients from two subacute care hospitals in Singapore which provide inpatient rehabilitation for stroke patients transferred from local acute stroke units. Although we interviewed participants at five time-points (admission, discharge, one month, six months, and one year after discharge), the primary outcome of this study was the frequency of participation in supervised therapy in the community. Hence, only data from the last four time-points were used in the analysis. The study was approved by the ethics

by subacute hospital's multidisciplinary team to continue rehabilitation after discharge; and (e) living in the community prior to stroke.

Of the 280 patients who were consecutively admitted, 55 patients did not meet the inclusion criteria, 10 patients refused participation, and 215 patients were recruited into the study. Figure 1 is a flowchart showing the number of participants at each stage of the study and reasons for non-participation at each stage. Twenty-three patients were re-admitted into acute hospitals for acute complications or unresolved problems so only 192 patients completed rehabilitation and were discharged. Five and 8 were lost to follow-up by one month and six months respectively, resulting in a low lost-to-follow-up rate of 3% and 4% respectively. However, the rate increased to 30% with 53 patients lost to follow up by one year. This was mainly attributable to subjects who only divulged their contact telephone numbers and subsequently changed it after the 6-month visit without informing us.

Measurements

At admission, we obtained socio-demographic variables such as age, gender, ethnicity (Chinese, Malay, Indian or others), housing type (as a surrogate measure of socio-economic class), educational level (formal education or none), and caregiver availability. In land-scarce Singapore where property is expensive, housing type has been shown to be an adequate surrogate marker of socio-economic class.[3] A caregiver was defined as a person aged 21 years and above who offers care to and takes responsibility of the patient, and is recognised as a caregiver by the patient. Hence, caregivers can include family members, relatives, friends or unpaid helpers.

We also included the medical variable ischaemic heart disease because we thought angina could influence a subject's participation in supervised therapy.

Functional ability was assessed using the Barthel Index (BI), which has been validated and widely used in stroke research.[4] The BI score ranges from 0 to 100, with 100 denoting complete independence. BI scores were treated as a categorical variable in this analysis. The 15-item short-form version of the Geriatric Depression Scale (GDS) was used to assess depressive symptoms. The GDS is a validated questionnaire to screen for likely clinical depression in the general population and in the elderly Chinese population in Singapore.[5,6] The scale ranges from 0 to 15, with a score of 5 and above indicative of likely clinical depression. The Abbreviated Mental Test (AMT) was used to assess cognitive impairment. The AMT has been shown to provide good predictive validity for cognitive impairment in elderly patients, and has also been validated in our local setting.[7,8] The 10-item scale ranges from 0 to 10 with a score of 4 to 6 indicative of possible cognitive impairment and a score of 3 or less indicative of probable cognitive impairment.

Neurological impairment was assessed using the National Institutes of Health Stroke Scale (NIHSS) which includes domains such as degree of paralysis, visual fields, balance, sensory system, and apraxia. The scores range from 0 to 42, with 42 denoting most severe neurological impairment. The NIHSS has high inter-rater reliability and good predictive validity for long-term stroke outcome.[9] Previous research[10] has defined three categories for the NIHSS based on clinical judgement using the following cut-off values: (a) mild impairment = 1–6; (b) moderate impairment = 7–12; and (c) severe impairment = 13–42.

We chose to measure the above co-variates because previous research[13-17] has identified them as independent predictors of functional recovery (age,[11] ethnicity,[12] stroke lesion type,[13] recurrent stroke,[13] depression,[14,15]cognitive impairment,[13,16,17] and social support[13]). Studies[13,15-19] have also shown that neurological impairment domains such as severity of paralysis,[13,15-17] sitting balance,[13] proprioception,[18,19] apraxia,[15] and hemianopia[15] are also independent predictors of functional recovery. Since these domains are sub-scales of the NIHSS, we used the NIHSS as a summative measure of neurological impairment.

The primary outcome of interest in this study was participation in supervised therapy (at an outpatient rehabilitation centre) at the frequency recommended by the subacute hospitals' multidisciplinary rehabilitation teams during discharge. For this study, only participation in physical therapy was measured as outpatient speech and cognitive therapy were poorly available in Singapore at the time of study. All participants were advised to attend an outpatient rehabilitation centre near their home, and given a referral letter and the centre's contact details at discharge, as per subacute hospitals' policy. All participants were also taught rehabilitation exercises appropriate to their needs at the time of discharge and advised to continue it at home until follow-up.

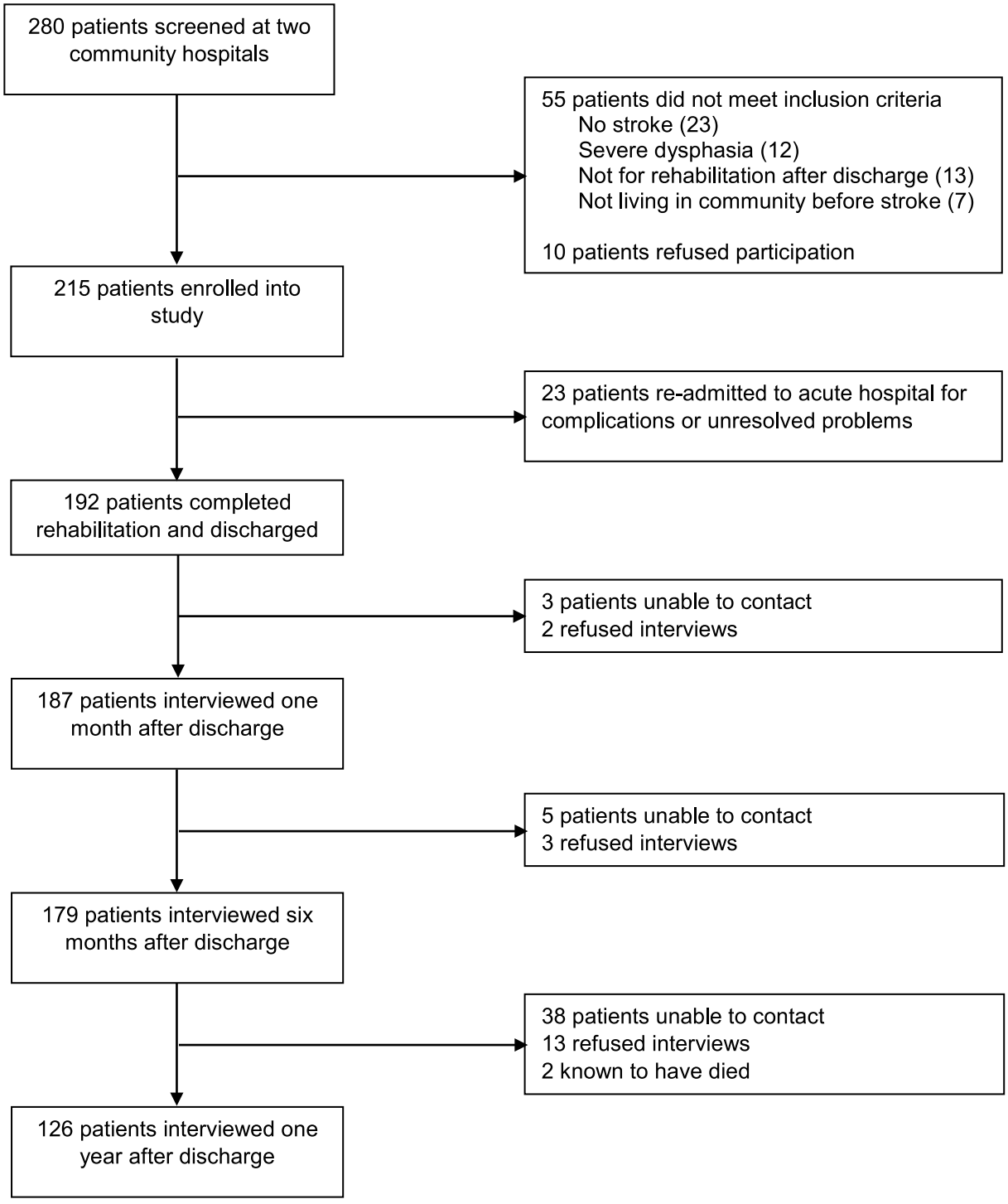
As in our previous study, we continued to use proportion of time spent performing therapy at the recommended frequency as a surrogate marker of rehabilitation intensity. For example, for supervised therapy, a patient may be recommended by the outpatient rehabilitation therapist to attend the centre for rehabilitation two times a week. If the patient only attended the centre for rehabilitation two times every four weeks on average between a pair of time points, then the proportion of time spent performing supervised therapy as recommended was 2/8 or 25%. If a patient never attended the outpatient rehabilitation centre, then the proportion of time spent performing supervised therapy as recommended was 0%. For unsupervised therapy, a patient may be recommended by the subacute hospital's multidisciplinary rehabilitation team to perform a set of exercises twice a day every day (i.e. 14 times a week). If the patient only

committees of both hospitals and all participants gave informed consent.

Patient Sample

From August to December 2002, potential participants were identified by reviewing admission diagnoses of all patients. Patients considered for the study fulfilled the following inclusion criteria: (a) diagnosed with a stroke as defined using World Health Organization's (WHO) criteria (rapidly developed clinical signs of focal disturbance of cerebral function lasting more than 24 hours with no apparent cause other than vascular origin, including subarachnoid haemorrhage); (b) onset of stroke symptoms occurring within one week before admission to acute stroke unit; (c) not suffering from severe dysphasia (because the measurement tools used in the study required participants to communicate); (d) assessed and recommended

Figure 1: Number of participants and reasons for non-participation at each stage of the study



performed the set of exercises three times a week on average between a pair of time points, then the proportion of time spent performing unsupervised therapy as recommended was 3/14 or 21%. We defined this proportion of time spent performing therapy as the participation rate. Type of therapy or duration of each rehabilitation session was not considered.

As far as possible, we verified subjects' self-reported therapy participation rate with caregiver corroboration and outpatient rehabilitation records. For example, although most post-discharge interviews were conducted at the subjects' homes or nursing home, we also tried to interview subjects at the outpatient rehabilitation centre as much as possible so that we could verify their self-reported therapy participation rate with centre staff and records. The source of reporting used for the data analysis was, by default, self-reported participation rates. If they differed from the caregiver report or outpatient rehabilitation records, the order of priority for which data to use was outpatient rehabilitation records, followed by caregiver report, then by patient self-report. If a subject was discharged to a nursing home, rehabilitation by nursing home therapists (if any) was considered as supervised therapy.

No subject received home-based therapy with professional supervision because it was expensive and poorly available in Singapore during the time of study. We captured data on rate of participation in supervised and unsupervised therapy using a four-category variable: 0-25%, >25% to 50%, >50% to 75%, and >75% of time recommended. To avoid Type 2 bias in subsequent analyses due to unequal distribution of therapy time completed, data from both unsupervised and supervised therapies were assigned to dichotomies with near-equal proportions in each category: participation in supervised therapy was dichotomised into 25% or less versus more than 25% of recommended time, while participation in unsupervised therapy was dichotomised into 75% or less versus more than 75% of recommended time. For purpose of discussion, we have termed more than 75% and 25% participation in unsupervised and supervised therapy respectively as frequent participation, and less than or equal to 75% and 25% participation in unsupervised and supervised therapy respectively as infrequent participation.

Interviews and measurements were administered by three research nurses who were trained by G.C.H.K. and S.K.S. (principal and co-principal investigators). Post-discharge interviews were conducted in patients' homes, nursing home or day rehabilitation centre after making an appointment to visit them via telephone beforehand. If subjects changed their telephone contacts without informing us, we attempted at least two home visits to contact them and, if they were not in, we left notices requesting them to contact us. We used a small financial incentive equivalent to US$10 for each visit to encourage sustained participation and minimise loss to follow-up.

Statistical Analysis

We used McNemar's test to compare differences in socio-demographic and clinical profile of study population at one month, six months, and one year. Chi-square analysis was used to determine the relationship between participation in unsupervised and supervised therapy, and between participation in supervised therapy at each time-point and demographic variables at the preceding time-point. As previous research[2] found that supervised therapy was superior to unsupervised therapy in predicting functional outcomes at one year, we focused on supervised therapy as the outcome variable in all subsequent multivariate analysis. Only demographic variables with p-value less than 0.15 on univariate analysis were included as co-variates in multivariate modelling. Our previous study[2] found that participation in supervised therapy dropped from 100% during admission to 33% one month after discharge, decreasing further to 28% at one year, with similar patterns of decline in participation in unsupervised therapy as well. Hence, we determined the independent predictors of participation in supervised therapy at one month, six months, and one year, using backward logistic regression with binary outcomes. To examine the factors associated with participation in supervised therapy over all three times points after discharge while taking in account correlations between measures taken on the same individual over time, we also performed backward generalised estimating equations (GEE) (repeated measures) analysis. Likelihood ratio statistics were used to determine the most parsimonious model. Data was analysed using STATA version 10 (Stata Corporation, College Station, TX, USA) and statistical significance was set at $p<0.05$.

RESULTS

Patient Characteristics

Table I details the socio-demographic and clinical profile of all subjects at discharge, one month, six months, and one year after discharge. At enrolment, there were more women in the group (54.2%) and four-fifths of the group was Chinese (82.5%), reflecting the ethnic distribution of Singapore. Almost 10% of persons with stroke had had a haemorrhagic stroke. The median length of stay was 14 (inter-quartile range=10-22) days in acute stroke units and 32 (inter-quartile range=24-42) days in subacute hospitals. Ten subjects had no caregiver at discharge (5.7%). Thirteen out of 192 subjects (6.8%) were discharged to nursing homes and the rest were discharged to their own homes. There was no significant difference in any socio-demographic and clinical variable between subjects remaining at one year and those lost to follow up since admission except for caregiver availability which was higher in the latter group (91.1% vs. 98.7%, p=0.03). There was also no significant difference in socio-demographic or clinical variables in the study population between each pair of adjacent time-points (i.e. discharge vs. one month, one month vs. six

Table I. Socio-demographic profile of subjects at one, six months and one year after discharge

Variable	At discharge, n (%) (N = 192)	One month after discharge, n (%) (N = 187)	Six months after discharge, n (%) (N = 179)	One year after discharge, n (%) (N = 126)
Age				
≤ 75 years	105 (59.0)	101 (59.1)	96 (58.9)	66 (58.9)
> 75 years	73 (41.0)	70 (40.9)	67 (41.1)	46 (41.1)
Gender				
Male	85 (44.3)	84 (45.4)	81 (45.5)	52 (41.6)
Female	107 (55.7)	101 (54.6)	97 (54.2)	73 (58.4)
Ethnicity				
Chinese	153 (81.0)	152 (83.5)	140 (80.0)	97 (79.5)
Malay	22 (11.6)	16 (8.8)	21 (12.0)	17 (13.9)
Indian	12 (6.3)	12 (6.6)	12 (6.9)	7 (5.7)
Others	2 (1.1)	2 (1.1)	2 (1.1)	1 (0.8)
Housing type				
1 – 3 room public flats	69 (39.2)	65 (38.7)	61 (37.9)	46 (40.0)
4 – 5 room public flats	92 (52.3)	92 (54.8)	88 (54.7)	61 (53.0)
Condominiums and private property	15 (8.5)	11 (6.5)	12 (7.5)	8 (7.0)
Educational level				
No formal education	120 (68.2)	116 (70.3)	110 (68.8)	80 (70.2)
Had formal education	56 (31.8)	49 (29.7)	50 (31.2)	34 (29.8)
Caregiver availability				
Present	164 (94.3)	156 (94.5)	149 (93.1)	102 (91.1)
Absent	10 (5.7)	9 (5.5)	11 (6.9)	10 (8.9)
Ischaemic heart disease				
Present	45 (25.1)	46 (26.1)	46 (26.0)	27 (21.4)
Absent	134 (74.9)	130 (73.9)	131 (74.0)	99 (78.6)
Barthel Index (BI)				
0 – 25	23 (12.5)	12 (6.6)	10 (5.7)	11 (8.7)
26 – 50	70 (38.0)	21 (11.5)	23 (13.1)	10 (7.9)
51 – 75	72 (39.1)	48(26.2)	30 (17.0)	21 (16.7)
76 – 100	19 (10.3)	102 (55.7)	113 (64.2)	84 (66.7)
Abbreviated Mental Test (AMT)				
0 – 3 (Probable impairment)	2 (1.5)	7 (3.9)	7 (4.1)	6 (4.8)
4 – 6 (Possible impairment)	12 (9.2)	17 (9.1)	21 (12.2)	13 (10.5)
7 – 10 (Normal)	117 (89.3)	156 (83.9)	144 (83.7)	105 (84.7)
Geriatric Depression Scale (GDS)				
0 – 4 (Normal)	96 (72.7)	139 (72.1)	122 (70.9)	93 (75.6)
5 – 15 (Probable depression)	36 (27.3)	50 (27.9)	50 (29.1)	30 (24.4)
National Institute of Health Stroke Scale (NIHSS)				
0 – 6 (Mild impairment)	99 (75.6)	154 (82.8)	152 (86.9)	104 (85.2)
7 – 12 (Moderate impairment)	32 (24.4)	27 (14.9)	23 (13.1)	16 (13.1)
13 – 42 (Severe impairment)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.6)

months, and six months vs. one year).

Participation in Therapy

Subjects with frequent participation in supervised therapy were more likely to have frequent participation in unsupervised therapy at each of the three time-points after discharge (OR = 4.61 [2.09 – 10.17] at one month, OR = 4.45 [2.17 – 9.12] at six months, and OR = 6.93 [2.60 – 18.48] at one year) **(Table II).**

Factors Associated with Participation in Supervised Therapy

Only younger age was predictive of frequent participation in supervised therapy at one month (OR = 2.13 [1.08 – 4.19]) **(Table III)**. At six months, subjects with a caregiver were less likely to participate in supervised therapy than those without (OR = 0.17 [0.04 – 0.66]), and those who participated frequently in supervised therapy at one month were more likely to participate frequently in supervised therapy at six months (OR = 13.57 [6.20 – 29.67]) **(Table IV)**. At one year, those with a caregiver were also less likely to have frequent

Table II. Relationship between participation in supervised and unsupervised therapy

One month (N=187)		Participation in supervised therapy		Crude OR (95%CI)	p-value
		≤25% of the time	>25% of the time		
Participation in unsupervised therapy	≤75% of the time	54 (43.9)	9 (14.4)	4.61 (2.09 – 10.17)	<0.001
	>75% of the time	69 (56.1)	53 (85.5)		
Six months (N=179)		Participation in supervised therapy		Crude OR (95%CI)	p-value
		≤25% of the time	>25% of the time		
Participation in unsupervised therapy	≤75% of the time	67 (56.8)	13 (22.8)	4.45 (2.17 – 9.12)	<0.001
	>75% of the time	51 (43.2)	44 (77.2)		
One year (N=126)		Participation in supervised therapy		Crude OR (95%CI)	p-value
		≤25% of the time	>25% of the time		
Participation in unsupervised therapy	≤75% of the time	52 (59.8)	6 (17.6)	6.93 (2.60 – 18.48)	<0.001
	>75% of the time	35 (40.2)	28 (82.4)		

(Numbers may not add up to 187 because of missing values.)

participation in supervised therapy than those without (OR = 0.13 [0.03 – 0.54]) **(Table V)**. Subjects with frequent participation in unsupervised and supervised therapy at six months were also more likely to have frequent participation in supervised therapy at one year (OR = 5.86 [2.07 – 16.57] and 43.27 [13.06 – 143.37] respectively).

Independent Predictors of Participation in Supervised Therapy

The independent predictor(s) of frequent participation in supervised therapy at one month was younger age (adjusted OR = 0.43 [0.20-0.91]); at six months were caregiver unavailability (adjusted OR = 0.07 [0.01 – 0.49]) and frequent participation in supervised therapy at one month (adjusted OR = 11.64 [4.52 – 29.97]); and at one year was frequent participation in supervised therapy at six months (adjusted OR = 76.46 [12.52 – 466.98] **(Table VI)**. The independent predictors of frequent participation in supervised therapy over all three time points were similar to those at each time-point: caregiver unavailability (adjusted OR=0.18 [0.05 – 0.60]), lower BI scores (i.e. greater functional disability), and frequent participation in unsupervised therapy (adjusted OR=5.42 [2.72 – 10.81]) **(Table VI)**.

DISCUSSION

We found that frequent participation in supervised therapy was positively associated with frequent participation in unsupervised therapy, younger age and lack of caregiver availability in the first post-stroke year. Frequent participation in supervised therapy at one month was strongly predictive of frequent participation in supervised therapy at six months, and frequent participation in supervised therapy at six months was strongly predictive of frequent participation in supervised therapy at one year. Also, patients who frequently participated in supervised therapy were more likely to frequently participate in unsupervised therapy at all three time-points. Our earlier paper[2] found that only a third of subjects in this cohort were frequently participating in supervised therapy at one month after discharge and this proportion subsequently decreased marginally to 28% by one year. This suggests that those who are frequently participating in supervised therapy at

Table III. Associated predictors of participation in supervised therapy at one month on bivariate analysis (N = 187)

Variable	≤25% of the time	>25% of the time	Crude OR (95%CI)	p-value
Age †				
≤ 75 years	60 (59.4)	41 (40.6)	**2.13 (1.08 – 4.19)**	**0.033**
> 75 years	53 (75.7)	17 (24.3)	1.00	
Gender				
Male	56 (66.7)	28 (33.3)	1.03 (0.56 – 1.91)	1.000
Female	68 (67.3)	33 (32.7)	1.00	
Ethnicity *,†				
Chinese	98 (64.5)	54 (35.5)	6.06 (0.76 – 48.22)	0.089
Malay	12 (75.0)	4 (25.0)	3.67 (0.35 – 38.03)	0.276
Indian	11 (91.7)	1 (8.3)	1.00	
Housing type †				
1 – 3 room public flats	44 (67.7)	21 (32.3)	0.27 (0.07 – 1.04)	0.056
4 – 5 room public flats	62 (67.4)	30 (32.6)	0.28 (0.08 – 1.02)	0.053
Condominiums & private property	4 (36.4)	7 (63.6)	1.00	-
Educational level				
No formal education	77 (66.4)	39 (33.6)	1.27 (0.61 – 2.63)	0.587
Had formal education	35 (71.4)	14 (28.6)	1.00	
Caregiver avai1ability				
Present	106 (67.9)	50 (32.1)	0.59 (0.15 – 2.29)	0.476
Absent	5 (55.6)	4 (44.4)	1.00	
Discharge destination †				
Own home	55 (31.6)	119	0.33 (0.10 – 1.09)	0.109
Nursing home	7 (58.3)	5 (41.7)	1.00	
Ischaemic heart disease				
Present	32 (69.6)	14 (30.4)	0.95 (0.46 – 1.97)	1.000
Absent	89 (68.5)	41 (31.5)	1.00	
Barthel Index (BI) at discharge †				
0 – 25	14 (63.6)	8 (36.4)	0.76 (0.22 – 2.60)	0.664
26 – 50	40 (59.7)	27 (40.3)	0.90 (0.33 – 2.43)	0.835
51 – 75	53 (74.6)	18 (25.4)	0.45 (0.16 – 1.25)	0.127
76 – 100	12 (57.1)	9 (42.9)	1.00	-
Abbreviated Mental Test (AMT) at discharge				
0 – 3 (Probable impairment)	1 (33.3)	2 (66.7)	4.88 (0.43 – 55.68)	0.202
4 – 6 (Possible impairment)	7 (63.6)	4 (36.4)	1.39 (0.38 – 5.09)	0.616
7 – 10 (Normal)	78 (70.9)	32 (29.1)	1.00	-
Geriatric Depression Scale (GDS) at discharge				
0 – 4 (Normal)	67 (69.1)	30 (30.9)	1.12 (0.44 – 2.82)	1.000
5 – 15 (Probable depression)	20 (71.4)	8 (28.6)	1.00	
National Institute of Health Stroke Scale (NIHSS) at discharge §				
0 – 6 (Mild impairment)	68 (71.6)	27 (28.4)	0.65 (0.27 – 1.56)	0.362
7 – 12 (Moderate impairment)	18 (62.1)	11 (37.9)	1.00	

(Numbers may not add up to 187 because of missing values.)
*** 'Others' category for ethnicity removed because of small number (n = 2).**
§ 'Severe impairment' category removed because no subjects in this category (n = 0).
† Variables with one or more subgroups which has a p-value less than 0.15.

one month are likely to remain so up to one year. This highlights that any effort to increase adherence to post-discharge rehabilitation as recommended should focus on the transition period from discharge to the first month back home. The transition of care from inpatient settings into the community has been identified as a significant challenge for patients and their caregivers and an area of research that has received little attention.[18] More research is needed to

Table IV. Associated predictors of participation in supervised therapy at six months on bivariate analysis (N = 179)

Variable	≤25% of the time	>25% of the time	Crude OR (95%CI)	p-value
Age †				
≤ 75 years	59 (61.5)	37 (38.5)	1.71 (0.87 – 3.37)	0.133
> 75 years	49 (73.1)	18 (26.9)	1.00	
Gender				
Male	53 (65.4)	28 (34.6)	1.13 (0.60 – 2.10)	0.751
Female	66 (68.0)	31 (32.0)	1.00	
Ethnicity *,†				
Chinese	93 (66.4)	47 (33.6)	5.56 (0.70 – 44.36)	0.105
Malay	13 (61.9)	8 (38.1)	6.77 (0.73 – 62.86)	0.093
Indian	11 (91.7)	1 (8.3)	1.00	-
Housing type				
1 – 3 room public flats	38 (62.3)	23 (37.7)	1.21 (0.33 – 4.47)	0.775
4 – 5 room public flats	60 (68.2)	28 (31.8)	0.93 (0.26 – 3.36)	0.916
Condominiums & private property	8 (66.7)	4 (33.3)	1.00	-
Educational level				
No formal education	77 (70.0)	33 (30.0)	0.64 (0.32 – 1.29)	0.277
Had formal education	30 (60.0)	20 (40.0)	1.00	
Caregiver availability †				
Present	103 (69.1)	46 (30.9)	**0.17 (0.04 – 0.66)**	**0.008**
Absent	3 (27.3)	8 (72.7)	1.00	
Discharge destination				
Own home	53 (31.7)	114 (68.3)	0.47 (0.14 – 1.51)	0.214
Nursing home	6 (50.0)	6 (50.0)	1.00	
Ischaemic heart disease				
Present	31 (67.4)	15 (32.6)	1.03 (0.50 – 2.10)	1.000
Absent	89 (67.9)	42 (32.1)	1.00	
Barthel Index (BI) at one month †				
0 – 25	9 (75.0)	2 (25.0)	0.96 (0.24 – 3.84)	0.952
26 – 50	13 (61.9)	11 (38.1)	1.77 (0.65 – 4.79)	0.261
51 – 75	25 (59.9)	15 (40.5)	1.96 (0.90 – 4.23)	0.089
76 – 100	69 (74.2)	30 (25.8)	1.00	-
Abbreviated Mental Test (AMT) at one month				
0 – 3 (Probable impairment)	5 (71.4)	2 (28.6)	0.98 (0.18 – 5.26)	0.982
4 – 6 (Possible impairment)	10 (58.8)	7 (41.2)	1.72 (0.61 – 4.81)	0.304
7 – 10 (Normal)	103 (71.0)	47 (29.0)	1.00	-
Geriatric Depression Scale (GDS) at one month				
0 – 4 (Normal)	86 (72.3)	33 (27.7)	0.64 (0.32 – 1.30)	0.265
5 – 15 (Probable depression)	30 (62.5)	18 (37.5)	1.00	
National Institute of Health Stroke Scale (NIHSS) one month §				
0 – 6 (Mild impairment)	101 (70.1)	43 (29.9)	0.76 (0.31 – 1.85)	0.639
7 – 12 (Moderate impairment)	16 (64.0)	9 (36.0)	1.00	
Participation in unsupervised therapy at one month †				
≤ 75% of the time	47 (77.0)	14 (23.0)	1.00	0.088
> 75% of the time	70 (64.2)	39 (35.8)	1.87 (0.92 – 3.82)	
Participation in supervised therapy at one month †				
≤ 25% of the time	99 (86.8)	15 (13.2)	1.00	**<0.001**
> 25% of the time	18 (32.7)	37 (67.3)	**13.57 (6.20 – 29.67)**	

(Numbers may not add up to 187 because of missing values.)
*** 'Others' category for ethnicity removed because of small number (n = 2).**
§ 'Severe impairment' category removed because no subjects in this category (n = 0).
† Variables with one or more subgroups which has a p-value less than 0.15.

understand the barriers faced by stroke survivors in accessing supervised therapy.

It is unlikely that greater disability or morbidity associated with older age were reasons why older stroke survivors were less likely to participate in supervised therapy at one month because functional status was controlled for in the multivariate model and neurological impairment, depression, cognitive

Table V. Associated predictors of participation in supervised therapy at one year on bivariate analysis (N = 126)

Variable	≤25% of the time	>25% of the time	Crude OR (95%CI)	p-value
Age				
≤ 75 years	46 (69.7)	20 (30.3)	1.48 (0.61 – 3.56)	0.513
> 75 years	34 (77.3)	10 (22.7)	1.00	
Gender				
Male	41 (78.8)	11 (21.2)	0.56 (0.24 – 1.29)	0.221
Female	48 (67.6)	23 (32.4)	1.00	
Ethnicity *				
Chinese	67 (70.5)	28 (29.5)	-	-
Malay	13 (76.5)	4 (23.5)	-	-
Indian	7 (100)	0 (0)	-	-
Housing type				
1 – 3 room public flats	28 (62.2)	17 (37.8)	1.01 (0.21 – 4.78)	0.988
4 – 5 room public flats	49 (81.7)	11 (18.3)	0.37 (0.08 – 1.81)	0.221
Condominiums & private property	5 (62.5)	3 (37.5)	1.00	-
Educational level				
No formal education	61 (77.2)	18 (22.8)	0.54 (0.23 – 1.30)	0.173
Had formal education	22 (64.7)	12 (35.3)	1.00	
Caregiver availability †				
Present	77 (77.0)	23 (23.0)	**0.13 (0.03 – 0.54)**	**0.004**
Absent	3 (30.0)	7 (70.0)	1.00	
Discharge destination				
Own home	30 (26.3)	84 (73.7)	0.50 (0.15 – 1.70)	0.312
Nursing home	5 (41.7)	7 (58.3)	1.00	
Ischaemic heart disease				
Present	20 (76.9)	6 (23.1)	0.75 (0.27 – 2.06)	0.631
Absent	70 (71.4)	28 (28.6)	1.00	
Barthel Index (BI) at six months				
0 – 25	6 (85.7)	1 (14.3)	0.44 (0.05 – 3.91)	0.465
26 – 50	7 (53.8)	6 (46.2)	2.29 (0.69 – 7.59)	0.177
51 – 75	17 (73.9)	6 (26.1)	0.94 (0.33 – 2.71)	0.911
76 – 100	56 (72.7)	21 (27.3)	1.00	-
Abbreviated Mental Test (AMT) at six months				
0 – 3 (Probable impairment)	3 (60.0)	2 (40.0)	1.85 (0.29 – 11.68)	0.515
4 – 6 (Possible impairment)	12 (70.6)	5 (29.4)	1.15 (0.37 – 3.59)	0.805
7 – 10 (Normal)	72 (73.5)	26 (26.5)	1.00	-
Geriatric Depression Scale (GDS) at six months				
0 – 4 (Normal)	64 (74.4)	22 (25.6)	0.83 (.034 – 1.99)	0.655
5 – 15 (Probable depression)	24 (70.6)	10 (29.4)	1.00	
National Institute of Health Stroke Scale (NIHSS) six months §				
0 – 6 (Mild impairment)	75 (71.4)	30 (28.6)	1.87 (0.50 – 6.97)	0.556
7 – 12 (Moderate impairment)	14 (82.4)	3 (17.6)	1.00	
Participation in unsupervised therapy at six months †				
≤ 75% of the time	45 (90.0)	5 (10.0)	1.00	**<0.001**
> 75% of the time	43 (60.6)	28 (39.4)	**5.86 (2.07 – 16.57)**	
Participation in supervised therapy at six months †				
≤ 25% of the time	75 (94.9)	4 (5.1)	1.00	**<0.001**
> 25% of the time	13 (30.2)	30 (69.8)	**43.27 (13.06 – 143.37)**	

impairment, and ischaemic heart disease were not associated with frequent participation in supervised therapy at one month. More likely reasons could be that either older stroke survivors chose not to participate in supervised therapy or their caregivers were not bringing their wards to rehabilitation centres for supervised therapy. Both these possible reasons may stem from an ageist attitude that rehabilitation does not benefit older persons. Other possible reasons include other age-related barriers to attendance at day rehabilitation centres which were not studied such as inconvenience, inaccessibility and cost. [19]

Our finding that post-stroke patients with caregivers were less likely to participate in supervised therapy compared to those without caregivers was contrary to the findings from a systematic review by Kwakkel et al.[11] which found that a higher

Table VI. Independent predictors for participation in supervised therapy >25% of the recommended time

Variables	Adjusted OR (95% CI)	p-value
At one month *		
Age >75 years (vs. ≤75 years)	0.43 (0.20 – 0.91)	0.028
At six months §		
Caregiver availability (vs. none)	0.07 (0.01 – 0.49)	0.007
Participation in supervised therapy >25% of the recommended time at 1 month	11.64 (4.52 – 29.97)	<0.001
At one year †		
Participation in supervised therapy >25% of the recommended time at 6 months	76.46 (12.52 – 466.98)	<0.001
Over all three time-points ‡		
Caregiver availability (vs. none)	0.18 (0.05 – 0.60)	0.006
Barthel Index score		
0 – 25	1.14 (0.41 – 3.19)	0.806
26 – 50	3.46 (1.26 – 9.54)	0.016
51 – 75	2.61 (1.19 – 5.72)	0.017
76 – 100	1.00	-
Participation in unsupervised therapy >75% of the recommended time	5.42 (2.72 – 10.81)	<0.001

*** Co-variates whose p-values were <0.15 on bivariate analysis and entered in the multivariate model before backward logistic regression were age, ethnicity, housing type, discharge destination, and Barthel index at discharge.**

§ Co-variates whose p-values were <0.15 on bivariate analysis and entered in the multivariate model before backward logistic regression were age, ethnicity, caregiver availability, Barthel index, and participation in supervised therapy at one month.

† Co-variates whose p-values were <0.15 on bivariate analysis and entered in the multivariate model before backward logistic regression were caregiver availability, and participation in supervised therapy at six months. Participation in unsupervised therapy at six months was not included in the model because it was collinear with participation in supervised therapy at six months and the latter was the variable of interest.

‡ Using backward generalised estimating equation (GEE) analysis with age, gender, ethnicity, housing type, educational level, caregiver availability, discharge destination, and ischaemic heart disease as fixed factors, and BI, AMT, GDS, NIHSS, participation in unsupervised therapy, and participation in supervised therapy (outcome measure) as repeated measures.

level of social support was predictive of better post-stroke functional recovery. The paper cited in Kwakkel et al.'s review which supported this conclusion was by Glass et al.[20] In their study, patient-perceived social support in the prior four weeks using the Inventory of Socially Supportive Behaviours, rather than availability of caregivers, was used to measure social support, which may explain our different findings. One would expect that those with caregivers would be more likely to be brought to rehabilitation centres and those without caregivers would have no one to bring them to rehabilitation centres. A possible explanation for this unexpected finding could be that patients with caregivers were less likely to participate in supervised therapy because there was already a caregiver to perform the ADLs for the stroke survivor, supplanting their perceived need for participation in supervised therapy. Another possible explanation is that those without caregivers were more motivated to maximise their functional recovery because they had no caregiver to rely on and hence were more likely to participate in supervised therapy over the long term. This explanation is supported by studies[21,22] that have found that personal motivation and other intra-personal factors such as

self-reliance, independence, and determination are important determinants of participation in supervised rehabilitation. A third possible explanation could be that subjects with caregivers were over-protected by their caregivers who may have reduced motivation or may have even discouraged stroke survivors from participating in supervised rehabilitation. Maclean et al.[23] has reported that overprotection from family members had a negative effect on stroke patients' motivation for rehabilitation. Further research is needed to determine which of these hypotheses is most likely to be operating and whether patient and caregiver self-efficacy are associated with participation in supervised therapy and, more importantly, post-stroke functional recovery.

Study Limitations

The primary independent variable, proportion of time subjects spent participating in therapy as recommended by an inpatient multidisciplinary rehabilitation team, is not an ideal marker of rehabilitation intensity as the degree of rehabilitation recommended was also dependent on the rehabilitation team and patient factors. However, as mentioned in our previous paper,[2] given the complexity of measuring rehabilitation intensity, we felt that the proportion of time subjects spent participating in therapy as recommended by an inpatient multidisciplinary rehabilitation team was a fair surrogate marker. Another limitation is that the AMT and GDS are only screening tools for cognitive impairment and depression respectively, and not diagnostic tools. However, we felt they were adequate for our study because they were used only to adjust for known predictors of participation in supervised therapy and were not primary outcomes of interest.

The high lost-to-follow-up rate between six months and one year is another limitation. Nevertheless, we found that there were no significant differences in socio-demographic and clinical variables between subjects remaining at one year and those lost to follow up (except for caregiver availability, which was higher in the latter group). The small number of subjects without caregivers in our sample suggests that the finding that post-stroke subjects with caregivers were less likely to participate in supervised therapy compared to those without caregivers should be interpreted with caution. We also acknowledge that since our time of data collection in 2005 until now, there have been many improvements to outpatient rehabilitation programmes (e.g. transport arrangements, case management, means testing), which have not been evaluated in our paper but are important modifiable factors that affect compliance to rehabilitation. Finally, it is important to note that our findings may only be unique to Singapore because different findings may be encountered in countries with different rehabilitation funding models and socio-cultural contexts.

In conclusion, we found that older age and caregiver availability were independently associated with infrequent participation in supervised therapy, and patients who frequently participated in supervised therapy at one month were more likely to continue to frequently participate in supervised therapy at subsequent time-points. Also, patients who frequently participated in supervised therapy were more likely to frequently participate in unsupervised therapy at all 3 time-points. Interventions to promote and sustain participation in supervised therapy in the first post stroke year should be focused on the transition of care during the first month after discharge. Further studies are needed to understand the reasons why patients are not participating in supervised therapy which may include ageist attitudes, lack of personal motivation or barriers to access.

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Table IV. Associated predictors of participation in supervised therapy at six months on bivariate analysis (N = 179)

Variable	≤25% of the time	>25% of the time	Crude OR (95%CI)	p-value
Age †				
≤ 75 years	59 (61.5)	37 (38.5)	1.71 (0.87 – 3.37)	0.133
> 75 years	49 (73.1)	18 (26.9)	1.00	
Gender				
Male	53 (65.4)	28 (34.6)	1.13 (0.60 – 2.10)	0.751
Female	66 (68.0)	31 (32.0)	1.00	
Ethnicity *,†				
Chinese	93 (66.4)	47 (33.6)	5.56 (0.70 – 44.36)	0.105
Malay	13 (61.9)	8 (38.1)	6.77 (0.73 – 62.86)	0.093
Indian	11 (91.7)	1 (8.3)	1.00	-
Housing type				
1 – 3 room public flats	38 (62.3)	23 (37.7)	1.21 (0.33 – 4.47)	0.775
4 – 5 room public flats	60 (68.2)	28 (31.8)	0.93 (0.26 – 3.36)	0.916
Condominiums & private property	8 (66.7)	4 (33.3)	1.00	-
Educational level				
No formal education	77 (70.0)	33 (30.0)	0.64 (0.32 – 1.29)	0.277
Had formal education	30 (60.0)	20 (40.0)	1.00	
Caregiver availability †				
Present	103 (69.1)	46 (30.9)	**0.17 (0.04 – 0.66)**	**0.008**
Absent	3 (27.3)	8 (72.7)	1.00	
Discharge destination				
Own home	53 (31.7)	114 (68.3)	0.47 (0.14 – 1.51)	0.214
Nursing home	6 (50.0)	6 (50.0)	1.00	
Ischaemic heart disease				
Present	31 (67.4)	15 (32.6)	1.03 (0.50 – 2.10)	1.000
Absent	89 (67.9)	42 (32.1)	1.00	
Barthel Index (BI) at one month †				
0 – 25	9 (75.0)	2 (25.0)	0.96 (0.24 – 3.84)	0.952
26 – 50	13 (61.9)	11 (38.1)	1.77 (0.65 – 4.79)	0.261
51 – 75	25 (59.9)	15 (40.5)	1.96 (0.90 – 4.23)	0.089
76 – 100	69 (74.2)	30 (25.8)	1.00	-
Abbreviated Mental Test (AMT) at one month				
0 – 3 (Probable impairment)	5 (71.4)	2 (28.6)	0.98 (0.18 – 5.26)	0.982
4 – 6 (Possible impairment)	10 (58.8)	7 (41.2)	1.72 (0.61 – 4.81)	0.304
7 – 10 (Normal)	103 (71.0)	47 (29.0)	1.00	-
Geriatric Depression Scale (GDS) at one month				
0 – 4 (Normal)	86 (72.3)	33 (27.7)	0.64 (0.32 – 1.30)	0.265
5 – 15 (Probable depression)	30 (62.5)	18 (37.5)	1.00	
National Institute of Health Stroke Scale (NIHSS) one month §				
0 – 6 (Mild impairment)	101 (70.1)	43 (29.9)	0.76 (0.31 – 1.85)	0.639
7 – 12 (Moderate impairment)	16 (64.0)	9 (36.0)	1.00	
Participation in unsupervised therapy at one month †				
≤ 75% of the time	47 (77.0)	14 (23.0)	1.00	0.088
> 75% of the time	70 (64.2)	39 (35.8)	1.87 (0.92 – 3.82)	
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> 25% of the time	18 (32.7)	37 (67.3)	**13.57 (6.20 – 29.67)**	

(Numbers may not add up to 187 because of missing values.)
*** 'Others' category for ethnicity removed because of small number (n = 2).**
§ 'Severe impairment' category removed because no subjects in this category (n = 0).
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