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Effect of Different Doses of Task-Specific Training on Upper Limb Motor Recovery in Individuals with Subacute Stroke: A Pilot Experimental Study

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ABSTRACT

Background: Task-specific training (TST) is an established rehabilitation approach for improving upper limb function after stroke. However, the optimal dose of repetitive task practice required to maximize recovery remains unclear.

Aim: To determine the effect of different doses of task-specific training on upper limb motor recovery in individuals with subacute stroke.

Methods: This pilot experimental study included 30 individuals with subacute stroke, allocated into three groups (n=10 each). Group A performed 3,200 repetitions (100 repetitions/session), Group B performed 6,400 repetitions (200 repetitions/session), and Group C performed individualized maximum repetitions (up to 300 repetitions/session) of functional tasks including eating, drinking, and combing hair. Training was provided four days per week for eight weeks. Outcomes were assessed using the Fugl-Meyer Assessment–Upper Extremity (FM-UE), Action Research Arm Test (ARAT), and Motor Activity Log (MAL). Paired t-tests, one-way ANOVA, and post hoc analyses were used for statistical analysis.

Results: All groups demonstrated significant improvements in FM-UE, ARAT, and MAL scores ($p<0.05$). Between-group analysis showed significant differences in FM-UE ($p=0.047$), MAL Amount of Use ($p=0.041$), and MAL Quality of Movement ($p=0.035$), while ARAT showed no significant difference ($p=0.46$). Post hoc analysis revealed significantly greater improvements in the individualized maximum repetition group compared with the 3,200-repetition group for FM-UE and MAL outcomes.

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Conclusion: Higher doses of task-specific training improved upper limb motor recovery following subacute stroke. Individualized maximum repetition training (approximately ≥300 repetitions/session) produced superior improvements in motor impairment and functional arm use, supporting the potential benefit of high-dose rehabilitation. Larger randomized controlled trials are recommended to confirm these findings.

KEYWORDS

• Subacute Stroke • Task-Specific Training • Upper Limb Rehabilitation • Repetitive Task Practice • Neurorehabilitation • Pilot Experimental Study

INTRODUCTION

Definition

Stroke is a cerebral vascular accident from either a blood clot or the rupture of a blood vessel, resulting in a sudden cessation of blood flow to an area of the brain.[1]

The cumulative incidence of stroke ranged from 105 to 152/100,000 persons per year, and the crude prevalence of stroke ranged from 44.29 to 559/100,000 persons in different parts of India during the past decade. These values were even higher than those of high-income countries.[2]

Although there is a general agreement, despite some inconsistencies, that enhancing the amount of rehabilitation could improve results for stroke patients, there is a lack of substantial data to determine what the ideal doses should be.[3]

The concept that the amount of neurorehabilitation administered can affect results is supported by three main sources: firstly, clinical trials have demonstrated that a higher dose is more effective than a lower one; 2–5 secondly, small Phase I feasibility studies have consistently shown a moderate correlation between the dose given and the degree of improvement; 6–8 and thirdly, a recent meta-analysis has identified a small-to-moderate effect size linked to dosage across various stroke rehabilitation studies.[4]

Need of the study

Although trials have been conducted effectively and demonstrate the advantages of increased therapy, there is still a significant gap between these scientific recommendations and the therapy typically provided in regular sessions. To better inform clinical treatment for the hundreds of thousands of individuals who annually endure the debilitating effects of stroke, it is crucial to determine the best dosing and timing.

Aims and objectives

Aim of the study:

- To find effective dosage of Task specific Training in patient with sub-acute and chronic stroke.

Objective of study:

- To find effect of 3200 repetition (1 hr. of training session including 100 repetitions/session, 4 days/ week for 8 weeks) of eating, drinking and combing hair Task specific Training in patient with sub-acute and chronic stroke on Fugl-Meyer UE, Action research arm test, Motor activity log.
- To find effect of 6400 repetition (1.5 - 2 hr. of training session including 200 repetition/session¸ 4 days/ week for 8 weeks) of eating, drinking and combing hair Task specific Training in patient with sub-acute and chronic stroke on Fugl-Meyer UE, Action research arm test, Motor activity log.
- To find effect of Individualized Maximum repetitions(2-3 hr. of training session including upto 300 repetition/ session, 4 days/ week or individual maximum repetition) of eating, drinking and combing hair Task specific Training in patient with sub-acute and chronic stroke on Fugl-Meyer UE, Action research arm test, Motor activity log.
- To compare effect of 3200 repetition, 6400 repetition and Individualized Maximum repetition of reaching and grasping Task

specific Training in patient with sub-acute and chronic stroke with respect to Fugl-Meyer UE, Action research arm test, Motor activity log.

Study design: Pilot experimental study

Study setting:

- Shree B. G. Patel College of Physiotherapy Anand.
- Nearby hospital in Anand.

Population: Patient with cerebrovascular accident.

Sample size: 30 (10 in each group)

Sample design: Convenient sampling

Inclusion criteria:

- Ischemic or hemorrhagic stroke as determined by a stroke neurologist and consistent with neuroimaging.
- Unilateral affection.
- 1st stroke
- Time since stroke ≥ 3-months.
- Cognitive skills to actively participate.
- Mild-to-moderate functional motor capacity of the affected upper limb, as indicated by a score of 10–48 on the Action Research Arm Test (ARAT). The lower limit of 10 on the ARAT meant that participants had at least some ability to partially open the hand, grasp and lift off the table at least 2–3 test items.
- Age > 18.

Exclusion criteria:

- Traumatic injury.
- Associated with fracture or soft tissue injury of upper limb.
- Clinical history of neuropathy or neurological/ psychological disorder which may affect recovery.
- Patient unable to provide consent form.
- Cerebellar involvement.
- Participant unavailable for 2-month follow-up.
- Inability to follow 2-step commands.
- Current participation in other upper limb stroke treatments (e.g. Botox).
- Participants living further than one hour away and unwilling to travel for assessment and treatment sessions.
- Pregnancy.

Duration of observation:

- 8 weeks

Duration of study:

- 1 years

Outcome measure:

Fugl Meyer Upper Extremity score (FM-UE) is an ordinal, 3 point rating scale is used for gradation, with 0 as minimum and 2 as maximum. For each component maximum score can be attained and the score of different steps can be totaled for maximum total score of FM-UE. The domains are divided as shoulder, elbow and forearm, wrist, hand and coordination.[5]

Action research arm test (ARAT) assessment consists of four subscales: 'grasp', 'grip', 'pinch', and 'gross movement', which together include 19 items. Each subscale's items are arranged so that if a patient completes the most challenging item, it indicates they can also complete all less challenging items within that subscale. Consequently, the patient is considered to have succeeded in all items of the subtest for that limb. Conversely, if the patient fails the simplest item, it suggests they will not succeed with any more difficult items in that subscale.[6]

The Motor Activity Log (MAL) involves a semi-structured interview designed for patients to evaluate how they use their paretic arm and hand in daily activities. Each activity is rated with two scores: one for the amount of use (AOU) and another for the quality of movement (QOM) of the affected arm. The questions focus on activities undertaken in the past week, or sometimes over the past year.3 Initially, a screening question confirms whether the activity was performed within the specified period. The patient is then asked to what extent the affected arm was used in the activity, with scores ranging from 0 (never using the affected arm) to 5 (always using the affected arm). For QOM assessment, the patient is questioned about how effectively the affected arm assisted in the activity, with scores from 0 (unable to use the affected arm)

to 5 (using the affected arm as effectively as before the stroke).[7]

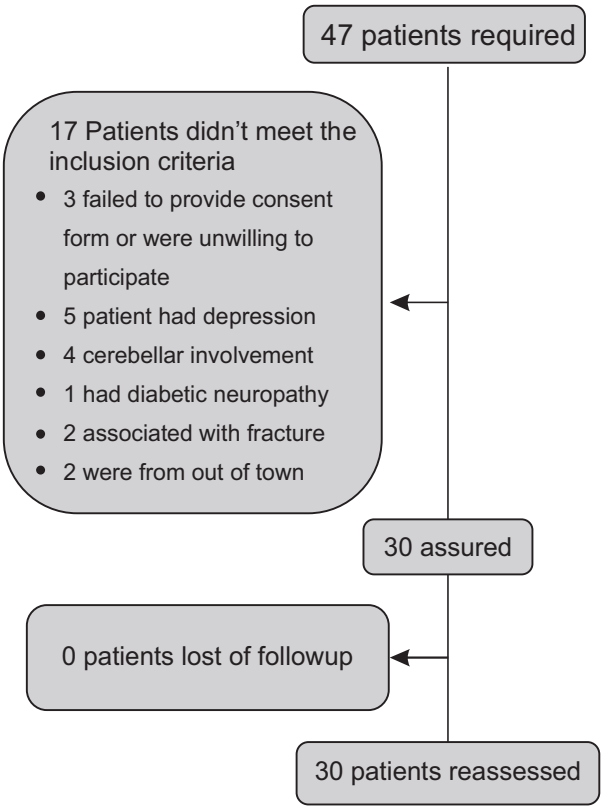


Figure a

Statistical analysis

All the statistical analysis were performed in IBM SPSS statistic v-26. Dropout data were not included for analysis. Kolmogorov Smirnov test was used to assess normality of data. Data are represented in the form of mean and standard deviation for normal data. Within group comparison was done using Pared T test and One way ANOVA was used for between group comparison. Post hoc analysis was carried out for detailed interpretation of result. Level of significance was kept 95% i.e. α value < 0.05.

RESULT

Observation of 30 patients were taken at first observation and follow up of 30 patients were taken. All the observation were taken by a qualified and experienced physiotherapist.

Group A, Group B and Group C showed statistically significant improvement in within group analysis in FM-UE, ARAT and MAL. Suggesting the efficacy of treatment on stroke patient.

In between group analysis for FM-UE score we found statistically significant (p-value = 0.047) improvement in between Group A and Group C suggesting improvement of upper limb function with higher dose of treatment but no statistically significant (P-value>0.05) improvement was found in between Group A and Group B, Group B and Group C.

In between group analysis for MAL score we found statistically significant (P-value<0.05) improvement in between Group A and Group C suggesting improvement of upper limb function with higher dose of treatment although there was no statistically significant (P-value>0.05) difference between Group A and B, and Group B and C

In between group analysis for ARAT score we found no statistically significant (P-value>0.05) improvement in between Group A and B, Group A and C, and Group B and C suggesting no improvement of upper limb function with higher dose of treatment.

Table 1: Baseline characteristic

	Group A	Group B	Group C
Age (Mean Years±SD)	67.6 ± 10.27	48 ± 10.17	62.8 ± 9.66
Gender (%male)	50% Male	60%	60%
Duration of stroke (Months±SD)	3.4 ± 0.49	3.4 ± 0.49	3.4 ± 0.49
FM-UE (Mean±SD)	42.8 ± 13.37	46.1 ± 12.21	44.9 ± 12.53
ARAT (Mean±SD)	29.7 ± 5.8	30.1 ± 5.24	29.9 ± 4.99
MAL AS (Mean±SD)	37.9 ± 16.09	45.7 ± 19.46	43 ± 18.02
MAL WS (Mean±SD)	44.3 ± 16.6	51.4 ± 20..52	48.8 ± 18.03

*The mean difference is significant at 0.05 level

(FM-UE - Fugl Meyer Upper Extremity score, ARAT - Action Research Arm Test, MAL AS - Motor Activity Log Amount Scale, MAL WS - Motor Activity Log Wellness Scale)

Table 2: Within and between group comparison

Scales	Group A			Group B			Group C			Anova	
	Pre Mean (SD)	Post Mean (SD)	P-Value	Pre Mean (SD)	Post Mean (SD)	P-Value	Pre Mean (SD)	Post Mean (SD)	P-Value	F	Sig.
FM-UE	42.8 (13.37)	51.2 (12.34)	0.000*	46.1 (12.21)	57.3 (10.46)	0.000*	44.9 (12.53)	57.9 (10.52)	0.000*	2.66	0.04*
ARAT	29.7 (5.8)	44.9 (8.8)	0.000*	30.1 (5.24)	48.7 (8.41)	0.005*	29.9 (4.99)	49.7 (8.28)	0.004*	0.79	0.46
MAL AS	37.9 (16.09)	80.5 (29.80)	0.000*	45.7 (19.46)	101.2 (34.3)	0.000*	43 (18.02)	121.3 (32.45)	0.026*	3.60	0.041*
MAL WS	44.3 (16.6)	86.6 (26.39)	0.000*	51.4 (20..52)	104 (31.38)	0.000*	48.8 (18.03)	124.7 (30.18)	0.021*	3.78	0.035*

*The mean difference is significant at 0.05 level

(FM-UE - Fugl Meyer Upper Extremity score, ARAT - Action Research Arm Test, MAL AS - Motor Activity Log Amount Scale, MAL WS - Motor Activity Log Wellness Scale)

Table 3: Post Hoc Analysis

Dependent Variable	Groups	Groups	Mean Difference	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
FM-UE	Group A	Group B	-9.80000	5.14112	0.067	-20.3487	.7487
	Group B	IM	-0.90000	5.14112	0.862	-11.4487	9.6487
	IM	Group A	10.70000*	5.14112	0.047*	.1513	21.2487
ARAT	Group A	Group B	-3.80000	4.00842	0.352	-12.0246	4.4246
	Group B	IM	-1.00000	4.00842	0.805	-9.2246	7.2246
	IM	Group A	4.80000	4.00842	0.242	-3.4246	13.0246
MAL-AS	Group A	Group B	-20.70000	15.19898	0.184	-51.8857	10.4857
	Group B	IM	-20.10000	15.19898	0.197	-51.2857	11.0857
	IM	Group A	40.80000*	15.19898	0.012*	9.6143	71.9857
MAL-WS	Group A	Group B	-17.40000	13.85707	0.220	-45.8324	11.0324
	Group B	IM	-20.70000	13.85707	0.147	-49.1324	7.7324
	IM	Group A	38.10000*	13.85707	0.011*	9.6676	66.5324

*The mean difference is significant at 0.05 level

(FM-UE - Fugl Meyer Upper Extremity score, ARAT - Action Research Arm Test, MAL AS - Motor Activity Log Amount Scale, MAL WS - Motor Activity Log Wellness Scale)

DISCUSSION

In our study we found statistically significant improvement of Task Specific Training on FM-UE, ARAT and MAL in all within groups' analysis as suggested by T test (P-value<0.05). Suggesting that Task Specific Training is a promising result giving treatment in patient with subacute stroke.

Recent studies in neuroscience and rehabilitation are increasingly aligning to emphasize the significance of task-specific or task-oriented practice as a crucial component. Engaging in repeated practice of a difficult movement can lead to enduring physiological modifications in motor neural networks, as well as behavioral improvements in motor learning and function. The general mechanism involves the strengthening of particular neuronal connections that are frequently engaged during challenging behavioral practice. The sustained enhancement from practice over several days and weeks promotes connectivity within the motor system through processes such as synaptogenesis, axonal sprouting,

angiogenesis, and possibly neurogenesis, as observed in animal models of stroke.[3]

ANOVA for between group analyses suggested statistically significant improvement of higher dosage compared to lower dosage treatment for FM-UE, MAL-AS and MAL-WS. Hence Post HOC analysis was carried out which suggested statistically significant improvement between Group A and Group C in FM-UE, MAS-AS and MAS-WS, suggesting individual maximum repetition is better compared to 3200 repetition. No statistically significant improvement was found between Group A and B, and Group B and C, suggesting no difference between effect of 6400 repetition compared to individual maximum and 3200 repetition.

Our result is in line with Catherine E. Lang et.al who found that in the higher dose, experimental groups with 57 hours of therapy compared to 24 hours for the lower dose, comparison groups, for every additional 10 hours of therapy, effect sizes increased a small amount (0.034 from model 3).[3]

In our study no statistically significant improvement was found in between group for ARAT which attributed to the treatment protocol of our study. ARAT consist of various activities which were not included in our study like gripping object of various diameter, grasp and lifting blocks and Pinch and lift the ball bearing marble from one shelf of a table to another. These result is in line with Chao Han et.al in which after six weeks of treatment, the Fugl-Meyer Assessment and Action Research Arm Test scores improved more significantly in groups C and B than in group A ($P < 0.05$). There were no significant differences in Fugl-Meyer Assessment and Action Research Arm Test scores between groups B and C ($P > 0.05$).[8]

CONCLUSION

There is a positive relationship between number of repetition and outcome of subacute stroke patient. Thus providing rehabilitation using ≥ 300 repetition for 8 weeks provides significantly better outcome compare to lower repetition therapy.

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