Individual Based Functional Telerehabilitation Physiotherapy Programme for Stroke Patients

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ABSTRACT:

Background: Stroke is defined by the World Health Organisation as "a clinical syndrome typified by rapidly developing signs of focal or global disturbance of cerebral functions, lasting more than 24 hours or leading to death, with no apparent causes other than of vascular origin". The telerehabilitation is a continuation of the rehabilitation process on patients' home. Implementing TR is an effective solution for rehabilitation services delivery in improving the patient's lifestyle(1).So the study was designed to determine whether the individual specific physiotherapy programme in stroke patients is helpful in improving the motor function and ADLs in stroke patients.

Method: A pre and post-test, experimental type study was performed on 24 stroke individual including both females and males in the age group of 24-60 years. 24 subjects were taken which were continued the 8 weeks of therapy session. All the 24 subjects were evaluated offline as pre therapy session evaluation and their informed consent was signed by themselves, assessment form and scales were filled by the therapist. After the completion of all the interventions sessions motor function and independence level with the help of fugl meyer scale and functional independence measures were assessed again for all the 24 individuals, out of which fifteen were evaluated offline and nine were online while the MMAS was assessed of 15 individual in offline mode and rest individuals were not evaluated for spasticity. Statistical analysis was performed using IBM SPSS version 25.0. The VMC of upper limb and lower limb, FMA upper limb and lower limb and FIM were analysed using paired sample t- test. The MMAS score of upper limb and lower limb were analysed using wilcoxon signed ranks test.

Results: The result showed that there were visible tendency to show improvement in individual based functional telerehabilitation physiotherapy programme. There were an improvement in voluntary motor control, motor functions and independence level of an affected individual.Paired t test of VMCUL showed {t=-6.629, df=23, p=0.000} and VMCLL showed{t=-4.147, df=23 ,p= 0.000}.Paired t test of FIM showed { t=-3.285, df= 23, p= 0.003}.Paired t test of FMAUL showed {t=-6.871, df=23, p=0.000} and FMALL showed { t=-4.689, df= 23, p= 0.000}.Wilcoxon signed rank test of MMASUL showed {z=-2.689, p=0.007} and the MMASLL showed {z=-2.980, p=0.003}.

Conclusion: The findings of the study suggest that individual based functional telerehabilitation physiotherapy programme was an effective intervention for increasing the motor functions and ADL's in stroke survivals at home.

Key Words: telerehabilitation, stroke, Functional independence scale,, Fugl meyer scale, modified modified ashworth scale, Voluntary motor control.

INTRODUCTION

Stroke is defined by the World Health Organisation as "a clinical syndrome typified by rapidly developing signs of focal or global disturbance of cerebral functions, lasting more than 24 hours or leading to death, with no apparent causes other than of vascular origin".

Stroke remains a major global health problem and its significance is likely to increase in the future due to on going demographic changes, including aging of the population and health transitions observed in developing countries. According to the American Heart Association, in the United States about 795,000 Americans have a new or recurrent stroke annually. About 4.7 million stroke survivors are alive today, and this number is increasing because of improved acute care. Recent scientific findings fundamental to motor learning and neuroplasticity have challenged the traditional paradigms for motor rehabilitation following stroke. Functional loss in the stroke occurs not only from cells died but also from reduced excitability in neurons that have survived the infarct(2).

The significance for rehabilitation is that there may be viable neurons available for recruitment in the stroke hemisphere, leading to the search for potent mechanisms that promote the restoration of voluntary recruitment of suppressed neurons(3). Stroke is a common cause of disability in adults. After a stroke, it is common for the individual to have difficulty managing everyday activities such as walking, showering, dressing, and participating in community activities.

The literature was cleared that movement retraining for stroke rehabilitation must be intense and prolonged and the patient must engage the task repeatedly and independently. There are numerous barriers for stroke survivors to access usual face-to-face care such as time restraints, resource limitations, geographical isolation, compliance with rehabilitation, and lack of awareness. One manner of addressing access barriers may be through technological innovation such as telemedicine, and more specifically, telerehabilitation.

Telerehabilitation refers to the use of information technology to provide distant support , assessment and information in people who have physical or cognitive impairement(4). Clinically, this term encompasses a range of rehabilitation and habilitation services that include assessment, monitoring, prevention, intervention, supervision, education, consultation, and counseling(5).

The objective of the telerehabilitation is a continuation of the rehabilitation process on patients' home. Implementing TR is an effective solution for rehabilitation services delivery in improving the patient's lifestyle(1). However it is reported less

implementation of this application in developing countries compared to developed country and one of the reason is high cost factor. In Canada , for instance the goal of telerehabilitation is to increase geography accessibility and quality of care for older adult(6).

In Finland , the significance of using telerehabilitation seems to improve economic barriers through reducing travelling cost and time(1). These showed that rehabilitation practitioners are turning to telerehabilitation as a way of improving access, enhancing the quality of care and reducing the cost.

Technology advancement in healthcare has increased life expectancy thereby increasing the number of people over the age of 60 years (7). Inaccessibility, dependency on caregivers and healthcare costs are challenged faced by the persons with stroke. So, the telerehabilitation is used for the practice of effective communication and information technologies solution to deliver clinical rehabilitation services.(8).

At the initial implementation of telerehabilitation projects (i.e, from 1900s to 1940s) , the rehabilitation clinicians generally use technology of telephones, radiographs and closed circuit television to connect to the patients .Then the improvement occurs in 1960 with the combination of television , satellite and visual pre-recorded video to deliver video conference with patients.(9).

It is expected that through the improvement of the internet with high speed wireless will increase the usability and effectiveness of telerehabilitation implementations towards stroke patients. Telerehabilitation is different from telemedicine in the fact that it requires repeated , routine and frequent interaction with the therapist along with complete visualisation of the client whereas telemedicine is often a consultation and the need for visualisation is often a small localised part of the body(10).

Telerehabilitation techniques can be used for stroke patients physical exercise, such as portable transcutaneous electrical stimulation, mirror therapy, home exercise program, and virtual reality exercise and showed that telerehabilitation can be the solution for post-stroke patient's physical rehabilitation during COVID-19 pandemic. This novel health innovation allowed the post-stroke patient to exercise at home and prevent them from the risk of COVID-19 infection(11).

In stroke rehabilitation there is not one optimal intervention for all persons post stroke. As they are a diverse group with variable levels of function, interventions must be carefully selected on the basis of individual abilities and needs. So, the choice of interventions must take into consideration a number of other factors, including phase of post stroke recovery(acute, sub-acute, chronic), severity of the stroke, age of patient , number of comorbidities, cognitive abilities, communication status, affective status, social and financial resources and potential discharge placement(12).

The current study was designed to determine whether the individual specific physiotherapy programme in stroke patients is helpful in improving the motor function and ADLs in stroke patients.

METHODOLOGY: A pre and post-test, experimental type study was performed on 24 stroke individual including both females and males in the age group of 24-60 years. 24 subjects were taken which were continued the 8 weeks of therapy session. All the 24 subjects were evaluated offline as pre therapy session evaluation and their informed consent was signed by themselves, assessment form and scales were filled by the therapist. After the completion of all the interventions sessions motor function and independence level with the help of fugl meyer scale and functional independence measures were assessed again for all the 24 individuals, out of which fifteen were evaluated offline and nine were online while the MMAS was assessed of 15 individual in offline mode and rest individuals were not evaluated for spasticity. subject was in front of phone/ laptop camera and based on intervention the position changed from supine, prone, sitting and standing etc.

Therapist standing/ sitting in front of camera.

Procedure:

- Therapist gave slow speed, clear command with good camera quality and network so that patient / caregivers were able to follow the commands.

- Therapeutic programme was continued for upto 8 weeks and after that post intervention data were taken.
- Individual based physiotherapy approach received based on their motor function and goals of an individual. The mainly used approaches were neurodevelopmental therapy, motor relearning programmes, proprioceptive neuromuscular facilitation techniques, mat activities, sit to stand, transfer and walking.

1. Bridging activities in crook lying position for relieving the pressure on buttocks. 10 times in a session.
2. Deep breathing exercises along with other interventions
3. Reflex inhibiting pattern in sitting, the patient leans forward and reaches both the hands down the floor.
4. Wand exercises in sitting position for upper limb.
5. Stretching of spastic muscles by caregivers.
6. Sit to stand with arm clasped and increased weight bearing on the affected LE by placing the stronger limb slightly forward than the affected limb.
7. Weight shifting exercise in short sitting position with foot and hand supported on ground and couch respectively. The elbow was extended or shoulders were approximated and knee or hips were flexed.
8. Balance training in standing with moving in the posture (weight shift) to reaching task. Weight shifts by moving forward-backward, side to side and diagonally.
9. Proprioceptive neuromuscular facilitation training in standing by drawing of circle on floor in diagonal pattern and tell the patient to reach the affected limb in each circle and support the body on sound limb.
10. Stairs climbing exercise.

DATA ANALYSIS: Statistical analysis was performed using IBM SPSS version 25.0. The VMC (Voluntary motor control) of upper limb and lower limb, FMA (fugl meyer assessment) upper limb and lower limb and FIM (functional independence measures) were analysed using paired sample t- test. The MMAS (modified modified ashworth scale) score of upper limb and lower limb were analysed using wilcoxon signed ranks test. P was set at 0.05 for all statistical analysis.

RESULTS: A total number of 24 subjects mean age 45.6 out of which 19 were male and 5 were female. The result showed that there were visible tendency to show improvement in individual based functional telerehabilitation physiotherapy programme. There were an improvement in voluntary motor control, motor functions and independence level of an affected individual. VMC (VOLUNTARY MOTOR CONTROL) result showed that there was significant difference between the pre and post test. Paired t test of VMCUL showed {t=-6.629, df=23, p=0.000} and VMCLL showed{t=-4.147, df=23 ,p= 0.000}. FIM (Functional Independence Measures) result showed there was significant difference between the pre and post test. Paired t test of FIM showed {t=-3.285, df= 23, p= 0.003}.FMA (Fugl Meyer Assessment Scale) result showed that there was significant difference between the pre and post test. Paired t test of FMAUL showed {t=-6.871, df=23, p=0.000} and FMALL showed { t=-4.689, df= 23, p= 0.000}. MMAS (Modified Modified Ashworth Scale) result showed that there was significant difference in pre and post test score of 15 individuals. Wilcoxon signed rank test of MMASUL showed {z=-2.689, p=0.007} and the MMASLL showed {z=-2.980, p=0.003}.
TABLE 1:

Paired Samples Statistics

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	VMCUL - VMCULP	-1.29167	.95458	.19485	-1.69475	-.88858	-6.629	23	.000
Pair 2	VMCLL - VMCLLP	-1.12500	1.32902	.27129	-1.68620	-.56380	-4.147	23	.000
Pair 3	FIM - FIMP	-7.66667	11.43476	2.33411	-12.49514	-2.83819	-3.285	23	.003
Pair 4	FMAUL - FMAULP	-5.70833	4.06982	.83075	-7.42687	-3.98980	-6.871	23	.000
Pair 5	FMALL - FMALLP	-2.37500	2.48145	.50662	-3.42283	-1.32717	-4.689	23	.000

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
MMASULP - MMASUL	Negative Ranks	9[a]	5.94	53.50
	Positive Ranks	1[b]	1.50	1.50
	Ties	5[c]		
	Total	15		
MMASLLP - MMASLL	Negative Ranks	12[d]	7.29	87.50
	Positive Ranks	1[e]	3.50	3.50
	Ties	2[f]		
	Total	15		

Test Statistics[a]

	MMASULP - MMASUL	MMASLLP - MMASLL
Z	-2.689[b]	-2.980[b]
Asymp. Sig. (2-tailed)	.007	.003

DISCUSSION: The overall result from the study of 24 patients showed that there was a significant improvement in motor function, voluntary motor control, reduction in spasticity and independence level of an affected individual after 8 weeks of therapeutic interventions.

Motor functions and motor control:

There was significant improvement in motor function and motor control after 8 weeks of individual based functional telerehabilitation physiotherapy programme. The result showed that there was significant difference between the pre and post test (p=0.000 in upper limb and p=0.000 in lower limb) of motor function. In this study the motor function of all the 24 individuals of mean age 45.6 showed 22.5% improvement in upper limb and 12.7% in lower limb. The motor function of sub- acute stage included 14 individuals showed 24.2% improvement in upper limb and 15.2% in lower limb while the chronic stage(TABLE 2) included 10 individuals showed 20.6% improvement in upper limb and 9.5% in lower limb.

The result showed that there was significant difference between the pre and post test (p=0.000 in upper limb and p=0.000 in lower limb) of motor control level in stroke individual. The voluntary motor control of 24 individuals of mean age 45.6 showed 31.3% improvement in upper limb and 25.8% in lower limb. The motor control of sub- acute stage included 14 individuals in showed 33.3% improvement in upper limb and 25.3% in lower limb while the chronic stage included 10 individuals showed 29.4% improvement in upper limb and 20.7% in lower limb.

The possible reason for improvement could be due to the intervention like bridging exercise it helped to strengthen the core muscles, the unilateral bridging on affected side which helped in standing for weight bearing on affected side. Bridge exercise was effective in improving weight bearing in a standing position and improving balance on stroke patients. The unilateral bridge exercise were especially more effective in anterior, posterior length in limit of stability following on standing.

Song & Heo et al(13) did a study to verify the effects of a modified bridging exercise on stroke patients with improvement in weight bearing on the affected side in standing and static balancing ability. Thirty patients who had a stroke were taken and unilateral bridging exercise was given and the result showed the significant changes in weight bearing in a standing position after the intervention.

The intervention of deep breathing exercise training might improve both the respiratory muscle functions and the exercise ability of patients with weakened respiratory muscles in stroke patients. Deep breathing exercise improves the tidal volume and total lung capacity of an individual which may be diminished after stroke. The aerobic exercise promotes neuroplasticity by increasing BDNF production and may facilitate the acquisition and retention of motor skills for poststroke rehabilitation.

Journal of Korean physical society identified the effect of breathing training on the physical function and psychological problems in patients with chronic stroke. 26 patients with chronic stroke result concluded that breathing training was effective improvement physical function, and psychological problems in patients with chronic stroke.

One study examined the effects of engaging in aerobic exercise over several weeks on motor learning in individuals with stroke. In this study, participation in an 8-week aerobic cycling program improved within-session performance of a motor sequence task and aerobic exercise training improved motor skill acquisition(14).

The intervention of PNF patterns exercise which improved the flexibility, ROM and helps in doing the motor task and improved the motor function. A study done to review possible mechanisms, proposed theories, and physiological changes that occur due to proprioceptive neuromuscular facilitation techniques. Four theoretical mechanisms were identified: autogenic inhibition, reciprocal inhibition, stress relaxation, and the gate control theory. Proprioceptive neuromuscular facilitation showed potential benefits if performed correctly and consistently(15).

The other possible reason for improvement could be the cortical reorganisation of brain because brain has ability to reorganize itself, both physically and functionally, throughout our life due to our environment, behaviour, thinking, and emotions and with the help of these interventions brain learned the movement and helped in improvement of motor function.

One study done by Mang et al (16) stated that recovery of motor function after stroke involves relearning motor skills and is mediated by neuroplasticity. Many molecular signaling pathways are involved, brain-derived neurotrophic factor (BDNF) has emerged as a key facilitator of neuroplasticity involved in motor learning and rehabilitation after stroke. Thus, rehabilitation strategies that optimize BDNF effects on neuroplasticity may be especially effective for improving motor function in poststroke individuals.

Two potential poststroke rehabilitation strategies that considered the importance of BDNF were the use of aerobic exercise to enhance brain function and the incorporation of genetic information to individualize therapy. Converging evidence demonstrated that aerobic exercise increases BDNF production and consequently enhances learning and memory processes.

The possible reason of improvement might be due to motor learning during rehabilitation interventions. During the therapy session there was repeated practice or experience of a certain movement or task in home environment which were helpful in controlling the voluntary control. The continue extrinsic feedback was delivered to the individual by the therapist that helped in performing the task accurately and positive feedback enhanced the motor learning in an affected individual.

One study (17) found the efficacy of the motor relearning approach in promoting physical function and task performance for patients after a stroke. The motor relearning programme was found to be effective for enhancing functional recovery of patients who had a stroke.

J et al (18) studied the impact of electromyographic biofeedback applied during functional gait activities and employed in accord with theories on motor learning was investigated in a chronic hemiplegic patient. There were significant changes in ankle power at push-off, both in amplitude and timing, as well as onset of ankle power at push-off relative to heel strike of the healthy leg. There was a significant increase in gait velocity, step length of the healthy side, stride length, and stride frequency.

Functional independence :

The result showed there was significant difference between the pre and post test ($p= 0.003$)of independence in ADLs. This study of 24 individuals mean age was 45.6 showed 7.82% improvement in independence level for the activities of daily livings. The subacute stage included 14 individuals showed 8.83% improvement while the chronic stage included 10 individuals showed 6.45% improvement in independence level.

The possible reason could be as there were 14 patients whose stroke duration was 2 months to 9 months and by giving early intervention for return to their daily activities was helpful. The early onset of rehabilitation was enabled the patient to perform more comfortable ADLs and to achieve more functional gain. The home environment such as stair rails and grab bar increased independence and safety at home. Supportive family and social networks were played an important role to return to normal activities and with the help of telerehabilitation these intervention was given for each individual.

Feys et al (19) investigated the effect of a specific therapeutic intervention on arm function in the acute phase after stroke which showed significant only at follow-up a specific intervention during the acute phase after stroke improved motor recovery.

Çakir T (20) found the effect of rehabilitation in patients admitted to their clinic after stroke. The FIM gain and FIM efficiency in patients with acute phase were higher in patients with chronic phase in that retrospective study conducted in 126 hemiplegic patients.

Morone et al (21) found the probability of achieving independence and the related prognostic factors with regard to single activities of daily living after 3 months of rehabilitation following stroke. The highest improvement after rehabilitation was observed for bowel and bladder function and transfer and mobility, whereas the lowest improvement was seen in bathing, grooming, dressing, and stair climbing.

The other reason might be due to core strengthening exercises for trunk stability because Core stability is important for functional integration of the passive spinal coloumn, active spinal muscles and the neural control unit in a manner that allow the individual to maintain intervertebral neutral zones within physiological limit, while performing ADLs.

Cabanas et al (22) systematically reviewed the literature on trunk training exercises in adult patients with stroke and found that trunk training exercises showed a moderate evidence to improve trunk performance and dynamic sitting balance. Trunk training exercises, performed with either stable or unstable surface, could be a good rehabilitation strategy.

Spasticity:

The result showed that there was significant difference in pre and post test score (p=0.007 in upper limb and p=0.003 in lower limb) of 15 individuals. The spasticity level of 15 individuals of mean age 48.4 showed 46% reduction in upper limb and 48.8% reduction in lower limb.

The reduction in spasticity might be due to regular stretching of tight muscles. This could partly be explained by the inhibition of afferent inputs from muscle receptors i.e, Muscle Spindle and Golgi Tendon Organ on spinal reflexes. This inhibit the tension in spastic muscle, so that allowed the parallel elastic component of muscle to lengthen.

As spasticity is the velocity-dependent increase in muscle tone due to the exaggeration of stretch reflex (23). The central lesion causing the UMNS disrupts the balance of supraspinal inhibitory and excitatory inputs directed to the spinal cord, leading to a state of disinhibition of the stretch reflex.

The other reason might be reflex inhibiting movement pattern which involved prolonged pressure on long tendons that inhibits the hypertonicity of muscles.

The reduction in spasticity might be due to weight bearing exercise in sitting with affected side hand open, elbow extended and upper extremity supporting body weight was used to promote inhibition of long finger flexors.

The mechanism of improvement in motor function and motor control was possibly due to the interventions like bridging exercise unilateral as well as bilateral which helped in strengthening of core muscle or made them capable for bearing the weight on affected side, deep breathing exercises which activate the bone derived neurotrophic factors(BDNF) that was a facilitator for neural reorganisation of brain and helpful in learning of tasks. Individual specific interventions was given and a continuous extrinsic feedback from the therapist as well as from the caregivers were given to the individual that might be helpful in accuracy of the task specific training in an affected individual. The proprioceptive neuromuscular facilitatory technique training in standing for the lower limb by drawing the circle on floor in diagonal pattern and command the patient to reach the affected foot in each circle by balancing himself / herself on sound side limb. By continuation or repeated practicing the task in blocked and then whole may also had contribution in improving the function in an individual specific telerehabilitation programme. The mechanism of improvement in functional independency and extensibility might be due to the home environment that was provided for doing the task like holding the glass, fruits, spoon and biscuits etc. in affected hand and reached them to the mouth that might be helpful for regaining self-care activities. Wand exercises was given with the help of a stick that might improve the range of motion and flexibility in an affected individual. Gait training and stairs climbing might helpful in improving the locomotion. Regular stretching of the tight structure might be helpful to improve of soft tissue extensibility and helpful in motor function as well as the independence level.

Conclusion:

The findings of the study suggest that individual based functional telerehabilitation physiotherapy programme was an effective intervention for increasing the motor functions and ADL's in stroke survivals at home.

Limitations and future recommendations:

1. The present study was conducted for 8 weeks at definite time interval for therapy. The length of the therapy session could have been longer to see the significant effect in motor function and ADLs.
2. Small sample size of the study.
3. No follow up measures were taken so as to see the retention of benefits.
4. Care giver were strictly bound to such patients during operating the whatsapp or zoom videocall and sometime the caregivers were busy in their own work so they were not able to continue the therapy on fixed time schedule.
5. There was network issue faced by the affected individual.
6. Homogenous group may also showed the same result if compared.
7. 15 persons were evaluated offline while 9 subjects were examined online so it may limit the study result.

Future recommendations:

Further comparative study could be done to see the effectiveness between in hospital based rehabilitation and telerehabilitation.

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