Research Article

Physiotherapy

A Comparative Study to Check the Effectiveness of Task Oriented Activity on Walking Speed in Sub-Acute Stroke Patients

[1]Tokupu K Shohe, [2]Trishna Saikia Baruah[*], [3]Mantu Paul,[4] Abhijit Dutta and [5] Abhijit kalita

[1]MPT Scholar, Faculty of Paramedical Sciences, Assam downtown University, India
[2]Assistant Prof. Physiotherapy Faculty of Paramedical Sciences, Assam downtown University, India
[3]Assistant Prof. Physiotherapy Faculty of Paramedical Sciences, Assam downtown University, India
[4,3]Associate Prof., Associate Dean, Faculty of Paramedical Sciences, Assam downtown University, India
[5] Assistant Prof. Physiotherapy Faculty of Paramedical Sciences, Assam downtown University, India

Abstract: Stroke which is also known as cerebrovascular accident (CVA) is a leading cause of impairment and disability in the world. There are many factors that affect the functional independence in post stroke people in which gait impairment plays a significant role. The purpose of stroke rehabilitation is to help patients to achieve as high level of functional independence as possible within their particular impairments. It is found that Task oriented activity has been shown to be an effective intervention to improve mobility. However, little is known about the impact of this intervention on the walking speed. The objective of study is to determine the combined effects of task oriented activity with conventional physiotherapy over conventional physiotherapy alone on walking speed in subjects with sub-acute stroke. This was a comparative study where pre and post design were used. Thirty (30) subjects with sub-acute stroke were taken considering the selection criteria; where Experimental group (Group-A) received task oriented activities and conventional physiotherapy and Control group (Group-B) received Conventional physiotherapy with 15 subjects in each group. Six minutes walk test (MWT) was used to assess the walking endurance and Functional ambulation categories (FAC) was used to evaluate the level of dependency of subjects in performing functional activities. Statistical analysis was done by using paired 't' tests which showed significant improvement as the mean value of Group A (experimental group) mean 6MWT increase from -0.517 to -17.582, mean FAC increase from -1.288 to -3.055 but when intergroup analysis was done, its result was significant only in 6MWT were P= 0.046. task oriented activity after stroke could significantly improve walking endurance but not much significant on the level of dependency of the subject in performing functional activities.

Keywords: Task oriented activity, conventional physiotherapy, sub-acute stroke, walking speed, 6MWT, FAC.

1. INTRODUCTION

Stroke which is also known as cerebrovascular accident (CVA) is a leading cause of adult disability worldwide and is a global health problem[1] and requires care over long periods of time to deal with lifetime disabilities[2]. Recurrence of stroke occurs in many individuals, which results in more disabling conditions and walking being the most affected activity in stroke, with as many as 80% of patients initially losing this ability [3,4]. Stroke is defined as a condition characterized by rapidly developing symptoms and signs of a focal brain lesion with symptoms lasting for more than 24 hours or leading to death with no apparent cause other than vascular origin. (WHO, 1989)[5]. Hemiparesis or hemiplegia is the most common symptoms secondary to stroke that could restrict joint movement and reduce the ability of muscle contraction especially on the contralateral side of the lesion that can cause deficiencies in movement, sensation, speech, cognition, perception, and balance[6-8]. Walking function is severely impaired following stroke, in more than half of the stroke survivors and these make walking regaining and enhancing walking competency an integral component of the treatment[9,10]. Task oriented activity is a group of interventions that are designed to enable people to accomplish specific tasks or acquire specific beliefs, such as in the ability to control one's disease[11]. In this approach, movement emerges as an interaction between many systems in the brain and is organized around a goal and constrained by the environment[11,12]. Task related activity is a rehabilitation strategy that requires patients to work in task-specific or self-driven or practice or goal-directed activity and functional movements in a natural environment to help patients derive optimal control strategies and for definite attentiveness and enthusiasm. During task-oriented training many types of movement are practiced, to limit compensatory movements and increase adaptive movements[13-16]. Hence, the purpose of this study is to compare the combined effectiveness of task oriented activity with conventional physiotherapy over conventional physiotherapy alone on walking speed with sub-acute stroke patients.

2. MATERIALS AND METHODS

2.1 Study Design

The study was a comparative study which was carried out with thirty (30) subjects, both male and female with a diagnosis of stroke by the physician and exhibiting a walking deficit were recruited for the study. Twenty (20) male and ten (10) female participants were present in this study. Participants were recruited through random sampling. Each participant was explained about the study and after receiving Informed Consent from each participant with Ethical approval received from Ethical Committee from Assam down town University with Approval number no– Adtu/Ethics/stdnt-lett/2021/05. This study was conducted at physiotherapy OPD Assam downtown university and physiotherapy OPD downtown hospital. Duration of the study was 8 months.

2.2 Inclusion criteria

This study includes both males and females with age group between 35-65 years, hemiplegia following stroke, functional ambulation category(FAC) score of 3 or more, doesn't have any medical contraindication to walking, Brunnstrom voluntary control(BRS) grade 3 or more, duration after stroke between 4 weeks to 6 months, presented the ability to walk at least 10 meters alone or with an aid, but without stand by assistance, Modified Ashworth scale (MAS) 1+, 2.

2.3 Exclusion criteria

The exclusion criteria were uncontrolled hypertension, recent pulmonary embolism, sub-acute systemic illness or infection, Atrial fibrillation, cardiac arrhythmias or any such conditions which make exercise contraindicated, aphasia, joint contraction pain or fracture of the musculoskeletal system, Hemianopsia, subjects with sensory impairments involving lower limbs, subjects with perceptual disorders, history of any orthopedics conditions interfering with gait, subjects with sensory impairment involving lower limbs.

3. PROCEDURE

The subject was assigned into two groups- Group A (experimental group) & Group B (control group) by random sampling, each group containing 15 subjects. Pre and post-test were conducted on Group A and Group B by 6MWT to assess the walking endurance of the subjects, FAC for evaluating the level of dependency of subjects in performing functional activities. All the subjects received the intervention of 20 therapy sessions, every 5 days/week lasting for 4 weeks time frame.

3.1 Group A (Experimental group)

The treatment begins with usual conventional physiotherapy of Range of motions exercise, Stretching, Strengthening exercise[17-18] in the affected lower limbs fellow by task oriented activities inspired by Dean CM, et al 2000[19] which was modified and consists of 2 task designed to strengthen the lower extremities and enhance the walking balance, speed and distance in a progressive manner. Tasks are (1) Lateral Step up and step down, (2) Sit to stand lasting for 20-30 minutes.

i.   **Lateral step up and step down (Fig.1)**

Activity were performed using stool of various heights (5.5 to 12 inches). The subjects stand and flex their knee against the stool with maximal effort. The pelvis was stabilized using therapist hand. Progressing by let the subjects slowly raises and lower themselves using involve leg while standing on the uninvolved leg and the foot on the uninvolved side is dorsiflexed and only the heel is allowed to touch the ground. Involved leg was force to control the motion as weights bearing in uninvolved leg were not allowed. Activities last for 10-15 minutes[20,21].

ii.   **Sit to stand (Fig.2(a, b)**

The subjects were seated on an armless, height-controlled chair, which were adjusted to allow for approximately 90 - degree angles at the hip and knee joints, initially individual performed five self-paced which was for familiarized with the activity, followed by sit to stand activity lasting for 10-15 minutes, instructions were given as follows "by the count of 3, stand up and hold for 10 seconds and sit down for 10 times. A one minute rest period was given between activities to prevent fatigue. Lean your back against the chair's back rest at the end of every repetition." The timing started once

the participant's back left the backrest and stopped once the   back touched the backrest[22].

Fig 1: Lateral step up and step down

Fig 2(a): Sit to Stand

Fig 2(b):Sit to Stand

3.2 Group B (Control group)

The control group received only the usual conventional physiotherapy of Range of motions exercise, Stretching, Strengthening exercise in the affected lower limbs for 20-30 minutes. Subjects also received Standing and balance retraining carried out in parallel bar and Walking in parallel bar progressing to free over ground.

i. Standing and Balance Retraining Carried Out in Parallel Bar

Initially the subjects stand in parallel bar with 2 hands then progress to 1 hand support, fellow by more complex activities by standing unsupported, changing the base of support, from wider to narrow base of support, tandem standing, standing on one leg for 10-15 minutes[18]. of dependency of subjects in performing functional activities

ii. Walking in Parallel Bar Progressing from assisted to Free Over Ground.

Parallel bars and the therapist supports him or her with the unaffected hand as required. Assistance was provided by the therapist to move the subject's leg in the correct pattern and thus preventing the subjects from moving the leg back in full extension. When the subject moves the leg back with the correct pattern, the therapist gradually reduces the amount of assistance. Secondly, as the movement components were practiced and the subjects were taken over actively with only

slight help, the walking were facilitated by walking within parallel bars and finally, the distance and speed of walking backward were progressively increased[23].

4. Outcome Measures

Six minutes walk test (6MWT)[24] and Functional Ambulation Category (FAC)[25] were used as outcome measures to assess the walking endurance of the subjects and to evaluate the leve

5. STATISTICAL ANALYSIS

Descriptive data was presented as mean ± standard deviation and number (percentage). The paired sample t-test and independent sample t-test was used to compare the results after 4 weeks in each group. The significance level of this study was set at $p < 0.05$.

6. RESULTS

This was an 8 months structured study performed to compare the combined effectiveness of task oriented activities with conventional physiotherapy and conventional physiotherapy in patients with sub-acute stroke. The result showed that all the interventions brought significant result in their groups i.e. Group A (Task oriented activity with conventional physiotherapy) Group B (Conventional physiotherapy) but in comparing both the groups it was found that Group A was more significant than Group B.

Table 1: Intra-group analysis of Group A and Group B of 6MWT							
Group	6 MWT	Mean ± S.D	N	T	Df	P	Remarks
Group A	Before Treatment (Pre- Test)	205.70 ± 21.99	15	-17.582	14	0.00	S
	After Treatment (Post- Test)	244.27 ± 28.09	15				
Group B	Before Treatment (Pre- Test)	209.34	15	-1.658	14	0.121	NS
	After Treatment (Post- Test)	220.14	15				

S* Significant NS* Not significant Values are mean± SD; (n=15)

Table 1: It is seen that in group A there was a significant difference between pre-test and post-test since p<0.05 and the protocol is effective since it means 6MWT score increase from 205.70 to 244.27. In group B, there was no significant between per-test and post-test since p>0.05 and protocol is not effective since mean value score increase from 209.34 to 220.14   .

Table 2: Intra-group analysis of Group A and Group B of FAC							
Group	FAC	Mean ± S.D	N	T	Df	P	Remarks
Group A	Before Treatment (Pre-Test)	3.13 ± 0.35	15	-3.055	14	0.009	S
	After Treatment (Post- Test)	3.53 ± 0.51	15				
Group B	Before Treatment (Pre-Test)	3.33 ± 0.48	15	-1.000	14	0.334	NS
	After Treatment (Post-Test)	3.40 ± 0.50	15				

S* Significant NS* Not significant Values are mean± SD; (n=15)

Table 2: It is seen that in group A there is significant difference between pre-test and post-test since p<0.05 and the protocol is effective since it means FAC score increases from 3.13 to 3.53. In group B there is no significant difference between pre-test and post-test since p> 0.05 and protocol is not effective since mean value score increases from 3.33 to 3.40.

Table 3: Inter-group analysis between Group A and Group B: Post test						
Scales	Group	Mean ± S.D	T	Df	P	Remarks
6MWT	Group A	244.27 ± 28.09	2.088	28	0.046	S
	Group B	220.14 ± 34.83				
FAC	Group A	3.53 ± 0.51	0.714	28	0.481	NS
	Group B	3.40 ± 0.50				

S* Significant NS* Not significant Values are mean± SD; (n=15)

Table 3: Independent t-test was performed to compare between experimental group (Task oriented activity with conventional physiotherapy) and control group (Conventional physiotherapy) With respect to 6MWT p= 0.046, which was statistically significant. With respect to FAC p= 0.481. Result for comparison of a six minutes walk test(6MWT) between both the groups has been demonstrated in Table 3, a change in outcome measures in both the groups was evident. It has been inferred that walking speed increased significantly among subjects in the experimental group as compared to that of subjects in the control group. Comparison of functional ambulation category (FAC) between the groups has been demonstrated in the Table 3, to find the level of dependency in performing functional activities in both the groups. It has been shown that Group A results better in level of dependency in performing functional activities to the overall FAC mean score. But, since p=.481 it is not significant

7. DISCUSSION

The study was to compare the combined effectiveness of task oriented activities with conventional (Group A) and conventional physiotherapy (Group B) on walking speed in patients with sub-acute stroke by measuring 6MWT for walking endurance and FAC for measuring the level of dependency in performing functional activities. Many randomized controlled trials studies[19, 26-27] have found task oriented intervention to be effective in improving walking speed and functional abilities in chronic stroke. The study shows that there was a significant effects of task oriented activity on gait endurance in sub-acute stroke patient. After stroke, trunk control has also been identified as an important early predictor of functional outcome[28,29]. Postural stabilization of the body will improve the performance of the core muscles which support the initiation of motor impulse processes to make more stable movements so as to improve balance[30]. The change in the experimental group was significantly larger than the control group. Bo Hyun kim et al (2012)[13] has demonstrated that task-oriented training after a stoke can improve the trunk control ability, balance and gait. A Anas Ahamad et al (2019)[31] shows that task-oriented training program was more effective in improving balance in stroke. B. Deekshita et al (2014)[32] found task oriented exercise appeared effective in improving standing balance in subject with the stroke. The result of this study are similar to those of K young kim et al (2017)[1] reporting that task-oriented-gait training improves the results of 6MWT and showed that task-oriented circuit training could improve the gait ability in patients with sub-acute stroke. Task oriented training could provide proper visual input and perhaps substitutes for absent or reduce proprioceptive input from the affected side[33] and improved motor performance, motor control strategies, sensory recovery, and daily function more than the conventional treatment[34] Walking ability as measured with the 6-minute walk test is associated with a higher quality of life and is a good predictor for the walking capacity in these patients[35], changes in the values of 6MWT showed significant improvement in the experimental group which represent the therapeutic effects of task oriented activity and support the earlier findings of studies on exercise designed to improve walking functions of stroke survivors when compared with conventional Physiotherapy[36].. Qurat-ul-Ain et al (2018)[2] reported circuit gait training improves mobility and gait in stroke patients. Wevers L et al 2009[4] support the use of

task-oriented circuit class training to improve gait and gait-related activities. Both groups significantly improved in their mean value, as pre and post-test mean value of Group A (205.70 to 244.27) and group B (209.34 to 220.14). Significance difference in between groups was identified for the 6 MWT (p < 0.05.). Cho et al. (2004)[37]reported that after task-oriented training, the walking speed of stroke patients increased significantly from 2.88 m/s to 3.74 m/s. Yang et al. (2009)[38] stated that the gait speed of stroke patients was increased significantly from 0.84 ± 12.7 m/s to 0.92 ± 13.5 m/s by task-oriented progressive resistance strength training. These results are similar to those of this study and suggested that task-oriented activities are more effective than conventional physiotherapy alone[39].Although there was no significant difference in variation of FAC were observed between experimental and control groups where the FAC mean score of group A, post treatment was 3.53 and the mean FAC score of group B post treatment is 3.40. FAC significance was shown pre and post-test within the groups. A meta-analysis of Byoung- Jinjeon et al (2015)[40] provides evidence of task-oriented training for improving functional after stroke. Sakina Katerawalaet al[12] in their study found evidence of effectiveness of task oriented approach on improving balance, self-efficacy and functional status. Study conducted by DocuAxelerad Any et al. (2016)[8] provides evidence of task oriented for improving functional after stroke. Thus our findings suggest that task oriented activity could improve the gait ability in patients with stroke and therefore task oriented should be considered an essential part of therapeutic program for sub-acute patients.

8. LIMITATION AND FUTURE SCOPE

Limitation of study includes that it consisted of a short course of treatment of 20 therapy sessions, the sample size was small, upper limbs were not taken into account. Whereas future scope can include, the study can done with larger sample size with longer duration, it can also be done by taking upper limbs into account, fellow up and recording of the effects of the interventions may also give more better results, further study can be done on how to help people maintain and improve their physical abilities after their stroke rehabilitation programs ends and also more research can be done to investigate the cost-effectiveness of the interventions.

9. CONCLUSION

All the interventions brought about some improvement in each group post-treatment based on the mean score but its significance varies. It has shown that the subjects who received task oriented with conventional physiotherapy are more effective when compared with the other Group A not only focused on restoring reduced motor control of the affected limb as well as postural control, but rather with the development of compensation movement strategies and improved coping with loss of function in enhancing the ability to maintain balance over the non-paretic lower limb. So, this study can be concluded that, the treatment protocol, Range of motion, stretching, strengthening, lateral step- up step-down and sit to stand could bring a significant difference with regard to walking endurance and walking speed but not much of difference in level of dependency in performing functional activities in patients with sub-acute stroke.

10. AUTHORS CONTRIBUTION STATEMENT

Tokupu k shohe, MPT scholar carried out the research work in data collection, review of literature and prepared the thesis as a part of the curriculum of Master in physiotherapy. Dr. Trishna Saikia Baruah (PT) (Corresponding Author) Assistant Professor, Assam Downtown university guided as the main supervisor in the whole study along with topic selection, literature reviews, methodology, results analysis and discussion of the study. Dr. Abhijit Dutta (PT), Associate Prof., Associate Dean Faculty of Paramedical Sciences, Assam down town University contributed in the study as co-guide and guided in literature reviews, data collection, discussion and in methodology part. Dr. Mantu Paul(PT), Assistant Professor, Assam Downtown university contributed in the study as co-guide and guided in literature reviews and data collection. Dr. Abhijit kalita (PT), Assistant Professor, Assam Downtown university contributed in the study as co-guide and guided in literature reviews and discussion part.

11. CONFLICT OF INTEREST

Conflict of interest declared none.

12. REFERENCES

1. Kim K, Jung SI, Lee DK. Effects of task-oriented circuit training on balance and gait ability in subacute stroke patients: a randomized controlled trial. J PhysTher Sci. 2017 Jun;29(6):989-992. doi: 10.1589/jpts.29.989. Epub 2017 Jun 7. PMID: 28626306; PMCID: PMC5468221.

2. Qurat-Ul-Ain, Malik AN, Haq U, Ali S. Effect of task specific circuit training on Gait parameters and mobility in stroke survivors. Pak J Med Sci. 2018 Sep-Oct;34(5):1300-1303. doi: 10.12669/pjms.345.15006. PMID: 30344596; PMCID: PMC6191776.

3. Martins JC, Aguiar LT, Nadeau S, Scianni AA, Teixeira-Salmela LF, Faria CDCM. Efficacy of Task-Specific Training on Physical Activity Levels of People With Stroke: Protocol for a Randomized Controlled Trial. PhysTher. 2017 Jun 1;97(6):640-648. doi: 10.1093/physth/pzx032. PMID: 28371936.

4. Wevers L, van de Port I, Vermue M, Mead G, Kwakkel G. Effects of task-oriented circuit class training on walking competency after stroke: a systematic review. Stroke.2009 Jul;40(7):2450-9. doi: 10.1161/STROKEAHA.108.541946. Epub 2009 May 21. PMID: 19461035.

5. Remya M Nair, Jince Augustine. Effectiveness of task oriented walking intervention on improving balance in MCA stroke patients. Int J PhysEduc Sports Health 2021;8(2):103-108.

6. Arabzadeh, Soodeh&Goljaryan, Sakineh&Salahzadeh, Zahra &Oskouei, Ali &Somee, Abbas. (2016). Effects of a Task-Oriented Exercise Program on Balance in Patients with Hemiplegia Following Stroke.Iranian Red Crescent Medical Journal.inpress.10.5812/ircmj.38429.

7. Kim B, Park Y, Seo Y, Park S, Cho H, Moon H, Lee H, Kim M, Yu J. Effects of individualized versus group task-oriented circuit training on balance ability and gait endurance in chronic stroke inpatients. J PhysTher Sci. 2016 Jun;28(6):1872-5. doi: 10.1589/jpts.28.1872. Epub 2016 Jun 28. PMID: 27390437; PMCID: PMC4932078.

8. DocuAxeleradAny et al. Role Of Task-Oriented Training After Stroke Science, Movement and Health, Vol. XVI, ISSUE 2, 2016 June 2016, 16 (2): 164-169.

9. Emmanuel Frimpong, M.Phil, OlajideAyinlaOlawale et al. Task-oriented circuit training improves ambulatory functions in acute stroke: a randomized controlled trial. Journal of Medicine and Medical Sciences Vol. 5(8) pp. 169-175, August 2014.

10. Outermans JC, van Peppen RP, Wittink H, Takken T, Kwakkel G. Effects of a high-intensity task-oriented training on gait performance early after stroke: a pilot study. ClinRehabil. 2010 Nov;24(11):979-87. doi: 10.1177/0269215509360647. Epub 2010 Aug 18. PMID: 20719820.

11. Choi JU, Kang SH. The effects of patient-centered task-oriented training on balance activities of daily living and self-efficacy following stroke. J PhysTher Sci. 2015 Sep;27(9):2985-8. doi: 10.1589/jpts.27.2985. Epub 2015 Sep 30. PMID: 26504340; PMCID: PMC4616141.

12. SakinaKaterawala, Ravi Shah et al. Effect of task oriented activity training on improving balance and self efficacy in sub acute stroke. International Journal of Health Sciences & Research (www.ijhsr.org) 109 Vol.9; Issue: 5; May 2019.

13. Bo Hyun Kim, PT, MSC, Suk Min Lee, PhD et al. The Effect of a Task-oriented Training on Trunk Control Ability, Balance and Gait of Stroke Patients. J. Phys. Ther. Sci.24: 519–522, 2012.

14. Aysha Khan, AmnaYaseen, et al. The effects of a task oriented walking interventions on balance in chronic stroke patients. Journal of Experimental Stroke and Translational Medicine.JESTM (2021) 13(1), 1-8 ISSN: 1939-067X

15. Vijay ghag, D. S., &Shyamganvir, D. S. (2018). Task-Oriented Training In Rehabilitation of Gait After Stroke: Systematic Review. Journal of Medical Biomedical and Applied Sciences, 6(3), 23-31. https://doi.org/10.15520/jmbas.v6i3.101

16. Amandeep Singh, DavinderKaur, RajneetKaurSahni, SimranGrewal, Comparison of Dual Task and Task Oriented Training Programme on Gait in Chronic Stroke, International Journal of Neurologic Physical Therapy .Vol. 5, No.2, 2019,pp. 42 - 50 .doi:10.11648/j.ijnpt.20190502.13

17. EkaRhestifujiayani et al. Comparison of Muscle Strength in Stroke Patients between The Given and Not Given Range of Motion Exercise. Nurse Media Journal of Nursing, 5 (2), 2015, 88 - 100 Available Online at http://ejournal.undip.ac.id/index.php/medianers

18. Dr P Keerthi Chandra Sekhar et al. Efficacy of isokinetic strength training and balance exercise on lower limb muscles in subjects with stroke.Int J physioth Res 2013(2); 25-19

19. Dean CM, Richards CL, Malouin F. Task-related circuit training improves performance of locomotor tasks in chronic stroke: a randomized, controlled pilot trial. Arch Phys Med Rehabil. 2000 Apr;81(4):409-17. doi: 10.1053/mr.2000.3839.PMID: 10768528.

20. Chinkulprasert C, Vachalathiti R, Powers CM. Patellofemoral joint forces and stress during forward

step-up, lateral step-up, and forward step-down exercises. J Orthop Sports PhysTher. 2011 Apr;41(4):241-8. doi: 10.2519/jospt.2011.3408. Epub 2011 Feb 2. PMID: 21289449.

21. Mohan.N. Effectiveness of lateral and forward step up exercises among selected muscles: An EMG study. Indian journal of Physiotherapy and Occupational therapy. Vol.2, No. 2 (2008-04-2008-06)

22. Mao YR, Wu XQ, Zhao JL, Lo WLA, Chen L, Ding MH, Xu ZQ, BianRH, Huang DF, Li L. The Crucial Changes of Sit-to-Stand Phases in Subacute Stroke Survivors Identified by Movement Decomposition Analysis. Front Neurol. 2018 Mar 26;9:185. doi: 10.3389/fneur.2018.00185. PMID: 29632510; PMCID: PMC5879445.

23. Yea-Ru Yang et al. Gait outcomes after additional backward walking training in patients with stroke: A randomized controlled trial. Article *in* Clinical Rehabilitation · June 2005 DOI: 10.1191/0269215505cr860oa · Source: PubMed

24. Darren K cheng et al. Validation of stroke-specific protocols for the 10-meter walk test and 6-minute walk test conducted using 15- meter and 30-meter walkways. Top stroke rehabil. 2020 may; 27(4):252-261. Doi: 10.1080/10749357.2019.1691815. Epub 2019 Nov 21. PMID: 31752634

25. Jan mehrholz et al. Predictive validity and responsiveness of the fubctional ambulation category in hemiparetic patients after stroke.Archphys med Rehabil. 2007 oct;88(10):1314-9. Doi: 10.1016/j.apmr.2007.06.764. PMID: 17908575.

26. Salbach NM, Mayo NE, Wood-Dauphinee S, et al.: A task-orientated intervention enhances walking distance and speed in the first year post stroke: a randomized controlled trial. ClinRehabil, 2004, 18: 509–519.

27. Yang YR, Wang RY, Lin KH, et al.: Task-oriented progressive resistance strength training improves muscle strength and functional performance in individuals with stroke. ClinRehabil, 2006, 20: 860–870.

28. E. Duarte, E. Marco, J. Muniese, R. Belmonte, P. Diaz, M. Tejero, *et al.*, "Trunk Control Test as a Functional Pre-dictor in Stroke," *Journal of Rehabilitation Medicine*, Vol. 34, No. 6, 2002, pp. 267-272. doi:10.1080/165019702760390356

29. C. L. Hsieh, C. F. Sheu, I. P. Hsueh and C. H. Wang, "Trunk Control as an Early Predictor of Comprehensive Activities of Daily Living Function in Stroke Patients," *Stroke*, Vol. 33, 2002, pp. 2626-2630. doi:10.1161/01.STR.0000033930.05931.93

30. Kusnanto, K., Ardiansyah, G., &Harmayetty, H. (2016). The Effectiveness of Nursing Interventions Truncal Control Exercise Against the Upper Limb Function, Balance, and Gait on the Client Post Stroke. NersJournal , 11 (2), 300–310.

31. A AnasAhamad et al. Comparison between the effects of task oriented program and balance training on improving balance in Stroke. International Journal of Health Sciences and Research (www.ijhsr:org) Vol.9; issue:10; October 2019.

32. B. Deekshita et al. Effect of task oriented exercise on standing balance in subject with stroke. Int J physiother. Vol(5), 242-247, December (2014)

33. Flor H and Diers M. Sensorimotor training and cortical reorganization. Neuro Rehabilitation, 2009; 25(5): 19-27.

34. Ching-Yi Wu, Pai-Chuan Huang, Yu-Ting Chen, Keh-Chung Lin and Hsiu-Wen Yang. Effects of Mirror Therapy on Motor and Sensory Recovery in Chronic Stroke: A Randomized Controlled Trial. Archives of Physical Medicine and Rehabilitation, 2013; 76(8): 406-12.

35. Mudge S, Stott NS: Timed walking tests correlate with daily step activity in persons with stroke. Arch Phys Med Rehabil, 2009, 90: 296–301.

36. Knox M, Stewart A, Richards CL. Six hours of task-oriented training optimizes walking competency post stroke: a randomized controlled trial in the public health-care system of South Africa. ClinRehabil. 2018 Aug;32(8):1057-1068. Doi:10.1177/0269215518763969. Epub 2018 Mar 13. PMID: 29529870.

37. Cho GH, Lee SM, Woo YK: The effects of a task-related circuit program on functional improvements in stroke patients. KorAcadUniPhysTher, 2004, 11: 59–70.

38. Lee HS, Kim MC: The effects of balance task-related circuit training on chronic stroke patients. J KorSocPhysTher, 2009, 21: 23–30.

39. ShahinoorBente Khan et al. Effectiveness of Task Oriented Physiotherapy Along with Conventional Physiotherapy for Patients with Stroke. International Journal of Neurologic Physical Therapy2019; 5(2): 37-41 http://www.sciencepublishinggroup.com/j/ijnptdoi: 10.11648/j.ijnpt.20190502.12 ISSN: 2575-176X (Print); ISSN: 2575-1778 (Online).

40. Joen BJ et al. Effect of Task-oriented Training for People with Stroke; A meta-analysis focoused on repetitive or circuit training. Top Stroke Rehabil. 2015 Feb; 22(1): 34-43. doi: 10.1179/1074935714Z.0000000035. Epub 2015 Jan 21 PMID:25776119