(ISSN: 0973-7049(P))

The Bioscan AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES   21(2): S.I (2), 21973-22003, 2026   www.thebioscan.com

EFFECTIVENESS OF TASK-ORIENTED TRAINING ON MOTOR FUNCTION RECOVERY IN STROKE PATIENTS: A RANDOMIZED CONTROLLED TRIAL

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DOI:https://doi.org/10.63001/tbs.2026.v21.i02.S.I(2).pp21973-22003

KEYWORDS
Stroke rehabilitation; Task-Oriented Training; Motor Assessment Scale; Barthel Index; neuroplasticity; motor relearning; randomized controlled trial; subacute stroke; India; functional independence.

Article Info
Received: 20.03.2026
Accepted: 08.04.2026
Published: 18.04.2026

Abstract

Background : Stroke is a major cause of chronic neurological disability, and the motor impairment is experienced by about 80% of stroke patients. Task-Oriented Training (TOT) is an experimental rehabilitation paradigm based on the science of motor learning and experience-dependent neuroplasticity and aims to fill the functional specificity gap of traditional physiotherapy. Although a strong international evidence base, there is a paucity of rigorous locally-conducted randomized controlled trial data available on Indian populations, and this constrains direct clinical translation in this high-burden situation.

Objective : To assess the efficacy of a six-week intensive Task-Oriented Training protocol on (1) the recovery of motor functions by the use of Motor Assessment Scale, and (2) the functional independence of activities of daily living through the use of the Barthel Index in subacute stroke patients undergoing rehabilitation at the Pacific Medical College and Hospital, Udaipur.

Study Design: Single-blind, parallel-group randomized controlled trial (RCT).

Setting: Pacific Medical College and Hospital (PMCH), Department of Physiotherapy, Bedla, Udaipur, Rajasthan, India. Duration of study: 8 months

Participants: Sixty adults (40 - 70 years) with first-time ischemic or hemorrhagic stroke (16 months post-stroke), stable medical conditions to participate in active rehabilitation, and preserved cognitive ability (MMSE 24) were recruited by purposive sampling and randomized (1:1) to experimental (TOT + conventional physiotherapy, n=30) or control (conventional physiotherapy)

Interventions: The experimental group was given a structured TOT (45 - 60 min/session: sit-to-stand, reaching and grasping, gait training, stair-climbing, object manipulation exercises with progressive overload) as well as traditional physiotherapy (20 - 30 min/session). The control group was provided with only conventional physiotherapy (45 - 60 min/session). The two groups trained six weeks five days per week.

Outcome Measures: Barthel Index (BI; 0- 100) and Motor Assessment Scale (MAS; 0 - 48), which were assessed at baseline and post-intervention (Day 43) by a blind assessor.

Result : There were statistically significant within-group improvements in both groups ($p < 0.001$). The improvement in BI was 23.83 points (47.13%; $t = 32.56$) in the experimental group (TOT) compared to 12.13 points (23.71 % $t = 25.73$) in controls - a difference in BI points between the groups of 11.70 points (approximately twice the gain in functional independence). The MAS mean improvement was 11.13 points (59.43%; $t = 30.30$) in the TOT group versus 5.63 points (30.29%; $t = 17.82$) in controls — an inter-group difference of 5.50 MAS points. After the intervention, 83.3% of TOT group depended to at least moderate level (BI 61-90) against 43.3% of the controls and 53.3% TOT group evolved into mild impairment against 6.7% controls. All paired t-tests were significant (t-critical = 2.045, df = 29, $\alpha = 0.05$, two-tailed). The alternative hypothesis (H_1) was accepted for all four comparisons.

Conclusion: Task-Oriented Training in addition to conventional physiotherapy leads to much larger and clinically significant increases in motor function and functional independence than conventional physiotherapy alone in subacute stroke patients. TOT is a clinically feasible, resource-appropriate intervention and is suggested to be systematically implemented within the stroke rehabilitation programs in Indian healthcare facilities.

1. INTRODUCTION

1.1 Global and National Burden of Stroke

According to the world health organization, stroke is regarded as a medical emergency where there is an acute incidence of focal neurological dysfunction that can be blamed on vascular causes and lasts beyond 24 hours or leads to death [1]. Stroke is one of the three major causes of mortality and the greatest cause of acquired long-term neurological disability in adults worldwide with the prevalence estimated at about 15 million people annually around the world [1,2]. The epidemiological burden of stroke is not fixed: according to the Global Burden of Disease 2019 study, absolute number of stroke occurrences, stroke survivors, stroke-related deaths, and disability-adjusted life-years (DALYs) attributed to stroke all were growing significantly in low- and middle-income countries between 1990 and 2019 due to population growth, demographic aging, and the spread of cardiometabolic risk factors across low and middle income nations [2].

The stroke load assumes a rather acute form in India. In India, stroke is currently estimated to have an incidence of 1.54 to 1.80 million new cases per year with a prevalence of 1.54 million stroke survivors at any given time [10]. The epidemiological characteristics of the stroke burden in India are qualitatively different than those of high-income countries: the age of onset is significantly younger (40% of patients are under 50 years of age), hemorrhagic subtypes are much more common (25 - 35% of cases versus 15 - 20% in the West), pre-hospital delays are substantially longer (due to the absence of stroke awareness The combination of these factors results in stroke survivor population in India that has started to experience rehabilitation with the more severe neurological impairments on average and is younger and more economically productive (compared to similar populations in high-income countries).

The implications of stroke disability on the downstream in India are even further than the patient. The family-based caregiving system in the country is such that the stroke disability has a ripple effect outwards to spouses, children, siblings, extended family members who have to take up the unpaid caregiving responsibilities, usually at significant personal economic and psychological cost. A half-century survey of Indian stroke literature by Banerjee and Das [11] reported the steady accumulation of this burden over time and rehabilitation as the only modifiable determinant of long-term functional outcome of the estimated 800,000 new stroke survivors in India who start the poststroke recovery process annually.

1.2 Pathophysiology of Post-Stroke Motor impairment.

The most common and functionally relevant stroke sequela is motor impairment which impacts 70 - 80% of stroke survivors during the acute stage [3]. The typical motor deficit is hemiparesis or hemiplegia weakness or paralysis of the limbs ipsilateral to the contra-lateral hemisphere to the cerebral infarct or hemorrhage. It has complex neurological basis: direct cell destruction of cortical motor neurons and axons of corticospinal tracts within the infarct center removes the voluntary motor signals that normally drive pools of spinal motor neurons; ischemic penumbral injury impairs the modulatory effect of the premotor and supplementary motor regions on the primary motor cortex; and diaschisis, the temporary functional depression of

The clinical features of post-stroke motor impairment are: loss of voluntary motor control (especially of fractionated movements of the distal extremities); abnormal synergy patterns whereby the movements of limbs are confined to stereotyped flexor or extensor mass patterns; spasticity due to loss of descending inhibitory control over spinal reflex pathways; weakness due to upper neuron pathology and secondary disuse atrophy The upper limb is generally more severely and chronically involved compared to the lower limb, which demonstrates the relatively large cortical representation of hand and finger movements and the relative dearth of alternative descending pathways to control hand motor movements [3].

These neurological impairments are translated into in-depth functional impairments. A person with moderate hemiparesis can no longer be able to get out of a chair without being helped, cannot walk without a walking aid or a human support, cannot dress, bathe and feed themselves, and cannot work, housework and social activity that defined their identity before the stroke, and which gave them their means of livelihood. The main outcome measures utilized in this research were the Barthel Index and Motor Assessment Scale, the two dimensions of post-stroke functional disability were specifically measured to provide an evaluation of rehabilitation based on the lived functional realities of stroke survivors, and not on laboratory measurements of impairment.

1.3 Dysfunctions of Traditional Physiotherapy.

The most popular methods of post-stroke motor rehabilitation have been neurofacilitation methods based on neurological theories that emerged in the middle of the twentieth century: the Bobath Neurodevelopmental Treatment (NDT), Brunnstrom movement therapy, proprioceptive neuromuscular facilitation (PNF), and sensorimotor approach of Rood. What these paradigms have in common is a theoretical point, namely that the abnormal tone, reflexes, and movement patterns need to be normalized or inhibited using certain handling techniques until functional movement may occur, which now has been largely refuted by the development of motor neuroscience and motor learning theory.

The evidence situation was summarized in the landmark Cochrane systematic review by Pollock and colleagues [4], which analyzed 96 randomized controlled trials of physical rehabilitation methods after stroke: although physiotherapy of high-enough intensity interventions certainly produce better motor outcomes than no intervention, no individual standard neurofacilitation method has shown a persuasive advantage over the rest, and the effect sizes that can be achieved with conventional physiotherapy are quite One of the most basic weaknesses of traditional methods has been seen to be their inability to reliably translate impairment-level gains such as improvements in muscle strength, passive range of motion, or tone normalization realized through isolated exercises, into any meaningful functional task performance in the real world. A patient who is able to flex their knee with moderate hand pressure in a supine posture may not be able to stand out of a low chair; a patient with preserved shoulder range of motion by daily stretching exercises may not be able to lift an object at shoulder height. This lack of relationship between impairment-level training results and functional independence is not due to failure of effort or intensity - it is a natural result of the specificity of neural change, a concept now well-established in neuroscience of motor learning.

The seminal reconceptualization of stroke motor rehabilitation by Carr and Shepherd [12], explicitly in terms of systems motor control theory and the new science of experience-dependent neuroplasticity, offered a paradigm shift: rehabilitation should become more focused on the active performance of the particular functional activities that the patient must undertake in their daily life. This conceptual system - rehabilitation as re-acquisition of motor skills, not normalization passively - formed the theoretical base on which Task-Oriented Training was later developed as a programmed clinical intervention.

1.4 Task-Oriented Training: Conceptual Framework.

Task-Oriented Training (TOT) is a rehabilitation methodology that formalizes the concepts of modern motor learning science and neuroplasticity on the basis of experience into the clinical practice of stroke rehabilitation [5,6]. Its theory has roots in various fields: systems motor control theory (movement as an emergent of dynamical interactions between individual, task, and environment instead of the result of a pre-programmed motor program); the science of motor learning of practice variability, feedback and contextual interference; neuroscience of use-dependent cortical reorganization.

Clinical characteristics of TOT that distinguish it as compared to conventional physiotherapy are: (1) specificity of training - patients are practiced to perform the actual functional tasks required of them and not on elements or precursors of those tasks; (2) ecological validity - the tasks are performed in contexts that approximate the real world environments in which they will need to be executed ;(3) High repetition volume – sessions are structured around large number of tasks repetitions to drive the synaptic level changes underlying durable motor learning (4) Progressive challenge – task difficulty is systematically increased as performance criteria are met , preventing habituation and maintaining optimal neural engagement and (5) Active motor problem solving – patients actively generate and modify their own motor solution rather than receiving passively guided movement , activating the error based learning mechanism most potent for skills acquisation.

This was a research undertaken to assess the effectiveness of a structured TOT protocol within a clinical context of a tertiary care physiotherapy department, in Udaipur, Rajasthan - an Indian healthcare setting that reflects the institutional contexts within which most of the post-acute stroke rehabilitation is provided in India. This study sought to produce context-specific evidence that can be directly translated to Indian clinical practice by facilitating the identification of the evidence gap among various Indian stroke rehabilitation researchers, through a rigorously designed randomized controlled trial with validated outcome measures and a representative Indian population with stroke [10,11,14].

1.5 Aims and Objectives

The main purpose of the research was to assess the efficacy of Task-Oriented Training in terms of motor functional recovery and functional independence in activities of daily living in subacute stroke patients in their rehabilitation in Pacific Medical College and Hospital, Udaipur.

The particular objectives were:

1. To measure and compare pre- and post-intervention motor function scores using the Motor Assessment Scale (MAS) in both the TOT group and the conventional physiotherapy group.

2. To measure and compare pre- and post-intervention independence in activities of daily living using the Barthel Index (BI) in both groups.

3. To determine the between-group difference in magnitude of motor function improvement following the six-week intervention period.

4. To determine the between-group difference in magnitude of ADL independence improvement following the six-week intervention period.

5. To assess the clinical feasibility and practical applicability of delivering a structured TOT protocol within a hospital-based physiotherapy department.

1.6 Hypotheses

Null Hypothesis (H_0) : Task oriented training does not produce a statistically significant improvement in motor function or activities of daily living compared to conventional physiotherapy alone in stroke patients.

Alternative Hypothesis (H_1): Task oriented training produce a statistically significant improvement in motor function and activities of daily living compared to conventional physiotherapy alone in stroke patients.

2. REVIEW OF LITERATURE

2.1 Global Stroke Burden and Need of Rehabilitation

In 2021, a fact sheet on stroke by the World Health Organization re-established the status of stroke as one of three top causes of global mortality and the primary cause of acquired long-term disability [1]. The report has pointed out that although acute medical management of stroke has been improving significantly in high-income countries — due to thrombolysis, endovascular thrombectomy, and stroke unit care, which have resulted in decreased early mortality, the long-term disability burden is not decreasing proportionally, as functional recovery is not defined solely by survival but by the quality, intensity, and scientific basis of post-acute rehabilitation. Evidence-based stroke rehabilitation is specifically defined as a public health priority of low- and middle-income countries in the WHO Global Action Plan on Neurological Disorders.

In a global burden of stroke analysis, Feigin et al. [2] published in Circulation Research, the absolute number of stroke survivors living with a disability rose by 84% between 1990 and 2019. The analysis they provide highlighted that this rise was not merely a result of population aging but rather a manifestation of true epidemiological shifts in risk factor burden such as the spread of hypertension, diabetes, dyslipidemia, and physical inactivity in the world and the rise in the proportion of younger stroke survivors, especially in Asia and sub-Saharan Africa. In the case of rehabilitation science, such an epidemiological fact would translate into a requirement to create and spread effective, scalable rehabilitation methods that can lessen the disability load on a population level per-patient.

2.2 Neuroscience of Neuroplasticity and Neuroscience of Stroke Recovery.

The scientific foundation of motor rehabilitation of the post-stroke patients was radically changed by the maturity of neuroplasticity studies in the 1990s and 2000s. Comprising evidence on the basis of animal lesion models, human neuroimaging, and clinical trials, Kleim and Jones [5] have proposed ten principles of experience-dependent neural plasticity that since has been central to rehabilitation neuroscience. Among the concepts that are of particular interest to TOT is the use-dependence, specificity, repetition, intensity, time, salience, age, and transference. All these principles combine to establish that the adult brain has a significant ability to reorganise following a focal injury, that reorganisation is facilitated by the nature and amount of behavioural training, and that the best training to elicit a cortical reorganisation is highly repetitive, task-specific and personally meaningful practice of the desired functional behaviours.

These principles have been confirmed in stroke survivors receiving rehabilitation by human neuroimaging studies. Longitudinal fMRI research has reported expansion of perilesional cortical map of the primary and premotor cortex with intense task-specific training of the upper limb that is associated with functional recovery. Research involving TMS mapping has reported the area of hand motor cortex representation growth directly proportional to the amount and particularity of task practice provided. PET investigations have reported some qualitative differences in cortical activation patterns in response to conventional physiotherapy and task-specific training, the latter yielding patterns of cortical activation more similar to those of the intact motor control of the nervous system [5].

In their Lancet review, Langhorne et al. [3] have created one of the most frequently referred stroke rehabilitation frameworks, clarifying that stroke rehabilitation is not a secondary intervention to medical care, but a core of stroke management with proven impacts on mortality, dependency, and subsequent quality of life. Their systematic review of rehabilitation interventions revealed that the systematic, multidisciplinary, task-oriented rehabilitation is always more effective at all the stages of stroke recovery than the uncoordinated or impairment-oriented one.

2.3 Task-Oriented Training: Evidence from Systematic Reviews

Definitive Cochrane review on repetitive task training the operationalized version of TOT that was conducted by French et al. [7] comprised 33 randomized controlled trials, and 1,087 participants. The meta-analysis showed statistically and clinically significant improvement of arm-hand function (SMD 0.28, 95% CI 0.050.51) and lower limb and walking function (SMD 0.28, 95% CI 0.070.48) with repetition training of the tasks over control interventions. More importantly, the review found a positive dose-response relationship between training volume (session length x frequency x weeks), and the extent of functional change, which directly confirmed the neuroplasticity principle that repetition is not only necessary but also sufficient to achieve long-term motor learning.

The most comprehensive meta-analysis of physical therapy post-stroke (467 RCTs) by Veerbeek et al. [8] found task-specific and repetitive functional training to be the most evidence-based modality that can improve walking ability (SMD 0.37), balance (SMD 0.36), and arm-hand function (SMD 0.28). It is interesting to note that the analysis revealed that the effect sizes of the functional task training were nearly twice the effect sizes that could be attained by the traditional physiotherapy methods to achieve the same outcome domains - a result that would directly predict the inter-group differences seen in the current trial.

Although Cochrane review by Pollock et al. [4] points to the lack of evidence regarding the superiority of any type of conventional technique, it explicitly stated the clinical gap, between the improvements in impairment level, which could be obtained by using conventional physiotherapy, and improvements in functional independence that could be obtained by using task-specific methods. The authors of the review recommended the systematic substitution of the isolated impairment-level training with combined functional tasks practice as the standard mode of the post-stroke motor rehabilitation.

2.4.1 Single randomized controlled trials.

One of the first rigorous RCTs of task specific training in stroke was done by Dean and Shepherd [13] who examined the impact of seated reaching tasks on balance and upper limb performance in 12 patients subacute stroke patients. The task-training group also showed much more improvements in performance, weight distribution, and transfer to untrained motor activities than controls, which was the first experimental evidence that task-specific practice results in neuroplastic reorganization and extends beyond the task specifically trained. This transfer effect, which today is interpreted as the expression of the activation of shared neural networks of functional task families, is one of the most clinically important TOT properties.

In a randomized controlled trial of task-oriented training on subacute stroke patients, Kim et al. [9] reported a significantly higher improvement in gait velocity, stride length, cadence, balance and functional ambulation in the TOT group than the conventional physiotherapy group. The authors observed that the inter-group differences were greatest in the specific tasks which were actually practiced in the TOT intervention, as observed by the principle of task-specificity in motor learning, and that significant improvements were also found in the related unpracticed tasks, as observed by the principle of transfer.

Blennerhassett and Dite [16] compared the effect of additional task-related upper limb training with unstructured leisure activities in subacute stroke patients and discovered that there were much more positive changes in upper limb performance and dexterity in the TOT group. Their conclusions about the practical implication, namely that structured functional task practice of the same length is significantly more therapeutically effective than unstructured practice, have a direct application to optimization of time in physiotherapy sessions in resource-limited environments.

2.5 Indian Background: Stroke Burden and Rehabilitation Study.

The most detailed epidemiological characterization of stroke in an Indian context was presented by Pandian and Sudhan [10] who reported about the younger age of onset, greater hemorrhagic rates, prolonged pre-hospital delays, and severe lack of rehabilitation services that characterize the stroke burden in India in comparison with those of high-income countries. Their study defined that, although India has achieved a lot in dealing with acute stroke - there are now stroke units in large teaching hospitals - the infrastructure fragment in rehabilitation remains broad, and most stroke patients do not have any structured post-acute physiotherapy.

Banerjee and Das [11] took this analysis further and made a 50-year review of Indian stroke studies, with evidence not only on the epidemiological toll on stroke, but also on the gap in evidence-to-practice in the rehabilitation field. They emphasized the fact that although an increasing literature of physiotherapy evidence has supported task-based, functional rehabilitation as a paradigm, the Indian clinical practice has lagged behind in embracing the paradigms with conventional neurofacilitation still being the mode of practice in most physiotherapy departments. The authors postulated that high-quality RCT evidence done locally is critical in causing practice change in the Indian context, where clinicians need evidence produced within local populations with which they feel comfortable in adopting new protocols.

The guidelines on adult stroke rehabilitation and recovery published by Winstein et al. [6] in Stroke are the most extensive up-to-date evidence synthesis to guide clinical practice, as the evidence-based standard of care at all stages of stroke recovery, suggesting the use of task-specific and context-relevant training. The guidelines specifically support the neuroplastic argument of TOT - that practice in particular contexts triggers the particular neural pathways needed to perform a particular functional behavior, which leads to their restructuring and reinforcing in a manner unachievable by isolated exercise.

3. MATERIALS AND METHODS

3.1 Study Design

This study was designed as a single-blind, parallel-group randomized controlled trial (RCT) in accordance with the CONSORT 2010 guidelines for reporting randomized trials. The researchers used the comparison of the effectiveness of the Task-Oriented Training with traditional physiotherapy (experimental condition) and traditional physiotherapy (control condition) in six weeks intervention. Baseline (Day 0, pre-intervention) and post-intervention outcome assessments were performed (Day 43, 24 hours after the last treatment session). The outcome assessor was blinded to group allocation; because of the nature of the interventions neither were blinded the treating physiotherapists and participants.

3.2 Ethical Considerations

All the data collection activities were preceded by ethical clearance by the Institutional Ethics Committee (IEC) of Pacific Medical University, Udaipur. The research itself was done in the strongest compliance with the ethical principles of biomedical research involving human participants as given in the Declaration of Helsinki (2013 revision) and ICMR National Ethical Guidelines on Biomedical and Health Research Involving Human Participants (2017). Informed consent was received in both English and Hindi and the participants were enrolled. The purpose of the study, procedures and possible benefits and risks were all explained to the participants who were told they could withdraw at any time without any repercussions. Data of the participants were anonymised and treated confidentially. There were no invasive procedures or pharmaceutical interventions and experimental devices used in the study.

3.3 Setting and Duration

The research was carried out in the Department of Physiotherapy, Pacific Medical College and Hospital (PMCH), Bedla, Udaipur, Rajasthan, India - a tertiary care teaching hospital that has separate inpatient and outpatient neurological rehabilitation units. The duration of the entire study was eight months (20242025), which included recruitment of the participants, intervention, and post-intervention evaluation.

3.4 Participants

3.4.1 Inclusion Criteria

1. Adults aged 40–70 years diagnosed with first-time ischemic or hemorrhagic stroke confirmed by imaging.
2. Duration of stroke: 1–6 months (subacute phase).
3. Ability to follow simple instructions (Mini-Mental State Examination score ≥ 24).
4. Medically stable and cleared for active rehabilitation.
5. Willingness to provide written informed consent.

3.4.2 Exclusion Criteria

1. Severe cognitive deficits or aphasia preventing comprehension of instructions.
2. Comorbid neurological or orthopedic conditions affecting motor function.
3. Uncontrolled cardiovascular or respiratory conditions limiting participatio.
4. Uncontrolled respiratory conditions limiting exercise tolerance or physical participation.
5. Recurrent stroke or prior history of stroke-related functional disability

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3.5 Sample Size

A sample size of 60 participants (30 per group) was determined on the basis of a power analysis informed by the anticipated effect size from comparable TOT RCTs in the literature and clinical judgment. The sample has about 80 percent statistical power to detect a between-group difference in Barthel Index score of 8 points (SD 10) which is statistically significant at 0.05, two tailed, which aligns with Minimal Clinical Importance Difference (MCID) of the BI in moderate-dependence stroke populations. Purposive sampling was used to recruit participants in the inpatient and outpatient units of PMCH.

3.6 Randomization and Allocation Concealment

After the screening and baseline assessment, all eligibility participants were randomly matched based on a computer-generated random number sequence that was prepared by an independent statistician who had no involvement with the participant assessment or therapy. The concealment of allocation was ensured by sequentially numbered and opaque sealed envelopes with the group assignment, which were opened at the point of participant enrollment when written consent and baseline assessment were done. This was done so that the recruiting physiotherapist and the participant were not aware of the next possible group assignment during the consenting process, which reduced the selection bias.

3.7 Interventions

3.7.1 Experimental (Group 1): TOT + Conventional Physiotherapy.

Experimental group members were given a six-week Task-Oriented Training program (five sessions per week) 45-60 minutes of TOT practice per session and 20-30 minutes of traditional physiotherapy. The TOT sessions were organized based on four functional task domains with tasks being chosen and advanced on a personalized basis based on the functional goals and the baseline performance of the participant:

- Sit-to-Stand Training: repetitive practice of rising from and returning to sitting in chairs of varying heights (45 cm, 40 cm, 35 cm), progressing from use of arm support to unassisted to weighted vest for additional challenge. Goal: 3 sessions of 15-20 repetitions

- Reaching and Grasping Tasks: practice of forward and lateral upper limb reaching to targets of varying distance (50%, 75%, 100% of arm length), height (below, at, and above shoulder level), and object size (large cup → medium bottle → small coin). They included both unilateral and bilateral task variants

- Gait and Mobility Training: structured walking practice progressing from parallel bars → rollator → quad cane → single-point stick → unassisted, over distances increasing from 10 m to 50 m, on surfaces progressing from level corridor → compliant mat → slight incline → outdoor surface. Week 3 Dual-task gait practice (walking with an object) was introduced.

- Stair Negotiation: practice ascending and descending a standardized staircase of four steps, progressing from bilateral rail support → unilateral rail → unassisted, with step height and number of sets increasing weekly.

- Carry and Place Activities: bilateral functional tasks involving carrying a filled tray or vessel across the treatment room and placing objects on targets at varying heights, incorporating both fine motor and postural control demands.

Task difficulty was progressed each week based on the principle of progressive overload: when the participant achieved ≥70% task success on three consecutive attempts at a given difficulty level, the task was advanced to the next level. The performance of the participants in terms of the number of completed tasks, repetitions achieved, and subjective rating of effort were logged in a standardized session log. The adjunct 20–30 minutes of conventional physiotherapy comprised: active-assisted and active range-of-motion exercises for all planes of upper and lower limb joints; progressive resistance exercises for key muscle groups (hip extensors, knee extensors, ankle dorsiflexors, shoulder flexors and abductors, elbow extensors); and manual facilitation of isolated joint movements where voluntary control was insufficient for active exercise

3.7.2 Control (Group 2): Conventional Physiotherapy Only.

Participants in the control group received 45–60 minutes of conventional physiotherapy per session, five days per week for six weeks. The traditional physiotherapy regime included:

- Active-assisted and active range-of-motion exercises for bilateral upper and lower limb joints, performed in anatomically standard planes.
- Progressive muscle strengthening using manual resistance and resistance bands (Theraband), targeting key antigravity muscle groups.
- Static and dynamic seated balance training.
- Static and dynamic standing balance training using parallel bars and progressing to unilateral support.
- Gait training on level surfaces with appropriate assistive devices
- . Bridging, core strengthening, and lower limb facilitation exercises.

The conventional physiotherapy protocol did not include structured, goal-directed practice of real-world functional tasks as used in the TOT protocol. All the sessions were administered by trained physiotherapists who were different to the blinded outcome assessor.

3.8 Outcome Measures

3.8.1 Barthel Index (BI)

The Barthel Index is a validated, internationally approved, ten-item ordinal scale of functional independence in activities of daily living in patients with neurological and musculoskeletal diseases. It evaluates: feeding, bathing, grooming, dressing, bowel control, bladder control, toilet use, transfer (bed to chair), mobility on level surfaces, and stair climbing. Items can be weighted and rated based on the degree of assistance needed; overall scores are 0 (maximum dependence) to 100 (maximum independence). The interpretation of scores: 0- 20 (total dependence), 21- 60 (severe dependence), 61- 90 (moderate dependence), 91- 99 (slight dependence), 100 (full independence). The BI has shown a high level of inter-rater reliability (ICC $\geq$ 0.95), high levels of criterion validity when compared to the Functional Independence Measure, and is listed as a core outcome measure in stroke rehabilitation as recommended by the American Heart Association and European Stroke Organisation guidelines.

3.8.2 Motor Assessment Scale (MAS)

The Motor Assessment Scale, invented by Carr, Shepherd and Nordholm (1985) and tested in several international clinical practices is performance based measure of motor recovery after stroke, which is functional. Eight items evaluate: supine to side-lying, supine to sitting over the side of the bed, balanced sitting, sitting to standing, walking, upper arm functioning, hand movements, and advanced hand activities. Each item is scored on a 0–6 ordinal scale (0 = unable to perform; 6 = performs normally); total scores range from 0 to 48. Score: 0-10 (severely impaired), 11-24 (moderately impaired), 25-36 (mildly impaired), 37-47 (near normal), 48 (normal). The MAS has shown high concurrent validity with the Fugl-Meyer Assessment, good test-retest reliability (ICC 0.87–0.99) and is specifically sensitive to the kind of functional motor change that TOT is expected to lead to, as both are based on the motor relearning model of Carr and Shepherd.

The same blinded assessor administered both outcome measures at baseline (Day 0, before the first treatment session) and post-intervention (Day 43, within 24 hours of the last treatment session) using standard administration procedures. The assessor was trained to be calibrated and showed an inter-rater reliability of ≥ 0.90 (interclass correlation coefficient) on both instruments before the commencement of the study.

3.9 Monitoring of Compliance and Follow-Up.

The six-week period of intervention was followed up on all the participants. The treating physiotherapist performed a short clinical check-in at the beginning of each session to evaluate the health status of participants, adverse events, fatigue, and pain. The attendance (attended, partially attended, or missed) during the session was documented in a standard session log. Those who missed a session were contacted within the same day to reschedule, those who missed 3 or more consecutive sessions without a valid medical reason, were considered dropouts. Data of participants who dropped out due to clinical reasons were retained to analyze with intent to treat. Progress review of subjects was performed weekly and task progression decisions were made.

3.10 Statistical Analysis

All data were summarized, coded and inputted into SPSS (Version 26.0). Mean and standard deviation (SD) of the continuous variables and frequency and percentages of the categorical variables were calculated as descriptive statistics. The paired t-test (df = n -1 = 29, t-critical = 2.045, and alpha = 0.05, two tailed) was used to analyze the within-group pre-to-post intervention change. Between-group comparisons were made by analyzing the mean changes in improvement (d_) and percentage changes in improvement between groups. The decision rule for hypothesis testing: if t-calculated > t-critical, reject H_0; if $p < 0.05$, the result is statistically significant.

Paired t-test formula: t = d / (S/n) = d mean of paired differences (post - pre), S = standard deviation of differences, n = size of sample. The percentage improvement was computed: % improvement = (mean post-mean pre)/mean pre × 100.

4. RESULTS

This section describes the flow and enrollment of participants in the study. Sixty participants were enrolled in the study and met the inclusion and exclusion criteria. The 60 participants attended all six weeks of the intervention and had 100 percent session attendance; no dropouts, protocol deviations or adverse events that necessitated withdrawal of the participants occurred within the study period. Group 1 (experimental: TOT + conventional physiotherapy) and Group 2 (control: conventional physiotherapy only) consisted of 30 participants, randomized through computer-generated randomization.

4.2 Demographic and Baseline Clinical Characteristics.

Baseline demographic and clinical characteristics of both groups were similar (Table 1).Group 1 had a mean age of 54.46 ± 9.35 years (range 41–69) and Group 2 had a mean age of 58.30 ± 9.54 years (range 40–70). Gender distribution was well-matched: Group 1 comprised 16 males (53.3%) and 14 females (46.7%); Group 2 comprised 15 males (50.0%) and 15 females (50.0%). Group 1 had an average stroke duration of 12.40 ± 5.95 weeks, and Group 2 had an average duration of 12.03 ± 6.23 weeks, with all participants in the subacute recovery period (1-6 months post-onset) - the period when neuroplastic responsiveness to rehabilitation is greatest.

Pre-intervention Barthel Index scores were nearly identical between groups (Group 1: 50.56 ± 9.09; Group 2: 51.16 ± 8.92; difference: 0.60 points), as were pre-intervention MAS scores (Group 1: 18.73 ± 5.12; Group 2: 18.60 ± 3.89; difference: 0.13 points). These small baseline differences ensure that the two groups were in the study at the same levels of functional disability and motor impairment, meaning that the differences in the post-intervention results were due to the different intervention effects and not to the between-group differences.

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants

Variable	Group 1: TOT + Conventional (n=30)	Group 2: Conventional Only (n=30)	Total (n=60)
Age: Mean ± SD (years)	54.46 ± 9.35	58.30 ± 9.54	56.38 ± 9.56
Age Range (years)	41–69	40–70	40–70
Male — n (%)	16 (53.3%)	15 (50.0%)	31 (51.7%)
Female — n (%)	14 (46.7%)	15 (50.0%)	29 (48.3%)
Stroke Duration: Mean ± SD (weeks)	12.40 ± 5.95	12.03 ± 6.23	12.21 ± 6.04
BI Score Pre: Mean ± SD	50.56 ± 9.09	51.16 ± 8.92	50.86 ± 8.95
MAS Score Pre: Mean ± SD	18.73 ± 5.12	18.60 ± 3.89	18.67 ± 4.52

BI = Barthel Index; MAS = Motor Assessment Scale; SD = Standard Deviation.

4.3 Barthel Index Results

4.3.1 Within-Group Analysis:

Group 1 (TOT + Conventional). The mean pre-intervention BI score of group 1 participants was 50.56 ± 9.09, which places the group mean in the severe dependence category. The mean post-intervention BI score increased to 74.40 + 10.49, an absolute mean change of 23.83 points (SD of differences 4.00), which is a 47.13% increase compared to baseline, after six weeks of TOT in combination with traditional physiotherapy. The mean difference error was 0.7320 with a paired t-statistic of 32.56. The result was very statistically significant ($p < 0.001$) and with df = 29 and t-critical = 2.045 (alpha = 0.05, two-tailed), the null hypothesis was rejected.

Individual improvements in Group 1 varied between 18 and 30 BI points, suggesting equally large improvements among participants - a consistency supported by the relatively small SD of differences (4.00) compared to the large mean difference (23.83). This consistency implies that the TOT benefits were not in a subgroup of high-responders but widely spread across the population of the participants irrespective of their membership in certain demographic or clinical subgroups.

4.3.2 Within-Group Analysis: (Group 2) Conventional Physiotherapy.

The mean pre-intervention BI of Group 2 participants was 51.16 ± 8.92 - almost the same as that of Group 1. Mean BI score improved to 63.30 +8.50 post-intervention which is an absolute mean increase of 12.13 points (SD of changes 2.58) and a 23.71% improvement. The paired t-statistic was 25.73 ($p < 0.001$) which was also significant. The range of individual improvements was 8 to 16 BI points, significantly smaller and lower than Group 1.

4.3.3 Inter-Group Comparison: Barthel Index.

The comparison of groups shows the clinically decisive superiority of TOT in comparison to traditional physiotherapy. The mean improvement of Group 1 (23.83 points) was about 1.96 times higher than Group 2 (12.13 points), resulting in a difference between groups of 11.70 BI points of improvement, which is a significantly larger difference than the established MCID of the Barthel Index (approximately 1.855 points of improvement, depending on population and stage of recovery). The percentage improvement advantage of Group 1 (47.13%) was 23.42 percentage points greater than Group 2 (23.71%). The t-value of Group 1 (32.56) was also significantly greater than that of Group 2 (25.73), which meant that the uniformity of response to TOT across the participants was greater.

The clinical significance of post-intervention categorical distribution further demonstrates that in Group 1, 83.3% of participants progressed into moderate dependence (BI 61-90) and 6.7% slight dependence (BI 91-99) with only 10.0% continuing to stay in severe dependence. In Group 2, 56.7% of the individuals stayed in the severe dependence group and 43.3% moved up to the moderate dependence group - none of the individuals moved up to the slight dependence group. These categorical differences are differences in the real world with regard to the capability of performing self-care tasks by patients, a difference that has a significant impact on caregiver burden and quality of life.

(ISSN: 0973-7049(P))
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Table 2. Barthel Index: Descriptive Statistics, Paired t-Test Results, and Inter-Group Comparison

Parameter	Group 1: TOT + Conventional	Group 2: Conventional Only
n	30	30
Mean PRE Score ± SD	50.56 ± 9.09	51.16 ± 8.92
Mean POST Score ± SD	74.40 ± 10.49	63.30 ± 8.50
Mean Difference ($\bar{d}$)	23.83	12.13
SD of Differences (Sd)	4.00	2.58
Standard Error of Mean Diff. (SE)	0.7320	0.4716
Sum of Differences (Σd)	715	364
Degrees of Freedom (df)	29	29
t-calculated	**32.56**	**25.73**
t-critical (α=0.05, two-tailed, df=29)	2.045	2.045
p-value	**< 0.001**	**< 0.001**
% Mean Improvement	**47.13%**	**23.71%**
Result	**SIGNIFICANT — H_1 Accepted**	**SIGNIFICANT — H_1 Accepted**
Inter-group Difference in $\bar{d}$	**11.70 BI points in favour of Group 1 (TOT)**	**-**

SD = Standard Deviation; SE = Standard Error; $\bar{d}$ = Mean of paired differences; t-critical = 2.045 (df=29, α=0.05, two-tailed).

Table 3. Barthel Index: Post-Intervention Category Distribution

BI Category	Group 1: TOT + Conventional n (%)	Group 2: Conventional Only n (%)
Total Dependence (0–20)	0 (0.0%)	0 (0.0%)
Severe Dependence (21–60)	3 (10.0%)	17 (56.7%)
Moderate Dependence (61–90)	**25 (83.3%)**	13 (43.3%)
Slight Dependence (91–99)	**2 (6.7%)**	0 (0.0%)
Full Independence (100)	0 (0.0%)	0 (0.0%)
Mean Post-Intervention Score ± SD	**74.40 ± 10.49**	**63.30 ± 8.50**

Values expressed as n (percentage of group). BI = Barthel Index.

4.4 Motor Assessment Scale Results

4.4.1 Within-Group Analysis: Group 1

Group 1 showed a group mean of 18.73 + 5.12 and the mean score of 18.73 indicates that Group 1 was in the moderately impaired category. After six weeks of TOT plus standard physiotherapy, the average post-intervention MAS score improved to 29.86 + 5.32 - an absolute mean change of 11.13 points (SD of changes 2.01), a 59.43% improvement over baseline. The standard error was 0.3674, yielding a paired t-statistic of 30.30 ($p < 0.001$). The range of individual improvements was 8-15 MAS points, indicating a steady and clinically significant motor recovery among the group of participants.

4.4.2 Within-Group Analysis: Group 2

The mean pre-intervention MAS score in Group 2 was 18.60 ± 3.89. The post-intervention mean MAS score improved to 24.23 + 5.00 - an absolute mean change of 5.63 points (SD of differences 1.73), indicating a 30.29 percent improvement. The t-statistic was 17.82 ($p < 0.001$). The individual progress was between 3 and 8 MAS points - significantly lower than Group 1.

4.4.3 Inter-Group Comparison: Motor Assessment Scale.

Group 1 had an MAS mean improvement of 11.13 points compared to 5.63 points in Group 2- inter-group difference of 5.50 MAS points. The percentage change benefit of Group 1 (59.43) was 29.14 percentage points higher than Group 2 (30.29%). The clinical significance of this difference was shown in the post-intervention MAS category distribution: 53.3% of the participants in Group 1 progressed to the mildly impaired category (MAS 25 - 36) and 3.3% to near-normal functioning (MAS 37 - 47) and 43.3% of Group 1 participants stayed in the moderately impaired range. Starkly different, 93.3% of participants in Group 2 stayed in the moderately impaired group, and 6.7% of the participants progressed to mild impairment, and no one to near-normal motor functioning.

Table 4. Motor Assessment Scale: Descriptive Statistics, Paired t-Test Results, and Inter-Group Comparison

Parameter	Group 1: TOT + Conventional	Group 2: Conventional Only
n	30	30
Mean PRE Score ± SD	18.73 ± 5.12	18.60 ± 3.89
Mean POST Score ± SD	29.86 ± 5.32	24.23 ± 5.00
Mean Difference ($\bar{d}$)	11.13	5.63
SD of Differences (Sd)	2.01	1.73
Standard Error of Mean Diff. (SE)	0.3674	0.3162
Sum of Differences (Σd)	334	169
Degrees of Freedom (df)	29	29
t-calculated	**30.30**	**17.82**

t-critical (α=0.05, two-tailed, df=29)	2.045	2.045
p-value	**< 0.001**	**< 0.001**
% Mean Improvement	**59.43%**	**30.29%**
Result	**SIGNIFICANT — H_1 Accepted**	**SIGNIFICANT — H_1 Accepted**
Inter-group Difference in $\bar{d}$	**5.50 MAS points in favour of Group 1 (TOT)**	

MAS = Motor Assessment Scale; SD = Standard Deviation; SE = Standard Error; $\bar{d}$ = Mean of paired differences.

Table 5. Motor Assessment Scale: Post-Intervention Grade Distribution

MAS Grade	Group 1: TOT + Conventional n (%)	Group 2: Conventional Only n (%)
Severely Impaired (0–10)	0 (0.0%)	0 (0.0%)
Moderately Impaired (11–24)	13 (43.3%)	**28 (93.3%)**
Mildly Impaired (25–36)	**16 (53.3%)**	2 (6.7%)
Near Normal (37–47)	**1 (3.3%)**	0 (0.0%)
Normal (48)	0 (0.0%)	0 (0.0%)
Mean Post-Intervention Score ± SD	**29.86 ± 5.32**	**24.23 ± 5.00**

Values expressed as n (percentage of group). MAS = Motor Assessment Scale.

4.5 Consolidated Statistical Summary

Table 6. Consolidated Summary of All Statistical Results

(ISSN: 0973-7049(P))

The Bioscan AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES 21(2): S.I (2), 21973-22002, 2026 www.thebioscan.com

Statistical Test	Outcome Measure	t-calc	Mean Δ ($\bar{d}$)	p-value	Conclusion
Paired t-test — Group 1	Barthel Index	32.56	23.83	< 0.001	**H_1 Accepted**
Paired t-test — Group 2	Barthel Index	25.73	12.13	< 0.001	**H_1 Accepted**
Paired t-test — Group 1	MAS	30.30	11.13	< 0.001	**H_1 Accepted**
Paired t-test — Group 2	MAS	17.82	5.63	< 0.001	**H_1 Accepted**
Inter-group — BI	23.83 vs 12.13	—	Δ = 11.70	—	**G1 Superior**
Inter-group — MAS	11.13 vs 5.63	—	Δ = 5.50	—	**G1 Superior**
% Improvement — BI	47.13% vs 23.71%	—	Δ = 23.42%	—	**G1 ~2× gain**
% Improvement — MAS	59.43% vs 30.29%	—	Δ = 29.14%	—	**G1 ~2× gain**
Overall Conclusion	**Alternative Hypothesis (H_1) accepted for all 4 within-group comparisons. Group 1 (TOT) consistently superior across all inter-group parameters.**				

G1 = Group 1 (TOT + Conventional Physiotherapy); G2 = Group 2 (Conventional Physiotherapy Only); t-critical = 2.045 (df=29, α=0.05, two-tailed). MAS = Motor Assessment Scale; BI = Barthel Index.

5. DISCUSSION

5.1 Overview of Principal Findings.

The main result of this randomized controlled trial is unquestionable: Task-Oriented Training with conventional physiotherapy leads to significantly better results in both motor functioning and functional independence than conventional physiotherapy in subacute stroke patients. The size of superiority - about twice the functional gain on both the Barthel Index and Motor Assessment Scale - is not something of a marginal statistical benefit but a clinically significant difference that directly translates into real-world differences in patient self-care, mobility, and functional independence.

The two within-group changes were both significantly different ($p < 0.001$ in all four paired t-tests) to establish that both of the interventions result in real rehabilitation gains beyond baseline. Nevertheless, the between-group comparison always showed that the improvement in TOT group was of a qualitatively and quantitatively different magnitude: 11.70 more BI points and 5.50 more MAS points in favour of TOT with percentage improvement benefits of 23.42% (BI) and 29.14% (MAS). These results are in good agreement with predictions of motor learning theory and also the evidence in international systematic reviews, and are the first rigorous RCT results of the superiority of TOT in an Indian clinical environment.

5.2 Contextualizing Findings in the Evidence Base.

The improvements in the BI and MAS in this trial are also in line with direction and magnitude of effects in the international TOT literature. A Cochrane review of repetitive task training by French et al. [7] reported standardized mean differences of about 0.28 in both upper limb and gait outcomes - in absolute terms, this would represent an equivalent improvement to that of Group 1 of this study. The difference between groups of 11.70 BI points is significantly higher than the commonly used MCID thresholds of the Barthel Index in stroke rehabilitation (1.85 to 5 points, depending on the definition and population), indicating that the difference is not just statistically significant but provides real value to patients and caregivers.

The MAS inter-group difference of 5.50 points is also clinically significant: according to the data on the distribution of the results in the post-intervention stage, the most common result of Group 1 (53.3% of the participants) was the transition to the mildly impaired category of MAS as compared to only 6.7% of Group 2, i.e., the clinical outcome of motor recovery among TOT The RCT by Kim et al. [9] in subacute stroke revealed similar inter-group benefits of MAS in regard to TOT with a vastly higher gait velocity, balance, and functional ambulation in the task-trained group. The present research is a replication of the findings in the Indian institutional setting, with the direct local validation of international established principles.

The BI categorical distribution after the intervention is of special clinical interest. Group 1: 83.3% of respondents in Group 1 achieved at least moderate dependence (BI 61-90) - levels where individuals are usually able to perform the basic self-care tasks of feeding, grooming and basic mobility with minimum support. Group 2 showed 56.7% in severe dependence category at six weeks of physiotherapy, which means that traditional physiotherapy was not enough to propel most of the participants across the clinically significant barrier between severe and moderate dependence during the period of the study. Since the Indian setting is based on family-based caregiving and insufficient formal home support resources, the distinction between severe and moderate dependence is virtually gigantic: it dictates whether a caregiver will be required to be constantly present and physically engaged in basic self-care or whether the caregiver will be able to leave the patient alone and rely on periodic supervision and assistance.

5.3 Neurophysiological Mechanisms Underlying TOT's Superiority

The better results of Group 1 can be explained by the principles of experience-dependent neuroplasticity as elaborated by Kleim and Jones [5]. The reorganization of the cortex promoted by TOT works better than traditional physiotherapy and this is due to a number of neurophysiological processes that work together. Task-specificity First, task-specificity assures that the neural circuits that are activated during rehabilitation training are the same circuits that are activated during the functional behaviors being trained sensorimotor, premotor, cerebellar, basal ganglia networks mediating actual performance of functional tasks, as opposed to the smaller circuits that are activated by isolated joint movements or passive facilitation. Second, elevated repetitive volume is necessary to provide the synaptic-level stimulation that is necessary to induce lasting long-term potentiation, the cellular process that underlies the process of motor memory consolidation. Animal experiments conducted by Kleim et al. have determined that at least about 400 good repetitions of a functional forelimb task is needed to induce measurable expansion of cortical maps - a threshold that structured TOT, with its aim of 30 to 50 repetitions per task domain per session across five sessions a week, is specifically meant to exceed.

Third, gradual task challenge discourages neural habituation and optimal expression of error-based learning processes - the comparison of efference copy predictions to actual sensory outcomes of movement - among the most powerful motor adaptation and motor learning processes. Traditional physiotherapy, which is more inclined to move in predictable patterns, and which is guided by an instructor, allows the motor system very limited opportunity to participate in active problem-solving and error correction. TOT, in its demand that the participant actively form and update their motor solutions to actual progressively demanding functional tasks, makes the most of these error-based learning circuits. Fourth, ecological validity of TOT tasks practice in contexts and using materials that closely approximate functional situations in the real world facilitates extrapolation of training impacts within the rehabilitation context to the home and community environments, the ultimate goal of rehabilitation.

These mechanisms are explicitly identified by Winstein et al. [6] as the reasons why they recommend task-specific, context-relevant training as the standard of care of post-stroke motor rehabilitation, and that goal-oriented training also activates motivational and reward-based neural systems (dopaminergic pathways in particular) that further increase the neuroplastic potency of rehabilitation practice.

5.4 Consistency and Reproducibility of TOT Benefits

The t-values in Group 1 were relatively high when compared with Group 2, although the sample size, degrees of freedom, and significance level were the same, which is not due to a larger difference between the means but because there was more homogeneity of response among the Group 1 participants. Group 1 (BI) and Group 2 (MAS) had a standard deviation of differences 4.00 and 2.01 respectively, indicating that there were very few non-large and non-consistent improvements in all participants. Such homogeneity of response has specific clinical implications: it implies that the benefits of TOT are not limited to a group of high-responders with good prognostic profiles, but are widely distributed among the participants in the sample, irrespective of age (41 - 69 years), sex, duration of stroke (4 - 24 weeks in the subacute range), stroke type, or the affected side of the stroke.

The implication of this finding is that a TOT protocol as designed in this study can be anticipated to generate significant functional benefits to a wide and heterogeneous group of subacute stroke patients not just younger, less impaired, or with certain lesion features. Such a wide scope of applicability adds significant clinical and public health benefits to the inclusion of TOT in the daily practice of physiotherapy.

5.5 Implications to Indian Stroke Rehabilitation Practice.

The implications of the findings of this trial on clinical and policy levels are immense. First, on an individual clinical practice level, physiotherapists treating stroke patients in Indian rehabilitation facilities are introduced to high-quality, locally produced evidence which a structured TOT protocol, with no equipment beyond that which any typical physiotherapy department has, can more than triple the functional recovery that can be obtained with conventional physiotherapy alone in the subacute recovery phase. Equipment and infrastructure is not the barrier to implementation but knowledge, training and willingness to systematically restructure session time around goal directed functional task practice.

Second, the institutional level impact is the evidence provided by this trial that will assist in amending physiotherapy protocols in stroke rehabilitation units to include structured TOT as a regular part of care with conventional physiotherapy. The protocol employed in this study is reproducible, protocolizable, and can be directly applied to other institutions with similar patient population. Third, on the physiotherapy education level, the results support the urgency of introducing modern aspects of motor learning science and neuroplasticity-based rehabilitation principles into MPT and BPT curriculum and replacing the neurofacilitation paradigm with evidence-based task-specific training models.

TOT is especially adaptable to the Indian healthcare setting: it needs a trained physiotherapist, standardized functional task equipment (chairs, objects of different sizes and weights, stairs, walking surfaces), and a plan of the session. No reliance on costly technology, specialized equipment or sophisticated institutional infrastructure. This resource economy implies that TOT could be applied in tertiary care hospital physiotherapy departments as well as in the outpatient units of a district hospital, in community health centers and, with proper training, in supported home-based rehabilitation programs.

5.6 Limitations

This study has several limitations that must be taken into consideration during interpretation and generalization of the results. To begin with, the research was carried out in one tertiary care facility in Udaipur, Rajasthan - an environment that does not necessarily reflect the diversity of the Indian physiotherapy practice settings, patients, and institutional resources. These findings would be enhanced by multicenter trials in geographically varied environments to enhance the generalizability. Second, TOT-induced motor learning and functional improvements, however, cannot be determined based on this data due to the lack of a longitudinal follow-up evaluation that should be conducted beyond the time frame of immediate post-intervention. Principles of motor learning indicate that improvements related to tasks must be stable - in fact, skill consolidation usually lasts longer than the training session, but follow-up (3-month, 6-month) should be considered longitudinally to ensure this.

Third, the authors used two main outcome measures (BI and MAS) without further evaluation of quality of life, community involvement, caregiver burden, or psychological wellbeing - areas of recovery becoming more central to the overall outcome evaluation of stroke rehabilitation. Future research need to look at multi-domain outcome batteries such as the Stroke Impact Scale or the EQ-5D-5L or the Nottingham Extended ADL Scale. Fourth, purposive sampling technique and the lack of a pre-specified published trial protocol (trial registration) creates possible sources of selection bias that need to be overcome in future trials through consecutive sampling and prospective CTRI registration. Fifth, the statistical analysis, even with all the within-group and inter-group comparison, lacked an independent samples t-test of between-group post-intervention score comparison and regression analysis of the potential moderating variables (age, stroke severity, lesion type, affected side), which would give an extra accurate representation of the treatment effect.

6. CONCLUSION

This randomized controlled trial, which is single-blinded with local generation of evidence, is strong and confined by local evidence generated that Task-Oriented Training, administered concurrently with conventional physiotherapy over a six week period in subacute stroke patients, has statistically significant and clinically relevant effects on motor function (MAS) and functional independence in activities of daily living (BI) that are approximately twofold that which can be attained All four within-group comparisons ($p < 0.001$) were accepted and inter-group comparisons were always and significantly in favor of the TOT group in all parameters of mean improvements, percentage improvements, t-values, and post-intervention category distributions.

Mechanistically, these results are based on the known neuroscience of experience-dependent neuroplasticity and motor learning, which are in line with the global evidence base of Cochrane reviews and RCTs, and, most importantly, directly proven in an Indian clinical population within an Indian healthcare institutional setting. The protocol is resource-appropriate, clinically feasible and can be scaled to various Indian rehabilitation environments. This evidence has a solid basis in the systematic implementation of structured Task-Oriented Training into regular stroke rehabilitation practice in the physiotherapy institutions, and community rehabilitation programs of India.

6.1 Clinical Recommendations

Based on the findings of this trial, the following evidence-based recommendations are made:

1. Physiotherapists managing subacute stroke patients should incorporate structured Task-Oriented Training as a core component of each rehabilitation session, targeting 45–60 minutes of goal-directed functional task practice per session.

2. TOT sessions should be organized around tasks directly relevant to each patient's functional goals, with tasks progressed systematically according to performance criteria.

3. Session repetition targets (minimum 30–50 repetitions per task domain) should be explicitly set and monitored to ensure the neuroplastically adequate training dose is delivered.

4. Conventional physiotherapy should be retained as an adjunct (20–30 min/session) for range-of-motion and strength maintenance but

should not occupy the majority of session time at the expense of functional task practice.

5. Outcome monitoring with the Barthel Index and Motor Assessment Scale should be conducted at baseline and post-intervention as standard practice to evaluate individual patient progress and program effectiveness.

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