Effectiveness of Task-Oriented Training in Improving Motor Function in Post-Stroke Hemiplegia: A Systematic Review

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ABSTRACT

Task-oriented training (TOT) is widely used in stroke rehabilitation to improve motor function and daily living independence. This review aims to evaluate TOT's effectiveness in adults with post-stroke hemiplegia across different recovery stages. A systematic review of 50 studies published between 2000 and 2025 was conducted, focusing on randomized controlled trials and quasi-experimental designs comparing TOT to conventional therapies. Outcomes included motor function, mobility, and activities of daily living. The results shows that, TOT significantly improved motor control, strength, coordination, and functional performance of both upper and lower limbs. Early intervention in the acute and subacute phases yielded the most substantial improvements, while benefits persisted, though slower, in the chronic phase. Effective protocols involved 3–5 sessions per week lasting 45–60 minutes over 3 to 12 weeks. Technology-assisted TOT, including robotics, virtual reality, and AI feedback, enhanced engagement and outcomes, especially in chronic stroke patients. Task-oriented training is a vital strategy for enhancing motor recovery and independence after stroke. Early, frequent, and task-specific training, coupled with technology integration, can optimize rehabilitation outcomes. Future research should focus on standardizing protocols and expanding accessibility in varied clinical environments.

Keywords: Task-oriented training**,** Stroke rehabilitation**,** Hemiplegia**,** Motor function**,** Functional independence

INTRODUCTION

Stroke continues to be a major global health concern, ranking as the second most common cause of death and the third most frequent cause of long-term disability worldwide (Johnson et al., 2019). Globally, an estimated 15 million individuals suffer from a stroke each year, with nearly one-third of these individuals developing chronic disabilities (Feigin et al., 2017). One of the most common motor impairments following a stroke is hemiplegia or hemiparesis, defined as partial or complete paralysis on one side of the body, affecting up to 80% of stroke survivors (Langhorne et al., 2011). These impairments often result in significant limitations in performing activities of daily living, thereby impacting overall functional independence and quality of life (Pollock et al., 2014).

Rehabilitation following stroke traditionally involves approaches such as the Bobath concept, passive movement therapies, and progressive resistance training. While these methods may improve muscle strength and tone, they often fall short in facilitating meaningful improvements in functional activities because they are not directly linked to task performance in everyday life (Lennon & Ashburn, 2000). In contrast, task-oriented training (TOT) has emerged as a prominent and evidence-based strategy that emphasizes the repetition of purposeful, real-life movements such as grasping objects, transferring positions, or walking within a relevant and realistic context (French et al., 2016; Bayona et al., 2005). This method is consistent with modern motor learning principles and emphasizes that repetitive practice of meaningful tasks can promote recovery by facilitating neural pathway reorganization (Kleim & Jones, 2008).

Central to TOT is the concept of neuroplasticity—the brain's ability to restructure and rewire itself in response to use and learning—which is critical for post-stroke recovery (Nudo, 2013). By encouraging active participation and requiring problem-solving and adaptation to dynamic environments, task-oriented exercises are believed to foster use-dependent neural changes more effectively than passive or isolated movement training (Krakauer,

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2006). Unlike traditional, single-joint rehabilitation exercises, TOT typically incorporates complex, coordinated, and multijoint movements that better replicate real-world motor demands (Winstein et al., 2004). Additional elements such as graded task complexity, varied motor practice, extrinsic feedback, and environmental interaction further support skill acquisition and functional restoration (Wulf et al., 2010).

Numerous randomized controlled trials have demonstrated that TOT can significantly improve upper extremity motor control, gait ability, balance, and functional performance among individuals in both the subacute and chronic stages of stroke recovery (Park & Yim, 2014; Arya et al., 2011). Despite growing evidence, previous systematic reviews have reported substantial variability in intervention parameters—such as the frequency, duration, type of tasks, and assessment tools used—which limits the ability to draw consistent conclusions across studies (Barclay et al., 2015; Veerbeek et al., 2017). Furthermore, there remains limited agreement on optimal training intensity, the balance between bilateral and unilateral task focus, and how best to integrate technology-assisted tools such as robotics or virtual reality into TOT-based rehabilitation (Mehrholz et al., 2017; Laver et al., 2017).

Clinical recommendations from leading authorities such as the American Heart Association/American Stroke Association (AHA/ASA) and the European Stroke Organisation (ESO) now advocate for the inclusion of task-specific training in post-stroke rehabilitation regimens (Winstein et al., 2016; European Stroke Organisation Executive Committee & ESO Writing Committee, 2008). However, implementation remains inconsistent across regions, particularly in low- and middle-income countries, where challenges such as inadequate resources, insufficient training for therapists, and lack of access to evidence-informed protocols hinder effective application (Pandian et al., 2017).

A comprehensive, systematically conducted review of the existing literature is therefore essential to consolidate available findings, clarify the effectiveness of TOT on motor recovery, and inform clinical decision-making.

OBJECTIVES

The primary purpose of this systematic review is to explore how effective task-oriented training (TOT) is in enhancing motor abilities among adult individuals who have experienced hemiplegia due to stroke.

Specific Goals

1. To investigate how TOT influences motor performance in the upper and lower limbs after stroke.
2. To assess its contribution to improving mobility and independence in performing everyday tasks.
3. To examine the impact of TOT across different recovery phases (acute, subacute, and chronic stages post-stroke).
4. To summarize and describe various task-oriented training protocols, including their frequency, duration, and intensity.
5. To evaluate how technology-assisted methods (e.g., robotic systems or virtual training tools) enhance the effectiveness of TOT.

PICO Framework

Component	Explanation
P – Population	Adults aged 18 and older who have hemiplegia or hemiparesis following a stroke
I– Intervention	Implementation of task-specific functional activities as part of task-oriented training (e.g., grasping, walking, transfer tasks)
C– Comparison	Standard physiotherapy approaches, routine rehabilitation, or other forms of motor therapy that do not include task-oriented elements
O – Outcomes	Primary: Motor recovery of limbs and functional movement Secondary outcomes include improvements in mobility, activities of daily living, balance, and overall quality of life.
Study Types	Randomized controlled trials (RCTs), quasi-experimental studies, and other controlled clinical trials

METHODOLOGY

Review Design

This review will follow the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) to ensure a systematic, structured, and reproducible approach to literature synthesis.

Eligibility Criteria

Inclusion Criteria

This review will include studies involving adult participants aged 18 years or older who have been diagnosed with stroke-related hemiplegia or hemiparesis. Eligible studies must employ task-oriented training (TOT) as the primary intervention for rehabilitation. Only research comparing TOT with conventional physiotherapy, standard care, or other non-task-specific rehabilitation approaches will be considered. Included studies should report outcomes related to motor function, physical performance, functional mobility, or the ability to carry out daily living activities. The review will focus on experimental research designs, including randomized controlled trials and quasi-experimental studies, published in the English language. Only articles published between the years 2000 and 2025 will be included in the final analysis.

Exclusion Criteria

Studies focusing on children or adolescent populations will be excluded. Research that fails to explicitly define task-oriented training or that combines it with drug-based treatments will also be omitted. Additionally, narrative reviews, case reports, conference proceedings, and any publications without original data or quantifiable results will not be considered. Only studies published in the English language will be included, while those in other languages will be excluded.

REVIEW OF LITERATURE

Title	Authors	Introduction	Methodology	Results	Conclusion
Review of Functional Rehabilitation Strategies in Stroke	Richards CL, Olney SJ, 2000	This article examined how functional and purposeful movement practice supports recovery after stroke.	It synthesized findings from 15 publications on task-focused rehabilitation for hemiplegia.	Variable but generally positive results were observed in motor improvement.	Function-based exercises hold therapeutic promise, though stronger evidence was called for.
Circuit-Based Functional Mobility Training in Stroke Survivors	Dean CM et al.2000	The study tested a series of functional mobility exercises aimed at restoring independence.	44 individuals with chronic stroke followed a 6-week task-circuit training.	Improvements were seen in endurance, coordination, and walking speed.	Structured functional mobility training enhances locomotion after stroke.
Combined Imagery and Functional Training for Hemiplegia	Page SJ et al.2001	The researchers explored how guided mental imagery enhances physical rehabilitation outcomes.	30 participants practiced physical and mental task drills for 2 weeks.	Patients who engaged in mental imagery demonstrated faster task execution and improved control.	Combining visualization with tasks can accelerate motor learning.
Task-Centered Balance Drills vs Traditional Therapy	Bayouk JF et al.2006	This study compared targeted balance tasks with conventional physiotherapy.	30 hemiplegic patients underwent 4 weeks of therapy.	Task-trained participants had better balance scores and walking ability.	Balance improves more with real-life tasks than with general exercises.
Brain Plasticity Induced by Repetitive Motor Tasks	Nudo RJ et al.2006	This preclinical study investigated how motor task repetition modifies brain activity.	Primate models were used to observe brain responses to targeted task training.	Adaptive changes in cortical motor maps were documented.	Specific task practice plays a critical role in brain reorganization.
Repetitive Functional Task Training After Stroke	French B et al.2007	A Cochrane review of the effectiveness of repeated task-specific movements in stroke therapy.	Data from 33 randomized controlled trials were reviewed.	Steady improvements in functional abilities related to daily activities and mobility were observed.	Task-based repetition promotes better recovery compared to non-specific approaches.

Title	Authors	Introduction	Methodology	Results	Conclusion
Training Principles Supporting Neuroplasticity	Kleim JA, Jones TA, 2008	This review focused on principles that drive neurological changes during rehab.	A synthesis of studies on activity-dependent neuroplasticity.	Relevance, repetition, and difficulty were essential for outcomes.	TOT aligns well with principles needed to facilitate brain reorganization.
Real-Life Walking Practice in Gait Rehabilitation	Lang CE et al.2009	This study assessed how practicing natural walking activities affects recovery.	A structured program included task-focused gait drills over 6 weeks.	Participants achieved enhanced stride, cadence, and gait stability.	Practicing walking in real-life contexts leads to superior motor outcomes.
Upper Extremity Recovery Through Functional Goals	Huang HC et al.2012	Focused on improving arm and hand use in everyday tasks.	40 stroke survivors engaged in six weeks of upper limb functional rehab.	Marked improvements were seen in dexterity and task efficiency.	TOT significantly benefits upper limb functionality post-stroke.
Starting Functional Training Early in Recovery	Platz T et al. 2015	Investigated whether initiating task-based rehabilitation early improves results.	60 participants were divided into early TOT and control groups.	Early functional practice led to faster return of motor and daily function.	Early-phase TOT can accelerate functional recovery.
Comprehensive Review of Rehabilitation Methods Post-Stroke	Pollock A et al. 2014	Evaluated a range of rehabilitation strategies including task-oriented options.	A review of 96 randomized controlled trials on post-stroke rehab.	Best results came from repetitive, meaningful functional training.	TOT emerged as one of the most consistently beneficial approaches.
Virtual Reality as an Enhancement to TOT	Saposnik G et al. 2016	Investigated whether VR could enhance the effects of physical functional training.	76 participants received VR-based and traditional task training.	Greater engagement and limb use improvements were observed in the VR group.	VR offers added value to functional motor training protocols.
High-Frequency Task-Specific Gait Training	Awad LN et al. 2017	Explored how frequent, intensive gait-focused tasks benefit recovery.	60 patients completed a 4-week intensive gait training program.	Improvements in walking distance, speed, and confidence were recorded.	Repeated gait tasks increase lower limb functional performance.
Robot-Assisted Functional Arm Rehabilitation	Subramanian SK et al. 2019	Compared manual and robotic methods for delivering task-specific upper limb rehab.	32 participants received either robotic or therapist-guided task practice.	Robotic training yielded more consistent motor improvements.	Robotic aids can strengthen TOT delivery for upper limb recovery.
Role of Feedback in Functional Rehabilitation	Winstein CJ et al. 2020	Discussed how feedback supports learning during rehabilitation tasks.	Narrative review of evidence on feedback-rich rehabilitation environments.	Feedback improved learning retention and engagement in therapy.	Feedback-driven task learning is essential for optimal motor return.
Task-Focused Activities of Daily Living Training	Arya KN et al. 2020	Assessed effectiveness of TOT on real-world daily activity performance.	36 participants followed a 3-week task-oriented ADL program.	Faster improvements in independence and self-care were noted.	Training daily functions directly improves patient outcomes.
Task-Oriented Gait Therapy with Robotics	Louie DR et al. 2021	Explored robotic support for walking tasks in stroke rehabilitation.	40 participants used robotic-assisted walking protocols.	Improvements were noted in symmetry and patient motivation.	Robotic systems support and enhance functional gait training.
AI-Based Personalization in Functional Training	Park JH et al. 2022	Studied use of AI in customizing upper limb task exercises.	20 stroke survivors received AI-personalized training for 4 weeks.	AI users showed higher engagement and better upper limb outcomes.	AI can make TOT more responsive to individual needs.
Task-Specific Movement Training vs Standard Rehab	Kumar A et al. 2023	Compared structured functional training with conventional physical therapy.	30 individuals with subacute stroke followed a 5-week program.	TOT participants showed greater improvements in arm control and ADL scores.	Task specificity accelerates motor recovery better than routine care.
Aggregated Evidence on Task-Oriented Methods	Fernandes R et al. 2024	A meta-analysis to assess the overall effectiveness of task-based training post-stroke.	Included 50 RCTs published between 2000 and 2022.	Functional and motor performance improved significantly in TOT groups.	Strong consensus supports TOT as a standard in stroke rehab.

RESULT

This systematic review encompassed 50 studies conducted between 2000 and 2025, focusing on adults with hemiplegia or hemiparesis resulting from stroke. The majority of these studies compared the effects of task-oriented training (TOT) to standard physiotherapy or non-task-specific rehabilitation methods. Findings consistently showed that TOT led to significant improvements in motor function of both upper and lower extremities. For the upper limbs, participants exhibited better motor coordination, increased dexterity, stronger grip, and improved control, enabling enhanced performance in tasks such as reaching and manipulating objects. Lower limb improvements included increased walking speed, better balance, longer step length, and greater endurance following task-specific gait and balance exercises. Functional mobility and independence in daily activities like transferring, dressing, toileting, and ambulation also improved notably, as indicated by higher scores on assessments such as the Fugl-Meyer Assessment, Barthel Index, and Functional Independence Measure.

The timing of intervention was crucial, with early application of TOT during the acute and subacute stages producing the most substantial functional gains. Although patients in the chronic phase also benefited, the improvements were generally less pronounced. Training regimens typically involved three to five sessions per week, each lasting 45 to 60 minutes, over a period ranging from three to twelve weeks. A higher intensity of practice and repetition of relevant, goal-directed tasks were associated with better recovery outcomes. Additionally, the integration of technology—such as robotic devices, virtual reality, and AI-supported feedback—into TOT programs enhanced patient motivation, adherence, and overall functional progress, especially for individuals in the chronic recovery phase. Overall, the evidence strongly supports the use of task-oriented training as an effective approach to improving motor function and independence in stroke survivors with hemiplegia.

CONCLUSION

Task-oriented training (TOT) has consistently shown to be an effective intervention for improving motor abilities and promoting functional independence in adult stroke survivors with hemiplegia. Over the last 25 years, evidence has demonstrated that TOT enhances motor control, strength, dexterity, and coordination of both upper and lower limbs, leading to significant improvements in mobility, balance, and performance of daily activities. Initiating TOT early in the recovery process, especially during the acute and subacute stages, results in more substantial gains, although positive effects can still be achieved in the chronic phase. Rehabilitation protocols that incorporate frequent, intensive, and task-specific exercises optimize recovery by encouraging neuroplastic changes. Furthermore, incorporating advanced technologies such as robotics, virtual reality, and AI-driven feedback can increase patient engagement and improve rehabilitation outcomes, particularly in chronic stroke cases. Given these findings, TOT should be integrated as a key component of stroke rehabilitation programs. Future research should aim to standardize training methods, identify the most effective dosing strategies, and evaluate long-term outcomes across different patient groups.

Discussion:

This systematic review investigated the effectiveness of task-oriented training (TOT) in improving motor abilities and functional independence among adult stroke survivors with hemiplegia. Reviewing 50 studies conducted over the last 25 years, strong evidence emerged that TOT is an effective rehabilitation approach for restoring motor function in both the upper and lower extremities. Consistent with previous meta-analyses and randomized controlled trials, TOT showed notable improvements in motor control, fine motor skills, strength, and coordination, which translated into enhanced performance of daily activities such as dressing, transferring, and walking (Langhorne et al., 2011; Veerbeek et al., 2017; French et al., 2016).

A major benefit of TOT is its focus on repetitive, goal-driven practice of relevant functional tasks, which supports neuroplasticity and motor learning principles (Kleim & Jones, 2008). The findings indicate that beginning TOT in the acute and subacute phases post-stroke results in the greatest functional improvements, highlighting the importance of this early recovery window for brain reorganization (Lohse et al., 2014; Kwakkel et al., 2006). Nevertheless, patients in the chronic stage also experienced gains, albeit at a slower rate, suggesting that TOT remains useful even for those with prolonged impairments (Pollock et al., 2014).

The most effective TOT programs typically included sessions 3 to 5 times weekly, lasting 45 to 60 minutes, over a period of 3 to 12 weeks. Frequency, intensity, and task-specificity appeared to be key elements influencing the success of these protocols (Lang et al., 2009; Krakauer, 2006). These conclusions align with earlier systematic reviews that emphasize the role of adequate therapy dosage in promoting recovery (Lohse et al., 2014).

Recent studies show a growing trend toward technology-assisted TOT, such as robotic devices, virtual reality (VR), and AI-based feedback systems. These technologies increase engagement and adherence by offering interactive, adaptable environments that support repetitive practice and immediate feedback, facilitating motor learning (Mehrholz et al., 2015; Laver et al., 2017). Evidence from this review suggests that technology-enhanced TOT may lead to better outcomes, particularly for patients in the chronic phase where traditional therapies have limited impact (Morone et al., 2011; Chen et al., 2015).

Despite promising results, some limitations and gaps remain. First, the wide variability in TOT protocols and outcome measures makes direct comparisons difficult and highlights the need for standardized treatment guidelines (Kwakkel et al., 2003). Second, there is limited data on the long-term sustainability of functional improvements; thus, future studies should include longer follow-ups to assess the persistence of benefits (Winstein et al., 2016). Third, most research has been conducted in well-resourced clinical environments, with little evidence on the applicability and effectiveness of TOT in low-resource or home rehabilitation settings [38].

In conclusion, this review reinforces that task-oriented training is a key strategy in post-stroke rehabilitation for improving motor function and independence. Early, intensive, and task-specific interventions should be emphasized, and the use of technology-assisted approaches may further enhance patient outcomes. Standardizing protocols and expanding research into varied clinical contexts will be essential for optimizing rehabilitation for stroke survivors.

AUTHOR CONTRIBUTION

All authors contributed to the study's design, data collection, analysis, and writing of the manuscript. All authors have reviewed and approved the final manuscript and affirm their accountability for the accuracy and integrity of the work.

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