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THE EFFECTIVENESS OF EARLY INTERVENTIONS IN POST-ISCHEMIC STROKE PATIENTS ON NEUROLOGICAL RECOVERY AND QUALITY OF LIFE: A SYSTEMATIC REVIEW

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Abstract

Introduction: Individuals recovering from ischemic stroke often endure significant neurological impairments, including motor deficits, cognitive challenges, and emotional disturbances. These complications substantially reduce their quality of life and impose a heavy burden on both the healthcare system and caregivers. Objective: To evaluate the effectiveness of early interventions in improving neurological recovery and quality of life in post-ischemic stroke patients. Method: Following PRISMA guidelines, five databases (Scopus, PubMed, ScienceDirect, Web of Science, ProQuest) were searched for English-language RCTs and quasi-experimental studies published between 2020 and 2025. Quality appraisal was conducted using Joanna Briggs Institute (JBI) tools. Results: Eleven studies (n = 11) met the inclusion criteria. Interventions initiated within 24-48 hours post-stroke consistently demonstrated superior improvements in neurological function (NIHSS), independence (Barthel Index), and motor skills (mRS, FMA) compared to delayed care. Early nursing and multidisciplinary rehabilitation also significantly enhanced mental well-being and health-related quality of life (SF-36, EQ-5D). Conclusion: Early interventions administered during the acute phase of ischemic stroke are effective in enhancing recovery and improving quality of life. These findings highlight the importance of timely, structured, and multidisciplinary stroke rehabilitation programs as a standard part of stroke management.

Keywords: *Early Intervention, Ischemic Stroke, Neurological Recovery, Quality Of Life, Stroke Rehabilitation*

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INTRODUCTION

Stroke is a leading cause of long-term disability and mortality worldwide, with ischemic strokes accounting for approximately 80% of all cases. As populations age, the prevalence and overall disease burden of stroke are expected to increase substantially (Wei et al., 2024). Post-ischemic stroke patients frequently experience residual deficits such as hemiparesis, aphasia, cognitive impairment, and mood disorders, which compromise their quality of life and complicate long-term recovery (Wang et al., 2022). Although advancements in acute management such as thrombolysis and mechanical thrombectomy have contributed to improved survival rates, many stroke survivors continue to struggle with persistent functional impairments. In countries like China, stroke remains the leading cause of disability, with a reported prevalence of 336.3 per 100,000 population (Liu et al., 2021). In Indonesia, stroke remains the leading cause of death and long-term disability, yet access to early specialized rehabilitation is often hindered by geographical and healthcare system constraints (Yang & Hartanto, 2024).

The associated economic burden is immense, ranging from direct healthcare expenditures to indirect costs including lost productivity and the need for long-term caregiving support (Bisevac et al., 2022). In recent years, there has been growing interest in early rehabilitation as a means to optimize stroke recovery. The period immediately following a stroke particularly the first 24 to 72 hours is believed to represent a critical window of heightened neuroplasticity. During this time, the brain demonstrates an increased capacity for repair and functional reorganization, making it an ideal period for initiating rehabilitative and supportive interventions (Lin et al., 2020).

Early intervention in the context of post-ischemic stroke encompasses a range of therapeutic strategies implemented shortly after stroke onset, typically within the first 72 hours. According to Liu et al. (2023), this period is often referred to as the "golden recovery phase," during which timely interventions can substantially influence the trajectory of neurological and functional recovery. These interventions may include physical rehabilitation (e.g., mobilization and physiotherapy), pharmacological treatments (such as rtPA or neuroprotective drugs), non-invasive brain stimulation techniques (e.g., repetitive transcranial magnetic stimulation [rTMS], transcranial direct current stimulation [tDCS]), and coordinated multidisciplinary care (Liu et al., 2021).

Despite growing recognition of the importance of the “golden recovery phase,” there is a lack of recent systematic reviews that simultaneously evaluate both neurological recovery and quality of life in post-ischemic stroke patients. This study seeks to address this gap by providing an updated synthesis of early interventions initiated within the first 72 hours after stroke onset. Specifically, this systematic review aims to identify, analyze, and synthesize empirical evidence regarding the impact of early interventions on neurological outcomes and quality of life in individuals recovering from ischemic stroke.

METHOD

This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Five academic databases Scopus, PubMed, ScienceDirect, Web of Science, and ProQuest were searched systematically for relevant literature published between 2020 and 2025. The search terms were constructed using Medical Subject Headings (MeSH) and Boolean operators, including: ("early intervention" OR "timely treatment" OR "acute care" OR "initial therapy") AND ("post-ischemic" OR "ischemic stroke" OR "cerebral infarction") AND ("rehabilitation" OR "recovery" OR "therapy") AND ("quality of life" OR "neurological outcome").

Eligibility Criteria

The inclusion criteria for this systematic review were guided by the PICOS framework. The target population consisted of adult individuals aged 18 years or older who had been diagnosed with acute ischemic stroke within the first 72 hours of symptom onset. The interventions of interest included various early treatment approaches administered shortly after stroke occurrence, such as early rehabilitation, pharmacological agents (e.g., rtPA, neuroprotective therapies), non-invasive brain stimulation techniques, and multidisciplinary therapeutic programs.

The studies reviewed compared these early interventions with either standard care or interventions that were delayed beyond the 72 hour window. Outcomes of interest focused primarily on neurological recovery, measured using validated scales such as the National Institutes of Health Stroke Scale (NIHSS), the Modified Rankin Scale (mRS), and the Barthel Index, as well as assessments of health-related quality of life, including tools like the SF-36 and EQ-5D. Additional outcome measures included levels of functional independence, hospital readmission rates, and stroke-related complications. Eligible studies were limited to experimental research design specifically randomized controlled trials and quasi-experimental studies published in English between 2020 and 2025.

Study Selection

The study selection process began with the identification of relevant articles from multiple academic databases. A total of 469 articles were initially retrieved, with the following distribution: Scopus (n = 252), PubMed (n = 50), ScienceDirect (n = 46), ProQuest (n = 64), and Web of Science (n = 57). After removing duplicate records (n = 29), titles and abstracts were screened to exclude irrelevant studies (n = 264). Subsequently, articles that did not specifically address the effectiveness of early interventions in post-ischemic stroke patients with respect to neurological recovery and health-related quality of life were excluded (n = 165). As a result, 11 articles met the eligibility criteria and were included in the final analysis of this systematic review. (Figure 1).

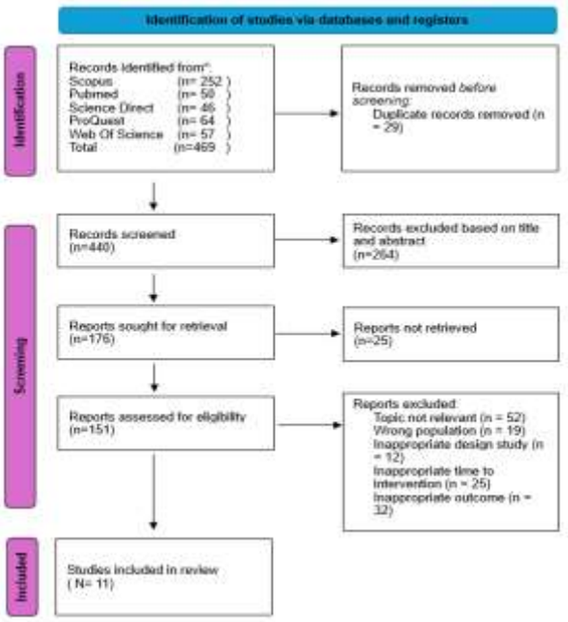

Figure 1 Diagram Flow PRISMA. Haddaway, N. R., Page, M. J., Pritchard, C. C., & McGuinness, L. A. (2022). PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and Open Synthesis Campbell Systematic Reviews, 18, e1230. https://doi.org/10.1002/cl2.1230

Data Extraction and Synthesis Approach

Data from the included studies were extracted by two independent reviewers using a standardized data extraction form developed in Microsoft Excel. Disagreements during data extraction were resolved through consensus meetings among all authors. The form was designed to capture key information, including: (1) author(s) and year of publication; (2) study design and country of origin; (3) participant characteristics (sample size, age, gender); (4) details of the intervention (type, timing, duration, and frequency); (5) comparison group details; (6) outcome measures used (e.g., NIHSS, mRS, Barthel Index, SF-36); and (7) key findings relevant to neurological recovery and quality of life. Any discrepancies in data extraction between the two reviewers were resolved through discussion and consensus, or by consulting a third reviewer if necessary.

Given the significant heterogeneity in intervention types, outcome measures, and study populations across the included articles, a quantitative meta-analysis was not feasible. Therefore, a narrative synthesis approach was employed to analyze and synthesize the findings. The results were grouped thematically based on the type of intervention (e.g., physical rehabilitation, pharmacological therapy, multidisciplinary care) and key outcomes (neurological function, functional independence, and quality of life). This approach allowed for a comprehensive and structured summary of the evidence regarding the effectiveness of different early interventions post-ischemic stroke.

Methodological Quality Assessment

This systematic review utilized the Joanna Briggs Institute (JBI) critical appraisal tools to assess the methodological quality of included studies prior to data extraction. The appraisal process was tailored to the respective study designs, specifically randomized controlled trials (RCTs) and quasi-experimental studies. The JBI checklists consist of structured criteria designed to evaluate research rigor and internal validity. A predetermined cutoff of ≥75% (agreed upon by researchers) was applied to ensure high-quality inclusion; studies scoring below this threshold were excluded to safeguard the review's validity (Munn et al., 2021). In the last screening, eleven studies reached a score higher that 75% and were ready to do data synthesis.

Table 1. Criteria for Assessment of Research Results.

No.	Author , Years	Study Design	Result
1.	(Lin et al., 2020)	RCT	13/13= 100 %
2.	(Wang et al., 2022)	RCT	12/13= 92 %
3.	(García-Pérez et al., 2024)	RCT	11/13 = 85 %
4.	(Zhang et al., 2021)	Quasi-experimental study	9/9 = 100%
5.	(Hu & Liu, 2021)	RCT	13/13 = 100%
6.	(Liu et al., 2021)	RCT	11/13 = 85%
7.	(Krastev et al., 2024)	Quasi-experimental study	9/9 = 100%
8.	(Yu et al., 2021)	Quasi-experimental study	9/9 = 100%
9.	(Han et al., 2021)	RCT	11/13 = 85 %

10.	(Zheng et al., 2021)	RCT	13/13 = 100%
11	(Liu et al., 2023)	RCT	12/13 = 92 %

RESULT AND DISCUSSION

Result

Characteristics of selected studied

A total of 11 studies met the inclusion criteria for this systematic review, encompassing a variety of early interventions in post-ischemic stroke patients. The studies were conducted in China, Spain, Serbia, Taiwan, Slovakia, and Australia, with sample sizes ranging from 40 to 6033 participants. Most studies defined early intervention as treatment initiated within 24 to 72 hours after stroke onset, and a substantial proportion initiated interventions even earlier, within the first 24 to 48 hours, in order to capitalize on the acute neuroplasticity window.

Types of early interventions

The types of interventions varied widely, including early physical rehabilitation, occupational therapy, neuromuscular electrical stimulation (NMES), early nursing care, aerobic exercise programs, virtual reality-assisted therapy, early antithrombotic treatment, and combined multidisciplinary strategies. Across these studies, early intervention showed consistent effectiveness in improving neurological function, functional independence, and quality of life. Key outcome measures included the National Institutes of Health Stroke Scale (NIHSS), Modified Rankin Scale (mRS), Fugl-Meyer Assessment (FMA), Barthel Index, and various quality of life instruments such as the SF-36, EQ-5D, WHOQOL-BREF, and GQOLI-74.

Early physical rehabilitation and mobilization

Several studies demonstrated that interventions initiated within 24 to 48 hours yielded more favorable outcomes than delayed interventions. (Wang et al., 2022) reported that patients receiving early rehabilitation between 24-48 hours post-stroke had improved lower extremity motor function and greater independence. (Lin et al., 2020) found that early rehabilitation combined with virtual reality significantly enhanced muscle strength and mood state. (García-Pérez et al., 2024) also observed that early occupational therapy improved quality of life, cognitive performance, and emotional well-being. (Hu & Liu, 2021) highlighted the role of early nursing interventions in reducing post-stroke complications and enhancing overall recovery, while (Zhang et al., 2021) confirmed the benefits of early mobilization with moderate intensity and frequency in improving neurological status, ADL, and fatigue reduction.

In addition, the TIME trial protocol investigated different time windows for first mobilization after ischemic stroke in a large cohort (n = 6033), aiming to compare mortality, disability, and other clinical outcomes; in this context, early mobilization within 24 hours was reported as feasible and associated with reduced disability.

Overall, these mobilization and physical rehabilitation studies indicate that initiating structured rehabilitation within the first 24–72 hours, particularly within 24–48 hours, is associated with more favourable neurological and functional outcomes than starting later

Nursing-based early rehabilitation interventions

Several studies examined early nursing and rehabilitation nursing programmes implemented shortly after stroke onset. A randomized controlled trial on patients with ischemic stroke hemiplegia evaluated early rehabilitation nursing initiated within 24 hours of onset, including psychological support, limb function training, and diet guidance. This intervention improved neurological function, reduced the incidence of lower extremity deep vein thrombosis (LEDVT), and enhanced quality of life and nursing satisfaction. A quasi-experimental study of early systematic rehabilitation nursing provided within 72 hours in elderly patients with stroke sequelae found improvements in upper limb motor and sensory function, reductions in negative psychological symptoms, and gains in activities of daily living and overall quality of life.

These nursing-based interventions indicate that structured early rehabilitation nursing within 24–72 hours can be associated with better functional and quality of life outcomes compared with routine care.

Technology-assisted rehabilitation (VR and NMES)

Technology-assisted interventions were also represented among the included studies. A randomized controlled trial from Taiwan investigated early rehabilitation combined with virtual reality training, initiated within 72 hours after stroke. Patients in the experimental group showed increased muscle strength, reduced depression and anxiety, and improved functional status at discharge compared with controls. Other studies incorporated neuromuscular electrical stimulation (NMES) and electromyographic biofeedback as components of early rehabilitation programmes, usually in conjunction with conventional physiotherapy and Bobath-based techniques, and reported gains in motor function and activities of daily living. Collectively, these findings suggest that integrating VR or NMES into rehabilitation started within the first 72 hours can enhance motor and functional outcomes relative to standard therapy alone.

Early occupational therapy interventions

One randomized controlled trial (EOTIPS) evaluated early occupational therapy delivered within 48 hours post-stroke. Participants in the intervention group demonstrated significant improvements in quality of life, independence, perceptual–cognitive skills, and symptoms of depression and anxiety compared with usual care. 15 This indicates that occupational therapy initiated during the acute phase may positively influence both functional performance and psychosocial outcomes.

Pharmacological and other medical early interventions

On the pharmacological side, (Krastev et al., 2024) showed that early antithrombotic therapy initiated after thrombolysis was safe and effective, leading to better functional outcomes. (Liu et al., 2023) compared early versus delayed antihypertensive treatment and concluded that timing did not significantly influence mortality or long-term disability, though safety was preserved. Meanwhile, larger-scale trials such as the TIME study by (Zheng et al., 2021) explored the optimal time window for mobilization and found that early initiation within 24 hours was both feasible and associated with reduced disability. Overall, the evidence from the included studies supports the effectiveness of early interventions in enhancing post-stroke recovery. Most interventions showed statistically and clinically significant improvements in motor function, independence, emotional well-being, and health-related quality of life. These findings emphasize the value of initiating structured, multidisciplinary stroke rehabilitation programs within the acute phase ideally within the first 72 hours after onset.

Table 2. Result of Literature Reseach

Title	Sample	Design	Country	Time to Intervention	Intervention	Instrument	Result	Key Findings Related to Early Intervention	Population	Age (Years)	Gender (%)
Effectiveness of Early Rehabilitation Combined With Virtual Reality Training on Muscle Strength, Mood State, and Functional Status in Patients With Acute Stroke: A Randomized Controlled Trial (Lin et al., 2020)	152 patients	Randomized controlled trial	Taiwan	Within 72 h post-stroke	Early rehabilitation combined with virtual reality training	Medical Research Council Manual Muscle Testing scale, Hospital Anxiety and Depression Scale, Postural Assessment Scale for Stroke, Barthel scale	Participants in the experimental group showed increased muscle strength, decreased depression and anxiety, and increased functional status at discharge	Early rehabilitation combined with VR training has beneficial impacts on mood state and muscle strength at discharge	Patients with acute ischemic stroke	64.5 ± 13.5 (EG), 66.9 ± 13.3 (CG)	71.1 % male (EG), 56.1 % male (CG)
Early physical rehabilitation therapy between 24 and 48 h following acute ischemic stroke onset: a randomize	110 patients	Randomized controlled trial	China	24-48 h post-stroke	Early physical rehabilitation therapy	Modified Rankin Scale, Simplified Fugl-Meyer Assessment	Patients in the early rehabilitation group had more favorable outcomes and improve	Early physical rehabilitation training between 24 and 48 h may be beneficial and improve patients'	Patients with acute ischemic stroke	60.27 ± 10.57 (ER), 61.04 ± 11.46 (SR)	37.50 % female (ER), 44.50 % female (SR)

d controlled trial (Wang et al., 2022)							d lower extremity function within the first week	lower extremity function within the first week		
Early Occupational Therapy Intervention post-stroke (EOTIPS): A randomized controlled trial (García-Pérez et al., 2024)	60 adults	Randomized controlled trial	Spain	Within 48 h post-stroke	Early Occupational Therapy Intervention (EOTIPS)	Stroke and Aphasia Quality of Life Scale, Barthel Index, Modified Rankin Scale, Montreal Cognitive Assessment, Fugl Meyer Assessment, Berg Balance Scale, Timed Up & Go, Communicative Activity Log, Beck Depression Inventory-II, Hamilton Anxiety Scale	Participants in the intervention group showed significant improvements in quality of life, independence, perceptual-cognitive skills, and symptoms of depression	EOTIPS was effective in improving quality of life, perceptual-cognitive skills, independence, and reducing levels of depression	Adults who suffered a stroke	66.60 ± 10.60 (Control), 68.50 ± 10.70 (Experimental)	53.33 % male (Control), 63.33 % male (Experimental)
Optimization of Early Mobilization Program for Patients With Acute Ischemic Stroke: An Orthogonal Design (Zhang et al., 2021)	57 patients	Orthogonal experiment with blinded follow-up assessment	China	24-72 hours of onset	Early mobilization programs with different initiation times, intensities, frequencies, and durations	NIHSS, mRS, BI, FSS, IDA, SS-QoL, IPA	Early rehabilitation with high-intensity physical exercise at 24-48 hours after stroke onset, 2-3 times/day, was benefici	Early mobilization at 24-48 hours post-stroke, with high-intensity and moderate frequency, significantly improved neurologi	Acute ischemic stroke patients	64.00 ± 7.98 to 71.00 ± 9.42	Optimization of Early Mobilization Program for Patients With Acute Ischemic Strok

							al for stroke patients.	cal deficits, self-care capacity, self-efficacy, quality of life, and social participation, and reduced post-stroke fatigue at 3 months.			e: An Orthogonal Design
Effects of early rehabilitation nursing on neurological functions and quality of life of patients with ischemic stroke hemiplegia (Hu & Liu, 2021)	123 patients (70 control, 53 study)	Randomized controlled trial	China	Within 24 hours of onset	Early rehabilitation nursing including psychological nursing, limb function training, and diet guidance	ESS, BI, FMA, WHOQOL-BREF	ERN improved neurological functions, reduced the incidence of LEDVT, and improved QOL in patients with ISH.	Early rehabilitation nursing significantly improved neurological functions, reduced complications and LEDVT incidence, and enhanced quality of life and nursing satisfaction in ISH patients.	Ischemic stroke hemiplegia patients	55.72 ± 18.38	Effects of early rehabilitation nursing on neurological functions and quality of life of patients with ischemic stroke hemiplegia
Effects of Different Intervention Time Points of Early Rehabilitation on Patients with Acute Ischemic Stroke: A Single-Center, Randomized Control Study (Liu, Lu, Bi, Fu, et al., 2021)	90 patients	Single-center, randomized control study	China	Within 72 hours of onset (ultraearly) or from 72 hours to 7 days (early)	Ultraearly or early rehabilitation programs including Bobath rehabilitation technique, brain circulation therapy apparatus, and electromyographic biofeedback technique	NIHSS, MBI, FMA	Ultraearly rehabilitation within 72 hours of stroke onset was more effective than early rehabilitation started from 72 hours to 7 days.	Ultraearly rehabilitation significantly improved neurological function, daily living activities, and motor function compared to early rehabilitation.	Acute ischemic stroke patients	76.5 ± 6.36 (ultra early), 71.5 ± 14.8 (early)	Effects of Different Intervention Time Points of Early Rehabilitation on Patients with Acute Ischemic Stroke: A Singl

											e-Center, Randomized Control Study
Analysis of Safety and Efficacy of the Early Initiation of Antithrombotic Secondary Prevention in Patients Treated with Intravenous Thrombolysis for Acute Ischemic Stroke (Krastev et al., 2024)	489 patients	Quasi-experimental study	Slovakia	Within 24 hours	Early antithrombotic therapy	Modified Rankin Scale (mRS), National Institutes of Health Stroke Scale (NIHSS)	Early antithrombotic treatment showed no safety concerns and resulted in a significantly higher proportion of patients with an excellent functional outcome.	Early antithrombotic treatment after intravenous therapy in patients with acute ischemic stroke revealed no safety concerns compared with standard antithrombotic therapy and resulted in a significantly higher proportion of patients with an excellent functional outcome.	Patients with acute ischemic stroke	71 (median)	56.9 % male
The effect of early systematic rehabilitation nursing on the quality of life and limb function in elderly patients with stroke sequelae (Yu et al., 2021)	97 patients	Quasi-experimental study	China	Within 72 hours	Early systematic rehabilitation nursing	Fugl-Meyer Assessment (FMA), Hamilton Anxiety Scale (HAMA), Hamilton Depression Scale (HAMD), Barthel Index, Generic	Early systematic rehabilitation nursing improved upper limb motor and sensory function, alleviated negative psychology, raised ability of daily	Early systematic rehabilitation nursing is more beneficial for the improvement of upper limb motor and sensory function, alleviation of negative psycholo	Elderly patients with stroke sequelae	66.6 (mean)	52.6 % male

						Quality of Life Inventory-74 (GQOLI-74)	living, and increased quality of life.	gy, raise in ability of daily living, and increase of life quality in elderly patients with stroke sequelae.			
Remote Ischemic Conditioning With Exercise (RICE) Rehabilitative Strategy in Patients With Acute Ischemic Stroke: Rationale, Design, and Protocol for a Randomized Controlled Study (Han et al., 2021)	40 patients	Single-center, double-blinded, randomized controlled trial	China	Within 24 hours	Remote Ischemic Conditioning (RIC) with exercise	Modified Rankin Scale (mRS), National Institutes of Health Stroke Scale (NIHSS), Barthel Index	The study aims to determine the rehabilitative effect of early RIC followed by exercise on patients with acute ischemic stroke.	The study is designed to evaluate the safety and feasibility of RIC with exercise (RICE) as a novel rehabilitation strategy in patients with acute ischemic stroke.	Patients with acute ischemic stroke	18-80	Not specified
Time Window for Ischemic Stroke First Mobilization Effectiveness: Protocol for an Investigator-Initiated Prospective Multicenter Randomized 3-Arm Clinical Trial (Zheng et al., 2021)	6033 patients	Pragmatic, investigator-initiated, multicenter, randomized, 3-arm clinical trial	China	Within 24 hours, 24-72 hours, after 72 hours	Early mobilization	Modified Rankin Scale (mRS), National Institutes of Health Stroke Scale (NIHSS), Barthel Index	The TIME Trial aims to compare different time windows for the start of mobilization after stroke with regard to mortality, disability, and other clinical outcomes.	The TIME Trial is designed to answer the question "when is the best time to start mobilization after stroke?"	Patients with acute ischemic stroke	≥18	Not specified
Early versus delayed antihypertensive	4810 patients	Multicentre, randomised	China	24-48 hours vs. day 8	Early antihypertensive treatment	Modified Rankin Scale (mRS),	Early antihypertensive treatment did not	Early antihypertensive treatment did not	Patients with acute	≥40	65.0% male

treatment in patients with acute ischaemic stroke: multicentre, open label, randomised, controlled trial (Liu et al., 2023)	, open label, endpoint trial	National Institutes of Health Stroke Scale (NIHSS)	reduce the odds of dependency or death at 90 days compared with delayed treatment.	reduce the odds of dependency or death at 90 days among patients with mild-to-moderate acute ischaemic stroke and systolic blood pressure between 140 mm Hg and <220 mm Hg who did not receive intravenous thrombolytic treatment.	ischaemic stroke

Discussion

Interpretation of Key Findings

This systematic review suggests that early interventions administered within the first 72 hours after ischemic stroke onset are associated with beneficial effects across multiple domains, including motor recovery, neurological function, and health-related quality of life. Most of the included studies indicated that earlier initiation of rehabilitation strategies such as physical and occupational therapy, nursing-based programmes, and selected pharmacological approaches—was linked with better functional outcomes compared with standard or later initiation of care.

Across different modalities, interventions including early mobilization, virtual reality–assisted rehabilitation, and comprehensive nursing care were consistently associated with improvements in functional independence and emotional well-being, supporting the concept that coordinated, structured early rehabilitation can positively influence the acute recovery trajectory. (Zhang et al., 2021; Lin et al., 2020; Hu & Liu, 2021).

Rather than focusing on the results of individual trials in isolation, the overall pattern across studies indicates a converging signal: when multimodal rehabilitation and supportive care are introduced promptly during the acute phase, patients tend to show better neurological and functional recovery than those managed with delayed or less structured approaches..

Importance of Intervention Timing and Neuroplasticity

Timing emerged as a central determinant in the effectiveness of post-stroke rehabilitation. Several trials reported that interventions initiated within 24–48 hours post-onset conferred more favourable neurological and functional outcomes than those started later in the first week. (Wang et al., 2022; Zhang et al., 2021).

In particular, studies of early physical rehabilitation and mobilization demonstrated greater improvements in lower limb function, activities of daily living (ADL), and broader functional independence when therapy began within this narrow early window. Similarly, the TIME study (Zheng et al., 2021) supported the feasibility and safety of initiating mobilization within the first 24 hours and suggested a potential reduction in disability when early mobilization protocols are appropriately implemented.

These findings are aligned with contemporary neuroplasticity theory, which posits a time-limited window of heightened neural responsiveness immediately after stroke, during which the brain is more amenable to repair and functional reorganization. Early rehabilitation appears to capitalize on this “golden recovery phase,” as described by Liu et al. (2023), providing a plausible mechanistic rationale for

why interventions started within 24–48 hours often yield superior outcomes compared with later initiation..

Cost-Effectiveness of Early Intervention

None of the 11 included studies conducted a full economic evaluation; however, their clinical findings offer indirect signals of potential cost-effectiveness. Improved functional outcomes, reflected in higher Barthel Index scores and lower disability on the mRS, are closely linked to shorter hospital stays, reduced long-term institutional care, and decreased caregiver burden, all of which can lower overall healthcare expenditures.

Evidence from studies outside the core set of 11 articles further supports this interpretation. For example, Pyne et al. (2025) and other economic analyses suggest that structured early rehabilitation, although initially resource intensive, may be cost-effective over the long term by reducing the societal and economic burden of chronic stroke disability. (Pyne et al., 2025; Miri et al., 2024). It is important to emphasize that these cost-effectiveness data derive from supplementary literature rather than the primary evidence base of this review and should therefore be interpreted as complementary rather than direct proof.

Future research should incorporate formal economic evaluations—such as cost–utility analyses using Quality-Adjusted Life Years (QALYs)—embedded within trials of early interventions, to provide more robust evidence for policymakers and healthcare administrators. (Miri et al., 2024; Pyne et al., 2025)..

Variability in Outcomes and Methodology

Despite the broadly consistent direction of the findings, there was considerable heterogeneity across the included studies in terms of intervention type, intensity, duration, delivery setting, and patient characteristics. Some trials evaluated comprehensive, multidisciplinary rehabilitation programmes, whereas others focused on single modalities such as neuromuscular electrical stimulation (NMES), early antithrombotic therapy, or systematic nursing care.

Outcome measures were also highly variable, including NIHSS, mRS, FMA, Barthel Index, and multiple quality-of-life instruments (SF-36, EQ-5D, WHOQOL-BREF, GQOLI-74), which complicates direct comparison and aggregation of effect sizes across trials. This heterogeneity, while reflecting the multifaceted nature of stroke rehabilitation, limited the feasibility of conducting a formal meta-analysis and constrains the precision of pooled effect estimates.

Moreover, not all early interventions produced clear benefits. For example, early antihypertensive therapy as examined by Liu et al. (2023) did not significantly alter mortality or long-term disability, even though it was shown to be safe. This highlights that “earlier” is not necessarily better for all types of interventions and that timing effects may differ by mechanism of action and patient profile. Collectively, these methodological and clinical differences underscore the need for cautious interpretation of the evidence and for more standardized intervention protocols and outcome frameworks in future studies.

Implications for Clinical Practice

From a clinical perspective, the overall body of evidence can be characterized as promising and moderately strong in support of early, multidisciplinary interventions during the acute phase of ischemic stroke. Early mobilization, structured physiotherapy, occupational therapy, nursing-led rehabilitation, and selected pharmacological strategies appear to be safe and generally well tolerated when implemented within the first 24–72 hours in appropriately selected patients. (Zhang et al., 2021; Hu & Liu, 2021; Krastev et al., 2024).

These findings support the integration of standardized early rehabilitation pathways into acute stroke care, including: Protocols for safe early mobilization and positioning; Early physiotherapy and occupational therapy focused on functional task practice; Nursing-based interventions targeting prevention of complications, psychological support, and ADL training; Timely secondary prevention measures, such as antithrombotic therapy, when clinically indicated.

For health systems, especially in low- and middle-income countries, the results underscore the need to strengthen stroke units and multidisciplinary teams capable of initiating early rehabilitation within 24–72 hours of admission, while ensuring safety monitoring and individualized decision-making. However, given the heterogeneity and limited number of trials, clinical implementation should be accompanied by ongoing audit, outcome monitoring, and, where possible, participation in pragmatic trials or registries..

Limitations and Future Research

This review has several limitations. First, substantial clinical and methodological heterogeneity across the 11 included studies covering intervention types, timing, intensity, settings, and outcome measures precluded meta-analysis and limits the generalisability of the findings. Second, most trials were conducted in middle- and high-income countries with relatively well-developed stroke systems, so the applicability of early-intervention models to low-resource settings remains uncertain. Third, restriction to English-language, indexed publications may have introduced publication and

language bias, and some studies showed risks related to selection processes, blinding, and allocation concealment, which could overestimate treatment effects (as reflected in the JBI item-level assessments). Finally, many studies focused on short-term or subacute outcomes, with limited follow-up of longer-term functional status and quality of life. Future research should prioritise multicentre randomised controlled trials in low- and middle-income settings, using standardised early-rehabilitation protocols, harmonised outcome measures, and extended follow-up. Embedded cost-effectiveness and cost–utility analyses, including QALY-based evaluations, as well as stratified analyses by age, stroke severity, comorbidities, and stroke subtype, are also needed to identify which patients benefit most and to inform scalable, context-appropriate models of early post-stroke care.

CONCLUSION

This systematic review suggests that early interventions within the first 72 hours after ischemic stroke are promising for improving neurological recovery, functional independence, and quality of life. Interventions initiated within 24–48 hours appear particularly beneficial, consistent with a time-limited window of heightened neuroplasticity. Across modalities early rehabilitation, occupational therapy, nursing care, neuromuscular stimulation, and selected pharmacological strategies interventions were generally feasible, safe, and associated with favourable outcomes. Nonetheless, these conclusions should be regarded as moderate rather than definitive, given the small number of studies, their heterogeneity, and the absence of meta-analytic pooling. Clinically, the findings support integrating structured, multidisciplinary early rehabilitation into acute stroke care pathways, including protocols for safe early mobilization and nursing-led interventions where patient stability and resources permit. Future research should prioritise high-quality multicentre RCTs in low- and middle-income settings, with standardised protocols, longer-term follow-up of quality-of-life outcomes, and formal cost-effectiveness (including QALY-based) analyses to guide scalable early stroke care models..

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