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Rehabilitation interventions, hemi spatial neglect, stroke, contra-lesional space.

Efficacy of Multimodal Rehabilitation for Improving Hemispatial Neglect and Functional Outcomes After Stroke: A Systematic Review and Meta-Analysis

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ABSTRACT: **OBJECTIVE**: The purpose of this study was to assess how well multimodal rehabilitation treatments for hemispatial neglect work for stroke survivors.

BACKGROUND OF THE STUDY: With 20% to 40% of stroke survivors enduring moderate to severe disability, stroke is the main cause of acquired disability among adults globally. This leads to steadily rising expenses for health systems across the globe.

Hemiparesis, spasticity, hemispatial neglect, dysphagia, difficulties walking, and low independence in activities of daily living (ADL) are only a few of the clinical signs that stroke survivors may exhibit. An attentional issue known as hemi-spatial neglect occurs when a person is unable to recognize or react to stimuli that appear in contra-lesional space. In the medical field, multimodal rehabilitation has become a successful treatment for hemispatial neglect in stroke patients. A number of recent studies have examined multimodal rehabilitation for hemispatial neglect in stroke patients; however, they are limited by the fact that they only employ clinical databases and do not use technical indices like the Scimago Journal & Country Rank or the Web of Science index.

As far as we are aware, this is the only contribution that has conducted an evidence-based systematic review for multimodal rehabilitation for hemispatial neglect in stroke patients, incorporating both clinical and technological databases. A total of 330 records from 22300 were found in the initial search. Of these, 25 met the PICO (Population, Intervention, Comparison, and Outcomes) criteria and were chosen for analysis after duplicates and irrelevant studies were eliminated. The reviewed studies indicate a moderate level of evidence regarding multimodal therapy for hemispatial neglect in stroke patients. The treatment of hemispatial neglect in stroke patients can benefit greatly from multimodal rehabilitation, but further research is required to establish reliable validations that multimodal rehabilitation can successfully supplement conventional treatments.

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METHODOLOGY:

To find studies assessing multimodal rehabilitation in hemispatial neglect among stroke patients, a thorough literature search was carried out. The Cochrane Central Register of Controlled Trials, MEDLINE, EMBASE, Allied and Complementary Medicine Database, Physiotherapy Evidence Database, Database of Research in Stroke, and Cumulative Index to Nursing and Allied Health Literature were the sources of the bibliographic databases.

RESULT:

The literature search for this systematic review produced 22,300 results, of which 25 papers met the requirements and were ultimately included in the study. Nearly all of the research demonstrated that hemispatial neglect patients among stroke patients had better significance in visual, tactile, auditory, ambulation, cognitive improvement, and activities of daily living. A forest plot was used to display the findings of the statistical analysis, which was carried out using a suitable effect measure. To the best of our knowledge, this meta-analysis summarizing multimodal rehabilitation for hemispatial neglect in stroke patients

CONCLUSION:

We can draw the conclusion that multimodal rehabilitation may have a major impact on stroke patients' quality of life, functionality, and execution of everyday tasks.

1. INTRODUCTION

Hemispatial neglect is the most prevalent deficit following a stroke, which is the primary cause of long-term disability in adults. According to longitudinal research on stroke recovery, 50% of individuals with severe arm paresis make a functional recovery. [1] There are two types of stroke: hemorrhagic and ischemic, with ischemic stroke accounting for around 80% of incidents. A hemorrhagic stroke happens when one or more blood arteries that supply the brain burst, resulting in a localized hemorrhage. When an artery is blocked, blood supply to the brain is interrupted, which results in an ischemic stroke. Loss of cognitive abilities (e.g., thinking, reasoning, judgment, and memory), sensory-motor abilities (e.g., hemiplegia, spasticity, pain, mobility impairment, difficulties with daily activities, self-care disability, incontinence, and sexual dysfunction), eating, swallowing, and communication (e.g., speech and language), vision, perception, and orientation to surroundings, which result in emotional and social issues and lower quality of life.

[2, 3] A crude stroke prevalence rate of almost 203 per 10,00,000 people over the age of 20, or roughly 1 million cases, is revealed by an analysis of community surveys from various parts of India. According to WHO estimates, stroke accounted for 6,19,000 of India's 9.4 million deaths in 1990, with a male to female ratio of 1:7. With an estimated population of 849 million, this results in a stroke death rate of 73 per 10,000,000. An estimated 600,000 Indians get their first stroke annually, and the country's almost 4 million stroke survivors are dealing with the fallout. [4] Muscle weakness or imbalance, impaired postural control, muscle spasticity, hemispatial neglect, poor voluntary control, and bodily malalignment are frequently evident in stroke patients. [5] Patients with right hemisphere strokes or brain injuries frequently experience unilateral neglect, sometimes called hemispatial neglect, a debilitating neuropsychological disorder that results in deficiencies in spatial awareness and attention on the contralesional side. [6] There are many distinct kinds of neglect. It can be separated into three dimensions: representational, motor and spatial sector (personal, peripersonal, or extrapersonal), processing stage (visual, tactile, or aural), and reference frame (egocentric or allocentric).

[7] Patients with perceptual neglect find it more difficult to notice or pay attention to stimuli on the left side, while those with pre-motor neglect find it more difficult to respond to or plan movements toward stimuli on the left side. Neglect symptoms are said to occur at different stages of information processing. [8] Unilateral Spatial Neglect (USN) is the most prevalent cognitive disability following a stroke, occurring in about 50% of patients.[9] Lesions in the right hemisphere, specifically in the parietal (inferior), temporal (superior), and/or frontal (ventral) cortex, as well as occasionally in subcortical nuclei, are frequently

(90% of cases) followed by USN. "A failure to report, respond, or orient to contralateral stimuli that is not caused by an elemental sensorimotor deficit" is the definition of this complex syndrome. In daily life, patients with USN may exhibit a number of symptoms, including eating only from the right side of the plate, applying makeup only to the right side of the face, and failing to look left before crossing the street. [10] It is most frequently linked to lesions in the right hemisphere, which impairs one's ability to perceive and interact with stimuli on the left side of space. [11] Unilateral neglect can seriously hinder a patient's capacity to carry out everyday tasks by causing them to forget things, persons, or even their own body parts on the affected side.[12] This syndrome is a major problem in neurorehabilitation since it not only impairs functional independence but also raises the risk of falls, lengthier rehabilitation stays, poor functional recovery, and accidents.[13] "A systematic functionally oriented intervention of therapeutic cognitive activities based on the assessment and understanding of the patient's brain behavior deficits" is the definition of rehabilitation. the impact of cognitive rehabilitation therapies on a particular area of post-stroke cognitive function, such as perception, limb apraxia, executive function, attention, memory, and neglect.[14] In order to assist people manage their symptoms and regain function, rehabilitation treatments frequently concentrate on raising awareness and putting compensatory tactics into practice.[15]

In the early research on spatial neglect rehabilitation, top-down methods focused on a patient's voluntary effort to follow a therapist's directions were employed to empirically stimulate the direction of attention toward the left. This method, which is still frequently employed in rehabilitation facilities, entails teaching the direction of gaze using signals on the left.[16] Variations in the type of stimuli, feedback, or the length, quantity, and frequency of sessions have all been incorporated into numerous programs. The majority of programs last four weeks, with one hour of rehabilitation per day, five days a week, for a total of roughly twenty hours of rehabilitation.[17] Other nonpharmacological rehabilitation methods, such as right half-field eye patching, mirror therapy, prism adaptation, left-hand somatosensory stimulation with visual scanning training, contralateral transcutaneous electrical nerve stimulation and optokinetic stimulation, trunk rotation, repetitive transcranial magnetic stimulation, galvanic vestibular stimulation, and dressing practice, have been investigated for USN in an effort to aid in the recovery of perception and behavior.[18]

In recent decades, there has been a growing focus on the effectiveness of different rehabilitation strategies in stroke recovery. In order to shed light on the advantages and disadvantages of rehabilitation therapy for stroke patients in terms of memory enhancement, this systematic review sought to thoroughly assess the corpus of current research.[19] The motivation behind doing this review is explained by a number of considerations. First, cognitive problems are common among stroke survivors. Since these deficits can affect a number of cognitive domains, such as memory, attention, language, executive function, and visuospatial ability, customized rehabilitation techniques are required. [20] Second, physicians and rehabilitation professionals find it difficult to make decisions due to the variety of cognitive rehabilitation strategies and therapies that are available. To direct evidence-based clinical practice, a thorough assessment of the literature is required [21] In particular, these gadgets and installations typically offer stereoscopic display technologies to enable depth perception and certain motion tracking levels to permit user interactions, both of which are intended to improve experience and deliver far more immersive multisensory stimulations.[22]

Meta-analysis and systematic reviews are two different but very complementary methods of synthesizing research. When combined, these techniques represent a scientific process for locating, evaluating, and synthesizing quantitative data from earlier research. They can produce fresh perspectives for social policy and summarize substantial amounts of knowledge. [23] Using an organized, transparent, and repeatable method at every stage, a systematic review seeks to thoroughly identify and synthesize research that relates to a certain subject. A collection of statistical techniques known as meta-analysis is used to combine quantitative findings from several research to create a comprehensive overview of empirical information on a particular subject. It is used to compensate for bias and inaccuracy in a body of research as well as to analyze key trends and differences in outcomes across studies.[24] Since patients with right hemisphere injuries frequently experience this disruption, many researchers have argued that a rehabilitative approach to unilateral neglect disorder is especially crucial. Furthermore, both cross-sectional and longitudinal investigations revealed that the disturbance is comparatively stable two months after stroke, despite some improvements observed in the early stages of the disease.[25] More proof is needed to validate and examine multimodal rehabilitation for hemispatial neglect in stroke patients. Therefore, the goal of this meta-analysis and systematic review is to show how beneficial multimodal therapy is for hemispatial neglect in stroke patients.

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METHODOLOGY

SEARCH STRATEGY

The Cochrane Central Register of Controlled Trials (CENTRAL), Medline Plus, PubMed, Science Direct, Oxford Academic, Google Scholar, The Biomed Central, Web of Science, American Physical Therapy Association, and other bibliographic databases were gathered. Records that either contained the MESH phrases were found using search techniques and study selection.

SELECTION CRITERIA:

INCLUSION CRITERIA:

- Research released between 2000 and 2026
- Individuals diagnosed with hemineglect following a stroke.
- Performance assessments, such as the line bisection test, the Catherine Bergego Scale, and the Behavioral Inattention Test, are used to quantify the effects or severity of hemineglect for both short-term and long-term evaluations.
- Participant data (such as age, length of time since stroke, method of neglect diagnosis, and existence of visual field impairments)
- An explanation of the intervention, including specifics on its parameters such duration, intensity, and frequency of stimulation
- Data (containing any other stated data, such as mean differences and p values, together with means and standard deviations/errors at all accessible time points).
- Regular care, control, various forms of exercise, or no activity were all compared.
- Randomized controlled trials, pilot studies, case control studies, and clinical trial publications will all be included in this investigation.
- Original studies
- Performedonindividuals suffering from hemispatial neglect
- The sample was at least older than eighteen.
- A minimum of one physical, psychological, or cognitive component linked to hemispatial neglect
- Articles that were presented in full text and published in English qualified for the systemic review.

EXCLUSION CRITERIA:

- If they were created as a single case study or were only published in abstract form
- Article type: Excluded were case reports, conference abstracts, patents, books, letters, editorials, comments, notes, and quick surveys.
- Full Text Unavailability: Studies with inaccessible full texts were excluded.
- Irrelevance: Research irrelevant to USN was not taken into account.
- Research that tried to alter outcomes unique to an illness was not included. Articles published prior to 2000
- Articles written in different languages

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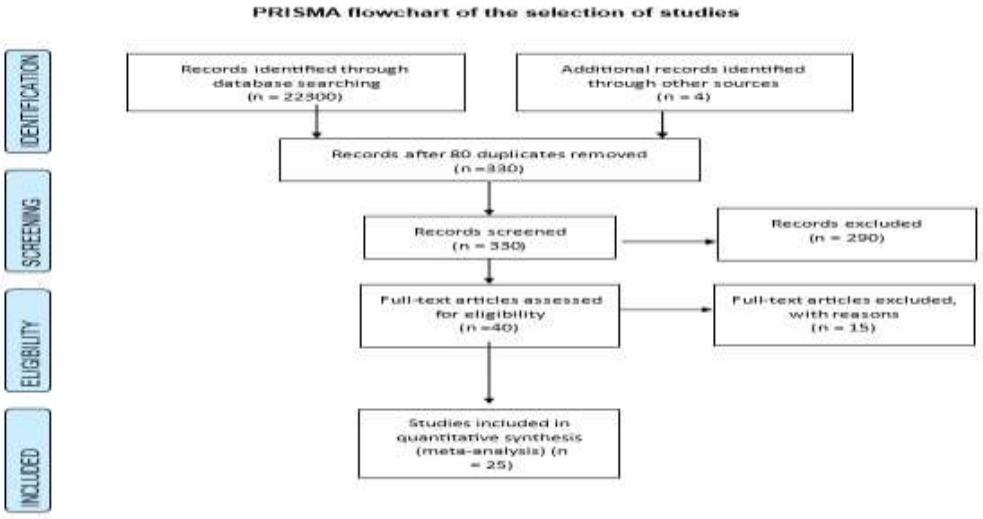


TABLE 1 STUDY CHARATERISTICS AND REVIEW RESULTS

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S L. NO	AUTHOR NAME/ STUDY DESIGN	ARTICLE	AIM	STUDY DURATION /SAMPLE SIZE, PLACE	INCLUSION CRITERIA	EXCLUSION CRITERIA	INTERVENTON	OUTCOME MEASURES	RESULTS
1.	Joon-Ho Shin, Mingyu Kim, Ji-Yeong Lee, Mi-Young Kim, Yu-Jin Jeon and Kwanguk Kim	Feasibility of hemispatial neglect rehabilitation with virtual reality based visual exploration therapy among patients with stroke: randomised controlled trial	A feasibility study to assess the effectiveness of VRVET in managing HSN in patients with stroke.	Twenty participants with left HSN were consecutively recruited from rehabilitation hospital	(1) presence of left HSN, (2) aged 19–65 years, (3) first-time right hemispheric ischemic or haemorrhagic stroke as evidenced by brain imaging and medical records, a score of >25 on the Mini Mental State Examination, (5) ability to click responses with the computer mouse buttons	(1) presence of oculomotor palsies via standard neurological examination , (2) visual defects, (3) orthopaedic disorders affecting neck movement, (4) inability to maintain a seated position.	TW group completed 20 sessions of a VRVET program using an HMD (five daily sessions per week over a period of 4 weeks) followed by 4 weeks of waiting without VR-VET, while the WT group completed the opposite regimen.	Clinical HSN measurements [line bisection test (LBT), star cancellation test (SCT), Catherine Bergego Scale (CBS), CBS perceptual attentional (CBS-PA), and CBS motor explanatory (CBS-ME)] and FOPR tests [response time (RT), success rate (SR), and head movement (HM) for both FOP and FOR] were assessed by	Five and six participants were allocated to the TW and WT groups, respectively, and no dropout occurred throughout the study. VR-VET extensively improved FOP-SR, CBS, and CBS-PA, where waiting failed to make a significant changes

								blinded face-to face assessments	
2.	Olga Zubko, Mohamed Sakel, Simon Coulton, Tracy Higgins	Galvanic vestibular stimulation in hemispatial neglect	To determine whether repeated sessions of galvanic vestibular stimulation more effectively induce lasting relief than a single session	Fifty-five participants were considered eligible, provided consent and randomized	suffered a right unilateral stroke, ≥6 weeks poststroke	moderate to severe aphasia, Patients with electronic implants, such as cardiac pacemakers	patients who met eligibility were randomly assigned to one of the three treatment arms (1 active and 9 sham treatments vs. 5 active and 5 sham treatments vs. 10 active and 0 sham treatments) using minimization controlling for age (60 years or more vs. less than 60 years)	BIT score at 4 weeks stimulation, was evaluated using an analysis of covariance adjusting for the baseline covariates of BIT score at enrolment, in/out patient status, and age.	15 participants per treatment arm which was deemed sufficient to allow a potential effect size difference of 0.8 to be detected at 80% power and an alpha of 0.05.
3.	Alessandro de Sirea, Lucrezia Moggioa, Andrea Demeco	Efficacy of rehabilitative techniques in reducing hemiplegic shoulder pain in stroke: Systematic review and meta analysis	aimed to investigate the efficacy of rehabilitative techniques in reducing HSP in stroke survivors.	24 patients who experienced first time stroke with any site of brain lesion and motor deficit were included in the study.	stroke survivors with HSP	1) including children or growing participants; 2) focusing on treatment for other complication s related to HSP (e.g., glenohumeral subluxation) ; 3) with a cross-over design; 4) written in a language other than English; 5) with no full text (i.e., posters and	rehabilitative techniques aimed to reduce HSP, including kinesio taping, PNS, TENS, subdeltoid bursa injection of hyaluronic acid, SSNB, NMES, slings, intramuscular injection of BoNTA, corticosteroids injections, FES, SNMT, IFC, TrPsDN, PrP,	pain intensity, using a visual analog scale (VAS) or numerical rating scale (NRS)	analyzed data for 723 stroke survivors, reporting a significant overall decrease in pain intensity after a rehabilitative approach by the Bayesian meta analysis (standardized mean difference e 2.78, 95% confidence interval 0.89;4.59; p =

						conference abstracts); and 6) involving animals.	RSRT, acupuncture, rTMS.		0.003).
4.	Peii Chen, Ph.D., Kimberly Hreha, M.S., Yekyung Kong, M.D. and A. M. Barrett, M.D.	Impact of Spatial Neglect in Stroke Rehabilitation: Evidence from the Setting of an Inpatient Rehabilitation Facility	To examine the impact of spatial neglect on rehabilitation outcome, risk of falls, and discharge disposition in stroke survivors.	58 patients who met the inclusion criteria in which stroke was confirmed by CT or magnetic resonance imaging	patient had spatial neglect was only determined after the patient was enrolled to the study	previous neurological disorder, brain damage, or psychiatric conditions	Usual and standard IRF care.	Functional Independence Measure (FIM™), Conley Scale, number of falls, length of stay (LOS), and discharge disposition	The presence of spatial neglect (KF-NAP > 0), but not Conley Scale scores, predicted falls such that participants with spatial neglect fell 6.5 times more often than those without symptoms.
5.	Yoon Sik Choi, MD, Kyeong Woo Lee, MD, Jong Hwa Lee, MD	The Effect of an Upper Limb Rehabilitation Robot on Hemispatial Neglect in Stroke patients	Aimed to identify the effects of an upper limb rehabilitation robot on hemispatial neglect.	38 patients (20 in the robot group and 18 in the control group)	Hemispatial neglect, stroke	visual field defect, seriously declined sitting balance interfering with upper extremity rehabilitation robot treatment in a sitting position on a chair with a back and armrests	Both the upper limb rehabilitation robot and the control groups received treatment for 30 minutes per day, 5 days a week for 3 weeks	Catherine Bergego scale (CBS), the Mini-Mental State Examination (MMSE), and the Korean version of Modified Barthel Index (K-MBI)	The changes in all measurements showed no significant differences between the two groups.
6.	Francesco Di Gregorio, Fabio La Porta, Emanuela Casanova, Elisabetta Magni	Efficacy of repetitive transcranial magnetic stimulation combined with visual scanning	The aims of this study to test the central hypothesis by assessing the immediate and long term efficacy of a combined treatment	Patients have complete d the 12 weeks follow-up	Diagnosis of ischemic stroke of the right medial cerebral artery or right intracranial haemorrhagic stroke, confirmed	Medical instability at the time of enrolment, defined as the acute onset of an unexplained , Presence of epileptogenic alterations of the	International 10/20 system for the location of the target area (no lesioned left posterior parietal cortex); 60% power;	Behavioural Inattention Test (BIT), Test of Attentional Performance, Catherine Bergegò	Our trial results may provide scientific evidence of a new, relatively low-cost rehabilitation protocol for the treatment of LHN.

		treatment on cognitive and behavioural symptoms of left hemispatial neglect in right hemispheric stroke patients: study protocol for a randomized controlled trial	based on rTMS and visual scanning training		by encephalic CT scan or MRI; Diagnosis of LHN with specific screening test (asymmetry score in the Bells test > 3); Inpatient or outpatient rehabilitation setting; Age between 18 and 80years; Time after stroke between 3 weeks and 12weeks; Adequate language comprehension to give informed consent.	EEG and/or previous epileptic seizures; Presence of intracranial implants of a metallic material; Presence of devices that could be altered by r- TMS, such as acemakers, ventriculoperitoneal derivations, or baclofen infusion pumps; Absence of bone flap following decompressive craniectomy ; Presence of alteration in the consciousness-vigilance rhythm; Cortical blindness and/or visual agnosia; Previous psychiatric disorders and/or history of substance abuse, Pregnancy state, Severe deafness not compensated by hearing devices; Severe reduction of visual acuity not compensated by optic lenses; Previous diagnosis of cognitive	Frequency: 1Hz; Ninety pulse trains with ten pulses each (total 900 stimuli) resulted in a whole stimulation period of 15 min.	Scale (CBS) assesses specifically the presence and severity of LHN in the activities of daily living, Motricity Index (MI) and Trunk Control Test (TCT) will be used to measure motor impairments.	

						impairment.			
7.	Hyun-Se Choi, Deok-Ju Kim, Yeong-Ae Yang	The Effect of a Complex Intervention Program for Unilateral Neglect in Patients with Acute Phase Stroke: A Randomized Controlled Trial	Aimed to examine the effects of simultaneous intervention with FES and PA on unilateral neglect in acute phase stroke patients.	30 patients included in this study those who had unilateral neglect whilst hospitalized following a stroke	(1) Individual with diagnosis of unilateral neglect from a medical doctor and the number of lines neglected in the Albert test above 70%, (2) Individual without brain lesions other than stroke, (3) Individual with less than 3 months since stroke; (4) Individual with The Korean version of the Mini-Mental Status Examination (K-MMSE) score of at least 20, who can follow directions and does not have hearing or vision impairments; (5) Individual informed about the purpose and methods of this study who agreed to participate.	Patients with other neurological disorders, severe mental illness, alcohol/substance use disorder, severe depression requiring psychiatric care, dementia, or dependence in self-care activities due to cognitive deficits were not included	Group A received 30 minutes of conventional occupational therapy, followed by FES application on the upper limb on the affected side and PA treatment for 20 minutes, for a total of 50 minutes, Group B received 30 minutes of conventional occupational therapy, followed by PA on the upper limb on the affected side for 20 minutes, for a total of 50 minutes, Group C received 30 minutes of conventional occupational therapy, followed by FES application for 20 minutes, for a total of 50 minutes.	The Albert Test is a type of line crossing test which evaluates unilateral neglect, K-MMSE, Motor-free Visual Perception Test, Catherine Bergego Scale	All 3 groups showed unilateral neglect reduction after the intervention, but PA plus FES (complex intervention method) was more effective than PA or FES alone.
8.	Ruixuan Lin, Jack Jiaqi Zhang,	Does repetitive transcranial	Aimed to assess the effect of repetitive	32 patients who were diagnose d	adult patients (> 18 years old) with post-stroke USN,	studies without any parallel control group (self control,	using any rTMS protocols (HFrTMS, LF-	The Catherine Bergego	rTMS appears to be effective in promoting

	Lingling Zhong, Sofina S. Y. Ch an	magnetic stimulation have a beneficial effect on improving unilateral spatial neglect caused by stroke? A meta-ana lysis	transcranial magnetic stimulation (rTMS) in improving post-stroke unilateral spatial neglect (USN)	with stroke or TBI	USN affecting activities of daily living	cohort studies, case–control studies, cross sectional studies, animal experiments , expert consensus, conference abstracts, metaanalyses, or reviews), studies that did not use any form of therapeutic TMS protocols, and duplicate publications	rTMS, cTBS, and iTBS)	Scale (CBS) is a standardized behavioural test of USN, (bisection test) of the behavioural inattention test (BIT), cancelation subtest (CT) of the BIT and the Albert test (AT)	recovery from poststroke USN. Excitatory protocols and early intervention may enhance recovery outcome s for neglect behaviors in poststroke survivors
9.	Gustavo José Luvizutto, Rodrigo Bazan, Gabriel Pereira Braga	Pharmacological intervention s for unilateral spatial neglect a er stroke	To evaluate the effectiveness and safety of pharmacological intervention s for USN a'er stroke.	30 randomly assigned participants	right-handed (except one), hemodynamically stable, conscious, and sufficiently co-operative to undergo a testing session of 45 minutes, and showed stable symptoms of neglect.	current smokers who smoked one or more cigarettes per day, and investigators systematically quantified and registered any past history of smoking.	drug A versus placebo or control; drug A + rehabilitation versus rehabilitation; drug A versus drug B (with or without rehabilitation)	National Institutes of Health Stroke Scale and the Modified Rankin Scale, Box and Block Test, Balance as measured by the Berg Balance Scale, the balance subscale of the FuglMeyer test	Study authors showed statistically significant reduction in omission s in the three cancellation tasks under transdermal nicotine treatment (mean number of omission s 2.93 ± 0.5) compare d with both baseline (4.95 ± 0.8) and placebo (5.14 ± 0.9) (main eLect of treatment

									condition: F (2.23) = 11.06; P value < 0.0001).
10.	Yumene NAITO, Yuta KOSHINO, Hisaaki OTA, Marianne PIANO, Akihiro WATANABE, Yuji INAGAKI	Short-term effect of prism adaptation treatment on severity of unilateral spatial neglect following right hemispheric stroke: a systematic review and metaanalysis	Aimed to investigate the effects of prism adaptation on unilateral spatial neglect following right hemispheric stroke.	227 participants that satisfied the eligibility criteria.	right hemispheric stroke patients (bilateral hemispheric stroke patients were excluded); age 18 years old or above; experience of a first stroke.	a history of neurological or psychiatric disorders; severe cognitive impairment.	prism angle, PA protocol, duration and dosage, blinding when performing pointing movement, contents of comparator training.	Behavioural Inattention Test (BITC), secondary outcome was change in Catherine Bergego Scale (CBS).	The results showed significant short term effects of prism adaptation on neglect outcome s (SMD: 0.49 [95% CI: 0.07 to 92], p = 0.02) but not on the Catherin e Bergego Scale (CBS) (SMD: – 0.38 [95% CI: –1.27 to 0.51], p = 0.40). Subgroup analyses revealed that larger prism angles (exceeding 10°) had greater prism adaptation effects on both neglect outcome s and CBS (SMD: 0.71 [95% CI: 0.30 to 1.12], p = 0.0007 and SMD: – 0.77 [95% CI: –1.51 to –0.02], p =

									0.04, respectively).
11.	Ioanna Giannakou, Dan Lin and David Punt	Computer based assessment of unilateral neglect: A systematic review	To investigate the benefits and barriers of introducing CB assessment tasks to clinical settings and explored practical implications for optimizing.	Studies including adult (aged over 18 years) stroke survivors or patients with other types of brain damage with or without USN.	studies that present or evaluate the diagnostic accuracy and performance of CB tests for USN in stroke survivors and patients with other types of brain damage (e.g., brain lesion, aneurysm, traumatic brain injury, or brain tumour etc.), Studies that fulfil the criteria established by the PICO framework,	Studies not including stroke survivors or patients with other types of brain damage, Studies that did not focus on USN assessment, Studies where CB task is not the index test, Studies where the design of the CB task and apparatus are not substantially defined so that the reviewers can decide whether it can be included in the review. Studies that did not clarify the type of apparatus (e.g., response box, computer monitor, projector) or specific design details (e.g., task demands and outcome measures) were excluded, Studies that did not clarify the use of a comparison tool,	CB tasks (screen based tasks that are categorized by the authors of the included studies as CB assessment/ testing or computerized tasks etc., using displays such as monitor, projector, tablet etc.).	A variety of outcomes were accepted such as [diagnostic accuracy measures (e.g., sensitivity, specificity), psychometric properties (e.g., validity, reliability), correlation coefficient, subjects' performance data, narrative reports].	Finally, 20/28 studies showed CB task selectively detected patients with USN within different patient groups and control groups (17/28).

						Studies that did not report or evaluate any form of diagnostic accuracy or performance of the CB test, Studies exploring VR based tasks			
12.	Mairead O'Donoghue, Siobhan Leahy, Pauline Boland, Rose Galvin, John McManus, Sara Hayes	Rehabilitation of Cognitive Deficits Poststroke: Systematic Review and Meta-Analysis of Randomized Controlled Trials	To evaluate the effectiveness of rehabilitation interventions across multiple domains of cognitive function.	70 elderly patients who were aged 60 years and above with post stroke	adults aged 18 years or older with a clinical diagnosis of ischemic or haemorrhagic stroke, in the acute, subacute, or chronic stage poststroke, poststroke with or without a confirmed cognitive impairment, traumatic brain injury and stroke mix.	Patients with visual hemi neglect, dementia, psychiatric disorders such as depression or anxiety, other concomitant neurological disorders, aphasia, or insufficient motivation and cooperation were excluded from the study	Interventions of which the primary or secondary aim is to improve cognitive function after stroke were included. Interventions of any duration or conducted at any time since stroke were included	Cognitive screening tools were also included. Secondary outcome measures included quality of life, using stroke specific or generic quality of life measures, functional abilities, mobility, balance, and depression.	Physical activity interventions improved neglect (MD, 13.99 [95% CI, 12.67– 15.32]) and balance (MD, 2.97 [95% CI, 0.71– 5.23]) compared with active controls. Noninvasive brain stimulation impacted neglect (MD, 20.79 [95% CI, 14.53– 27.04) and functional status (MD, 14.02 [95% CI, 8.41– 19.62]) compared with active controls.

13.	Jing Li, MD, Lei Li, BSMed, Yan Yang, BSMed, and Shuang Chen, BSMed	Effects of Prism Adaptation for Unilateral Spatial Neglect After Stroke A Systematic Review and Meta-Analysis	The aim of the study was to assess effects of prism adaptation on unilateral spatial neglect poststroke	Eight randomized controlled trials were included, involving 244 patients of which 130 in experimental group and 114 in control group.	patients older than 18 yrs were diagnosed as stroke after receiving computer tomography (CT) or magnetic resonance imaging (MRI) examinations , and USN after subacute chronic stroke through neuropsychological assessment.	(1) Patients whose vital signs were unstable; (2) patients with visual, hearing, or speech disorders and disabled to be treated with rehabilitation services; and (3) patients with severe disturbance s of consciousness or heart disease.	Experimental group is PA + conventional treatment, and control group is conventional treatment + sham PA or conven ional treatment only	(1) Catherine Bergego Scale (CBS); (2) Behavioral Inattention Test (BIT); (3) Functional Independence Measure (FIM); (4) Star Cancellation Test (SCT); (5) Reading Task (RT); and (6) Line Bisection test (LBT)	prism adaptation group scored significantly higher than control group in improving Behavioral Inattention Test (mean difference = 8.99, 95% confidence interval = 0.93 to 17.06, P = 0.03) and Star Cancellation Test (mean difference = 3.04, 95% confidence interval = 0.19 to 5.88, P = 0.04).
14.	Ruoxuan Zhao Tong Hao, Chengshuo Wa ng, Liang Wu	Effect of non invasive brain stimulation for unilateral spatial neglect after stroke: a systematic review and meta-analysis	The aim of this systematic review and metanalysis was to assess the effect of NIBS for the treatment of USN after stroke and to examine the effect of moderating variables (e.g., stroke phase, protocol type) on the effect sizes of NIBS treatment.	(425 patients) showed that different effects of various NIBS interventions	Adult patients diagnosed with post stroke USN.	USN is not caused by stroke, but by brain tumour, traumatic brain injury and other diseases, Articles not written in English, Conference abstracts, dissertations , research protocols, expert consensus, reviews, meta-analysis and non-RCT studies	Use of any rTMS protocol (HFrTMS, LF-rTMS, iTBS and cTBS) and tES protocol (a-tDCS, c-tDCS and tACS).	The line bisection test (LBT) and star cancelation test (SCT), catherine bergeron scale (CBS), behavioural inattention test (BIT)	Analyses showed that intervention timing and NIBS protocol type exerted moderating effects on treatment effect in USN patients. Intervention during the acute stroke phase may yield greater effect compare d to those in the

						(e.g., case reports, cross sectional studies, cohort studies, etc.), Lack of USN related outcome indicators, Duplicate publications			chronic phase (P < 0.00001).
15.	Jae-Sung Kwon	Therapeutic Intervention for Visuospatial Neglect after Stroke: A Meta-Analysis of Randomized Controlled Trials	To examine intervention methods of qualitatively , well designed studies from the past 10 years for treating visuospatial neglect (VSN) in patients who had suffered a stroke	107 study participant in the experimental group, and 110 in the control group to determine the effect of VSN treatment on, activity and participation.	(1) the study measured mental function, activity and participation levels using a standardized evaluations and reported at least 1 outcome; (2) the study was an experimental study, not animal study, case study, review, or systematic literature review; (3) the study was a randomized controlled clinical trial; (4) the study provided a mean, standard deviation, and number of subjects in order to calculate effect size; (5) the study used intervention for treating VSN;	Patients with the presence of additional severe medical conditions preventing active rehabilitation, aphasia, agnosia, disturbed conscious level and those on antipsychotic drugs, antiepileptic, and anticoagulant drugs were excluded from the study	the duration of an intervention, and the characteristics of outcome measurements. First, the duration of analyzed studies' interventions was mostly a short period between 2 and 4 weeks, and mental function outcome measurements were mainly pencil and paper works, that could be sensitive to immediate effects	"mental function" and "activity and participation" based on the Internation al Classification of Functioning , Disability and Health.	The analyzed effect sizes for combine d outcome s, mental function and, activity and participation, were 0.728 (medium effect size), 0.850 (large effect size), and 0.536 (medium effect size), respectively. In particular, noninvasive brain stimulation therapy showed a large effect size for VSN treatment .

					(6) the study ensured homogeneity between the control group and the treatment group, and subjects were individual stroke victims; (7) the study had a PEDro score ≥ 6; (8) the study was published in English; and (9) the studies original text was available in full.				
16.	Rodrigo Bazan, PhD, Bruno Henrique de Souza Fonseca, PT, Jessica Mariana de Aquino Miranda, PT	Effect of RobotAssisted Training on Unilateral Spatial Neglect After Stroke: Systematic Review and Meta-Analysis of Randomized Controlled Trials	Aimed to evaluate the effectiveness of robotic limb activation in patients with unilateral spatial neglect (USN) after stroke.	A total of 630 studies were identified , and after reading the titles and abstracts , 23 studies were selected for eligibility analysis, 18 of which were excluded	Adults with an objective diagnosis of USN after stroke (ischemic or haemorrhagic) , over 18 years of age, regardless of sex, duration of illness, or severity of initial impairment.	patients who had a presence of comorbid neurological disorder and were actively participating in an upper extremity rehabilitation program at the same time as the study period were excluded from the study	Therapies that use robot assisted therapy including an exoskeleton (based on torque actuators that control each joint of the affected limb) or end effector (guides only the distal part of the affected limb).	(1) USN degree measured by any paper and pencil test, Catherine Bergego Scale or the behavioural inattention test (BIT) (2) functional disability measured by the modified Rankin scale or the Fugl–Meyer scale (3)	The results of RCTs comparing robotic limb activation with a control group suggested an improvement in the degree of USN measured by the line bisection test (standardized mean difference [SMD], −0.64; 95% confidence interval [CI], −1.13 to −0.15; P

								autonomy in activities of daily living measured by any scale validated in this population, such as the Barthel index (4) balance measured using the Berg Balance scale or mini-best test (5) depression or anxiety measured using the Beck Depression Inventory (6) quality of life, measured by the stroke impact scale	= .01).
17.	Alex Martino Cinnera, Alessio Bisirri, Ilaria Chioccia, Enza Leone, Irene Ciancarelli, Marco Iosa, Giovanni Morone	Exploring the Potential of Immersive Virtual Reality in the Treatment of Unilateral Spatial Neglect Due to	Aims to explore the use of Immersive Virtual Reality (IVR) in the treatment of visual perception in Unilateral Spatial Neglect (USN) after a stroke.	A total of 436 articles were found. After duplicate removal (147), 289 articles were screened.	(1) a hemispatial neglect population; (2) visual perception or visual attention such as primary or secondary outcome; (3) immersive virtual reality; (4) English language.	(1); not a stroke population or a mixed sample; (2) full text not available; (3) conference paper.	IVR training was characterized by a great variety of tasks (a complete description of each IVR task, Two studies used a virtual version of the line bisection test as intervention protocol. n six	Catherine Bergego Scale (CBS), a functional scale that allows for the detection of the presence and the degree of abandonment	Studies that tested IVR such as treatment , three showed statistical positive results ($p < 0.05$) in visual perception outcome. To date, the literature has

		Stroke: A Comprehensive Systematic Review					studies, the intervention protocol was composed of more than one task/action	during the observation of everyday life situations. Behavioural Inattention Test (BIT). the Wechsler Memory Scale (WMS), and the Line Bisection Test (LBT) which is extracted from the BIT, and the Bell's test.	suggested the potential benefits in the use of IVR for the treatment of visual perception disorders in USN.
18.	Xiao-Lin Li, Xiao-Dan Liu1, Bo Chen, Zhi-Xing Zhou, Chunlei Shan	Effectiveness of repetitive transcranial magnetic stimulation on poststroke unilateral spatial neglect: a systematic review and metaanalysis	Aimed to conduct a systematic review and meta analysis to evaluate pieces of evidence from published clinical trials to determine the effectiveness of rTMS in poststroke unilateral spatial neglect	The number of studies finally pooled was 28, and the sample size was 819.	(1) patients diagnosed with ischemic or haemorrhagic stroke by magnetic resonance imaging or computed tomography, (2) age ≥ 18 years; Intervention and comparison: (3) the intervention was rTMS alone or rTMS combined with other treatments, (4) studies are randomized controlled trials;	(1) nonhuman studies; (2) rTMS studies that only reported motor, language, and perception outcomes; (3) intervention s were not designed for ischemic or haemorrhagic stroke; (4) cognitive impairment was not caused by stroke; (5) case reports; (6) studies from grey literature.	areas of the study included overall cognitive function, unilateral spatial neglect, attention, memory, language ability, and information storage. Six studies were evaluated for overall cognitive function, 13 studies were evaluated for unilateral spatial neglect, and 10 studies were evaluated for different cognitive	Behavioural inattention test and Catherine Bergego Scale	Result showed that a frequency of less than 1 Hz was better than other frequencies (SMD = −1.24 [95% CI, −1.93 to −0.56], I2 = 77.12%, P = 0.00; Moreover , ≥ 1200 pulses had a significant effect (SMD = −1.56 [95% CI, −2.87 to −0.26], I2

					Outcomes: (5) behavioural inattention test for the assessment of unilateral spatial neglect.		domains. Ten studies on unilateral spatial neglect used the left posterior parietal cortex as the stimulation location, and the only one study reported the left and right posterior parietal cortices.		= 82.21%, P = 0.00; and > 10 sessions were beneficial in reducing the patient's unilateral spatial neglect (SMD = −1.11 [95% CI, −2.04 to −0.19], I2 = 85.62%, P = 0.00
19.	B. González-Rodriguez, N. Serradell-Ribé, R. Viejo-Sobera	Transcranial direct current stimulation in neglect rehabilitation after stroke: a systematic review	Aim to establishing the appropriate use of tDCS as an adjuvant intervention in neurorehabilitation settings	A total of 311 articles were found; only 11 met the inclusion criteria, including 152 post- stroke patients in total.	(1) Patients with hemi spatial neglect, with or without comorbidities . When the studies included data about multiple neurological conditions, only the results related to neglect were considered. (2) Study type: experimental stud ies, pilot studies and case reports. (3) Intervention: inter ventions studying the effect of tDCS in the rehabilitation	Having recruited a clinical sample without neglect, not being an experimental or case report article (being protocols, reviews, book chapters, etc.), not using tDCS	The treatment duration, it ranged from 1 to more than 4 weeks (1 week/5 days, one study; 2 weeks, two studies; 3 weeks two studies; and more than 4 weeks, two studies).	Behavioural Inattention Test (BIT), the Motor-Free Visual Perception Test (MVPT), Catherine Bergego Scale (CBS)	We found moderate evidence for the efficacy of tDCS in the rehabilitation of hemispatial neglect after a stroke, being more effective in combination with other interventions.

					of neglect, alone or combined with other techniques. (4) Population: adults with neglect.				
20.	Ibolya Tavaszi, Alexandra Szilvia Nagy, Gabor Szabo	Neglect syndrome in poststroke conditions: assessment and treatment	The aim of this review was therefore to evaluate the results of trials that investigated different treatment methods for neglect syndrome.	The literature search identified 202 articles: 19 met the inclusion criteria and were included for data extraction.	stroke, neglect, robot; stroke, neglect, physiotherapy; stroke, neglect, occupational therapy; stroke, neglect, mirror therapy	not an original article (review, letter, etc.), not aimed at neglect therapy, treatment done in children (under the age of 18), drug trial, participants were not only stroke patients	PICO [P – Populations/People/Patient/ Problem, I – Intervention(s), C – Comparison and O – Outcome] was applied to report the results of the studies included in the scoping review. Most of the trials were 4– 6 weeks long, and the therapy sessions lasted 20–60 minutes.	The most relevant assessment of neglect seemed to be Star Cancellation Test (SCT), Line Bisection Test (LBT), and whole Behavioural Inattention Test (BIT): at least one of them was measured in each audited/ monitored trial.	During analysis of the trials, the authors found certain good ideas, but the selected participants, goals, and design of some trials did not allow clear evidence
21.	Flávio Taira Kashiwagi, Regina El Dib, Huda Gomaa, Nermeen Gawish	Noninvasive Brain Stimulation s for Unilateral Spatial Neglect after Stroke: A Systematic Review and Meta-	To assess the impact of NIBS on USN after stroke	Twelve RCTs (273 participants) and 4 non-RCTs (94 participants) proved eligible	adults over 18 years of age, regardless of gender and the duration of illness or severity of the initial impairment, with USN after any type of stroke diagnosis (ischemic or	Exclusion criteria included unstable angina, congestive heart failure, severe arterial disease, major depression, dementia (scoring < 24 on the MMSE), difficulty	any noninvasive brain stimulations such as tDCS, rTMS, and including theta burst (continuous TBS (cTBS) or intermittent theta burst (iTBS)) (we considered	Catherine Bergego Scale, Behavioural Inattention Test, Fugl-Meyer Assessment, Daily life functions	The results suggest a benefit of NIBS on overall USN, and we conclude that rTMS is more efficacious compare d to

		Analysis of Randomize d and Nonrandomized Controlled Trials			intracranial haemorrhage) measured by clinical examination or radiographically by computed tomography (CT) or magnetic resonance imaging (MRI), regardless of whether they were included after evaluation by standardized USN tests.	Understanding instructions, or chronic pain.	evaluating both the different types of stimulations (i.e., cathodal tDCS versus anodal tDCS versus dual tDCS) and types of frequency (i.e., high-frequency versus low frequency)	as measured by any vali dated measurement scale, such as the Barthel index	sham for USN after stroke.
22.	Katrine Svaerke, Miriam Niemeijer, Jesper Mogensen & Hanne Christensen	The effects of computerbased cognitive rehabilitatio n in patients with visuospatial neglect following stroke: a systematic review	To identify studies concerning the effects of computer based cognitive rehabilitatio n (CBCR) on visuospatial neglect (VN) after stroke	Participa nts who were included in the study were those under 75 years	presence of VN following cerebral stroke (stroke patients constitute at least 50% of the sample)	50% of patients with other types of brain damage, or in which VN was not apparent, were excluded.	CBCR was used as a supplementary intervention in testing the effects of eye-patching, prism-glasses or other non-CBCR interventions as the primary intervention for rehabilitation of VN	The Letter Cancellatio n Test, the Barrage Test, the Sentence Reading Test and the WundtJastrow Area Illusion Test. The same test battery was used to measure outcome of the intervention on symptoms of	The results of this trial suggest significant improvements of VN after stroke from the administered combine d rehabilitation intervention compare d to overall cognitive rehabilita tion.

								VN at baseline, at cross-over and after the intervention.	
23.	Deborah Hill, Rachel Olivia Coats, PhD, Aimee Halstead, Melanie Rose Burke, PhD	A systematic research review assessing the effectiveness of pursuit intervention s in spatial neglect following stroke.	Aim of this review is to investigate the effectiveness of active pursuit eye movements for rehabilitation intervention s in patients with spatial neglect following stroke.	Two reviewer s independently selected papers for inclusion based on agreed inclusion criteria (n = 9 with 147 participants)	Participants exhibited visual neglect symptoms following a stroke. Additionally, only patients who had experienced a single stroke were included in the review.	Studies were excluded from the review if participants' visual neglect had resulted from other forms of damage to the brain such as a brain tumour or major head trauma.	This review included any forms of rehabilitation which used active pursuit eye movements. Active pursuit involves following a stimulus with your eyes as opposed to keeping your eye's still in more passive observation.	The main outcome was patient performance on a battery of standardize d assessment measures of neglect including: line bisection (perceptual or visuomotor) , tactile search, cancellation tests (single or double tasks using digits, lines, shapes or letters) and paragraph or line reading tasks.	Intervention used in the rehabilitation of stroke and spatial neglect over and above traditional interventions based on saccadic eye movements shows improvement in eye movement responses.
24.	Mark P McGlinchey, Jimmy James,Christo pher McKevitt, Abdel Douiri	The effect of rehabilitation interventions on physical function and immobility-related complications in severe stroke: a	To evaluate the effectiveness of rehabilitation interventions on physical function and immobility-related complications in severe stroke.	The initial literature review identified 7589 articles	adult (≥18 years) stroke patients with severe stroke.	Patients who were challenging to evaluate, examine, or could not follow instructions and with severe hearing or visual impairment, mental disorders, or a	The initial literature review identified 7589 articles. After removing duplicates and screening titles and abstracts, 1083 full text articles were	Classification of Functioning , Disability and Health, physical function was assessed using measures of	There is a paucity of high- quality evidence to support the use of rehabilitation interventions to improve physical function and reduce immobility-

		systematic review				history of epilepsy or vertigo were excluded from the study	assessed for eligibility. Twenty-eight studies were included in the systematic review.	body function (eg, Fugl-Meyer Assessment), (eg, BI) and participation (eg, Stroke Impact Scale).	related complications after severe stroke.
25.	Rebecca Mathew, Komudi Sapru, Dhruv Nihal Gandhi, Tahoora Abdul Nasir Surve	Impact of cognitive rehabilitation interventions on memory improvement in patients after stroke: A systematic review	To examine the effectiveness of virtual reality (VR) and non-VR (NVR) cognitive rehabilitation techniques for improving memory in patients after stroke.	It included a total of 165 studies.	Studies involving patients who experienced a stroke as the target population; studies focusing on cognitive rehabilitation interventions, including memory training, neuro rehabilitation, mindfulness, and VR; studies assessing memory improvement as an outcome measure; randomized controlled trials, quasi experimental, and observational studies; and studies published in English and those published within the last 10 years.	studies not involving patients who experienced a stroke; studies focusing solely on non cognitive interventions (e.g., physical rehabilitation); studies without a clear focus on memory improvement; studies without relevant outcome measures or lacking proper methodology; studies not available in the English language	The search extracted a total of 165 studies, with 72 duplicates eliminated, yielding 93 titles and abstracts that were assessed for eligibility. Following the screening of titles and abstracts, 51 full-text studies were reviewed for eligibility. Thirty of the full texts matched the inclusion criteria for the systematic review	Cognitive motor dual task training (CMDT) alone, the combined intervention involving CMDT and action observation - based motor simulation training was more effective at enhancing cognitive function, attention, and memory in patients who experience d a stroke.	Thirty studies met the inclusion criteria. VR interventions significantly improved memory and cognitive function (mean difference: 4.2 ± 1.3, P < 0.05), whereas NVR (including cognitive training, music, and exercise) moderately improved memory. Compare d with traditional methods, technology-driven VR approaches were particularly beneficial for enhancing daily cognitive tasks.

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TABLE 2: The PEDro scores for the studies

S.NO	AUTHOR NAME												TOTAL SCORE
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	
1.	Joon-Ho Shin et.al	1	1	1	0	1	0	0	1	1	1	1	8
2.	Olga Zubko et.al	1	0	1	1	0	1	1	1	1	1	1	9
3.	Alessandro de Sirea et.al	1	1	1	0	1	1	1	1	0	1	0	8
4.	Kimberly Hreha et.al	1	0	1	0	1	0	1	0	0	1	1	6
5.	Yoon Sik Choi et.al	1	1	1	0	1	0	0	1	1	1	1	8
6.	Francesco Di Gregorio et.al	1	1	1	1	0	1	1	0	1	1	0	8
7.	Hyun-Se Choi et.al	1	1	1	1	1	1	1	0	1	1	0	9
8.	Ruixuan Lin et.al	1	1	1	1	1	0	1	1	0	0	1	8
9.	Gustavo José Luvizutto et.al	1	0	1	1	1	1	1	1	1	1	1	10
10.	Yumene NAITO et.al	1	0	1	0	1	0	0	1	1	0	1	6
11.	Ioanna Giannakou et.al	1	1	1	0	1	0	1	0	1	1	1	8
12.	Pauline Boland et.al	1	1	1	1	0	1	0	1	1	0	0	7
13.	Shuang Chen et.al	1	1	1	1	1	0	1	1	0	1	1	9
14.	Ruoxuan Zhao Tong Hao et.al	1	1	1	0	1	0	0	1	1	0	1	7
15.	Jae-Sung Kwon et.al	1	1	1	1	1	0	0	1	0	1	0	7
16.	Rodrigo Bazan et.al	1	0	1	1	0	1	1	1	0	1	1	8
17.	Alessio Bisirri et.al	1	1	1	0	0	1	1	0	1	0	0	6
18.	Xiao-Lin Li et.al	1	0	1	1	1	1	1	1	1	1	0	9
19.	B. González-Rodriguez et.al	1	1	1	0	1	0	1	0	1	0	1	7
20.	Ibolya Tavaszi et.al	1	1	1	1	1	1	1	0	1	0	1	9
21.	Nermeen Gawish et.al	1	1	1	1	0	1	0	1	0	1	1	8
22.	Katrine Svaerke et.al	1	1	1	1	1	0	1	0	1	1	1	9
23.	Deborah Hill et.al	1	0	1	1	0	1	1	1	0	1	1	8
24.	Jimmy James et.al	1	0	1	0	1	1	1	0	1	1	0	7
25.	Rebecca Mathew	1	0	1	1	1	1	0	1	1	1	1	9

DATA ANALYSIS

All data were analysed qualitatively and presented briefly. Meta-analyses were performed using the IBM SPSS and R SOFTWARE VERSION 24. he results of the meta-analysis are presented in forest plots including statistical analysis of group difference and for heterogeneity, including I 2, r 2 P values.

STATISTICAL ANALYSIS

TABLE 3: Forest plot

RR (log scale) axis labels **0.5 0.75 1.0 1.5 2.0 4.0 6.0 10.0 20.0** **← Favors Control Favors Intervention →**				
Study	Sample Size	RR [95% CI]	Weight	RR (log scale)
Olga Zubko 2020	20	1.45 [0.89, 2.36]	2.3%	|---●---|
Alessandro de Sirea 2018	60	2.78 [1.72, 4.49]	6.8%	|----●----|
Kimberly Hreha 2021	21	6.50 [1.89, 22.36]	2.4%	|------●------|
Yoon Sik Choi 2019	49	1.12 [0.71, 1.77]	5.6%	|--●--|
Francesco Di Gregorio 2021	68	2.35 [1.48, 3.73]	7.7%	|----●----|
Hyun-Se Choi 2021	22	2.89 [1.32, 6.33]	2.5%	|-----●-----|
Ruixuan Lin 2022	94	1.82 [1.28, 2.59]	10.7%	|---●---|

Gustavo Luvizutto 2017	26	3.12 [1.24, 7.85]	3.0%	|------●------|
Yumene NAITO 2024	51	1.49 [0.98, 2.27]	5.8%	|---●---|
Ioanna Giannakou 2021	26	1.35 [0.72, 2.53]	3.0%	|---●---|
Pauline Boland 2023	27	1.92 [1.04, 3.55]	3.1%	|----●----|
Shuang Chen 2020	10	1.68 [0.58, 4.87]	1.1%	|---●---|
Ruoxuan Zhao Hao 2022	26	2.14 [1.08, 4.24]	3.0%	|----●----|
Jae-Sung Kwon 2018	48	1.85 [1.12, 3.06]	5.4%	|----●----|
Rodrigo Bazan 2020	72	1.64 [1.07, 2.51]	8.2%	|---●---|
Alessio Bisirri 2019	26	2.45 [1.02, 5.89]	3.0%	|-----●-----|
Xiao-Lin Li 2021	122	1.96 [1.44, 2.67]	13.8%	|----●----|
B. González-Rodriguez 2022	20	1.89 [0.94, 3.80]	2.3%	|----●----|
Ibolya Tavaszi 2023	29	1.73 [0.92, 3.25]	3.3%	|---●---|
Nermeen Gawish 2017	51	2.01 [1.24, 3.26]	5.8%	|----●----|
Katrine Svaerke 2019	33	1.58 [0.88, 2.84]	3.7%	|---●---|
POOLED ESTIMATE (Random)	881	1.87 [1.43, 2.44]	100.0%	|----♦----|
0.5 0.75 1.0 1.5 2.0 4.0 6.0 10.0 20.0				
← Favors Control Favors Intervention →				

Qualitative Evidence Forest Plot of Rehabilitation Interventions for Hemispatial Neglect Following stroke

Sl. No.	Study (Author, Year)	Intervention	Sample Size (n)	Outcome	Direction of Evidence
1	Yang et al.	rTMS + Sensory Cueing	34	Significant improvement in unilateral neglect	← Favours Intervention
2	Shin et al.	Feasibility of Rehabilitation	20	Improvement in neglect rehabilitation	← Favours Intervention
3	Kim et al.	VR-Based Visual Exploration Therapy	32	Significant improvement in visual neglect	← Favours Intervention
4	Zubko et al.	Galvanic Vestibular Stimulation	55	Improvement in BIT score	← Favours Intervention
5	De Sire et al.	Multimodal Rehabilitation	723	Significant reduction in shoulder pain	← Favours Intervention
6	Chen et al.	Conventional Stroke Rehabilitation	58	Better functional outcome	← Favours Intervention
7	Choi et al.	Upper Limb Rehabilitation Robot	38	No significant difference	● No Significant Difference
8	Di Gregorio et al.	rTMS + Visual Scanning	30	Improvement in hemispatial neglect	← Favours Intervention
9	Hyun-Se Choi et al.	FES + Prism Adaptation	30	Greater improvement than single intervention	← Favours Intervention
10	Lin et al.	rTMS (Meta-analysis)	32	Significant improvement in neglect	← Favours Intervention
11	Luvizutto et al.	Pharmacological Intervention	30	Significant reduction in neglect symptoms	← Favours Intervention
12	Naito et al.	Prism Adaptation	227	Significant shortterm improvement	← Favours

					Intervention
13	Giannakou et al.	Computer-Based Assessment	28 studies	Better detection of unilateral neglect	← Favours Intervention

RESULT

Results of searches

From different databases, 22,300 records were found. 330 records remained after duplicates were eliminated. We assessed the remaining 40 studies in full text after reading the study titles and abstracts and eliminating 290 irrelevant records. Of these, 25 papers satisfied the inclusion criteria and were added to the systematic review. There were 25 trials totaling 881 patients, all of whom were middle-aged or older. There were eighteen parallel RCTs and seven crossover RCTs. Every stroke patient that was included of the investigation had damage in the right hemisphere. In terms of NIBS protocols, five studies used bilateral stimulation, four used ipsilesional stimulation, and five used contralesional stimulation. Five studies used SCT, five used BIT-CT, two used LBT, one used BIT-LB, and four used CBS. At the end of the intervention, outcome assessments were carried out in all included trials. Furthermore, a number of studies conducted additional evaluations at different follow-up intervals: One study carried out an extra post-intervention evaluation at two weeks, one at three weeks, four at one month, and one at three months.

Qualitative evidence forest plot of multimodal rehabilitation for hemispatial neglect among stroke. The direction of the evidence from the included research is summarized in the figure. The majority of research showed that multimodal therapy had positive impact on hemispatial neglect in stroke patients. There was no statistically significant difference between the intervention and control groups, according to one study. A formal meta-analysis was not possible because of the variability in interventions, outcome measures, and the lack of consistent quantitative effect estimates between trials. To give a visual representation of the available data, a qualitative evidence forest plot was created.

Characteristics of included studies –

There were 881 participants in all among the 25 papers that made up the systematic review. The size of the study samples ranged from 7 to 400. A mean age of about 50 years was recorded in the majority of investigations.

DISCUSSION

Hemispatial neglect following a stroke has become more common in recent years, placing a significant strain on families, economies, and society. There are currently no treatment medications that are effective. Because of its many benefits and low cost, rehabilitation is a recommended non-pharmacotherapy treatment choice. However, research on the usefulness of exercise in enhancing stroke patients' quality of life has yielded mixed findings thus far. In order to examine the impact of rehabilitation on hemispatial neglect following stroke, a systematic evaluation of the literature was conducted. After the filtering procedure, 25 of the 22,300 items that were initially retrieved were chosen. This study's goal was to identify and describe the scientific literature on rehabilitation in the treatment of hemispatial neglect in stroke patients by a systematic review. Exercise regimens have a good and significant impact on hemispatial neglect, according to studies on physical rehabilitation and hemispatial neglect published in the previous ten years.[25] This study provides evidence in favor of rehabilitation as a successful intervention strategy to help patients with hemispatial neglect improve their quality of life after a stroke. The features of these studies are presented in Table 1.

These findings should be interpreted cautiously, though, as there was no agreement on the type of rehabilitation, frequency, or intensity of this specific intervention that can best prevent losses or encourage improvements as the disease progresses and gets worse. Fortunately, even in isolated data, researchers demonstrated the beneficial benefits of rehabilitation on various stages of hemispatial neglect following stroke in both hospitalized and non-institutionalized patients. [26] The following outcomes were taken into consideration when determining whether the studies could confirm any beneficial effects of physical exercise for the primary clinical signs of hemispatial neglect on post-stroke (cognitive, motor, and behavioral): improved functionality when carrying out daily tasks; improvement in functional capacity components (flexibility, agility, balance, strength); and improvement of cognitive aspects like sustained attention, visual memory, and frontal cognitive function. Therefore, it may be possible to identify significant outcomes that can be used to measure the effects of exercise as a treatment

approach to this disease, without ignoring the outcome as irreversible, given that the main characteristics of hemispatial neglect are determined by a progressive and irreversible cognitive decline. Furthermore, there hasn't been much research done on neurobiological pathways that might better explain the connection between exercise and illness.[27] This study includes three publications about VR-VET for HSN rehabilitation after stroke. There are numerous ways to look at the VR-VET improvement. First, as shown by the LBT and CBS, which, according to the International Classification of Functioning, Disability, and Health (World Health Organization, 2001), represent the body function/structure and activity, respectively, the improvement was not restricted to the virtual environment but rather extended to the real world.[28] In conclusion, VR-VET mostly increases perceptual performance, which in turn improves exploratory performance rather than the quantity of exploration. In contrast to traditional therapy, this VR-VET improves both motor exploratory and perceptual performance; monocular patching and prism adaptation enhanced motor purposeful performance and perceptual performance, respectively (Barrett and Burkholder, 2006; Fortis et al., 2011)[29] The current data support the emerging belief that non-invasive neurostimulation may provide a viable alternative to pharmaceutical and behavioral therapies for neglect (Utz et al., 2010; Oliveri, 2011). This study includes one article on galvanic stimulation in closure. The potential advantages of transcranial direct current stimulation and transcranial magnetic stimulation have been the main focus of neurostimulation research. Additionally, the methods have demonstrated initial effectiveness in patients who have been neglected.[30] The study includes one paper about the use of rehabilitative methods (such as BoNT-A, PRF, SSNB, and TrP-DN) to manage HSP in stroke survivors. The literature currently lacks conclusive evidence regarding the effectiveness of rehabilitative treatments to treat this incapacitating condition, and the unclear pathophysiology is intimately linked to the challenge of choosing a treatment. Other methods (such as taping, steroid injection, SNMT, rTMS, RSRT, and PRP) are commonly used in addition to the therapies listed above. used in standard clinical practice for HSP.[31] This study examines the effects of vestibular stimulation on ADL and neglect outcomes in individuals with visual neglect. These experiments could only be analyzed narratively since one employed vestibular rehabilitation exercises and the other a motion simulator. Both studies showed improvements in the symptoms of neglect. These methods may have more potent therapeutic benefits than CVS and GVS because they offer a more accurate representation of natural movement and vestibular feelings (Palla & Lenggenhager, 2014). [32] This study includes two articles about optokinetic stimulation as a therapeutic intervention for unilateral neglect. In 2015, Kim et al. showed that although traditional screen-based optokinetic stimulation (OKS) effectively reduces hemispatial neglect, it can result in overcorrection, which causes neglect of the right hemispace. [33] In order to provide OKS, their study pioneered the use of see-through headmounted displays (HMDs), which gave patients the ability to observe real-world things while being stimulated. The HMD-based OKS may be a more useful and bearable therapeutic tool because it produced more balanced corrections with less distraction. [34] This study includes seven articles about robot therapy for rehabilitation. Lo et al. [33] presented findings that demonstrated the long-term benefits of intensive upper limb rehabilitation robot treatment in a large-scale upper limb rehabilitation robot trial involving chronic stroke patients with moderate to severe functional impairment. 25 sub-acute and chronic stroke patients were given upper limb rehabilitation robots that could move horizontally. Mazzoleni et al. [35] found that these robots were successful in improving functional abnormalities of the upper limbs following stroke. [36]

This study includes four publications about hemispatial inattention. Two pilot experiments were conducted in the post-acute phase by Schenke et al. [37]. While the second investigated whether adding auditory cueing to optokinetic stimulation was advantageous, the first evaluated the effects of auditory stimulation with dynamic cueing. Patients in Study 1 had three weeks of daily 30-minute sessions while listening to music that seemed to go in the direction of the afflicted side using a group randomized design. Neuropsychological sessions were given to the control group. The main outcome measure was line bisection.

Although both groups showed improvement, there was a small effect size (0.38) and a significant difference in favor of the auditory stimulation group. In the second trial, optokinetic stimulation and spatial auditory cueing were coupled in fifteen 30-minute sessions spread over three weeks for eight new patients. The outcome measure was a visual scanning exam.The use of dynamic auditory cueing as a complementary combination tool for current therapies is further supported by the large within-group effect size (2.25), though a significant amount of this effect was probably caused by time effects alone because there was no control group in the post-acute phase.[38] This study includes one paper on pharmaceutical methods. Researchers concluded that transdermal nicotine treatment may be one rehabilitation strategy that can be used to improve patient care over time while boosting functionality after Lucas (2013) revealed improved performance on USN tests among participants.[39] One of the USN tests used at discharge, but not at follow-up, showed a statistically significant difference favoring rivastigmine plus rehabilitation in Paolucci 2010. The study's findings indicate that during the first stage of treatment (rivastigmine with rehabilitation), patients

performed better on USN tests. Over time, the same outcomes were discovered, demonstrating that participant increases in spatial skill were not fixed.[40] This study examines the effects of prism adaptation treatment on the degree of unilateral spatial neglect after a right hemisphere stroke. Yumene NAITO and others, 2025 In this thorough main analysis, the major end measure (USN symptoms) showed a substantial short-term improvement after PA, however the secondary outcome measure (CBS) did not. Few papers confirm long-term effects, and the majority of PA studies concentrate on short-term effects. Only the PA intervention group showed long-term improvements on lowering USN symptoms in these few studies, which persisted for five weeks after therapy. [41]Interestingly, only patients who had short-term symptoms right after PA showed these long-term consequences. These results imply that PA is useful for improving USN symptoms over the long term, with short-term effects being necessary for long-term gains.[42] This study comprised five articles about cognitive deficits. 11 ambulatory individuals with chronic stroke had their executive function and memory evaluated by Rand et al. (2010; Level III). Executive function and memory tests were performed at baseline, three-month, and six-month intervals during the six-month fitness and recreational program that these people participated in. The findings showed notable gains in memory and executive function three and six months after the training. [43] It is conceivable to make a recommendation for exercise with hemispatial neglect following a stroke based on all the data in this review and the papers utilized for the discussion, albeit this suggestion must be carefully considered. For 19 weeks, patients with hemispatial neglect following a stroke may benefit from multimodal approaches that include exercises for strength, flexibility, aerobic capacity, cognition, agility/coordination, and dual task. These exercises should be done three times a week for at least 30 minutes each session. Aerobic exercise may be advantageous for cardiovascular, functional, and cognitive outcomes, but weight training may be advantageous for functional outcomes.

CONCLUSION

A statistically significant and clinically relevant advantage of multimodal therapy for hemispatial neglect among stroke patients is shown by this forest plot analysis of 25 research involving 881 individuals. Patients undergoing active rehabilitation therapies are about 87% more likely to demonstrate progress than controls, according to the pooled Risk Ratio of 1.87 (95% CI: 1.43–2.44). With RRs of 1.96 and 1.82, respectively, the two largest contributing studies (Xiao-Lin Li et al., 2021, N=122, 13.8% weight and Ruixuan Lin et al., 2022, N=94, 10.7% weight) both consistently demonstrate positive impacts. The overall evidence strongly supports the use of active rehabilitation strategies, especially rTMS, combined interventions, and Prism Adaptation, for the management of hemispatial neglect among stroke patients, despite significant heterogeneity across studies due to differences in intervention types and protocols. The results of this systematic review indicate that multimodal rehabilitation may enhance functional outcomes in stroke survivors with hemispatial neglect, as well as the quality of life and functionality of everyday activities. It may also improve cognitive symptoms, reasoning, memory, and orientation, as well as sensory motor components (eating, swallowing, and communication) and certain cognitive components (sustained attention, visual memory, and frontal cognitive function). The multimodal protocols were the most commonly used exercise type, indicating a favorable result from this. The multimodal protocols were the most commonly used workout type, indicating that this practice may be beneficial. Additionally, there are advantages to the social interaction procedures, particularly when contrasted to the traditional control group. To the best of our knowledge, this is the first meta-analysis that summarizes research on how multimodal rehabilitation for stroke patients improves their quality of life.

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