

# A Scoping Literature Analysis on the Effect of Cognitive Rehabilitation in Improving Higher Mental Functions Following Stroke

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DOI: <https://doi.org/10.52403/ijhsr.20230417>

## ABSTRACT

**Background & Objective:** Higher mental function is a common complain of patients dealing with stroke and potentially affect ability to complete functional activities. Cognitive rehabilitation programmes either attempt to retrain lost or poor memory functions, or teach patients strategies to cope with them. To review the efficacy of cognitive rehabilitation interventions for patients with post-stroke in cognitive impairment.

**Design:** Literature review

**Conclusion:** The study concluded that the effect of cognitive rehabilitation on higher mental function is effective in patients after diagnosed with stroke and significant positive impacts were seen in individuals with cognitive function such as planning, memory, execution etc.

**Keywords:** Cognitive Function, Cognitive Rehabilitation, Higher Mental Function, Stroke, Physical Therapy, Activity of Daily Living

## INTRODUCTION

Cognitive rehabilitation is a systematic, functionally oriented service of therapeutic activities that is based on assessment and understanding of the patient's brain behavioral deficit. Cognitive rehabilitation programmes make either attempt to retrain lost or poor memory functions, or teach patients strategies to cope with them. Different rehabilitation approaches are; Restoration, Substitution & Reconstructing. Cognitive training and retraining strategies are meant to strengthen and restore one's function.<sup>1</sup>

Cognitive impairment in elderly patients depicts less score in Mental Status Questionnaire, with limited functional activity and bad or poor result in rehabilitation. There are many techniques in rehabilitation which require cognitive skills

to learn, memorize commands and direction and exercise, which was a hurdle in geriatric rehabilitation. Because of their coping issues in geriatric, they were not considered suitable for the rehabilitation programs. Cognitive impairment will not intervene in the early rehabilitation of elderly stroke patients where they can regain functional abilities and participate in community level. In stroke patients cognitive impairment incidence is around 5% to 10% of the geriatric population.<sup>2</sup> The patient and their families try to hide the cognitive issues thinking that they will be admitted to the rehabilitation department. Most patients from acute medical wards are sent to rehabilitation centres, where in they are prone to get many risk factors associated to delirium (medications which includes hypnotics, tranquilizers, and neuroleptics).

Hence, it is crucial to identify cognitive impairment early because cognition level is very important in succession of rehabilitation.

In the field of cognitive rehabilitation, there is a shift from diagnostic analysis of neuropsychological impairments to systemic linkage of diagnosis with intervention procedures. The National Institute of Neurological Disorders and Stroke (NINDS) established group to promote evidenced based interventions in the evaluation, treatment and assisting the patient encountered with difficulty in thought processing.<sup>3</sup>

According to the lesion related characteristics, the severity of the cognitive deficits varies, size and location and change in cerebral blood flow and functional networks. Hence it is important to know cerebral post ischemic changes. A new approach to investigate cerebral blood flow by means of Arterial Spin Labelling (ASL) is non-invasive, non-ionizing magnetic resonance imaging (MRI) technique using arterial blood as a tracer. It is safe, economical, quantifiable measure to know the glucose metabolism associated with neuronal activity.<sup>4</sup>

Many researchers have found that a sensory-cognitive-motor network system is necessary to ascertain the accuracy of an action. The sensory-cognitive- motor neural circuits involve the frontal cortex, subcortex, basal ganglia (caudate nucleus, globus pallidus, and thalamus), brainstem, and cerebellum. They can ensure safe and effective posture changing for adaptation to complex environments at home or in a community. Cognition is associated with gait velocity. Evidence has been increasing on the associations between cognitive function and balance in the elderly patients with Alzheimer's or Parkinson's disease. However, limited research has focused on this relationship after stroke.<sup>5</sup>

Cognitive rehabilitation is very important to improve cognitive functions such as attention, memory, task execution abilities, by applying any intervention to improve

cognitive process, which helps improve the patient's functional abilities to perform activities of daily living and to gain independence to perform their own job. As globally everything is modernizing they are many modern interventions for cognitive rehabilitation such as traditional and computerized cognitive training which are widely used nowadays. Traditional cognitive training involves paper and pencil activities, puzzle activities, peg designs, enhances the functional abilities of the damaged area of the brain, which takes place on one-on-one basis with the therapist and patients sitting together that can raise confidence in patient. Computer-assisted cognitive rehabilitation (CACR) is based on computer programs which are specific to the affected area of the patient, and level of difficulty can be adjusted as per the patient's ability.<sup>6</sup>

Cognitive dysfunction mainly includes memory impairment, aphasia, apraxia, agnosia, dyslexia, visual space impairment and so on. The risk of cognitive dysfunction within 12 months after stroke is greater, and it may last several years later. Among them, nearly one-third of them have dementia, the incidence of dementia due to cerebral infarction is about 30.1%, and the incidence of dementia due to cerebral hemorrhage is about 30.1%. Therefore, post stroke cognitive impairment is an important reason that affects the rehabilitation outcome of patients and the impact of physical dysfunction.

Early cognitive rehabilitation training can not only improve the cognitive dysfunction of patients after stroke, but also promote the recovery of patients' activities of daily living (ADL). Post stroke cognitive impairment has varying levels of visual spatial function, orientation, attention, and memory impairment, and their occurrence will be delayed the recovery of other body functions of stroke patients affects the prognosis and recovery process.

At present, modern medicine focuses on drug intervention combined with rehabilitation intervention, aiming to

improve the cognitive function of patients because of actively controlling the primary disease.<sup>7</sup> At present there are many conventional therapy techniques for stroke condition. The need for the study is to review the articles on cognitive rehabilitation after stroke to enhance functional independence through the use of different interventions specific to the individual's needs and abilities that have been impaired due to brain injury or stroke.

## **METHODOLOGY**

### **A) Search and Selection Guidelines**

A highly sensitive search approach, as advised by the Cochrane Collaboration, was used to conduct a thorough search of literature to the end of October 2022. The terms (MeSH) stroke, cognitive training, higher mental function, physical therapy, physiotherapy, rehabilitation and activity of daily living (ADL) were pooled with text when apt. Only English-language articles and randomized controlled trials from 2000 to 2022 are taken into consideration for the selection. Through electronic searches of the following databases (Medline, Embase, CINAHL, PubMed, Web of Science, Google Scholar, Allied and Complimentary Medicine Database, REHABDATA, GEROLIT, ProQuest), journals (BMJ, JAMA, Archives of Physical Medicine and Rehabilitation, Clinical Rehabilitation, etc) and conference proceedings, we were able to locate randomized trials.

### **B) Study Selection**

Studies that compared the effects of a physiotherapy intervention on improving higher mental functions in stroke patients were for this review. Trials using interdisciplinary teams were disregarded since it was difficult to determine how much physiotherapy was involved. To provide a comprehensive picture of the impact of delivering physiotherapy intervention goal on cognitive recovery, all trials were ultimately analyzed.

### **C) Extraction of Data and Quality Evaluation**

Data was retrieved from all papers using predetermined criteria after being read by two separate review writers, with any inconsistencies being handled through discussion. By keeping track of the specific eligibility requirements, the randomization and blinding procedure, the allocation concealment, the similarity in treatment groups at baseline, the variation in co-interventions received throughout the trial period, the performance of an intention to treat analysis, and the number of patients lost to follow-up, publications were evaluated for methodological quality.

### **D) Summary of Quantitative Data**

Outcome measures include 14 domains, which include disease specific evaluation (NIH Stroke Scale, Stroke Impact Scale, Fugl-Meyer Motor Assessment Score), language screening & severity (Boston Diagnostic Aphasia Examination, Aphasia Severity Rating Scale), learning test (Auditory Verbal Learning with Task, Groton Maze Learning Task), executive functions (Montreal Battery of Evaluation of Amusia, Set Shift Task, Barcelona Music Reward Questionnaire, Wisconsin Card Sorting Test), memory test (Rivermead Behavioural Memory Test, Wechsler Memory Scale), cognition (Cog State Computerized Assessment Battery, Lowenstein Occupational Therapy Cognitive Assessment, Cognitive Failure Questionnaire, Mini Mental State Examination), upper limb and dexterity function (Box and Block Test, Wolf Motor Function Test, Action Research Arm Test), mental health (Montreal Cognitive Assessment), behaviour (Neuro-behavioral Functioning Inventory, Dysexecutive Functioning Questionnaire), gait outcomes (Functional Ambulatory Categories, Stride Velocity, Gait Speed, 10-Minute Walk Test, Dynamic Gait Index), Functional mobility & ADL (Functional Independence Measure, Barthel Index, Lawton & Brody IADL Scale, Basic Activities of Daily Living),

Depression (Hospital Anxiety Depression Scale), Fall risk & Balance (Timed Up and Go test, Berg Balance Scale), and Disability & Quality of life (Canadian Occupational Performance Measure, Utrecht Scale for Evaluation of Rehabilitation Participation, Stroke Specific Quality of Life Scale, Performance Quality Rating Scale) were included in the selected trials.

Out of 186 potentially relevant studies identified, 25 randomized control trials were included for the literature analysis. All the analyzed studies show different levels of cognitive changes following interventions like music therapy, virtual rehabilitation, computer aided cognitive rehabilitation, physical activity, cognitive rehabilitation, transcranial magnetic stimulation, balance and postural control. The effects were tabulated in table 1.

## RESULTS

Author (s)	Findings
Vera Leoa, et.al; (2019) <sup>8</sup>	Cognitive and neurobiological insight on how a repetitive sung melody can function as a verbal mnemonic aid after stroke.
Jeffrey M, et.al; (2019) <sup>9</sup>	Both interventional and control groups showed significant training-related improvement on motor and cognitive functions, and functional status. And the interventional group shows higher follow-up values than the control group.
Renate M, et.al; (2017) <sup>10</sup>	Computer based cognitive flexibility training did not improve subjective cognitive function or quality of life after stroke.
Hwi Young, et.al; (2016) <sup>11</sup>	Study showed considerable improvement in cognitive function but no difference in functional independence & ADL.
Wonjae Choi, et.al; (2014) <sup>12</sup>	Performance of a cognitive motor function dual task using auditory cues may influence balance improvements in chronic stroke patients.
Ana Lucia, et.al; (2016) <sup>14-5</sup>	Significant improvements in global cognitive functioning, attention, memory, visuo-spatial abilities, executive functions, emotions and overall recovery in virtual reality group.
Adam Viktorisson, et.al; (2021) <sup>13</sup>	Concluded as many stroke survivors experience a change in their physical activity level following stroke and unimpaired cognition level enhances physical activity after stroke.
Wang Bo, et.al; (2018) <sup>14</sup>	Cognitive performance in the combined training group showed significant improvement after the intervention than the control groups.
Michelle P, et.al; (2008) <sup>5</sup>	Study results suggests that acute treadmill exercises improve subsequent skilled movement of the hemiplegic upper extremity that seems unrelated to attention, visuo-motor processing or strength.
Haiyu Jiang, et.al; (2022) <sup>16</sup>	Early cognitive training in stroke survivors improves QoL and promote the recovery of cognitive function.
Ana Luca, et.al; (2020) <sup>4</sup>	A within-group analysis revealed that the improved general cognitive functioning, attention, visuospatial ability and executive functions. These improvements generalized to verbal memory, processing speed and self-perceived cognitive deficits specific assessments. Treatment group improved in orientation domain on the MoCA, and specific processing speed and verbal memory outcomes.
Su-yeon, et.al; (2020) <sup>17</sup>	Cognitive task training showed improvement in all the outcome scores after intervention.
Valerie Paulin, et.al; (2016) <sup>18</sup>	Study provide evidence of supporting the feasibility of using cognitive orientation to daily occupational performance.
Sara McEwen, et.al; (2020) <sup>19</sup>	Result showed large treatment effect on follow-up performances of self-selected activities and untrained activities.
Yan-Ci Liu, et.al; (2016) <sup>20</sup>	Cognitive dual task training improved cognitive dual task gait performance and motor dual task training improve motor dual task gait performances, although such improvements did not reach significant group differences.
Gye Yeop, et.al; (2014) <sup>21</sup>	Dual task training improved the cognition and walking abilities.
Tal Adamit, et.al; (2021) <sup>22</sup>	Functional and cognitive occupational therapy improved IADL and reintegration to normal living index than the control group.
Youze H, et.al; (2021) <sup>23</sup>	The combination strategy of computer aided self-regulation learning and computer aided cognitive training is an effective tool for improving the generalization abilities, cognitive functions and motor functions of post stroke cognitive impairments.
Tor Ivar G, et.al; (2021) <sup>24</sup>	The high intensity interval training combine with standard care improved gait parameters, executive functions and balance than the standard care alone group.
Jennifer S Wong, et.al; (2016) <sup>25</sup>	The study showed no significant change in physical activity scale for individuals with physical disabilities and active specific balance confidence among the participants.
Daan Meester, et.al; (2018) <sup>26</sup>	Increase in cognitive response during dual task walking showed negative small to medium effect size for comparison between the two groups.
Takatoshi hara, et.al; (2016) <sup>27</sup>	The combined rTMS group shows increased FMA score, upper limb function and action research test.
Yuan-Wen, et.al; (2021) <sup>28</sup>	The real-transcranial direct current stimulation improved the cognitive functions than the sham-transcranial direct current stimulation and difference in ADLs.
In-Seok Park, et.al; (2015) <sup>29</sup>	The cognitive functions were enhanced in both repetitive trans magnetic stimulation and computer assisted cognitive rehabilitation groups.
Hui-xian Yu, et al; (2021) <sup>7</sup>	Altered cognitive function leads to reduction in balance and anticipatory reactions.

Table 1: Effects of interventions on cognitive function following stroke.

## DISCUSSIONS

This review of literature, evaluated the effects of cognitive rehabilitation on higher mental function in participants after

diagnosed with stroke. Overall, the result suggested a beneficial effect of cognitive rehabilitation in cognitive impaired patients after stroke in daily life after the treatment.

No statistically effect were observed at long term follow-up. Administration of physical, occupational therapy, virtual training, computer-based cognitive training, repetitive transcranial stimulation and many more interventions aim to improve the cognitive and motor dysfunction from stroke. The study by Yan-Ci Liu, Yea-Ru Yang, et.al (2017) found that improvement in number of cadences during single walking was by cognitive dual task training which suggests that CDTT can improve cognitive gait performance and MDTT can improve motor dual task performance which can be easily implemented as intervention in stroke rehabilitation.<sup>8</sup>

Dual task performances enable the patient to return to social community and perform complex community activities. Daan Meester, et.al (2018), found that dual task gait training aided for greater improvement in cognitive functioning.<sup>26</sup>

According to Adam Viktorisson, et.al (2021), cognitive impairment may hinder the physical activity intervention in patients with stroke. Participants who were physically active six months after stroke presented with significantly less cognitive impairments. In a study it was found that physical exercise, cognitive training, and both physical exercise and cognitive training enhanced the cognitive functioning in cognitively impaired patients and particularly improvement in the performance in Trail Making Test Part B and many other cognitive functions such as execution, memory and attention. Combined intervention induced reorganization of neuronal networks, efficient perception and executive processing and neuroplasticity in cognitive impaired participants.<sup>13</sup>

Many researchers found that due to small group for intervention, physical exercise and exercise therapy is limited do not specify cognitive function as a primary outcome. Jennifer Wong, et.al (2015), found that individual with decreased physical activity demonstrated smaller changes in BBS scores.<sup>25</sup> HIIT showed no benefit on cognitive function as evaluated by the

MoCA score. He Youze, et.al (2021), in their result revealed that CA-SRL and CACT resulted in improvement in the cognitive function and helped in achieving cognitive gains, ADL execution, motor functions and relearning ability.<sup>23</sup>

Balance is the ability to maintain the posture and control the center of gravity in a given position which is classified as static and dynamic balance. Virtual Reality has found to be extensively beneficial for the individual's with impaired balance in stroke. Many of the postural sway impairments have also been corrected by Virtual Training. There was great improvement in the dynamic balance in about 6 weeks of duration measured by BBS and TUG outcome measure, whereas static balance ability did not improve by VRBT.

Transcranial direct current sham stimulation and cognitive training together has shown improvement in cognitive function in executive function in stroke patients, and through some non-specific effects such as induced muscle movements, tactile and temperature sensory inputs.<sup>29</sup>

Following a stroke, memory issues are a typical cognitive complaint that can impair one's ability to carry out functional tasks. Cognitive rehabilitation either teaches patients coping mechanisms or makes an effort to retrain weak or damaged memory skills. Participants who received treatment right away reported having less memory issues in daily life, but there is no proof that this impact will last over the long term.<sup>29</sup>

Das Nair R, Cogger, et.al (2017) found that the degree of clinical and methodological variation in memory rehabilitation trials was a key source of worry. Due to the small sample size and limited number of research, we were not able to thoroughly examine what caused this heterogeneity. We speculate that it might have been brought about by the several studies' use of multiple objective memory function assessments.<sup>30</sup>

Interventions that encourage self-monitoring and self-regulation for deficits in executive functioning (including impaired self-awareness) and social communication skills

interventions for interpersonal and pragmatic conversational problems are advised after TBI for impairments of higher cognitive functioning. After a moderate or severe TBI, comprehensive, holistic neuropsychological rehabilitation is advised to increase post-acute participation and quality of life.

It has been established that cognitive therapy is more advantageous than traditional rehabilitation. There is strong evidence that the best form of treatment for those who experience neurocognitive impairment and functional limitations after a stroke is cognitive rehabilitation.<sup>31</sup> Overall, there was not enough data to prove or disprove whether cognitive rehabilitation is an elective treatment for memory function, mood, independence in daily living activities, or quality of life.

There were 15 comparisons (which included 550 participants) of cognitive rehabilitation with no active treatment. In every one of these comparisons, cognitive rehabilitation was shown to be of benefit. There were 17 comparisons (with 696 participants) between cognitive rehabilitation and conventional forms of rehabilitation. Cognitive rehabilitation was shown to be of greater benefit than conventional rehabilitation in 94.1% of these comparisons. Examining this evidence base, there is clear indication that cognitive rehabilitation is the best available form of treatment for people who exhibit neurocognitive impairment and functional limitations after TBI or stroke. Additional research needs to elucidate the mechanisms of change underlying the efficacy of cognitive rehabilitation and the comparative effectiveness of different interventions.<sup>32</sup>

In our initial review, we indicated that cognitive rehabilitation should be directed at achieving changes that improve persons' functioning in areas of relevance to their everyday lives. The majority of studies have relied on changes in cognitive functioning, assessed by standardized neuropsychologic testing or other cognitive measures, as proximal outcomes of cognitive

rehabilitation. Our reviews are consistent with the view that cognitive rehabilitation is effective in helping patients learn and apply compensations for residual cognitive limitations, although several studies suggest that intervention may directly improve underlying cognitive functions.

Our systematic reviews provide more limited evidence regarding improvements at the level of functional activities, participation, or life satisfaction after cognitive rehabilitation. Although improvements at the level of social participation and quality of life are valued as the distal health-related outcomes of cognitive rehabilitation, it is often not possible to observe improvements on these more global outcomes within the limited timeframes used in most investigations of cognitive rehabilitation. The possible reasons for this include the relatively brief periods of intervention, limited opportunity to address the application of interventions to everyday functioning, lack of follow-up assessing community functioning, or failure to include the relevant outcome measures. A number of studies have evaluated treatment effects based on observations of everyday functioning or performance on tasks derived from activities of daily living, which provide evidence for the effects on daily functioning. Studies of comprehensive-holistic cognitive rehabilitation provide the best evidence for improvements in health-related outcomes, such as social participation and quality of life.

Although numerous study authors provided separate data for those who had strokes, several of the studies contained samples with mixed diagnoses, and the sample sizes were small. The studies that included only stroke patients could have been compared to those that included stroke patients as part of a mixed diagnosis group using a sensitivity analysis, but because most trials had small sample sizes, further fractionating may have resulted in a further reduction in power, which we felt would have produced results that were inconclusive. Studies of mixed diagnoses are helpful in assessing the

possibility for training programmes to be generalizable across diagnostic groupings and reflect common clinical practise in many centres, but there are likely to be differential effects of the training based on diagnosis and even severity.

## CONCLUSIONS

The current review article shows improvement in higher mental function after stroke by cognitive rehabilitation along with the standard or routine physical therapy. This literature also revealed there is no research conducted to improve HMF after stroke. Literature shows by standalone cognitive rehabilitation higher mental function can be improved by virtual rehabilitation, computer based rehabilitation, occupational therapy, transcranial magnetic stimulation, combined physical exercise with cognitive therapy, combined intervention of repetitive transcranial magnetic stimulation and intensive occupational therapy, virtual rehabilitation balance training with a video game system with a balance board game system, cognitive and motor dual task gait training, neurofeedback and computer assisted cognitive rehabilitation, computer-aided SRL (CA-SRL) training and Computer Aided Cognitive training (CACT), cognitive task training, memory group training and computerized cognitive training, combination of cognitive strategy & task- specific training, High-Intensity Interval Training.

### *Declaration by Authors*

**Ethical Approval:** Not Applicable

**Acknowledgement:** None

**Source of Funding:** None

**Conflict of Interest:** The authors declare no conflict of interest.

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- How to cite this article: Shreya Shama Shetty, Riyas Basheer KB. A scoping literature analysis on the effect of cognitive rehabilitation in improving higher mental functions following stroke. *Int J Health Sci Res*. 2023; 13(4):129-137.  
DOI: <https://doi.org/10.52403/ijhsr.20230417>

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