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Article *in* Topics in Stroke Rehabilitation · March 2010

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A Systematic Review of Cognitive Interventions to Improve Functional Ability in People Who Have Cognitive Impairment Following Stroke

Tammy Hoffmann, PhD, BOccThy (Hons),[1] Sally Bennett, PhD, BOccThy (Hons),[1] Chia-Lin Koh, MPhil, BS,[2] and Kryss McKenna, PhD BOccThy (Hons)[1]

[1]Division of Occupational Therapy, School of Health and Rehabilitation Sciences, The University of Queensland, Brisbane, Queensland, Australia; [2]School and Graduate Institute of Occupational Therapy, National Taiwan University, Taipei, Taiwan

Purpose: Cognitive impairment is a frequent consequence of stroke and can impact the ability of people who have had a stroke to perform everyday activities. There are a number of intervention strategies that various health professionals may use when working with people who have cognitive impairment post stroke. The purpose of this systematic review was to determine whether interventions for people with cognitive impairment after a stroke improve their functional performance of basic and/or instrumental activities of daily living (ADL). **Method:** Searches were performed in the Cochrane Central Register of Controlled Trials, MEDLINE, EMBASE, CINAHL, PsycINFO, PsycBITE, OTseeker, and Dissertation Abstracts. Studies were eligible for inclusion if they were a randomised controlled trial or quasi-randomised controlled trial that evaluated an intervention that focused on providing cognitive retraining to adults with clinically defined stroke and confirmed cognitive impairment and measured functional ability, either basic or instrumental ADL, as either a primary or secondary outcome measure. **Results:** Four studies, involving a total of 376 participants, were included in this review. There was no statistically significant difference between groups on basic ADL performance in any of the four studies or on instrumental ADL in the one study that measured this. **Conclusion:** There were not an adequate number of high quality trials to be able to make recommendations that support or refute the use of specific cognitive retraining interventions to improve functional outcomes following a stroke. More research is required before conclusions can be made about the effect of cognitive interventions on functional outcomes post stroke. **Key words:** *activities of daily living, cerebrovascular accident, cognitive impairment, cognitive interventions, function, self-care, stroke, systematic review*

Stroke is a leading cause of chronic disability in many developed countries in the world.[1,2] Cognitive impairment is a frequent consequence of stroke, with estimates of 35% of patients presenting with cognitive impairment in the 3 months following stroke[3] and up to 32% of patients demonstrating persistent cognitive impairment up to 3 years following the onset of their first stroke.[4]

There is some variation in how cognitive impairment is defined and classified. Cognition typically includes domains such as attention and concentration, memory, and executive functioning,[5] and some authors also include visuospatial perception and apraxia as cognitive impairments.[6] However many texts classify the latter as disorders that are separate from cognitive impairment. The National Stroke Foundation of Australia's *Clinical Guidelines for Stroke Rehabilitation and Recovery*[7] was used to clarify and guide the selection of cognitive domains for this review. For the purposes of this review, cognitive impairment is considered to encompass impairments in attention and concentration, memory, orientation, and/or executive functions.

A significant relationship has been found between cognitive abilities and functional performance.[4,8,9] Cognitive impairment following stroke can reduce a person's independence in performing basic activities of daily living (ADL; such as eating, dressing, and toileting) and instrumental ADL (such as housework and social interactions).[4,10,11] Ongoing care and support is often required by people with cognitive impairment and can subsequently place a strain on caregivers and society.[12,13] It is therefore

Top Stroke Rehabil 2010;17(2):99–107

www.thomasland.com

doi: 10.1310/tsr1702-99

important to identify not only interventions that treat cognitive impairment following stroke but also those that may improve a person's ability to perform functional activities. McKinney and colleagues[14] argue that restoration of function is unlikely in people with cognitive impairments following stroke and that rehabilitation should aim to reduce the effect of impairment on functional activities.

Evaluation of the effectiveness of cognitive rehabilitation typically focuses on whether improvement has occurred in the cognitive domain(s) that were targeted, such as memory.[15,16] However for many areas of health care, including stroke management, there is growing recognition of the need to examine not only whether interventions improve an individual's performance at the impairment level but also whether interventions improve an individual's ability to perform activities and participate in life situations that are important to him or her.[17–19] To inform clinical practice, there is a need to develop and synthesise evidence that has measured outcomes that extend beyond the impairment level.

To our knowledge, there is no systematic review that has specifically examined the effectiveness of cognitive interventions where the focus has been on improving the functional performance of people with cognitive impairment after stroke. A review by Cicerone and colleagues addressed the issue of the effectiveness of cognitive rehabilitation in people with traumatic brain injury and stroke, however it did not specifically focus on functional outcomes.[6] Two Cochrane reviews have evaluated the effectiveness of cognitive rehabilitation for specific cognitive domains, namely memory deficits[20] and attention deficits,[21] however these reviews focused only on interventions that specifically targeted these deficits. The purpose of this systematic review was to determine whether interventions for cognitive impairment after a stroke improve functional performance of basic and/or instrumental ADL.

Methods

Criteria for considering studies for this review

Types of studies

The review was restricted to randomised controlled trials (RCTs) and clinical trials where participants were quasi-randomly assigned to one of two or more treatment groups. Articles also needed to have been published in English.

Types of participants

Trials were included if their participants were adults (aged 18 years or over) with a clinically defined stroke and confirmed cognitive impairment (including attention and concentration, memory, orientation, and/or executive functions) as specified in each trial. Trials with mixed etiology groups were excluded unless participants who had had (and only had) a stroke comprised more than 50% of the participants in the trial, and separate data for the participants with stroke were available either in the published article or from the trial authors.

Types of interventions

We included all interventions for cognitive impairment following a stroke, regardless of the discipline of the health professional who provided the intervention. We did not include trials that examined the effects of change from pharmaceutical interventions on cognitive function following stroke.

Types of outcome measures

We included trials that measured functional ability, either basic or instrumental ADL, as either a primary or secondary outcome measure.

Search methods

Comprehensive search strategies were used in the following electronic bibliographic databases: the Cochrane Central Register of Controlled Trials (CENTRAL; The Cochrane Library, last searched November 2009), MEDLINE (1966 to November 2009), EMBASE (1980 to April 2009), CINAHL (1982 to April 2009), PsycINFO (1840 to November 2009), PsycBITE, OTseeker, (up to November 2009), and Dissertation Abstracts. The search strategy was developed in conjunction with an experienced medical librarian. The search strategy that was used in MEDLINE (Ovid) is shown in **Appendix A**. This strategy was adapted

for use in the other databases. In an effort to identify further published, unpublished, and ongoing trials, the following strategies were also used:

- Tracking relevant references through the cited reference search in Science Citation Index (SCI) and Social Science Citation Index (SSCI)
- Scanning the reference lists of identified studies and reviews
- Identifying unpublished research by searching Dissertation Abstracts and contacting key researchers in the area

Data collection and analysis

Study selection

One review author (C.K.) reviewed the titles of articles identified in the searches and references. Irrelevant studies were eliminated and the abstracts of the remaining studies were obtained. Using the abstracts obtained from the searches, two review authors (C.K. and T.H. or S.B.) independently completed the first phase of study selection according to the four eligibility criteria (types of studies, participants, interventions, and outcome measures). The full texts of the studies that were considered as eligible for inclusion from this process or for which eligibility was unclear were obtained. Two review authors (C.K. and T.H. or S.B.) independently completed the second study selection to finally decide on each trial's inclusion or exclusion. Any disagreement was resolved by discussion based on the inclusion criteria. If no consensus was reached, the third review author made the decision.

Assessment of methodological quality

Review authors (T.H. and S.B.) independently evaluated the methodological quality of eligible trials, using the eight internal validity items from the PEDro scale After reviewing the trials, each of the eight items was assigned a yes (present) or no (absent or not reported) to indicate the methodological quality of the studies.

Data extraction and data analysis

Two of the review authors (T.H. and S.B.) independently recorded the following information from each trial using a self-developed data extraction form:

- *Sample characteristics:* such as age, level of education, sex, first or recurrent stroke, type and severity of stroke, time since onset of stroke, type of cognitive impairment, sample size, and number lost to follow-up
- *Methodological quality:* according to the eight internal validity items from the PEDro scale
- *Details of the interventions*: type of interventions, duration and frequency of interventions and follow-up, and individual or group therapy
- *Outcome measures*: details about measures of basic and/or instrumental ADL that were used in the trial and when they were administered

Extracted data were analysed using descriptive statistics to summarise their methodological quality and outcomes. It was expected that there would be a high level of heterogeneity among studies due to variation in the samples, interventions, and outcome measures used. If it were not possible to undertake a meta-analysis, a narrative summary of results would be provided using Review Manager software to calculate effect sizes for data from the individual studies.

Results

After removing duplicate articles, we found 1,659 references and identified 11 RCTs that provided interventions for cognitive impairment following stroke with functional outcomes. However of these, only four studies were eligible for inclusion in this review.[14,22–24]

Excluded studies

Of the identified 11 RCTs that provided interventions for cognitive impairment following stroke with functional outcomes, 7 were excluded. Four studies appeared eligible from the abstracts but the full text was in a language other than English and were therefore excluded from this review.[25–28] Three studies that appeared eligible were not included because separate data could not be obtained for participants with stroke,[29] there were less than 50% of participants with stroke,[30] or not all participants met the definition of cognitive impairment that was used in this review.[31]

Description of included studies

Due to substantial clinical diversity amongst the studies found in terms of interventions and outcomes and in some instances lack of available data, it was not possible to undertake a meta-analysis. A narrative summary was undertaken with respect to methodological quality, participants, interventions, outcomes, and effect sizes.

Methodological quality

Table 1 indicates which of the internal validity criteria were met for each of the four studies that were included in this review. As per the criteria for this review, all four studies were RCTs. Three studies concealed allocation sequence.[14,22,23] As is the case with many rehabilitation RCTs, it was not possible for any of the studies to achieve blinding of participants or therapists. There was similarity between group characteristics at baseline in all but one study[23] and adequate follow-up in all but one study.[14] Two studies[22,23] used intention-to-treat analysis.

Summary of participants

A total of 376 people with cognitive impairments following stroke participated in the four studies included in this review. Three studies[14,22,24] included participants who were receiving acute hospital care, and one study[23] included participants from a rehabilitation unit with an average time since stroke of 13.1 months. Further details of participant characteristics are provided in **Table 2**.

Summary of interventions

Each study included in this review used a different intervention. The interventions included time pressure management (aimed at preventing or managing time pressures)[23]; cognitive skill remediation retraining of time estimation[32] based on the *Thinking Skills Workbook* developed by Carter and colleagues,[33] which incorporated feedback, reinforcement, and grading of tasks; attention process training using sustained, selective, alternating, and divided attention tasks[22]; and provision of feedback about the results of extensive cognitive testing and recommendations for compensating for specific deficits to patients, carers, and professionals involved in their care.[14] Further details of the interventions are provided in **Table 2**.

Summary of outcome measures

Only one study[14] measured ADL as a primary outcome; it measured both basic ADL, using the Barthel Index, and instrumental ADL, using the Extended Activities of Daily Living scale. Basic ADLs were measured as secondary outcomes in the remaining three studies, using the modified Rankin Scale[22] and the Barthel Index.[23,24,32] A wide range of measures were used to test cognitive function as the primary outcome including the information intake task, Mental Slowness Observation Test, and Mental Slowness Questionnaire[23]; Integrated Visual Auditory Continuous Performance Test Full-Scale Attention Quotient (FSAQ)[22]; time estimation[32]; and

Table 1. Details about which of the internal validity criteria were met for each of the included studies

	Study and whether each criterion was met			
Criteria (from PEDro scale)	**Barker-Collo, 2009**	**Carter, 1988**	**McKinney, 2006**	**Winkens, 2009**
Random allocation	Yes	Yes	Yes	Yes
Concealed allocation	Yes	No	Yes	Yes
Baseline similarity	Yes	Yes	Yes	No (differed on time since stroke)
Blinded participants	No	No	No	No
Blinded therapists	No	No	No	No
Blinded assessors	Yes	No	Yes	Yes
Adequate follow-up (>85% of participants)	Yes	Yes	No	Yes
Intention to treat analysis	Yes	No	No	Yes

Table 2. Characteristics of included studies

Study	Participants	Intervention	Comparison	Measures	Time of assessment
Barker-Collo, 2009	78 acute incident stroke survivors Recruited from two hospitals, New Zealand 47 males, 31 females Identified as having attention deficit N = 38 Attention process training group (mean age 70.2 y) N = 40 Standard care group (mean age 67.7 y) Baseline time since stroke mean 18.53 d	Attention process training (APT) for up to 30 h. Individual APT conducted for 1 h on weekdays for 4 wks.Participants discharged from hospital before 30 h was achieved continued to receive APT sessions in the community. APT incorporated sustained, selective, alternating, and divided attention tasks.	Standard care	*Primary outcome:* IVA-CPT Full-Scale Attention Quotient (FSAQ) *Secondary outcomes:* modified Rankin scale, Trail Making Test, Bells test, Paced Auditory Serial Addition Test trials, SF-36, Cognitive Failure Questionnaire, General Health Questionnaire-28	Baseline, 5 wks, and 6 wks after randomisation
Carter, 1983, 1988	33 acute inpatient stroke patients Recruited from a single hospital, USA 16 males, 17 females N=16 Cognitive skills remediation training group (mean age 70.5 yrs) N=17 rehabilitation as usual (mean age 73.4 yrs)	Cognitive skills remediation training administered on an individual basis for 30–40 min three times per week for an average of 3–4 wks. The cognitive skills remediation training was based on the *Thinking Skills Workbook*.[33] Participants in the cognitive skills remediation group also received rehabilitation as usual.	Rehabilitation as usual	*Primary outcomes:* Time judgment tests, visual scanning, visual-spatial tests, from the *Thinking Skills Workbook*.[33] However for the purpose of this review only time judgement scores are reported as the visual scanning and visual-spatial tests are considered measures of perceptual skill. *Secondary outcomes:* Barthel Index	Baseline, Post intervention (mean of 22 d following baseline assessment)
McKinney, 2002	228 stroke patients Recruited from three hospital wards, United Kingdom 121 males, 107 females N = 112 Extensive cognitive assessment and feedback group (median age 72 y) N = 116 Routine care group (median age 72 y)	Feedback of results from an extensive battery of cognitive assessments to assess specific cognitive functions was provided to the patient, and if the patient agreed, the carer. Recommendations were made to help patients to compensate for any specific deficits. A summarised report with specific recommendations was provided to professionals involved in their rehabilitation. This was made available to the patient's general practitioner, consultant, and any other professionals working with the patient.	Routine care	*Primary outcomes:* Barthel Index, Extended ADL Scale, Cognitive Failures Questionnaire, General Health Questionnaire-28 for patients and carers, Caregiver Strain Index. *Secondary outcomes:* London Handicap Scale and satisfaction with care	Baseline, 3, and 6 months after randomisation
Winkens, 2009	37 stroke patients Recruited from eight rehabilitation centres, outpatients and inpatients, The Netherlands 21 males, 16 females N = 20 Time pressure management group (mean age 49.5 y) N = 17 Care as usual group (mean age 53.9 y)	Time pressure management (TPM) which was aimed at preventing or managing time pressures. Treatment was given in sessions of 1, 1.5, or 2 h/wk for 10 h in total. TPM treatment was given in three main stages: (1) to enhance the patient's awareness of mental slowness, (2) focus on the acceptance and acquisition of the TPM strategies, and (3) focus on generalisation.	Care as usual Cognitive training for slowed information processing in this group was mostly restricted to education about brain damage, and speed of information processing and its possible consequences for daily functioning, with advice about how to deal with these consequences.	*Primary outcomes:* Information intake task and the number of strategies used, Mental Slowness Observation Test (the number of strategies used, number of correct elements and time in seconds), Mental Slowness Questionnaire. *Secondary outcomes:* Barthel Index, fatigue, depression, quality of life, and neuropsychologic tests for speed of information processing, memory, attention, and executive functioning.	Baseline, at conclusion of the intervention, and at 3 months follow- up

Cognitive Failures Questionnaire.[14] Only the study by McKinney and colleagues[14] considered broader primary outcomes and used measures including the General Health Questionnaire for patients and carers and the Caregiver Strain Index.

Effects of interventions for cognitive impairment

Basic ADL

Three studies[14,23,24] found no statistically significant difference between groups on basic ADL performance when measured using the Barthel Index. No statistically significant differences were found between groups on the modified Rankin Scale in the other study that measured basic ADL.[22]

Instrumental ADL

No statistically significant difference between groups was found on the Extended Activities of Daily Living scale in the one study that measured instrumental ADL.[14]

Cognitive outcomes

Two studies reported statistically significant differences between groups for a limited number of cognitive outcomes. Barker-Collo and colleagues[22] reported a statistically significant difference between groups in change from baseline at 5-week follow-up on the Integrated Visual Auditory Continuous Performance Test Full-Scale Attention Quotient (mean difference = 2.76; 95% CI, 1.31 to 4.21) and Auditory Attention (mean difference = 1.95; 95% CI, 0.48 to 3.45). Participants in the time pressure management group in the study by Winkens and colleagues[23] demonstrated a greater reduction in the time taken to complete the Mental Slowness Observation Test compared with the care as usual group at 3 months ($P = .01$).

Other primary outcomes

No statistically significant differences were found between groups on the General Health Questionnaire for patients and carers, the Carer Strain Index, London Handicap Scale, or a satisfaction with care scale.[14]

Discussion

The aim of this review was to examine the effects of interventions for cognitive impairments on functional outcomes for people who have experienced a stroke. We included four studies. Meta-analyses were not possible due to considerable clinical and methodological diversity. This review found no statistically significant results for the effects of interventions for cognitive impairments following stroke on functional outcomes. Some benefits were found for a limited number of cognitive outcomes. At this stage, there are not an adequate number of high-quality trials to be able to make recommendations that support or refute the use of specific cognitive retraining interventions to improve functional outcomes following a stroke.

This review was based on a small number of trials and each trial evaluated a different type of intervention. Most of the trials included a small number of participants. Addressing these issues should be a priority in research design in the stroke rehabilitation area. During the search for this review, it was evident that there are a number of nonrandomised studies that have measured functional outcomes following interventions for cognitive impairment after stroke that could be incorporated in a future review of this area.

Four studies that appeared from the abstract to be eligible for this review were not included as the main text of these studies was not in English. There is potential that the noninclusion of these studies may have biased the findings of this review. More research is required before conclusions can be made about the effect of cognitive training on functional outcomes post stroke. Given the importance of providing interventions that aim to reduce the effect of impairments, such as cognitive impairment, on a person's ability to perform functional activities, future trials should ensure that a measure of functional performance is included in the outcome measures.

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APPENDIX A

Search Strategy That Was Used in MEDLINE (Ovid)

1. exp cerebrovascular disorders/ or brain injuries/ or brain injury, chronic/
2. (stroke$ or cva or poststroke or post-stroke).tw.
3. (cerebrovasc$ or cerebral vascular).tw.
4. (cerebral or cerebellar or brain$ or vertebrobasilar).tw.
5. (infarct$ or isch?emi$ or thrombo$ or emboli$ or apoplexy).tw.
6. 4 and 5
7. (cerebral or brain or subarachnoid).tw.
8. (haemorrhage or hemorrhage or haematoma or hematoma or bleed$).tw.
9. 7 and 8
10. exp hemiplegia/ or exp paresis/
11. (hemipar$ or hemipleg$ or brain injur$).tw.
12. 1 or 2 or 3 or 6 or 9 or 10 or 11
13. cognition disorders/ or confusion/ or neurobehavioral manifestations/ or memory disorders/
14. (agnosia or amnesia or confusion or inattention).tw.
15. cognition/ or Arousal/ or Orientation/ or Attention/ or memory/ or perception/ or mental processes/ or thinking/ or Concept Formation/ or Algorithms/ or "Recognition (Psychology)"/ or Judgment/ or Awareness/ or Problem Solving/ or "Generalization (Psychology)"/ or "Transfer (Psychology)"/ or comprehension/ or Impulsive Behavior/ or Learning/
16. ((cogniti$ or arous$ or orientat$ or attention$ or concentrat$ or memor$ or recall or percept$ or think$ or sequenc$ or algorithm$ or judg?ment$ or awareness or problem solving or generali?ation or transfer or comprehension or learning) adj10 (disorder$ or declin$ or dysfunct$ or impair$ or deficit$ or abilit$ or problem$)).tw.
17. (dysexecutive syndrome$ or mental process$ or (concept adj5 formation) or impulsive behavio?r$ or executive function$).tw.
18. 13 or 14 or 15 or 16 or 17
19. Randomized Controlled Trials/ or random allocation/ or Controlled Clinical Trials/ or control groups/ or clinical trials/ or clinical trials, phase i/ or clinical trials, phase ii/ or clinical trials, phase iii/ or clinical trials, phase iv/
20. double-blind method/ or single-blind method/ or cross-over studies/ or Program Evaluation/ or meta-analysis/
21. randomized controlled trial.pt. or controlled clinical trial.pt. or clinical trial.pt. or meta analysis.pt.
22. random$.tw.
23. (controlled adj5 (trial$ or stud$)).tw.
24. (clinical$ adj5 trial$).tw.
25. ((control or treatment or experiment$ or intervention) adj5 (group$ or subject$ or patient$)).tw.
26. (quasi-random$ or quasi random$ or pseudo-random$ or pseudo random$).tw.
27. ((control or experiment$ or conservative) adj5 (treatment or therapy or procedure or manage$)).tw.
28. ((singl$ or doubl$ or tripl$ or trebl$) adj5 (blind$ or mask$)).tw.
29. (coin adj5 (flip or flipped or toss$)).tw.
30. versus.tw.
31. (cross-over or cross over or crossover).tw.
32. (assign$ or alternate or allocat$ or counterbalance$ or multiple baseline).tw.
33. controls.tw.
34. (treatment$ adj6 order).tw.
35. (meta-analy$ or metaanaly$ or meta analy$ or systematic review or systematic overview).tw.
36. or/19–35
37. occupational therapy/
38. Rehabilitation/ or Rehabilitation, Vocational/
39. activities of daily living/ or self care/
40. automobile driving/ or exp transportation/
41. "Task performance and analysis"/ or Work simplification/
42. exp leisure activities/
43. Home care services/ or Home care services, hospital-based/
44. Recovery of function/
45. exp work/ or Human activities/
46. occupational therap$.tw.
47. ("activities of daily living" or ADL or EADL or IADL).tw.
48. rehabilitation.tw.
49. ((self or personal) adj5 (care or manage$)).tw.
50. (dressing or feeding or eating or toilet$ or bathing or mobil$ or driving or public transport or public transportation).tw.
51. exp self-help devices/
52. (assistive adj5 (device$ or technology)).tw.
53. or/37–52
54. 12 and 18 and 36 and 53
55. limit 54 to (humans and "all adult (19 plus years)")

56. apraxias/ or apraxia, ideomotor/ or neglect/ or exp dementia/ or exp Arm/ or exp Hand/ or exp Depressive Disorder/ or depression/ or exp Pharmaceutical Preparations/ or exp Drug Therapy/
57. (apraxi$ or dysprax$ or aphasi$ or dysphasi$ or dementia or alzheimer$).ti.
58. atrial.tw.
59. 56 or 57 or 58
60. 55 not 59
61. (dose$ or drug$).tw.
62. 60 not 61
63. Magnetic Resonance Imaging/ or Diffusion Magnetic Resonance Imaging/ or Imaging, Three-Dimensional/ or Diagnostic Imaging/ or Radionuclide Imaging/ or Magnetic Resonance Imaging, Cine/
64. 62 not 63
65. (MRI or fMRI).tw.
66. 64 not 65