

Constraint induced movement therapy does not produce clinically significant improvement in upper limb function following stroke.

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Clinical Question

What is the evidence that constraint-induced movement training of the upper limb is more effective than any other movement training for adults following stroke?

Clinical Scenario

Constraint-induced movement therapy (CIM) is a relatively new but intense therapy protocol. Essentially a CIM approach to upper extremity therapy discourages the use of the unaffected (normal) arm and encourages the use of the hemiplegic arm in order to maximise function. What is the effectiveness of this intervention in training upper limb functional movement, and is it more effective than other movement training approaches?

Summary of Original CAT Findings

- 36 citations were located that met the inclusion/exclusion criteria.
- 1 guideline and 2 systematic reviews were located; guideline was excluded for lack of evidence therefore only 2 systematic reviews were appraised.
- One systematic review found small improvements in performance on the Action Research Arm test (ARA) but no improvements in functional use, and reported results in subjects ranging from 4 days to 4 years post-stroke. Interpretation of results limited by lack of statistical analyses of heterogeneity.
- One systematic review found improvements in performance on the ARA, however omitted key RCTs from appraisal which limits the value of this review.

Summary of Review Findings

- A further 24 citations were located that met the inclusion/exclusion criteria (total of 60 citations).
- 1 guideline and 3 systematic reviews were located and appraised, one systematic review was published since the original CAT in October 2002 and the guideline had been revised.
- The revised guideline reported that constraint induced movement therapy is a beneficial treatment approach for those stroke patients with some active wrist and hand movement (Teasell et al, 2003), however omitted key RCTs from appraisal and did not consider clinical importance of effect sizes (when reported) which limits the value of this guideline.
- The recent systematic review reported small, positive results at the level of hand and arm function, although for those papers which reported sufficient data to permit calculation of standardised mean differences such improvements did not reach statistical or clinical significance (van der Lee, 2003).
- There are still no RCTs to date have compared CIM to MRP (or any other motor rehabilitation approach which focuses on training isolated motor control of the hemiparetic upper limb) which limits the usefulness of the systematic reviews appraised for clinicians in Australia and Europe where upper limb rehabilitation is customary.

Clinical Bottom Line

Constraint-induced movement therapy provides a small, positive effect (neither statistically nor clinically significant) on upper limb function in patients who require upper limb training for hemiplegia following stroke, however existing studies have only compared its effectiveness to compensatory or bimanual training techniques (and not to techniques designed to practice retraining isolated active movement in the hemiplegic arm).

Limitation of CAT

This summary of evidence has been individually prepared and has not undergone a process of peer review.

Methodology

Search Strategy

Using the levels of evidence as defined by the Oxford Centre for Evidence-based Medicine levels of evidence (Phillips, Ball, Sackett, et al., 2001), the search strategy aimed to locate the following study designs:

- Systematic reviews and meta-analyses of randomised controlled trials (level 1a);
- Systematic reviews and meta-analyses of randomised and non-randomised controlled trials (level 2a);
- Randomised controlled trials (level 1b or 2b);
- Controlled trials, cohort (level 2b) or case-control studies (level 3b);
- Case series (level 4); or
- Expert opinion including literature/narrative reviews, consensus statements, descriptive studies and individual case studies (level 5).

A search was also conducted for clinical practice guidelines based on these levels of evidence.

Search Terms

Patient/Client: stroke or neurolog\$ or hemiplegi\$ or CVA

Intervention: constraint or learned non-use or forced use

Comparison: *nil*

Outcomes: increased functional use, increased active movement, decreased time spent in rehabilitation program (decreased length of stay).

Sites/Resources Searched

- National Health and Medical Research Council
- New Zealand Guidelines Group
- National Guidelines Clearinghouse
- UK Guidelines: National Electronic Library for Health, Clinical Guidelines Database
- Scottish Intercollegiate Guidelines Network (SIGN)
- Evidence Based Review of Stroke Rehabilitation (EBRSR) Clinical Guidelines Database
- Cochrane Library
- Database of Abstracts of Reviews of Effectiveness (DARE)
- PEDro – The Physiotherapy Evidence Database
- OTSeeker- The Occupational Therapy Evidence Database
- PubMed
- Medline – Pre Medline
- CINAHL
- Journals@Ovid Full text
- Proquest Full text
- Science Citation Index and Social Sciences Citation Index
- Australasian Medical Index
- Effective Health Care Bulletins
- Centre for Clinical Effectiveness (Monash University) – Evidence Reports
- Constraint Induced Movement Therapy Online- Publications
- Joanna Briggs Institute
- GOOGLE

Please note that limits included language (English only) and publication status (conference & meeting abstracts and letters were excluded).

Inclusion/Exclusion Criteria

Inclusion Criteria

- Studies including function or movement related outcome; for example range of active movement, or performance of upper limb functional tasks.
- Studies investigating movement training post- stroke whereby the patient undergoes paretic arm training in conjunction with contralateral arm restraint.
- Studies published in English

Exclusion Criteria

- Studies which reported less than 50% or a non-defined proportion of the participants were adults who had experienced a stroke, and
- a second publication of the same study presenting the same results.

Results

Results of Search

60 relevant publications were located and categorised as follows:

Table 1. Study designs of articles retrieved by search

Methodology of Studies Retrieved	Number Located	Source of Evidence
Clinical Practice Guidelines (Evidence Based)	1	EBRSR Clinical Practice Guidelines
Systematic Reviews or Meta – analyses	3	Citations appeared in CINAHL (2,3,4), SCI & SSCI (2,3), Constraint Induced Movement Therapy Online Publications (2,3,), Medline and PubMed (2,3), PEDro (3) and OTSeeker (3).
Randomised Controlled Trials	8	Citations appeared in CINAHL (6-13), Constraint Induced Movement Therapy Online Publications (6-13), Medline & PubMed (6-13), PEDro (6,7,9,11,12), OTSeeker (6,7,12), DARE (6,7), Journals@OVID (6,7), Proquest (6-10), SCI & SSCI (6-12).
Case controlled trials	1	Citation appeared in Medline, Pubmed, and Constraint Induced Movement Therapy Online.
Case series: Post – test only, Pre - test/Post - test	10	Citations appeared in Medline and Pubmed (17,18,21-24), CINAHL (18,22), Constraint Induced Movement Therapy Online Publications (13,16-20),SCI & SSCI (17,18,22), and Proquest (15,22).
Expert opinion including literature/narrative reviews, consensus statements, descriptive studies and individual case studies	37	Citations appeared in Medline and Pubmed (26-28,30,32,40,42,43,45,46, 50,58,61), CINAHL (25-27,30,35,43,47,55, 56,58), Constraint Induced Movement Therapy Online Publications (25-28,30-36, 38-58, 60,61), SCI & SSCI (26,27,30, 32-34,36,40,42,43,49,52,54,56,61), Proquest (26,27,29,36,43,46,47,54) and GOOGLE (29).
Qualitative studies	1	Citation appeared in CINAHL, Embase, Google, and Constraint Induced Movement Therapy Online Publications

NB. Search strategy eliminated duplicates; sites were searched in the order reported on page 2.

Specific Results

Since previous appraisal, the clinical guideline has been revised (September 2003) and is now based on five RCTs and 2 cohort studies, and a new systematic review has been published. This CAT is therefore based on the clinical guideline plus the systematic reviews they represent the highest level of available evidence. The studies and appraisal findings are summarised in Tables 2, 3, 4 & 5.

Table 3. Description and Appraisal of guideline by Teasell et al (2003)

<p>Objective of Guideline To provide treatment recommendations for upper extremity interventions following stroke.</p> <p>Methods Data Sources and search strategy – 1995-2001 MEDLINE, EBASE, MANTIS, PASCAL and Sci Search were used to identify studies, from 2001 onwards MEDLINE was used exclusively. Design of studies included – Both prospective and retrospective studies were considered, as were studies that used either an experimental or non-experimental design. Study inclusion / exclusion criteria – The articles reviewed included those studies involving patients who had suffered from a radiologically confirmed ischemic or hemorrhagic cerebrovascular accident. Number of studies screened vs. accepted – number of studies screened not specified; seven studies accepted. Patient Population – Patients post-stroke were included. Time since stroke, inpatient/outpatient status and age not specified. Total number=149 subjects at enrolment (dropouts not specified in all included studies). Data Extraction: Two abstractors, each blinded to the others' results reviewed each article independently for inclusion and rated quality using the PEDro scale; scoring discrepancies were resolved by a third reviewer. Analysis – No data synthesis; limited data on individual studies reported despite this being available in the individual papers (p values and mean difference scores without confidence intervals reported for three of the included studies). Outcomes – not specified; guideline reported tests of upper limb function, including force, speed of performance, quality of movement and function ability (reported tests included Fugl-Myer Score, Emory Test, Arm Motor Activity Rest Test, Motor Activity Log, and Action Research Arm Test). Follow-up – not discussed in guideline (no data extracted).</p> <p>Results Guideline did not report effect sizes nor baseline differences between experimental and control groups despite this information being available in original papers (for example, van der Lee et al, 1999).</p> <p>Guideline Conclusions Based on the results from three “good” quality RCTs, there is strong (Level 1a) evidence of significant benefit of CI movement therapies in comparison to traditional therapies. However, functional benefits appear to be confined to those patients with some active wrist and hand movements, particularly those with sensory loss and neglect.</p> <p>Reviewer Appraisal Comments</p> <p>Scope & Purpose</p> <ul style="list-style-type: none"> • While the overall objective of the guideline was described, a focused clinical question was not. The patients to whom the guideline is meant to apply are specifically described. <p>Stakeholder Involvement:</p> <ul style="list-style-type: none"> • The guideline development team included individuals from all relevant professional groups, however patients' views and preferences were not sought. <p>Rigour of Development:</p> <ul style="list-style-type: none"> • Search methods used were not exhaustive: guideline included only 7 of the 18 studies published at the time of searching. Included studies RCT's (Taub et al, 1993; Van der Lee et al, 1999; Dromerick et al, 2000; Sterr et al, 2002; Page et al, 2002) and case series studies (Wolf et al, 1989; Kopp et al, 1999). Therefore, there is the likelihood that an appropriate study was neglected to be included which may alter conclusion of review. • The methods for formulating the recommendations were described, however these were based only on an internal validity rating of RCTs (PEDro score) and not on the actual statistical results or clinical importance of the results of included studies. • Side effects and risks were not considered in formulating the recommendations. • There is an explicit link between the recommendations and the supporting evidence (references listed) • There is no discussion of external review by experts. • Procedure for updating the guideline is not apparent. <p>Clarity and Presentation:</p> <ul style="list-style-type: none"> • The recommendations are specific and unambiguous • The different options for management of stroke patients with different symptoms/severity are provided. • Key recommendations are easily identifiable however there are no tools for application which may allow easier dissemination and implementation. <p>Applicability</p> <ul style="list-style-type: none"> • The potential organisational barriers in applying the recommendations are not discussed, nor are costs. <p>Editorial Independence</p> <ul style="list-style-type: none"> • There is no discussion or record of the conflicts of interest of guideline development members.

Table 4. Description and Appraisal of SR by van der Lee (2003)

<p>Objective of Review To determine the effectiveness of constraint-induced movement therapy (CIMT) as a treatment modality for hemiparesis following stroke.</p> <p>Methods Data Sources – not specified. Design of studies included – RCT's. Study inclusion / exclusion criteria – Included RCT's/excluded uncontrolled studies and controlled (non-randomised). Number of studies screened vs. accepted – number of studies screened not specified; four studies accepted. Patient Population – Patients post-stroke were included. Time since stroke varied from 4 days to 20 years and included inpatients and outpatients. Total number=113 subjects at enrolment (8 dropouts across studies) - 76 involved in study of chronic stroke patients (Taub et al., 1993 & van der Lee et al., 1999); 23 subjects involved in study of acute stroke patients (Dromerick et al., 2000); and 14 subjects were involved in study of sub-acute stroke patients (Page et al., 2002). Data Extraction: Adult stroke patients given constraint-induced movement therapy or modified constraint-induced movement therapy (a decreased time of restraint of the unaffected arm), tests of upper limb function. Analysis – data synthesis limited; no testing for heterogeneity, author does not report on the validity of included studies. Outcomes – primary outcome: motor function (Action Research Arm Test [ARA]; Emory Motor Function Test); secondary outcome: ability of an individual to perform activities of daily living. Follow-up – two studies provided follow-up period post-intervention,- Taub et al, 1993, at 2 years post-intervention, & van der Lee et al, 1999, at 1 year post-intervention; drop-out rates to obtaining follow-up of primary outcome data ranged from 6% to 13% across studies (nil drop-outs in the Page et al, 2002, study).</p> <p>Results SR was unable to calculate effect sizes as a result of insufficient data available (Page et al, 2002; Taub et al, 1993) or baseline differences between experimental and control groups (Dromerick et al, 2000; van der Lee et al, 1999). Intensity of therapy: Control groups received between 1 and 6 hours, 3 or 5 days per week, of bilateral upper limb occupational therapy (Page et al, 2002, included a group which received no therapy); experimental groups received restraint/immobilisation of unaffected limb for 5 hours a day (Page et al, 2002), 6 hours a day (Dromerick et al, 2000; van der Lee et al, 1999), or 90% of waking hours (Taub et al, 1993). In addition, subjects in the Dromerick et al, 2000 study received 2 hours of occupational therapy per day, 5 days per week, which focused on retraining upper limb function. Subjects in the Page et al, 2002 study received 1 hour of therapy per day, 3 times a week, which focused on affected arm use in functional tasks, stretching of affected arm, as well as lower limb training. Standardised Mean Difference for ARA scores: 0.341 (-0.16 to 0.84) (Van der Lee et al, 1999); 0.45 (-0.44 to 1.34) (Dromerick et al, 2000). Effect sizes of standardised mean differences (in contrast to individual papers' reporting of results) do not reach statistical significance as demonstrated by the 95% CI which contain 0.</p> <p>Author's Conclusion The learned-non-use theory requires further exploration. The evidence regarding the effectiveness of CIMT is not yet convincing. However, no evidence of effect does not necessarily imply evidence of no effect.</p> <p>Reviewer Appraisal Comments</p> <p><i>Validity (Methodology, rigour, selection, biases)</i></p> <ul style="list-style-type: none"> • A focused clinical question was addressed by the reviewer. • No details of the methods used to select studies for inclusion or to extract data are reported. Reviewer's own search (up to year 2004) yielded an RCT (Page, Sisto, Leine, Johnston & Hughes, 2001), which was not included in this review, or the previous SR by van der Lee (2001). Therefore, there is the likelihood that an appropriate study was neglected to be included which may alter conclusion of review. • There is no assessment of validity of the included studies. • There is no statistical assessment of heterogeneity among trials. • Follow-up varied between trials (ranged from 0 to 2 years-post). All patients recruited to the included studies were accounted for at post-intervention (total of 8 drop-outs, no drop-outs in the Page et al, 2002 study). None of the studies with drop-outs used intention-to-treat analysis. <p><i>Results (Favourable or unfavourable, specific outcomes of interest, size of treatment effect, stat. and clinical significance)</i></p> <ul style="list-style-type: none"> • Statistical analysis provided for standardised mean difference (SMD) between improvement in both groups immediately post-intervention only. Missing data from Taub et al, 1993 and Page et al, 2002, did not allow a pooled effect size to be calculated; in addition differences in time post-stroke results in methodological difficulties in combining the effects of treatment across the four studies. • Reviewers aware that the ARA scores a maximum of 57 points and that the average baseline score on ARA was 29 points (across two of the included studies). However, no information on the magnitude of a minimally important difference is provided which complicates interpretation of the reported SMD for each study. (Previous research has used minimal clinically difference of 5.7 points which would give a clinically important SMD threshold of 0.42 for the van der Lee study (actual SMD was 0.34) and of 0.67 for the Dromerick paper (actual SMD was 0.45). • No information on program costs provided.

Table 5. Description and Appraisal of SR by van der Lee (2001)

<p>Objective of Review To determine whether constraint-induced movement therapy (CIM) produces greater benefit in improving upper limb function after stroke.</p> <p>Methods Data Sources – not specified. Design of studies included – RCT (either large randomised trials or small randomised trials). Study inclusion / exclusion criteria – not specified Number of studies screened vs. accepted – number of studies screened not specified; three studies accepted. Patient Population – Patients who had a stroke were included. The time since stroke ranged from 4 days to 4 years and included both inpatients and outpatients. Total number= 99 subjects at enrolment (8 dropouts across studies); 76 involved in study of chronic stroke patients (Taub et al, 1993 & Van der Lee et al, 1999), 23 subjects involved in study of acute stroke patients. Data Extraction: Adult stroke patients given constraint-induced movement therapy, tests of upper limb function. Analysis –data synthesis limited; Outcomes of continuous data were analysed as the difference in standardised mean scores with 95% confidence limits between intervention and control. No testing for heterogeneity. Author does not report on the validity of included studies. Outcomes – primary outcome: motor function (Action Research Arm Test (ARA)); secondary outcome: ability of an individual to perform activities of daily living. Follow-up – two studies (Taub et al, 1993 & Van der Lee et al, 1999) provided follow-up period post-intervention; drop-out rates to obtaining follow-up of primary outcome data ranged from 6% to 13% across studies.</p> <p>Results SR did not calculate effect sizes due to insufficient data presentation and baseline difference between groups. Intensity of therapy: control groups received 2 to 6 hours per day of bimanual occupational therapy training; intervention patients received 6 hours per day of constraint (plus 2 hours occupational therapy focused on retraining upper limb function in the Dromerick et al, 2000 study). Standardised Mean Difference for ARA scores: 0.341 (-0.16 to 0.84) (Van der Lee et al, 1999); 0.45 (-0.44 to 1.34) (Dromerick et al, 2000). Effect sizes of standardised mean differences (in contrast to individual papers' reporting of results) do not reach statistical significance as demonstrated by the 95% CI which contain 0.</p> <p>Author's Conclusion The evidence in favour of CIM at this time is not decisive, is level II at the most, and may not be specific for CIM, but may be caused by the more intensive training.</p>
<p>Reviewer Appraisal Comments</p> <p><i>Validity (Methodology, rigour, selection, biases)</i></p> <ul style="list-style-type: none"> • A focused clinical question was addressed by the reviewer. • No details of the methods used to select studies for inclusion or to extract data are reported. Reviewer's own search (up to year 2000) yielded identical results; however a new RCT was published after this date which was not included in the review (Page, Sisto, Leine, Johnston & Hughes, 2001) which poses the threat that a relevant study which would change the overview's conclusion was omitted. • There is no assessment of validity of the included studies. • There is no statistical assessment of heterogeneity among trials. • Follow-up varied between trials (ranged from 0 to 2 years-post). All patients recruited to the included studies were accounted for at post-intervention (total of 8 drop-outs) however no study used intention-to-treat analysis. <p><i>Results (Favourable or unfavourable, specific outcomes of interest, size of treatment effect, stat. and clinical significance)</i></p> <ul style="list-style-type: none"> • Statistical analysis provided for standardised mean difference (SMD) between improvement in both groups immediately post-intervention only. Missing data from Taub et al, 1993 did not allow comparison across all three included studies; and differences in time post-stroke results in methodological difficulties in combining the effects of treatment across studies. • No information on the magnitude of a minimally important difference is provided which complicates interpretation of the reported SMD for each study. • No information on program costs provided.

Table 6. Description and Appraisal of SR by Dickson (2002)

<p>Objective of Review To determine what evidence there is for traditional and contemporary approaches to motor control following stroke for occupational therapists (included assessment of constraint-induced movement therapy as one therapy technique within the review).</p> <p>Methods Data Sources – Cochrane Library, MEDLINE and CINAHL databases and hand searches of “relevant publications” (no further details specified). Design of studies included – systematic reviews, RCT (either large randomised trials or small randomised trials), repeated measures designs. Study inclusion / exclusion criteria – not specified. Number of studies screened vs. accepted – number of studies screened not specified, one study accepted. Patient Population – Patients who had a stroke were included. The time since stroke was not specified within review. Total number of patients within CIM trial= 23 subjects at enrolment (3 dropouts). Data Extraction: Adult stroke patients given constraint-induced movement therapy, tests of upper limb function. Analysis – data synthesis not completed; No testing for heterogeneity. Author does not report on the validity of included study. Only “vote-counting” was completed. Outcomes – primary outcome: motor function (Action Research Arm Test (ARA)); secondary outcome: ability of an individual to perform activities of daily living (FIM upper limb items; Barthel Index). Follow-up – no follow-up period post-intervention; drop-out rates to obtaining primary outcome data post-intervention was 13%.</p> <p>Results SR did not calculate effect sizes. ...“this study, involving 23 patients, did indicate that less arm impairment was seen inpatients receiving constraint-induced movement therapy. However, there was no significant difference in the patient’s performance of activities of daily living.” (Dickson, 2002; pp271).</p> <p>Author’s Conclusion There is only limited evidence to support the use of new approaches (constraint-induced movement therapy) for rehabilitation of motor control following stroke.</p>
<p>Reviewer Appraisal Comments</p> <p>Validity (Methodology, rigour, selection, biases)</p> <ul style="list-style-type: none"> • A focused clinical question was addressed by the reviewer. • No details of the methods used to select studies for inclusion or to extract data are reports. Reviewer’s own search yielded larger number of trials and systematic reviews on CIM which were not included in this study. Therefore there is the possibility that a relevant study which would change the overview’s conclusion was omitted. • There is no assessment of validity of the included studies. • There is no statistical assessment of heterogeneity among trials. <p>Results (Favourable or unfavourable, specific outcomes of interest, size of treatment effect, stat. and clinical significance)</p> <ul style="list-style-type: none"> • There is no statistical analysis provided for included study, nor any reporting of effects reported in original paper. • No information on program costs provided.

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Articles critically appraised for this summary of evidence

Evidence Based Guideline

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Level Ia Evidence

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Level IIa Evidence

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Level Ib Evidence

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Level IIb Evidence

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Level III Evidence

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Level IV Evidence

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Level V Evidence

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