Does constraint induced movement therapy improve upper limb function following stroke?

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Date: October 2002
Review Date: October 2003

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 Key Findings
- 36 citations were located that met the inclusion/exclusion criteria.
- 2 systematic reviews were located and 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.
- 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. Neither systematic review addressed cost comparisons.

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)
- University of Ottawa Clinical Practice Guidelines
- Cochrane Library
- Database of Abstracts of Reviews of Effectiveness (DARE)
- PEDro – The Physiotherapy Evidence Database
- PubMed
- Medline – Pre Medline
- CINAHL
- Embase
- 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
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
39 relevant publications were located and categorised as follows:

Table 1. Study designs of articles retrieved by search

<table>
<thead>
<tr>
<th>Methodology of Studies Retrieved</th>
<th>Number Located</th>
<th>Source of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical Practice Guidelines (Evidence Based)</td>
<td>1</td>
<td>University of Ottowa Clinical Practice Guidelines</td>
</tr>
<tr>
<td>Systematic Reviews or Meta – analyses</td>
<td>2</td>
<td>All citations appeared in CINAHL and Constraint Induced Movement Therapy Online Publications; Medline, PubMed and PEDro also retrieved reference number 3.</td>
</tr>
<tr>
<td>Randomised Controlled Trials</td>
<td>4</td>
<td>All citations appeared in CINAHL, Embase and Constraint Induced Movement Therapy Online Publications; Medline, PubMed and PEDro also retrieved reference numbers 4,6,8.</td>
</tr>
<tr>
<td>Controlled trials or cohort studies</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>Case series: Post – test only, Pre - test/Post - test</td>
<td>6</td>
<td>Citations appeared in Medline and Pubmed (9,10,11,12,13,14,15), CINAHL (13), Embase (13), Constraint Induced Movement Therapy Online Publications (9,10,11,12,13), and Science Citation Index (9,10,11).</td>
</tr>
<tr>
<td>Expert opinion including literature/narrative reviews, consensus statements, descriptive studies and individual case studies</td>
<td>24</td>
<td>Citations appeared in Medline and Pubmed (16,17,18,19,23,24,25,27,28, 31,32,33,38,39), CINAHL (16,17,21,23,25,26,27,29,32,35,37), Constraint Induced Movement Therapy Online Publications (28,30,38,39), and GOOGLE (36, 37).</td>
</tr>
</tbody>
</table>

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

Specific Results
The clinical guideline was based on only two of the available four RCTs at its time of writing, nor did it specify details about intervention and so was excluded from appraisal. The systematic reviews were the only studies critically appraised for this summary, as they represented next highest level of evidence. The studies and appraisal findings are summarised in Tables 2 and 3.
Table 2. Description and Appraisal of SR by van der Lee (2001)

**Objective of Review**
To determine whether constraint-induced movement therapy (CIM) produces greater benefit in improving upper limb function after stroke.

**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.

**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.

**Authors Conclusions**
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.

**Reviewer Appraisal Comments**

**Validity (Methodology, rigour, selection, biases)**
- 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.

**Results (Favourable or unfavourable, specific outcomes of interest, size of treatment effect, stat. and clinical significance)**
- 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.
- Reviewer 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. SR reported a difference of 3.4)
- No information on program costs provided.
Table 3. Description and Appraisal of SR by Dickson (2002)

**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).

**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%.

**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).

**Authors Conclusions**
There is only limited evidence to support the use of new approaches (constraint-induced movement therapy) for rehabilitation of motor control following stroke.

**Reviewer Appraisal Comments**

**Validity (Methodology, rigour, selection, biases)**
- 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.

**Results (Favourable or unfavourable, specific outcomes of interest, size of treatment effect, stat. and clinical significance)**
- There is no statistical analysis provided for included study, nor any reporting of effects reported in original paper.
- No information on program costs provided.
References

Articles critically appraised for this summary of evidence

Level Ia Evidence

Level IIa Evidence

Related articles not included in the appraisal

Evidence Based Guideline

Level Ib Evidence

Level IIb Evidence

Level III Evidence

Level IV Evidence

Level V Evidence