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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| In adults with stroke and upper extremity hemiplegia (P), is constraint induced movement therapy (I) more effective than traditional physical therapy (C) in improving function of the affected upper limb as reflected by performance-based measures (O)? |

**AUTHOR**

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| **Prepared by** | Courtney Snyder | **Date** | 11/19/2022 |
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**CLINICAL SCENARIO**

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| Stroke is the leading cause of disability.1 Adults who experience a stroke often develop motor impairments which affect the opposite side of the body from where the brain damage occurs. This leads to one upper extremity being less functional than the other, requiring rehabilitation to work towards recovery. Some patients quickly recover their motor function, whereas 75% of patients have persistent upper extremity deficits after 3-6 months.1 There is a great need to determine effective rehabilitation strategies for restoring upper limb function in stroke patients. Constraint-induced movement therapy (CIMT) is one therapeutic technique that is gaining popularity in research literature and clinical practice. CIMT involves restraining the less affected upper limb and focusing on training the more affected side to practice skills intensively for extended periods of time. I am interested to learn if CIMT is a more effective treatment than conventional physical therapy interventions for improving upper limb function in adults who have had a stroke with upper extremity hemiplegia. This is important for clinicians to know so that rehabilitation efforts can be directed in ways that have the most potential benefits. The ability to functionally use one’s upper extremity is important for carrying out daily activities, participation, and quality of life. By understanding the efficacy of CIMT, clinicians can intervene quickly and wisely with evidence-based principles to ensure patients with stroke are able to use their affected arm with optimized motor recovery. |

**SUMMARY OF SEARCH**

[Best evidence appraised and key findings]

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| Eight studies met the inclusion and exclusion criteria including 5 systematic reviews/meta-analyses and 3 RCTs.* CIMT or mCIMT may have a greater effect on improving upper limb function and activities of daily living for individuals in the acute and sub-acute phases of stroke compared to traditional therapy.1
* Low intensity CIMT may be a more optimal level of therapy than high intensity CIMT for individuals in the acute and sub-acute stages of stroke.1
* When the amount of time in therapy is adjusted to be equivalent, CIMT appears to be more effective in improving upper limb motor capacity, upper limb motor ability, comprehensive function, and self-report measures compared to control interventions.2
* CIMT is shown to be significantly effective independent of time since stroke onset or CIMT regimen duration. It is important for there to be residual volitional movement to benefit from CIMT. The most optimal CIMT parameters are continuing to be understood.2
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**CLINICAL BOTTOM LINE**

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| Adults who have suffered from a stroke with upper extremity hemiplegia should receive CIMT for improving upper extremity function. CIMT appears to be effective in all phases post-stroke. The intensity should be adjusted based on the patient, with lower intensity CIMT appearing to be better for those in more acute phases. Evidence supports that CIMT is more beneficial than conventional therapy, even when the control intervention is matched to similar time in therapy. Benefits have been demonstrated immediately after CIMT intervention, but more long-term follow-up data is needed to show if the impact of CIMT persists over time. |

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| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

*The above information should fit onto the first page of your CAT*

**SEARCH STRATEGY**

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| **Terms used to guide the search strategy** |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| AdultStroke Cerebrovascular accidentUpper extremity hemiplegia | Constraint induced movement therapyModified constraint induced movement therapyForced use | Conventional therapyTraditional therapyUsual care | Upper limb Upper extremityFunctionMotor recoveryFugl-Meyer |

**Final search strategy (history):**

*Show your final search strategy (full history) from PubMed. Indicate which “line” you chose as the final search strategy.*

(stroke OR cerebrovascular accident) AND (constraint induced movement therapy OR modified constraint induced movement therapy) – 579 results

(stroke OR cerebrovascular accident OR hemiplegia) AND (constraint induced movement therapy OR modified constraint induced movement therapy) – 705 results

(stroke OR cerebrovascular accident OR hemiplegia) AND (constraint induced movement therapy OR modified constraint induced movement therapy) AND (conventional OR traditional OR usual care) – 142 results

**(stroke OR cerebrovascular accident OR hemiplegia) AND (constraint induced movement therapy OR modified constraint induced movement therapy) AND (conventional OR traditional OR usual care) AND (upper extremity OR upper limb) – 105 results**

*In the table below, show how many results you got from your search from each database you searched.*

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| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **PubMed****CINAHL****Embase****Cochrane** | **105****72****131****4** | **Systematic reviews and RCTs - 64****Academic journals - 69****Systematic reviews and RCTs - 71** |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| * English
* RCTs or systematic reviews comparing CIMT to conventional physical therapy or usual care
* Study includes adults over 18 years old with a diagnosis of a stroke (either ischemic or haemorrhagic) and upper extremity hemiplegia
* Includes outcome measures involving upper extremity function and motor recovery, such as the Fugl-Meyer Motor Assessment
 |
| **Exclusion Criteria** |
| * Study does not include RCTs
* Stroke subjects do not have upper limb hemiplegia
* Does not include outcome measures involving upper extremity function or motor recovery
* Does not investigate the effectiveness of CIMT
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**RESULTS OF SEARCH**

**Summary of articles retrieved that met inclusion and exclusion criteria**

*For each article being considered for inclusion in the CAT, score for methodological quality on an appropriate scale, categorize the level of evidence, indicate whether the relevance of the study PICO to your PICO is high/mod/low, and note the study design (e.g., RCT, systematic review, case study).*

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| **Author (Year)** | **Risk of bias (quality score)\*** | **Level of Evidence\*\*** | **Relevance** | **Study design** |
| **Shi et al, 20113** | **AMSTAR-2 Score: 9 yes items, 1 partial yes item, 6 no items****Rating of Overall Confidence of Findings: Moderate** | **1** | **high** | **Systematic Review and Meta-Analysis** |
| **Barzel et al, 20154** | **PEDro: 7/10**  | **2** | **mod** | **RCT** |
| **Wang et al, 20115** | **PEDro: 5/10** | **2** | **high** | **RCT** |
| **Stevenson et al, 20122** | **AMSTAR-2 Score: 9 yes items, 2 partial yes items, 5 no items****Rating of Overall Confidence of Findings: Moderate** | **1** | **high** | **Systematic Review and Meta-Analysis** |
| **McIntyre et al, 20126** | **AMSTAR-2 Score: 10 yes items, 1 partial yes item, 5 no items****Rating of Overall Confidence of Findings: Moderate** | **1** | **mod** | **Systematic Review and Meta-Analysis** |
| **Liu et al, 20171** | **AMSTAR-2 Score: 13 yes items, 2 partial yes items, 1 no item****Rating of Overall Confidence of Findings: High** | **1** | **high** | **Systematic Review and Meta-Analysis** |
| **Rocha et al, 20217** | **PEDro: 6/10** | **2** | **high** | **RCT** |
| **Kwakkel et al, 20158** | **AMSTAR-2 Score: 8 yes items, 3 partial yes items, 5 no items****Rating of Overall Confidence of Findings: Low** | **1** | **mod** | **Systematic Review and Meta-Analysis** |

\*Indicate tool name and score

\*\*Use Portney Table 36-1: Summary of Levels of Evidence (2020). If downgraded, indicate reason why.

**BEST EVIDENCE**

The following 2 studies were identified as the ‘best’ evidence and selected for critical appraisal. Rationale for selecting these studies were:

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| * **Liu et al, 20171**
* This study was chosen as the best available evidence and selected for critical appraisal because it was highly relevant to my clinical question due to the intervention, control comparison, population, and functional outcome. This study focused on subjects in the acute and sub-acute phases of stroke and looked at various outcome measures of arm function. According to the AMSTAR-2 analysis, this study had a rating of high overall confidence in the results of the review. This was also a systematic review and meta-analysis of RCTs, indicating level 1 evidence. This article closely aligns with my clinical question, has low risk of bias, and has more up-to-date evidence due to it being published within the last 5 years.
* **Stevenson et al, 20122**
* This study was chosen as the second-best available evidence due to its relevance to my PICO. It investigated a similar purpose of CIMT intervention, dose-matched control comparisons, the stroke population, and functional outcome. It included participants at all ranges of acuity post-stroke and specifically focused on dose-matched controls of conventional therapy for comparison. This study was also comprehensive with outcome measures of upper limb motor capacity and ability. The AMSTAR-2 resulted in a moderate overall confidence in the results of the review, but it was chosen over other articles due to the later publication indicating more recent evidence. These aspects led me to choose this reference as my second article because it will provide more information for my clinical question.
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**SUMMARY OF BEST EVIDENCE**

**(1) Description and appraisal of (Constraint-induced movement therapy in treatment of acute and sub-acute stroke: a meta-analysis of 16 randomized controlled trials) by (Liu et al., 2017)**

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| **Aim/Objective of the Study/Systematic Review:** |
| The aim of the study by Liu et al. was to determine the effectiveness of constraint-induced movement therapy (CIMT) for the clinically meaningful improvement of upper limb function in individuals with acute and sub-acute stroke, compared to traditional rehabilitation. Previous studies have addressed the effectiveness of CIMT over conventional rehabilitation in the chronic phase of stroke, but the impact of this intervention has not been thoroughly investigated in acute and sub-acute populations. High intensity CIMT has been proposed to be detrimental to early stroke rehabilitation, so this study also looked at modified CIMT with acute and sub-acute patients with stroke. |
| **Study Design**[e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| This study by Liu et al. is a systematic review and meta-analysis of RCTs.**Search Strategy**: The authors conducted a search of the literature using key words of stroke, cerebrovascular accident, constraint-induced therapy, forced use, and clinical trial, as well as MeSH headings with “or” in between phrases. Reference lists of included studies were reviewed to catch any additional articles that were not found in searched databases. The search resulted in 1086 potentially relevant studies. Study procedures were in accordance with PRISMA guidelines. **Selection Criteria**: Eligible studies were included in this review if they were RCTs with adult patients over 18 years old, participants were in the acute or sub-acute phase post-stroke (within 6 months), had a CIMT/mCIMT intervention group and control group with standard therapy, and used at least one outcome measure relating to upper limb motor function. Publications were limited to English or Chinese language. Studies were excluded if they assessed other rehabilitation therapies or were non-randomized trials. The authors narrowed down their search results to 16 studies with 738 total participants for the meta-analysis.**Methods**: Computerized and manual searches were done using the databases China National Knowledge Infrastructure, WanFang, Weipu Information Resources System, Chinese Biomedical Literature Database, PubMed, Medline, Embase, the Cochrane Central Register of Controlled Trials, and the Cochrane Database of Systematic Reviews. The search period was from the inception of each database to March 2016. The search results were reviewed by two authors to decide the inclusion of studies for meta-analysis based on reading titles and abstracts. If abstracts were insufficient for a decision, the authors reviewed the full text. The quality of each article was evaluated with the PEDro scale. A third reviewer helped resolve discrepancies in article selection and quality assessment. Data was extracted for all outcome variables and statistical analysis was done to determine weighted mean difference (WMD), 95% confidence intervals (CI), standard deviation, and heterogeneity (I2). Subgroup analysis was performed according to the intensity of mCIMT. Publication bias and sensitivity were also assessed.  |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| This systematic review was conducted in the Shadong Province of China. The authors did not discuss the settings of the included trials, but it can be inferred that studies were conducted in English- and Chinese-speaking countries. Furthermore, interventions likely took place in acute care settings, inpatient rehabilitation facilities, or outpatient therapy clinics based on the acuity of included patients and the nature of CIMT requiring clinician guidance. |
| **Participants**[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| There were 16 included studies, 10 of which were written in English and 6 were written in Chinese. All participants were in the acute and sub-acute phase of stroke. Time post-stroke ranged from 1 day to 3 months. A full summary of the participants’ time post-stroke is shown in Table 1. 5 studies used the Action Research-Arm Test (ARAT), 6 used the modified Barthel Index (mBI), 13 used the Fugl-Meyer Motor Assessment of the Arm (FMA), 4 used a Motor Activity Log (MAL) for amount of use (AOU) and quality of movement (QOM), and 2 used the Wolf Motor Function Test (WMFT). PEDro scores of included studies had a median of 6.5 points (good) and ranged from 5 (fair) to 8 (good). There were 738 total participants with 379 who received CIMT and 359 in the control group.Table 1: Participant Characteristics in 16 Included Studies

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| **Study** | **Time Post-Stroke** |
| Dromerick et al. (2000) | 4-14 days |
| Page et al. (2005) | 2-9 days |
| Ro et al. (2006) | 6-12 days |
| Boake et al. (2007) | 5-19 days |
| Dromerick et al. (2009) | 9.7 +/- 4.6 days |
| He et al. (2010) | 2-3 days |
| Wu et al. (2010) | 2-3 days |
| Zhang et al. (2011) | < 3 months |
| Singh et al. (2013) | 2-4 weeks |
| Huang et al. (2014) | 3-12 weeks |
| Yoon et al. (2014) | < 6 weeks |
| El-Helow et al. (2015) | < 2 weeks |
| Thrane et al. (2015) | < 4 weeks |
| Zhang et al. (2015) | 1-10 days |
| Liu (2016) | < 3 months |
| Song et al. (2016) | 6-12 days |

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| **Intervention Investigated**[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| Participants in the control group of included RCTs received traditional rehabilitation therapy. The authors did not go into detail of what conventional therapy entailed, but this information is available in each of the RCT articles that were included for systematic review and meta-analysis. For example, Boake et al. outlined standard therapy in the control group as traditional techniques for stroke UE rehabilitation, which included functional tasks and daily activities to improve strength, muscle tone, and range of motion, with similar frequency and duration of therapy as the CIMT group. Other RCTs included similar definitions of conventional and standard therapy for the control treatment. |
| *Experimental* |
| Participants in the experimental group received CIMT or mCIMT. CIMT involves restraint of the less affected limb using a padded mitten, while engaging the affected arm in intensive task-oriented training. The traditional approach implements this training for 90% of daily waking hours over 2 weeks per month, but modified CIMT uses lower intensity training. For the included studies of this meta-analysis, length of therapy intervention often consisted of 2 weeks, with one study consisting of 10 weeks and another lasting 30 days. Intensity and frequency of CIMT varied between studies. Most patients in the studies received CIMT for 2-3 hours per day for 5-6 days per week over the course of 2 weeks. Some interventions lasted for longer duration of 4-10 weeks or higher intensity of 4-6 hours per day. Table 2 summarizes treatment details of the 16 included studies.Table 2: CIMT Treatment Parameters of 16 Included Studies

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| **Study** | **Duration of Therapy** | **Frequency of Therapy** |
| Dromerick et al. (2000) | 2 weeks | 2 hours/day, 5 days/week |
| Page et al. (2005) | 10 weeks | 0.5 hours/day, 3 days/week |
| Ro et al. (2006) | 2 weeks | 3 hours/day, 6 days/week |
| Boake et al. (2007) | 2 weeks | 3 hours/day, 6 days/week |
| Dromerick et al. (2009) | 2 weeks | 2-3 hours/day, 5 days/week |
| He et al. (2010) | 4 weeks | 1 hour/day, 5 days/week |
| Wu et al. (2010) | 4 weeks | 1 hour/day |
| Zhang et al. (2011) | 2 weeks | 4 hours/day, 5 days/week |
| Singh et al. (2013) | 2 weeks | 2 hours/day, 5 days/week |
| Huang et al. (2014) | 2 weeks | 3 hours/day, 5 days/week |
| Yoon et al. (2014) | 2 weeks | 6 hours/day, 5 days/week |
| El-Helow et al. (2015) | 2 weeks | 2 hours/day, 5 days/week |
| Thrane et al. (2015) | 2 weeks | 3 hours/day, 5 days/week |
| Zhang et al. (2015) | 2 weeks | 2 hours/day, 5 days/week |
| Liu (2016) | 2 weeks | 2 hours/day, 5 days/week |
| Song et al. (2016) | 30 days | 40 min/day |

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| **Outcome Measures**[Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| The authors sought to identify the effect of CIMT on upper extremity function and conducted a meta-analysis using the following outcome measures: Action Research Arm Test (ARAT), modified Barthel Index (mBI), Fugl-Meyer Assessment of the Arm (FMA), Motor Activity Log (MAL), and Wolf Motor Function Test (WMFT). Assessments were conducted pre-intervention and post-intervention, with 6 of the 16 studies also having follow-ups. The ARAT assesses upper limb function through observation of various tasks. There are 19 items with 4 subscales which comprise of grasp, grip, pinch, and gross movement. Each task is rated on a 4-point scale and the maximum score is 57, with higher scores indicating better function.9 The Barthel Index is indicative of ADL function, consisting of 10 activities with a total maximum score of 100.9 The modified version by Shah et al. kept the 10 items but adjusted the scoring from a 3-point to a 5-point scale for improved sensitivity. Each score is based on the amount of assistance required for each category, with a retained maximum score of 100.10 The FMA is a motor performance test for the affected UE that evaluates movements outside of synergistic patterns. There are 33 tasks, each rated from 0 to 2 with a maximum total score of 66 indicating better function.11 The MAL involves self-rating of performance of 33 activities of daily living using the affected arm. Each activity is rated for amount of use (AOU) and quality of movement (QOM), each on a scale from 0 to 5. The MAL obtains the averages of the amount of use and quality of use for outcomes.11 The WMFT consists of 17 items, with 15 timed tasks and 2 strength tasks to test upper extremity motor ability. Items are scored on a 6-point scale and lower scores indicate lower function. The maximum possible score is 75.12 Liu et al. did not specify who administered these tests and where they were taken, but it can be assumed they were conducted by the researchers or clinicians at their respective rehabilitation facilities. |
| **Main Findings**[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. You may summarize results in a table but you must explain the results with some narrative.] |
| Table 3: Meta-analysis of CIMT in Acute and Sub-Acute Stroke

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| **Outcome**  | **No. of Studies** | **WMD** | **95% CI** | **p-value** | **I2 (%)** |
| ARAT | 5 | 8.35 | 1.98-14.71 | < 0.001 | 86.0 |
| mBI | 6 | 10.706 | 4.417-16.966 | < 0.001 | 91.2 |
| FMA | 13 | 10.822 | 7.419-14.226 | < 0.001 | 85.4 |
| MAL-AOU | 4 | 1.014 | -0.114-2.142 | < 0.001 | 92.3 |
| MAL-QOM | 4 | 0.812 | 0.331-1.293 | 0.074 | 56.7 |
| WMFT | 2 | 5.998 | -1.862-13.858 | 0.269 | 18.2 |

There was on overall significant weighted mean difference shown by the ARAT in favor of the CIMT intervention. High intensity CIMT resulted in a non-significant difference, whereas studies with low intensity CIMT yielded a significant difference, supporting its efficacy in acute and sub-acute stroke. The 5 studies that assessed the ARAT were 86% heterogeneous. There was an overall significant standardized mean difference favoring CIMT with the mBI, representing activities of daily living. This held true for both high and low intensity CIMT over control interventions. The 6 studies that assessed the mBI were 91.2% heterogenous.The FMA demonstrated a significant standardized mean difference in the overall studies, as well as for both high and low intensity. The 13 studies that assessed the FMA had 85.4% heterogeneity.The meta-analysis found a non-significant weighted mean difference in the MAL-AOU, but a significant difference in the MAL-QOM. However, high and low intensity CIMT led to significant differences in the MAL-AOU. The 4 studies that assessed MAL-AOU and MAL-QOM had 92.3% and 56.7% heterogeneity, respectively.The weighted mean difference for the WMFT was not found to be significant. The 2 studies that assessed WMFT had 18.2% heterogeneity.Additionally, publication bias was evaluated using the Begg’s test and Egger’s test. All p-values from each test were above 0.05, so no publication bias was found.  |
| **Original Authors’ Conclusions**[Paraphrase as required. If providing a direct quote, add page number] |
| The findings from this review suggest that CIMT or mCIMT may have a greater effect on improving upper limb function and activities of daily living for individuals in the acute and sub-acute phases of stroke compared to traditional arm therapy. Low intensity CIMT had advantages over high intensity CIMT with larger mean differences, possibly corresponding to a more optimal level of therapy for this population that leads to better results. The authors also propose that the amount of CIMT may play a role in outcomes. Future research involving larger scale, well-designed multi-center studies should be conducted to better quantify the effect of CIMT or mCIMT on arm motor function in individuals with acute and sub-acute stroke. |
| **Critical Appraisal** |
| **Validity**[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| This level 1 systematic review and meta-analysis by Liu et al. leads to high confidence in the results of this research study due to the AMSTAR-2 quality assessment. The only concern that came from this assessment were that the authors did not specify why they chose RCTs as the only included study designs for review. Other weaknesses of this review pertain to inclusion criteria of the included studies, involving the variability of acuity after stroke within 4 months and variations in intervention intensity and duration, which led to heterogeneity in results, and this may affect reliability. Additionally, outcomes were only analyzed in the short-term with no analysis for long-term data over 3 months to indicate the lasting effects of CIMT. The meta-analysis only used outcomes after rehabilitation to reduce heterogeneity. Key strengths were the large sample size of 738 participants, the range of outcome measures to capture UE function, and a comprehensive search strategy. Also, no RCTs with a score below 5 on the PEDro scale were included for analysis. The quality of included studies ranged from fair to good, but no trials were considered excellent, so this was a limitation. The overall evidence quality from this publication has moderately high validity but is limited by several shortcomings to support its reliability. |
| **Interpretation of Results**[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| This systematic review was set apart by the focus placed on individuals post-stroke who were in the acute and sub-acute phases of recovery, compared to previous work that has looked more at the implications of CIMT in chronic stroke. Significant differences were seen in measures of the ARAT, mBI, FMA, and MAL-QOM, which are all indicators of upper extremity function and motor performance. This is signified when the 95% CI does not include zero. However, most of the confidence intervals are rather wide, indicating greater variability in the data. The MAL-QOM has a narrower confidence interval of 0.331-1.293, which shows there was less variability and greater precision. This demonstrates that the improvement of quality of movement following CIMT in those 4 trials can be more confidently attributed to the intervention. Heterogeneity was high for many of the compared trials that used the same outcome measures. However, analysing trials into sub-groups based on the intensity of CIMT led to decreased heterogeneity and significant differences remained in favor of CIMT compared to control groups. The results of this systematic review suggest that CIMT is favorable over control interventions for arm motor function and daily living in acute and sub-acute stroke, but this evidence does not guarantee CIMT may always result in superior benefits and more consistent research is needed to establish an optimal protocol and confirm the comparison with higher quality studies. It remains unclear whether CIMT or mCIMT should be used for acute and sub-acute stroke. It would have been more informative if consistent CIMT protocols were used to demonstrate significant effects, as well as comparisons between CIMT protocols. |
| **Applicability of Study Results**[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
| The findings from the systematic review by Liu et al. are highly relevant to my clinical question and scenario as a direct comparison was made between CIMT and conventional therapy as a control intervention. The control therapies were not concretely specified and likely varied across included studies. The protocols for CIMT concerning length of therapy and intensity were also variable across studies. It was most common for CIMT to last for 2 weeks and time in therapy consisted of 2-3 hours/day for 5 days/week. This may be the best approach as it is considered low intensity, which led to superior results over high intensity CIMT in this population. CIMT appears to be a worthwhile intervention for individuals after stroke within 6 months post-onset with the goal of improving motor function of the involved upper extremity. It is promising that this intervention will lead to results in the short-term, but long-term results need to be investigated. |

**(2) Description and appraisal of (Constraint-Induced Movement Therapy Compared to Dose-Matched Interventions for Upper-Limb Dysfunction in Adult Survivors of Stroke: A Systematic Review with Meta-analysis) by (Stevenson et al., 2012)**

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| **Aim/Objective of the Study/Systematic Review:** |
| Stevenson et al. carried out this systematic review to evaluate the efficacy of CIMT in improving upper limb function of adults who have had a stroke, compared to interventions with similar duration of therapy. Although the efficacy of CIMT has been reported in several previous systematic reviews, there have been limitations of methodological quality and variability of control interventions. The authors aimed to address this gap in the literature by investigating whether CIMT is an effective treatment due to increased amount of practice or if its efficacy remains superior when compared to dose-matched control interventions. |
| **Study Design**[e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| This study by Stevenson et al., is a systematic review and meta-analysis of RCTs and crossover studies.**Search Strategy**: The authors implemented a search of the literature using terms such as constraint-induced therapy, cerebrovascular disorders, upper extremity, and adult, as well as other related words for each category according to their search strategy for CINAHL reported in the Appendix. 490 total results were identified through database searching.**Selection Criteria**: To be accepted for this systematic review, studies must have had a randomized controlled or crossover design, involved adult survivors of stroke, had a CIMT intervention with supervised training and restraint components, and had a control group with equal therapy time to the CIMT group. Studies were excluded if they did not have a dose-matched control intervention. Study procedures were in accordance with PRISMA guidelines.**Methods**: A search was conducted of CINAHL, Cochrane Library, Embase, National Rehabilitation Centre, PEDro, PubMed, Scopus, and Web of Science between the inception of each database to February 2011. Also, tables of contents were hand-searched in multiple journals for January 2010 through February 2011. Titles and abstracts were screened by two authors, then full texts were reviewed if more information was needed to make a decision for inclusion. Reference lists of available relevant studies were also reviewed to identify any additional studies for eligibility. If the two authors could not agree on study selection, a third author was consulted. Each trial was assessed for quality using the PEDro scale by two authors independently, with a third author resolving any discrepancies. Data was extracted by one author for relevant study characteristics and outcomes, which was checked by a second author for accuracy. Information regarding study participants, CIMT elements, and control interventions were recorded. Outcome measures were categorized, then outcome data was extracted and analysed for baseline differences. Then, a meta-analysis was conducted to reflect results when at least three trials utilized the same outcome measures. The mean difference (MD) was calculated when trials used the same instrument, whereas the standardized mean difference (SMD was used when trials used different instruments to demonstrate the same outcome category. 95% CI were calculated, and statistics were deemed significant if the intervals did not contain zero. Heterogeneity was assessed and considered significant when p < 0.10 and I2 exceeded 50%. Subgroup analyses were performed when substantial heterogeneity was found. |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| This systematic review was conducted in the Department of Rehabilitation Services at St. Boniface Hospital, University of Manitoba in Winnipeg, Manitoba, Canada. The authors did not discuss the settings of the included trials, but it can be inferred that studies were conducted in English-speaking countries. Furthermore, interventions likely took place in acute care settings, inpatient rehabilitation facilities, or outpatient therapy clinics based on characteristics of included patients and the nature of CIMT requiring clinician guidance. |
| **Participants**[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| There were 22 studies that met the inclusion criteria for systematic review and meta-analysis. 19 out of 22 trials had blinded assessors, whereas it was unclear whether allocation was concealed for most of the trials. Studies had an average of 6.4 points (good) on the PEDro scale, ranging from 3 (poor) to 8 (good). There were follow-up assessments in 5 studies. All participants were screened to ensure they had residual voluntary movement of the affected upper extremity with minimum motor requirements. Participants in 14 of the studies were screened to meet the learned non-use requirement. 12 studies had exclusion criteria of spasticity. 20 studies required a certain level of cognition on the MMSE or NIHSS for participant eligibility. All participants were over 18, with the maximum age included at 95-100 years old. Time since stroke varied across trials. Most patients were within 1-year post-stroke, some being more acute than others within 2-4 weeks post-stroke, and 4 studies included participants who were over a year out from their stroke. Table 4 summarizes participant characteristics within the included studies.Table 4: Participant Characteristics in 22 Included Studies

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| **Study** | **Patient Age** | **Time Post-stroke** |
| Atteya (2004) | 18-75 years | 1-6 months |
| Boake et al. (2007) | “adult” | < 2 weeks |
| Dromerick et al. (2009) | Mean age 63.9 years | < 28 days |
| Dromerick et al. (2000) | > 47 years | < 2 weeks |
| Hayner et al. (2010) | 18-100 years | > 6 months |
| Lin et al. (2007) | > 43 years | > 1 year |
| Lin et al. (2008) | Not stated | Mean time post-stroke 18.9 months |
| Lin et al. (2009a) | > 30 years | > 6 months |
| Lin et al. (2009b) | > 23 years | > 6 months |
| Lin et al. (2010) | Mean age 49.6 years | > 3 months |
| Myint et al. (2008) | Mean age 63 years | 2-16 weeks |
| Page et al. (2001) | > 44 years | 1-6 months |
| Page et al. (2002) | 19-95 years | 4 weeks-6 months |
| Page et al. (2004) | 18-95 years | > 1 year |
| Page et al. (2005) | 18-95 years | < 2 weeks |
| Page et al. (2008) | 18-80 years | > 1 year |
| Suputtitada et al. (2004) | 18-80 years | > 1 year |
| Wang et al. (2011) | Mean age 63 years | Mean time post-stroke 11 weeks |
| Wu et al. (2007a) | > 65 years | 2 weeks-31 months |
| Wu et al. (2007b) | > 45 years | 1-3 years |
| Wu et al. (2007c) | > 40 years | 3 weeks-37 months |
| Wu et al. (2011) | Mean age 53.1 years | > 6 months |

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| **Intervention Investigated**[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| Most studies used conventional therapy as the control intervention. Five studies included a third group with no intervention, and two studies incorporated bilateral arm therapy as an additional control group. The content of control regimens are reported within the systematic review. Regimens mostly consisted of facilitating practice for the more-affected limb while enforcing compensation with the less-affected limb. Activities targeting the more-affected limb related to strength, ROM, ADL training, balance, dexterity, and functional task practice. No information was provided on difficulty progression of exercises and two trials had restraints in the control group. |
| *Experimental* |
| All studies had an experimental group that received CIMT with supervised training and a restraint component. 15 of the 22 studies involved supervised training for 20 or 30 hours, but several studies had more training time or were stretched out for longer. 3 studies had 60 hours of training and 6 trials lasted for 10 weeks instead of the traditional timeline of 2 or 3 weeks. Time in supervised practice was most often 2 hours/day for 5 days/week. One study involved group training, whereas all other studies are assumed to have one on one training. 18 of the 22 studies mentioned ongoing feedback during training to shape task difficulty. It was most common for participants to be restrained with a padded mitt on their unaffected upper limb for 5-6 hours/day and 5 days/week. Three studies instead used the restraint for 90% of waking hours. Eight studies addressed adherence and none of the trials had a home program. Table 5 outlines the details for CIMT interventions of the included studies.Table 5: CIMT Treatment Parameters of 22 Included Studies

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| --- | --- | --- |
| **Study** | **Duration of Supervised Practice (Total hours)** | **Restraint Component** |
| Atteya (2004) | 10 weeks (30 hours) | 5 hr/d, 5 d/wk with a sling/mitt |
| Boake et al. (2007) | 14-15 days (42-45 hours) | 90% waking hours with a mitt |
| Dromerick et al. (2009) | 2 weeks (20 hours) | 6 hr/d, 5 d/wk with a mitt |
| Dromerick et al. (2000) | 2 weeks (20 hours) | 6 hr/d, 5 d/wk with a mitt |
| Hayner et al. (2010) | 2 weeks (60 hours) | Min 6 hr/d, 5 d/wk with a mitt |
| Lin et al. (2007) | 3 weeks (30 hours) | 6 hr/d, 5 d/wk with a mitt |
| Lin et al. (2008) | 3 weeks (30 hours) | 3 hr/d, 5 d/wk with a mitt |
| Lin et al. (2009a) | 3 weeks (30 hours) | 6 hr/d, 5 d/wk with a mitt |
| Lin et al. (2009b) | 3 weeks (30 hours) | 6 hr/d, 5 d/wk with a mitt |
| Lin et al. (2010) | 3 weeks (30 hours) | 6 hr/d, 5 d/wk with a mitt |
| Myint et al. (2008) | 2 weeks (40 hours) | 90% waking hours with a shoulder sling |
| Page et al. (2001) | 10 weeks (30 hours) | 5 hr/d, 5 d/wk with a sling/mitt |
| Page et al. (2002) | 10 weeks (30 hours) | 5 hr/d, 5 d/wk with a sling/splint |
| Page et al. (2004) | 10 weeks (30 hours) | 5 hr/d, 5 d/wk with a mitt |
| Page et al. (2005) | 10 weeks (15 hours) | 5 hr/d, 5 d/wk with a mitt |
| Page et al. (2008) | 10 weeks (15 hours) | 5 hr/d, 5 d/wk with a sling/mitt |
| Suputtitada et al. (2004) | 2 weeks (60 hours) | Minimum of 60 hr with a mitt |
| Wang et al. (2011) | 4 weeks (60 hours) | 90% waking hours with a padded shoulder sling |
| Wu et al. (2007a) | 3 weeks (30 hours) | 6 hr/d, 5 d/wk with a mitt |
| Wu et al. (2007b) | 3 weeks (30 hours) | 6 hr/d, 5 d/wk with a mitt |
| Wu et al. (2007c) | 3 weeks (30 hours) | 6 hr/d, 5 d/wk with a mitt |
| Wu et al. (2011) | 3 weeks (30 hours) | 6 hr/d, 5 d/wk with a mitt |

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| **Outcome Measures**[Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| The authors conducted a meta-analysis using outcome measures organized into 4 categories based on the ICF model. Primary outcome measures included areas of upper limb motor capacity and motor ability. Secondary outcome measures covered comprehensive function and self-report measures. Each included trial has descriptions of the specific instruments that were used and the time frames for measurement collections. In the category of upper limb motor capacity, outcomes from the FMA and kinematic analysis of a reach task were used for meta-analysis. For upper limb ability, data from the ARAT was pooled for analysis. The Functional Independence Measure (FIM) was used to test comprehensive function. For self-report measures, the MAL-AOU and MAL-QOM were applied. See details for the FMA, ARAT, MAL-AOU, and MAL-QOM in the “Outcome Measures” section above from the systematic review by Liu et al. Kinematic analysis of a reaching task was used in four trials, with movement time as a common variable. Movement time is considered the interval from movement onset to completion.13 Decreased movement time is associated with more efficient movement. Lin et al. outlined their procedure for collecting this data. Positioning of each participant was standardized while sitting in a chair and performing a reach, grasp and lift of a can in front of them. Reference markers on the affected arm and a camera system were used to record the kinematics of each trial.13 The FIM assesses daily function and consists of 18 items in categories of self-care, sphincter control, transfers, locomotion, communication, and social cognition. Items are scored on a 7-point scale, with higher scores indicating greater independence. The maximum score is 126.14 Stevenson et al. did not specify who administered these tests and where they were taken, but it can be assumed they were conducted by the researchers or clinicians at their respective rehabilitation facilities. |
| **Main Findings**[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. Use a table to summarize results if possible.] |
| Table 6: Meta-analysis of CIMT for Outcomes

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| --- | --- | --- | --- | --- | --- |
| **Outcome**  | **No. of Studies** | **MD** | **95% CI** | **p-value** | **I2 (%)** |
| Upper limb motor capacity (overall) | 15 | 0.47 (SMD) | 0.27-0.66 | 0.06 | 40 |
| FMA | 10 | 4.01 | 1.34-6.69 | 0.15 | 32 |
| Kinematic analysis of a reach task | 4 | -0.44 (SMD) | -0.76 to -0.11 | 0.09 | 54 |
| Upper limb ability (overall) | 14 | 0.80 (SMD) | 0.57-1.02 | 0.10 | 35 |
| ARAT | 10 | 8.91 | 7.15-10.68 | Not reported | Not reported |
| Upper limb ability 3-6 months post-intervention | 4 | 0.54 (SMD) | 0.14-0.94 | 0.74 | 0 |
| FIM | 6 | 5.05 | 2.23-7.87 | 0.95 | 0 |
| MAL-AOU | 12 | 1.05 | 0.85-1.24 | < 0.001 | 88 |
| MAL-QOM | 11 | 0.89 | 0.69-1.08 | 0.05 | 46 |

A significant effect was found using SMD that favored CIMT on overall upper limb motor capacity, kinematic analysis of a reach task, overall upper limb ability, and upper limb ability 3-6 months post-intervention. Additionally, there were significant mean differences for CIMT compared to dose-matched controls in trials that examined outcomes with FMA, ARAT, FIM, MAL-AOU and MAL-QOM. Heterogeneity was not substantial among trials except for studies with MAL-AOU, which prompted subgroup analysis. A random-effects model was used and resulted in confirmation of favorable effects of CIMT on MAL-AOU. Heterogeneity of these trials was attributed to participant characteristics and elements of CIMT interventions.Sensitivity analyses were also conducted. Results demonstrated that there were no significant differences for clinical outcomes based on time since stroke onset or CIMT regimen duration. Additionally, sensitivity analysis showed that CIMT was still favorable for upper limb motor capacity and ability in trials that included a restraint component in control groups. |
| **Original Authors’ Conclusions**[Paraphrase as required. If providing a direct quote, add page number] |
| When compared to dose-matched control interventions, CIMT is demonstrated to have greater benefits on upper limb recovery in adults with stroke and residual motor capability with learned non-use of their affected arm. This effect has been shown as evident in performance-based measures of upper limb motor capacity, motor ability, comprehensive function, and a self-report measure on amount of use and quality of movement. Limited follow-ups have been done in trials, so evidence best supports CIMT immediately after intervention and more research is needed to evaluate the long-term impact of CIMT. This systematic review validates findings from previous studies supporting the efficacy of CIMT and presents a stronger conclusion due to the consistency of therapy duration and intensity in control groups related to CIMT. This negates the argument that effectiveness of CIMT is secondary to increased therapy time alone. Further research is needed to show the retention of CIMT, identify those best-suited for CIMT, solidify optimal treatment parameters, and demonstrate translation to clinical practice. |
| **Critical Appraisal** |
| **Validity**[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| This level 1 systematic review and meta-analysis by Stevenson et al. has a moderate rating of overall confidence in the study’s findings based on the AMSTAR-2. There were 5 areas where quality was lacking. Concerns include sources of funding were not disclosed, risk of bias was not assessed and interpreted for included studies, publication bias was not addressed, and conflicts of interest were not reported. Another weakness of this review was that the included studies did not all have complete descriptions of interventions, which may have affected the equivalency of therapies. Important principles of motor learning relevant to stroke rehabilitation could not be considered, and it was unclear whether the control interventions involved shaping techniques, which would affect results across studies. Furthermore, several studies had small sample sizes below 20 participants, which could lead to inflated effects. Also, one included study had a PEDro score of 3, and another had 4 points, which may affect the quality of the systematic review. It was a strength that the meta-analysis was able to be conducted for a variety of domains which each included instruments that are commonly used in stroke literature. Also, trials were limited to dose-matched control groups, which helped to establish more reliable findings. Most included trials had acceptable heterogeneity. Sensitivity analyses were beneficial to verify assumptions. The overall validity of evidence from this publication was moderate. |
| **Interpretation of Results**[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| The systematic review by Stevenson et al. was unique in how studies were only included for meta-analysis if control interventions were dose-matched to the amount of time spent in therapy for CIMT, to determine if CIMT is effective of itself or if therapy time is the key factor. Significant differences were seen in all examined outcome measures for the four ICF domains of upper limb motor capacity, ability, comprehensive function, and self-report measures. Confidence intervals were wide for the FMA and FIM, but all other measures had relatively narrow confidence intervals. This indicates that there was greater variability of results in the FMA and FIM trials. Heterogeneity was not substantial for most compared trials that used the same instruments, showing that there was low variability for included trials according to the meta-analysis. There was substantial heterogeneity only for studies that evaluated with the MAL-AOU, then sub-group analysis continued to support CIMT in favor of the control. There was a lot of variation on patient age, time since stroke, and CIMT treatment parameters for the included studies. I appreciated how the authors took this into consideration by conducting sensitivity analyses, which presented that CIMT continued to be more effective than dose-matched control therapy despite these different factors. This systematic did include lower quality trials, which can affect the results of this publication. There were also several weaknesses identified by the AMSTAR-2 assessment. However, this systematic review adds value to the literature by evening the comparison of CIMT and control by ruling out time in therapy as a contributor. The results of this systematic review suggest that CIMT has greater effects on stroke rehabilitation, regardless of time since stroke or frequency and intensity of CIMT. Higher quality evidence is needed to confirm these findings with clearly outlined control interventions and consistent CIMT parameters. |
| **Applicability of Study Results**[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
| The findings from the systematic review by Stevenson et al. are highly relevant to my clinical question as comparisons were made between CIMT and time-equivalent control interventions. It was beneficial that control therapies were consistent in their durations, but details of their logistics were still left out. The participant characteristics within this study were very variable, but the findings demonstrate that CIMT can be beneficial for all ages and phases post-stroke. Many of the CIMT protocols covered 30 total hours, while the way time was split varied across trials. Many restraint components involved a mitt and entailed 6 hours/day for 5 days/week. Time in supervised therapy mostly consisted of 2 hours/day for 5 days/week. I appreciated that the authors provided time in restraint as this was not available in the systematic review by Liu et al. CIMT appears to be a beneficial intervention for multiple areas that relate to upper extremity function. Unfortunately, follow-ups were limited, and the authors did not specify what time points they used for meta-analysis, but it can be assumed that they used post-intervention values. Lack of follow-up limits data to support the long-term effects of CIMT, but the available evidence supports the short-term benefits. It is unclear which CIMT protocol should be used, so future research is needed to best tailor CIMT interventions based on the patient. |

**SYNTHESIS AND CLINICAL IMPLICATIONS**

[Synthesize the results, quality/validity, and applicability of the two studies reviewed for the CAT. Future implications for research should be addressed briefly. Limit: 1 page.]

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| Overall, both studies assessed in this CAT indicate the use of CIMT for the rehabilitation of stroke-induced upper extremity hemiplegia with the goal of improving functional recovery. The first study included in the CAT by Liu et al. was highly relevant to my clinical question, was of high quality, and presented level 1 evidence. Meta-analysis of the included trials revealed that CIMT or mCIMT had a greater significant effect over conventional control rehabilitation on improving upper limb function for individuals in the acute and sub-acute phases after stroke. All participants were within 4 months of onset post-stroke. Performance-based and self-report outcome measures supported the advantage of CIMT. Additionally, the authors were able to organize results by the intensity of CIMT and found that low intensity CIMT appeared to have a greater impact on UE function for these individuals. The amount of CIMT appears to play a role in outcomes. Only short-term post-intervention data was available. Confidence intervals were relatively wide, indicating variability of results despite demonstrable significant effects. Overall, the Liu et al. systematic review and meta-analysis has a high overall confidence rating and can be readily applied to support upper extremity stroke rehabilitation with consideration of treatment parameters. Future systematic reviews should be performed to validate and explore work related to this study.The second study included in the CAT by Stevenson et al. was highly relevant to my clinical question, was of moderate quality, and presented level 1 evidence. Significant differences were observed in favor of CIMT over dose-matched control interventions for improving upper limb motor function, ability, comprehensive function, and self-report. Inclusion criteria of included studies allowed for a variety of patient ages and time since stroke onset, but all participants were required to have a certain degree of residual movement. Results showed that CIMT was beneficial regardless of age or stroke acuity. CIMT protocols were also variable in terms of duration, time in supervised training, and time in restraint. However, benefits were independent of these factors. Only short-term post-intervention data was available. The validity is set back by the inclusion of lower quality studies and the lack of addressing risk of bias, publication bias, and funding sources. Overall, the Stevenson et al. systematic review and meta-analysis has a moderate overall confidence rating and can be considered when implementing a rehabilitation program for upper extremity function after stroke. Future systematic reviews need to be conducted to confirm the work from this study with stronger conclusions.Based on the two studies described above, I conclude that CIMT is an effective treatment for individuals who have suffered a stroke and upper extremity hemiplegia. CIMT appears to have greater effects on upper extremity function compared to control interventions, even with equivalent time spent in therapy. If the individual is in the more acute stage after stroke, lower intensity CIMT may be more beneficial. I would recommend CIMT for any phase of stroke based on the presented evidence, as long as the individual has acceptable residual movement of the affected arm. The protocol should consist of at least 2 hours per day for 5 days per week, for 2 weeks. Many protocols use 30 total hours. The restraint component often consists of 5-6 hours per day for 5 days per week. CIMT should lead to meaningful benefits after the intervention, but progress may need to be maintained with continued therapy as long-term effects of CIMT remain unclear. |

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[List all references cited in the CAT]

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