CRITICALLY APPRAISED TOPIC

FOCUSED CLINICAL QUESTION

For an 8-year-old patient with Hemiplegic Cerebral Palsy, is Constraint Induced Movement Therapy (CIMT) or Bimanual Intensive Therapy (BIT) more effective in improving function in the involved upper extremity?

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CLINICAL SCENARIO

The patient is an 8-year-old male diagnosed with hemiplegic cerebral palsy, and his left upper and lower extremities are primarily impacted by his diagnosis. The child's physical therapist recommended he attend UNC Children's Hospital *Helping Kids with Hemiplegia* constraint camp. Interventions are individualized, goal-oriented, age-appropriate activities. Constraint Induced Movement Therapy (CIMT), Bimanual Intensive Therapy (BIT), and therapeutic handling intervention strategies are used to enhance function. These strategies are implemented throughout an 8-day camp, which led to the clinical question comparing these interventions.

Hemiplegic cerebral palsy (CP) effects approximately 1 in 1300 live births and remains one of the most common types of movement disorders impacting children in the United States.[1] Like this patient, children with hemiplegic cerebral palsy are primarily limited secondary to muscle stiffness and weakness in the involved upper and lower extremities, balance deficits, gait impairments, difficulties with fine motor skills, and preferential use of the non-involved upper and lower extremities.[2] Consequently, these limitations can impact the child's ability to participate in the home, school, and community environments. This clinical question holds exceptional value, for it will enable clinicians and *Helping Kids with Hemiplegia Camp* supervisors to select evidence-based interventions to improve participation and optimize functional outcomes in this highly prevalent patient population.

SUMMARY OF SEARCH

- Among the three databases searched, a total of eight studies were selected that met the inclusion and exclusion criteria. Studies included eight randomized controlled trials (RCTs), all of which were identified as Level 1b evidence. Two studies were selected and deemed to represent the "best evidence" for the clinical question based on the study's quality, validity, and relevance.
- The key findings from the two studies appraised suggest that:
  - When comparing intervention effectiveness in improving the functional use of the involved upper extremity in children with hemiplegia, both CIMT- and BIT-based interventions are beneficial.
  - In general, CIMT-based interventions demonstrated improved unilateral function of the involved upper extremity and BIT-based interventions demonstrated improved bilateral function of the upper extremities.
  - The differences between groups were considered to be modest and both intervention methods are equally supported by the evidence presented in these two high quality, randomized controlled trials.

CLINICAL BOTTOM LINE

Current research suggests that both CIMT and BIT interventions are beneficial for improving the function and use of the involved upper extremity for activities of daily living in children with hemiplegia. These two articles further validate these findings and suggest that both CIMT and BIT interventions demonstrate improved movement quality, efficiency, and use in the hemiplegic limb for this patient population. Future research should consider comparing a combined CIMT/BIT intervention approach to either CIMT or BIT alone in order to determine best practice. Clinicians can use the information presented in these studies to either conduct or refer to CIMT- and BIT-intervention camps such as the *Helping Kids with Hemiplegia* summer camp depicted in the clinical scenario above.

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

SEARCH STRATEGY

Terms used to guide the search strategy			
Patient/Client Group	**I**ntervention (or Assessment)	**C**omparison	**O**utcome(s)
Pediatric* Child Children Youth Hemiplegia Hemiplegic Hemiparesis Unilateral Paralysis Cerebral Palsy	"Constraint-Induced Movement Therapy" Learned nonuse Forced use	"Bimanual Intensive Therapy" "Bimanual Intensive Rehabilitation" "Bimanual upper limb therapy" "Hand-arm bimanual intensive therapy"	Participation Function

Final search strategy (history):

1. Pediatric* OR child OR children OR youth
2. (Hemiplegia OR hemiplegic OR hemiparesis OR unilateral paralysis) AND cerebral palsy
3. "Constraint-induced movement therapy" OR learned non-use OR forced use
4. "Bimanual-intensive therapy" OR "bimanual intensive rehabilitation" OR "bimanual upper limb therapy" OR "hand-arm bimanual intensive therapy"
5. Participation OR function
6. **#1 AND #2 AND #3 AND #4 AND #5 = 33 results**

Databases and Sites Searched	**Number of results**	**Limits applied, revised number of results (if applicable)**
PubMed	**33**	**n/a**
CINAHL	**22**	**Final search strategy above only produced 1 result in CINAHL. Therefore, a combination of the results found using #1 AND #2 AND #3 (20 total) and #1 AND #2 AND #4 (2 total) were reviewed.**
Web of Science	**4**	**n/a**

INCLUSION and EXCLUSION CRITERIA

Inclusion Criteria
High levels of evidence including Randomized Controlled Trials, controlled trials, systematic reviews, meta-analyses
Studies that focused on the pediatric population (less than 18-years old)
Studies that involved children diagnosed with hemiplegic cerebral palsy
Published in English
Exclusion Criteria
Studies that focused on a subject sample of individuals >18 years of age
Studies that involved children with diagnoses, conditions, etc. other than hemiplegic cerebral palsy

Low levels of evidence including case studies/series and expert opinion

Animal studies

RESULTS OF SEARCH

Summary of articles retrieved that met inclusion and exclusion criteria

Author (Year)	Risk of bias (quality score)*	Level of Evidence**	Relevance	Study design
Deppe et al. (2013)	**PEDro scale Score: 8/11**	**Level 1b**	**High**	**RCT**
Gordon et al. (2011)	**PEDro scale Score: 8/11**	**Level 1b**	**High**	**RCT**
Gelkop et al. (2015)	**PEDro scale Score: 9/11**	**Level 1b**	**Mod**	**RCT**
De Brito Brandao et al. (2012)	**PEDro scale Score: 7/11**	**Level 1b**	**High**	**RCT**
Facchin et al. (2011)	**PEDro scale Score: 8/11**	**Level 1b**	**High**	**RCT**
Sakzewski et al. (2011) Title: Participation…	**PEDro scale Score: 8/11**	**Level 1b**	**High**	**RCT**
Sakzewski et al. (2011) Title: Randomized trial…	**PEDro scale Score: 9/11**	**Level 1b**	**High**	**RCT**
Zafer et al. (2016)	**PEDro scale Score: 6/11**	**Level 1b**	**High**	**RCT**

BEST EVIDENCE

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

- **Sakzewski et al. Randomized trial of constraint-induced movement therapy and bimanual training on activity outcomes for children with congenital hemiplegia. (2011)[1]**
  - This single-blinded, matched pairs randomized controlled trial demonstrates high methodological quality with a PEDro assessment score of 9/11. This study lost a total of two points for blinding of the subjects and therapists administering the intervention, which is difficult to accomplish considering the overall design of the study. This study is classified as level 1b evidence and directly addresses the clinical question by comparing CIMT versus BIT in children with congenital hemiplegia. Researchers provided study limitations, areas for future research, and a thorough statistical analysis including both point measures and measures of variability for study outcomes.
- **Deppe et al. Modified constraint-induced movement therapy versus intensive bimanual training for children with hemiplegia – a randomized controlled trial (2013)[3]**
  - This single-blinded randomized controlled trial also demonstrates high methodological quality with a PEDro assessment score of 8/11 and is classified as level 1b evidence. This study was further classified as having "high relevance" to the clinical question, and the research findings were presented in a way that was easily interpretable from the reader's perspective. The researchers provided a thorough statistical analysis that included both point measures and measures of variability for outcomes, study limitations, and areas for future research.

SUMMARY OF BEST EVIDENCE

(1) Description and appraisal of "Randomized trial of constraint-induced movement therapy and bimanual training on activity outcomes for children with congenital hemiplegia" by Sakzewski L, Ziviani J, Fabbott D, et al. (2011)[1]

Aim/Objective of the Study/Systematic Review:

Among the literature, there are several studies that recognize the benefits of CIMT and BIT in children diagnosed with congenital hemiplegia. However, there remains conflict as to which intervention strategy is considered to be "best practice" for this patient population. Sakzewski et al. conducted this matched pairs randomized controlled trial with the objective to directly compare the effectiveness of CIMT and bimanual training (BIM) and evaluate whether one intervention strategy is indeed more effective when compared to the other in terms of hemiplegic upper extremity function and participation in daily activities.

Study Design

The study is a single-blinded, matched pairs randomized controlled trial design including the comparison of two groups who were assigned to participate in either the CIMT or BIM day camp. Study participants were matched based on their age, gender, whether their involved upper extremity was right versus left, and their score on the Melbourne Assessment of Unilateral Upper Limb Function (MUUL). Randomization was implemented by using a computer generated list and concealing envelopes that were opened by individuals who were not a part of the study.

Outcomes were measured by four occupational and physical therapists and obtained at baseline, 3 weeks, and 26 weeks post-intervention. Occupational therapists measured and assessed outcomes that were deemed primary outcomes, in which group allocation was concealed.

Setting

Eligible children who met the study's inclusion criteria were chosen from public and private medical specialists' offices in Queensland and Victoria, Australia. The interventions took place at community sporting facilities located in Melbourne and Brisbane, Australia. In order to promote participation and optimize the motivation of the children, the camp was tailored to be child-friendly with a "novel circus theme."[1 (pg. 314)]

Participants

A total of sixty-three children between the ages of 5- and 16-years-old were recruited for the study and randomly assigned to either the CIMT group or the BIT group. Overall, study participants were similar at baseline in terms of measures assessed and demographic information.

- CIMT group
  - Mean age: 10 years and 1 month
  - Gender: 17 males, 15 females
  - Left-sided hemiplegia: 50%
  - Motor type (dystonia + spasticity): 3%
  - Epilepsy: 16%
  - Learning disability: 31%
  - MACS classification: 25% Level I, 72% Level II, 3% Level III
  - GMFCS classification: 25% Level I, 75% Level II
  - Zancoli scale: 56% Level 1, 28% Level 2a, 16% Level 2b
  - House scale: 9% spontaneous use, 75% active assist, 16% passive assist
  - "Typical" school: 91%
  - "Special" school: 9%
  - Receiving concurrent occupational therapy services: 6% weekly/fortnightly, 16% monthly, 28% other
  - Receiving physiotherapy services: 19% weekly/fortnightly, 12% monthly, 16% other
- BIM group
  - Mean age: 10 years and 2 months
  - Gender: 16 males, 15 females
  - Left-sided hemiplegia: 11%
  - Motor type (dystonia + spasticity): 10%
  - Epilepsy: 26%
  - Learning disability: 29%
  - Manual Ability Classification Scale (hand function): 26% Level I, 74% Level II, 0% Level III
  - Gross Motor Function Classification System: 26% Level I, 74% Level II
  - Zancoli scale (hand function): 48% Level 1, 36% Level 2a, 16% Level 2b
  - House scale (hand function): 13% spontaneous use, 81% active assist, 6% passive assist
  - "Typical" school: 94%

- "Special" school: 6%
- Receiving concurrent occupational therapy services: 13% weekly/fortnightly, 10% monthly, 26% other
- Receiving physiotherapy services: 10% weekly/fortnightly, 3% monthly, 29% other

Intervention Investigated

CIMT Group (Experimental)

- Supervised by trained physiotherapists, occupational therapists, and camp volunteers/staff
- Mode of constraint for CIMT campers included a tailor-made glove, and study participants were instructed to wear the glove on the non-hemiplegic upper extremity at all times throughout the camp except when attending the restroom or to ensure safety
  - If certain tasks required bimanual use of the individual's hands, researchers placed Elastoplast tape around the non-hemiplegic fingers to serve as an alternative method of constraint
- Summary of interventions
  - CIMT camp participants were encouraged to use the involved upper limb as much as possible throughout the duration of the camp
  - Activities were goal-oriented, patient-centered, and age-appropriate
  - Intervention strategies:
    - Games that focused on the advancement of fine and gross motor skills
    - Circus-themed activities to maximize engagement and motivation for activity
    - Proper use of utensils during meal time
    - Debriefing period for self-reflection
- The intervention occurred 6 hours per day for 10 consecutive days

BIM Group (Control)

- Supervised by trained physiotherapists, occupational therapists, and camp volunteers/staff
- Summary of interventions
  - IBT camp participants were encouraged to use both the involved and non-involved upper extremities collectively throughout the duration of the camp
  - Activities were goal-oriented, patient-centered, and age-appropriate
  - Intervention strategies (same as CIMT group):
    - Games that focused on the advancement of fine and gross motor skills
    - Circus-themed activities to maximize engagement and motivation for activity
    - Proper use of utensils during meal time with a focus on bilateral upper extremity involvement
    - Debriefing period for self-reflection
- Dose was matched to the experimental group

Outcome Measures

- Measures were obtained at baseline, 3 weeks, and 26 weeks post-intervention.
- Primary Outcomes
  - Melbourne Assessment of Unilateral Upper Limb Function (MUUL)
    - Used to assess performance, function, and quality of movement of the hemiplegic upper extremity
    - Deemed the "best measure of unilateral capacity"[1 (pg. 315)]
  - Assisting Hand Assessment (AHA)
    - Outcome measure utilized to assess performance and function of bilateral upper extremities
    - Deemed the "only measure of bimanual performance with good evidence of validity and reliability"[1 (pg. 315)]
- Secondary Outcomes
  - Grip strength via hand-held dynamometer
  - Sensation
    - Moving two-point discrimination
    - Stereognosis
  - Jebson Taylor Test of Hand Function (JTTHF)
    - Used to assess "movement efficiency"[1 (pg. 315)] of the hemiplegic upper extremity

Main Findings

Researchers found that CIMT participants demonstrated significant improvements in MUUL, AHA, and JTTHF scores at the 3-week follow-up visit and MUUL and JTTHF scores at the 26-week follow-up visit. In comparison, BIM participants demonstrated significant improvements in AHA scores at the 3-week follow-up visit and AHA and JTTHF scores at the 26-week follow-up visit. Overall, CIMT group participants demonstrated greater improvements in unilateral function of the hemiparetic upper extremity post-intervention, and BIM group

participants demonstrated greater improvements in bilateral upper extremity function post-intervention.

Original Authors' Conclusions

In summary, the authors conclude that both CIMT and BIT interventions are beneficial for improving the function and use of the involved upper extremity in children with congenital hemiplegia. Although CIMT methods led to greater improvements in unilateral function and BIM methods in bilateral function, the differences in outcomes were considered to be modest.

Critical Appraisal

Validity

- Sakzewski et al. present level 1b evidence based on the study's overall quality and single-blinded, matched pairs randomized controlled trial design.
  - This study scored a total of 9/11 points on the PEDro scale, in which 2 points were deducted for lack of blinding of subjects and therapists administering the interventions.
  - Item 1 on the PEDro scale relates to the external validity of the study, or whether the study's results can and should be utilized by the reader. The eligibility criteria were specified in this study, and the overall applicability of the results are good. Children in the study were primarily classified as MACS Level II in terms of hand function, GMFCS Level II, Level 1 on the Zancolli scale, and active assist on the House scale. However, the study included participants from all levels in terms of the mentioned classifications. Furthermore, the inclusion of children both with and without learning abilities further validate the generalizability of the results.
  - Randomized allocation was also included in the study using computer-based distribution of participants to either CIMT or BIM groups. Concealed envelopes were then opened by non-study persons. Randomization increases the external validity of the study, which was conducted in an evidence-based manner.
  - Items 2-9 on the PEDro scale relate to the internal validity of the study, or whether the study results are credible. The CIMT and BIM groups were similar in terms of baseline characteristics and demographic information, and occupational therapists assessing primary outcomes were concealed to group allocation. Furthermore, intention-to-treat analysis was included.
  - Items 10-11 relate to the interpretability of the study results and whether the information presented to readers is sufficient. Results for between-group statistical analysis as well as both point measures and measures of validity are included, which support the interpretability of the study findings.
- The randomized controlled trial design is a major strength, categorizing the study to be high-level evidence. The study sample is representative of the congenital hemiplegia patient population, which implies that the results are generalizable for children outside of this study. Being the study included a matched pairs design between groups, this also decreased the opportunity for baseline differences among group members.
- Weaknesses of the study include the lack of a control group, lack of blinding of group participants and therapists conducting the CIMT and BIM training camps, and measures of impairment including grip strength, two-point discrimination, and stereognosis for interventions that are based on activity and participation.
- In summary, the design of the study was appropriate for the researchers' intentions and objectives. Furthermore, researchers took the necessary steps required to demonstrate results that are valid, reliable, generalizable, and interpretable.

Interpretation of Results

This study is classified as level 1b evidence and demonstrates good quality in terms of internal validity, external validity, and interpretability as indicated by the study's PEDro scale scoring of 9/11 points. Furthermore, the randomized controlled trial design assists in the researchers' efforts to limit the influence of confounding variables and bias, which would lead readers to question whether the results of the study should be interpreted and utilized in daily practice. Lastly, researchers included outcome measures that were deemed reliable and valid in terms of assessing and demonstrating intervention effectiveness.

While there are several strengths to the study, there are also limitations that should be taken into consideration. One of the primary weaknesses includes the study's methods and intervention frequency, duration, and intensity. For the practicing clinician, it may be difficult to ensure children are participating in either CIMT or BIM for 10 consecutive days for 6 hours per day. Additionally, researchers did not address whether there were strategies enforced throughout the CIMT and BIM training camps that ensured patient participation 100% of the time. Younger children may have demonstrated poorer compliance with the activities as compared to adolescent participants, which would have yielded a variety of results.

Another important factor to consider when interpreting the results of this study is that there are minimal differences in outcome assessment scores utilized between groups. The CIMT group demonstrated improvements in outcomes that evaluated unilateral use of the involved upper extremity, whereas the BIM group demonstrated improvements in outcomes that evaluated use of both the involved and non-involved upper extremities. Therefore, further research should consider implementing both methods of intensive

training and evaluate whether baseline characteristics and/or demographics influence these outcomes.

Researchers provided information regarding the clinical and statistical significance of the MUUL as well as the effect size for the AHA in comparison with other study methods and designs. CIMT group participants demonstrated statistically significant improvements at both 3- and 26-week follow-up visits for the MUUL and JTTHF. However, changes in MUUL outcomes for the CIMT group did not surpass the minimally clinical important difference (MCID) of 7.4%. The "overall group estimated mean change in bimanual performance,"[1 (pg. 315)] as measured by the AHA assessment tool, was small for both the CIMT and BIM training groups with an effect size of 0.22. This small effect size implies that there are minimal differences between groups regarding AHA outcomes, indicating that both CIMT and BIM interventions may lead to favorable outcomes for this patient population.

In summary, the results from this study suggest that children diagnosed with congenital hemiplegia demonstrate improvements in function, movement quality and efficiency, and overall participation in activities that require bilateral use of the upper extremities following either CIMT- or BIM-based training camps. However, it is important to recognize that these children were between the ages of 5- and 16-years-old and participated in intensive, supervised, motivating activities that were both age appropriate and based on the needs of the individual. For the practicing clinician, interventions focused on CIMT or BIM strategies should also focus on activity-based, goal-oriented tasks. Also, the interventions were conducted over the course of 10 consecutive days, which lasted for 6 hours each day. Therefore, to replicate the results the interventions should be conducted in a similar format.

Applicability of Study Results

Overall, this study is considered to be both relevant and applicable to the clinical question. Study participants were diagnosed with congenital hemiplegia and between the ages of 5- and 16-years-old, which includes the age and medical diagnosis of the patient depicted in the clinical question. Furthermore, the clinical question is based on a child that participated in a similar hemiplegia camp that also focused on goal-oriented, activity-based activities that were fun and inviting to campers. Lastly, *Helping Kids with Hemiplegia* implements both CIMT and BIM interventions strategies, which was the primary focus and aim of this study.

The purpose of the clinical question presented was to determine whether CIMT or BIM is more effective in terms of hemiplegic upper extremity function and participation, and this study suggests that both methods may, in fact, lead to positive outcomes. Therefore, future research should focus on the incorporation of both CIMT and BIM methods to facilitate change in upper limb function for this patient population.

(2) Description and appraisal of "Modified constraint-induced movement therapy versus intensive bimanual training for children with hemiplegia – a randomized controlled trial" by Deppe W, Thuemmler K, Fleischer J, Berger C, et al. (2013)[3]

Aim/Objective of the Study/Systematic Review:

The objective of the study was to determine if modified CIMT (mCIMT) is more effective in comparison to Intensive Bimanual Therapy (IBT) in improving involved upper extremity function and participation in activities of daily living in children with hemiplegia. Furthermore, researchers aimed to evaluate the influence of specific treatment characteristics such as treatment intensity, age, and severity of impairment on patient outcomes.

Study Design

This study is a single-blinded, randomized controlled trial design including the comparison of two groups who were randomly assigned to participate in either the mCIMT or IBT intensive training. The mCIMT intervention strategy was based on a "modified child-friendly interdisciplinary constraint-induced movement therapy programme"[3 (pg. 910)] developed in Germany termed kid-CIMT. Researchers assigned participants to either the mCIMT or IBT group via a computer-generated list of randomized numbers that were placed in concealed envelopes. Participants and therapists supervising and administering the kid-CIMT and IBT interventions were not blinded to group allocation. Outcome measures were assessed by experienced, non-study personnel who were blinded to group allocation. Outcomes were measured both pre- and post-treatment, which took place one week prior to and following the study.

Setting

The study was conducted at an inpatient pediatric rehabilitation clinic in Germany.

Participants

A total of forty-seven children between the ages of 5- and 16-years-old diagnosed with hemiplegia were recruited for the study and randomly assigned to either the kid-CIMT group or the IBT group. The etiology for

participants varied, including spastic hemiplegic cerebral palsy or acquired, non-progressive hemiplegia secondary to stroke, traumatic brain injury, or intracranial haemorrhage.

Kid-CIMT group:

- Mean age (± standard deviation): 5 years 10 months (± 1 year 10 months)
- Age range: 3 years 5 months – 11 years 5 months
- Sex: 8 males, 18 females
- Side of hemiplegia: 16 right-sided, 10 left-sided
- MACS level: 5 level I, 16 level II, 5 level III
- Etiology: 16 diagnosed with cerebral palsy, 8 with hemiplegia secondary to other etiologies

IBT group:

- Mean age: 6 years 10 months (± 2 years 1 month)
- Age range: 3 years 4 months – 11 years 3 months
- Sex: 7 males, 14 females
- Side of hemiplegia: 16 right-sided, 5 left-sided
- MACS level: 5 level I, 11 level II, 5 level III
- Etiology: 13 diagnosed with cerebral palsy, 5 with hemiplegia secondary to other etiologies

Intervention Investigated

Kid-CIMT Group (Experimental)

- Sessions were supervised by trained physiotherapists, occupational therapists, sport and music therapists specialized in music therapy for patients with neurological involvement, and educational instructors
- The kid-CIMT program was broken up into 2 parts: 60 hours (with constraint) and bimanual training (without constraint) for an additional 20 hours
  - Frequency of sessions: 4- 60 minute sessions/day, 5 days/week for a total of 4 weeks
  - Mode of constraint:
    - Elastic bandages were used to fixate the non-involved upper limb to the child's trunk
    - Children wore bandages at all times except during the last 60-minute session per day
- Intervention Description
  - Multidisciplinary CIMT approach based on the principles of shaping
  - Three main components:[3]
    - Sensation (10 minutes per day)
      - Tactile cues provided to stimulate an appropriate response in the hemiparetic limb
    - Mobilization (5-10 minutes twice per day)
      - Stretching to promote elongation of tissues that may be shortened secondary to non-use of the involved upper limb
    - Activity (primary element)
      - Goal-oriented tasks to promote upper limb participation and function
      - Progressive activities tailored to the individual needs of each participant
      - Proximal-to-distal approach:
        - Begins proximally with a focus on trunk and shoulder stability/control
        - Ends distally with a focus on arm and hand control

IBT Group (Control)

- Supervision and intervention dosage was matched to the experimental group
- Intervention Description
  - Members of the IBT group participated in a similar multidisciplinary approach that was based on the principles of shaping
  - Components of intervention were matched to the experimental group; however, participants were encouraged to utilize both the involved and non-involved upper extremities for all activities including:
    - Donning and doffing of clothing,
    - Meal preparation and proper use of utensils,
    - Throwing a ball with age-matched peers, etc.

Outcome Measures

- Primary Outcomes
  - Melbourne Assessment of Unilateral Upper Limb Function (MELBAss)
    - Measures the "quality and precision of clearly defined isolated motor functions"[3 (pg. 911)] of the involved upper extremity
  - Assisting Hand Assessment (AHA)
    - Measures the "spontaneous use"[3 (pg. 911)] of both the hemiparetic and non-hemiparetic limb
- Secondary Outcomes
  - Parents' Questionnaire on Self-Care Abilities from the Pediatric Evaluation of Disability Inventory

(PEDI)

Main Findings

Researchers found that kid-CIMT group participants demonstrated greater improvements in MUUL scores in comparison to IBT group participants. However, kid-CIMT and IBT group participants demonstrated similar improvements in overall AHA outcome scores post-intervention. Additionally, there was a statistically significant difference in post-treatment PEDI self-care scores for kid-CIMT group participants, whereas the post-treatment gain in PEDI self-care for IBT group participants was found to be insignificant.

Lastly, researchers discovered that participants with greater disability levels (severity of involvement) demonstrated greater improvements in outcomes when compared to participants with lower disability levels. Contrastingly, age did not have an impact on participant outcomes.

Original Authors' Conclusions

Overall, the authors conclude that children diagnosed with hemiplegic cerebral palsy or hemiplegia secondary to other etiologies are capable of improving the functional use of the involved upper extremity for activities of daily living following either modified CIMT or IBT intervention methods. While kid-CIMT group participants demonstrated greater improvements in unilateral upper limb function, both intervention methods led to significant improvements in the bilateral use of the involved and non-involved upper extremities. Considering the majority of everyday tasks require sufficient bilateral upper extremity function, both methods are considered appropriate when treating pediatric patients with hemiplegia.

Critical Appraisal

Validity

- Deppe et al. presents level 1b evidence based on the study's overall quality and single-blinded, randomized controlled trial study design.
    - This study scored a total of 8/11 points, suggesting that researchers took the necessary steps required to produce results that can be utilized by readers with increased confidence. Like the study conducted by Sakzewski et al., 2 of the 3 points deducted were due to lack of blinding of subjects and the therapists administering either the kid-CIMT or IBT interventions.
    - Item 1 on the PEDro scale refers to the external validity of the study. Eligibility criteria were specified for this study, and the overall applicability of the study results were good. More specifically, the eligibility criteria are pertinent to the patient identified in the clinical question.
    - Researchers also specify that participants were randomly assigned to either the kid-CIMT or IBT group using concealed envelopes, which adds additional external validity to the study's results.
    - Items 2-9 refer to the internal validity of the study. Baseline characteristics of study participants between groups were similar in terms of demographic information, hand function via the Manual Ability Classification System (MACS), and primary and secondary outcomes. Furthermore, approximately 89% of study participants who were randomly allocated to either the kid-CIMT or IBT group were analysed post-treatment. This also plays a key role in terms of the internal validity of the study, suggesting that the study results are credible and useful for readers.
    - Items 10-11 refer to the interpretability of the study results. Researchers performed a between-group statistical analysis, and both point measures and measures of validity are included in the results and discussion.
- Deppe et al. present high quality evidence, which is supported by the randomized controlled trial study design. This is a strength, for readers are able to interpret and apply the results of the study with increased confidence. Additionally, researchers chose outcome measures that have been used in previous studies evaluating the effectiveness of CIMT versus BIT/IBT intervention methods for comparative purposes. These outcomes can be used to assess intervention effectiveness in the clinic and are deemed valid and reliable assessment tools. Lastly, the kid-CIMT group provided additional insight as to whether a combination of CIMT and IBT methods may of benefit, which was achieved via 60 hours of CIMT followed by 20 hours of IBT. As Sakzewski et al. note, this type of intervention may be superior to only CIMT or IBT methods and should be further investigated in future research.
- Some of the key weaknesses of this study include the inclusion of hemiplegic children with various etiologies (i.e. congenital and non-congenital hemiplegia), the modest sample size, and the lack of long-term follow-up visits. Furthermore, the kid-CIMT group received 60 hours of CIMT plus an additional 20 hours of IBT whereas the IBT group solely received IBT intervention for a total of 80 hours. While this may serve as a strength, it may also serve as a weakness to this study.

Interpretation of Results

The results of this study suggest that patients diagnosed with hemiplegic cerebral palsy or other non-progressive hemiplegia may have the ability to improve the functional use of the involved upper extremity for activities of daily living following either kid-CIMT or IBT-based interventions. However, it is important to recognize that the children in this study were between the ages of 3- and 12-years-old, were able to follow instructions, and did not present with behavioral issues pre-intervention. Readers must also consider the intervention intensity and duration. These children underwent intensive training sessions for 80 hours total over the course of 4 weeks, which were supervised by experienced and trained health care professionals and educators. In order to incorporate these results into daily practice, clinicians should determine the study's relevance and applicability to each patient case.

During their discussion, researchers compare their results to those produced by the critically appraised article mentioned above conducted by Sakzewski et al. Both studies include the Melbourne Assessment and the Assisting Hand Assessment (AHA) tools as primary outcomes, but the effect sizes between these two studies vary. For the Melbourne Assessment, the effect size for Deppe et al. was greater than the effect size demonstrated by Sakzewski et al. (6.6 vs. 2.8) for the CIMT intervention group and the percent score for the IBT groups (2.3 vs. 0.9).[1,3] For the AHA, the effect for Deppe et al. was also greater for both the CIMT and IBT intervention groups as compared to those presented by Sakzewski et al. The primary difference between these two studies involved the chosen CIMT intervention. Children who participated in the CIMT intervention group by Sakzewski et al. underwent a total of 60 hours solely devoted to CIMT, whereas participants in the kid-CIMT intervention group by Deppe et al. underwent a total of 60 hours of CIMT and an additional 20 hours of IBT. This could have played a role in the calculated variance in effect sizes between studies.

As Deppe et al. suggest, both the kid-CIMT and IBT interventions demonstrated significant improvements in the functional use of the hemiplegic upper extremity for participants. However, children in the kid-CIMT group demonstrated greater improvements when compared to children in the IBT group for Melbourne Assessment outcomes regarding the unilateral function of the involved upper limb. Also of note, neither group demonstrated greater improvements when compared to the other in terms of the bilateral upper extremity via the Assisting Hand Assessment nor the PEDI self-care assessment tool. Despite this, it is difficult to say with confidence that CIMT methods are indeed superior to IBT methods regarding the unilateral functional capacity of the hemiplegic limb via the Melbourne Assessment tool due to the inclusion of 60 hours of CIMT plus 20 hours of IBT for the kid-CIMT intervention.

In summary, Deppe et al. present high quality evidence in their randomized controlled trial study that aimed to determine whether kid-CIMT is more effective in improving functional use in the affected limb as compared to IBT in children with hemiplegia. The results from this study propose that both modified CIMT and IBT methods are feasible and appropriate intervention options for this patient population.

Applicability of Study Results

This study is classified to be both relevant and applicable to the case presented in the clinical question. Study participants were diagnosed with either hemiplegic spastic cerebral palsy (n=29) or acquired non-progressive hemiplegia (n=13) secondary to stroke, traumatic brain injury, or non-traumatic intracranial hemorrhage (<2 years' duration) and were between the ages of 3- and 12-years-old, which includes the age and medical diagnosis of the patient described in the clinical question. Additionally, the study results are considered to be practical and feasible, for the clinical question is based on a child that participated in a hemiplegic camp-based intervention that included both CIMT and BIT interventions. This type of intervention is very similar to the kid-CIMT intervention implemented in this study, and future research designs should further investigate the effectiveness of combining both CIMT and BIT/IBT intervention strategies for this patient population.

SYNTHESIS AND CLINICAL IMPLICATIONS

Evidence Synthesis

The evidence reviewed in this analysis suggests that both Constraint-Induced Movement Therapy (CIMT) and Bimanual Training (BIM) are beneficial interventions in improving the effectiveness and functional use of the involved upper extremity in hemiplegic children. Sakzewski et al. and Deppe et al. both present high quality evidence in their randomized controlled trial studies to support these findings, which correspond to the results of previous studies with similar objectives and study designs.

Sakzewski et al. conducted a single-blinded, matched pairs randomized controlled trial in 2011 that aimed to directly compare equally intensive bouts of CIMT versus BIM (total of 60 hours per intervention) over the course of 10 consecutive days in children diagnosed with congenital hemiplegia. The Melbourne Assessment tool was selected to assess "quality of movement" and the Assisting Hand Assessment to "measure bimanual performance" at baseline, 3-weeks, and 26-weeks post-treatment.[1 (pg. 315)] Researchers determined that children who received the CIMT intervention demonstrated greater improvements in unilateral use and function of the affected limb (Melbourne Assessment) and children who received the BIM intervention demonstrated greater improvements in bimanual upper extremity utilization and performance (AHA). However, these

differences were deemed "small" by researchers, and the results "generally reflect specificity of practice."[1 (pg. 313)]

Deppe et al. conducted a similar single-blinded, randomized controlled trial design in 2013 with the aim to determine whether modified CIMT or Intensive Bimanual Training (IBT) is more effective in improving unilateral and bilateral function of the involved upper extremity in activities of daily living. The modified CIMT, or kid-CIMT, group was unique in that children underwent 60 hours of CIMT followed by 20 hours of IBT over the course of 4 weeks. In comparison, randomly allocated children to the IBT intervention group received 80 total hours of only IBT over the course of 4 weeks. Similar to Sakzewski et al., researchers selected the Melbourne Assessment and the AHA as primary outcomes to be assessed pre- and post-intervention. The study's results suggest that children who participated in the kid-CIMT intervention demonstrated greater improvements in unilateral function, or "isolated motor functions," in the involved upper limb (Melbourne Assessment), yet no intervention group was deemed superior in comparison to the other regarding bimanual use, or "spontaneous use," of the involved limb.[1 (pg. 909)] These results are similar to those presented by Sakzewski et al., where both methods of intensive training are considered to be effective in improving function in the hemiplegic upper extremity.

Clinical Implications

Several research studies have been conducted with similar aims and objectives for the pediatric population diagnosed with hemiplegia, all of which correspond to the clinical implications determined by both Sakzewski et al. and Deppe et al. One of the primary implications from this critical appraisal is that there are potential short- and long-term benefits for children diagnosed with hemiplegia to participate in camps that implement both CIMT and BIM/IBT intervention strategies regarding the functional use of the affected upper limb. Sakzewski et al. directly compared CIMT to BIM interventions in children diagnosed with congenital hemiplegia between the ages of 5- and 16-years-old, and the results suggest that both CIMT and BIM interventions conducted in a similar camp-based format may lead to significant improvements in upper extremity functional outcomes for relevant patient populations. Deppe et al. compared a modified CIMT intervention, or kid-CIMT, that involved a combination of CIMT and IBT directly to a IBT-only intervention group in children diagnosed with congenital or non-congenital hemiplegia between the ages of 3- and 12-years old, and the results from this study also suggest that both methods are effective in improving the use and function of the involved upper extremity.

When translating the evidence presented by these two studies into clinical practice, the intervention intensity, frequency, and duration should be taken into consideration. Children who participated in the study conducted by Sakzewski et al. underwent 60 hours of intensive training that focused on goal-oriented, activity-based interventions, whereas child participants in Deppe et al.'s study underwent 80 total hours of intensive training that focused on upper extremity function for activities of daily living. Furthermore, interventions took place in a group environment and activities were based on the needs of each individual. Implementing these characteristics may be difficult to achieve in a clinic-based setting; therefore, health care professionals should consider conducting or referring patients and their families to camps including CIMT and BIM/IBT interventions such as *Helping Kids with Hemiplegia* that can ensure a similar design and format for children who may benefit.

Future Implications

Future research should consider studying the effectiveness of a combined CIMT and BIM/IBT intervention and determining the optimal intensity/frequency/duration ratio to yield the greatest improvements in involved upper extremity function (both unilateral and bilateral) in children with hemiplegia. These parameters have yet to be established and vary amongst the available evidence comparing these two interventions. The articles reviewed also discuss the need for long-term follow up, which would determine whether the improvements in the affected limb subside or persist post-intervention. Lastly, future research should further investigate the influence of participant-specific characteristics such as age and level of disability on outcomes.

REFERENCES

1. Sakzewski L, Ziviani J, Abbott DF, Macdonell RA, Jackson GD, Boyd RN. Randomized trial of constraint-induced movement therapy and bimanual training on activity outcomes for children with congenital hemiplegia. *Developmental Medicine and Child Neurology*. 2011;53(4):313-320. doi:10.1111/j.1469-8749.2010.03859.x.
2. CHaSA. Hemiplegia. *Children's Hemiplegia and Stroke Association*. 2003. Available at: http://chasa.org/medical/hemiplegia/. Accessed November 14, 2017.
3. Deppe W, Thuemmler K, Fleischer J, Berger C, et al. Modified constraint-induced movement therapy versus intensive bimanual training for children with hemiplegia – a randomized controlled trial. *Clinical Rehabilitation*. 2013;27(10):909-920. doi:10.1177/0269215513483764.