BC Pediatric Constraint Induced Movement Therapy (CIMT) Guideline

This guideline was adapted with permission for Sunny Hill Health Centre for Children (SHHCC) and BC Center for Ability (BC-CFA) in British Columbia (BC), Canada from the original Pediatric CIMT evidence based care guideline by Cincinnati Children's Hospital Medical Centre, Cincinnati, Ohio, United States of America.
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Target Population

Inclusions:

- Children over one year of age with a unilateral upper extremity impairments associated with neurological conditions (e.g. cerebral palsy, traumatic brain injury, brachial plexus injury)
- Caregiver able and willing to commit to the time required for daily procedure and follow-up care

Exclusions:

This guideline is not intended for use with children with the following:

- Inability to participate in purposeful play or functional activity
- Contractures that limit functional arm use

Note: CIMT is known to be used clinically with infants; however, there is limited information available on appropriate protocols and the effectiveness of CIMT in infants. Therefore, this population is excluded from this guideline.

Target Users

Include but are not limited to (in alphabetical order):

- Neurologists
- Occupational Therapists
- Orthopods
- Patients and families
- Pediatricians
- Physical Therapists
- Physiatrists
- Primary Care Physicians

Guideline Objectives

The original CIMT guideline was based on 20 articles (Cincinnati Children's guideline 2009). Between 2007 and 2010, 28 new articles have been published, illustrating an expanding research interest in this intervention. Although evidence about CIMT has evolved since the original guideline was developed, there remain gaps in knowledge about this intervention.

This adaptation of the Cincinnati guideline was influenced by the following desires: 1) to address the new directions in research between 2007 to 2010; 2) to base treatment and assessment on available evidence; 3) to meet the needs and abilities of a diverse population of children and families; and 4) to offer options for service provision that fit within the BC service framework.

The objectives of this guideline are to:

- improve upper extremity function of the affected arm in children with a unilateral upper extremity impairment
- improve occupational performance in areas related to activity and participation including daily living skills, education, play, leisure, and social participation

- improve the coordination and consistency of care provided by therapists
- support the consistent use of outcome measures in order to evaluate the effectiveness of this treatment technique
- communicate current evidence and treatment guidelines to healthcare providers considering referral for CIMT
- promote family satisfaction.

Overview

Introduction

References in parentheses ( ) Evidence strengths in [ ] (See last page for definitions)

One of three children with cerebral palsy (CP) experiences hemiparesis: impairment affecting one side of the body *(Himmelmann 2005 [4], Hagberg 2000 [5])*. Hemiparesis is also common among children who experience traumatic brain injuries, childhood strokes, and other central nervous system conditions.

Neonatal brachial plexus injury (BPI) caused by a birth or traumatic injury to the brachial plexus (an injury of the peripheral nervous system), occurs in about 1.5 per 1000 live births *(Foad 2008 [4])*. Similar to children with hemiparesis, these children often present with poor functioning of one arm while the other arm is usually without problems *(Buesch et al., 2009 [IV])*.

Activity and participation in play, school, and self-care can be affected in children with impaired functioning of one of their arms. Abnormal muscle tone and flexion synergies, decreased strength, decreased active and passive range of motion, altered sensation, and neglect can impact hand and arm functioning *(Eliasson 2006 [X])*. Also, children with hemiplegia due to central nervous system damage are often affected by mirror movements-unconscious and uncontrolled movement of one hand following the same pattern as the contralateral hand-impacting the ability to use two hands when the hands are required to do different movements (for example, one hand stabilizes an object while the other acts on the object) *(Eliasson 2006 [X])*.

Current theory suggests that children with unilateral upper extremity impairment must overcome "developmental non-use", a term indicating that the children never have effectively used the impaired upper extremity *(Gordon 2006 [3])*. Another term frequently used in literature is "learned non-use"; a term referring to hemiplegia in an individual who previously had functional use of the arm (e.g. a person who had an acquired stroke or traumatic brain injury) *(Taub 1999 [5])*.

Traditionally, children with hemiplegia or BPI receive occupational therapy and physical therapy services to maximize their functional skills. Conventional treatment approaches focus on a mix of motor learning, biomechanical, developmental, neurodevelopmental, and rehabilitative (including compensatory) models (*Eliasson & Gordan, 2008 [5]. Deluca 2006 [2]. Eliasson 2005 [3]. Boyd 2010 [2], Cincinatti Consensus [5], Local Consensus [5]*).

In British Columbia, community-based therapy services (tier 2) are organized and funded through Early Intervention Therapy Programs for children (0 yrs – school entry) and School Therapy Programs (for students from school-entry to school-leaving). These services are informed by provincial Early Intervention Therapy Guidelines *(Ministry of Children and Family Development 2009)* and the Interministerial Protocols for the Provision of Support Services to Schools *(Interministry 1989)*. In addition to community-based therapy services, some areas provide regional (tier 2) specialized therapy services which are further supported by provincial (tier 4) subspecialized services delivered through Sunny Hill Health Centre and BC Children's Hospital. This provincial system of services and supports is described in the Children and Youth with Special Needs Framework for Action. *(Ministry of Children and Family Development, Ministry of Health & Ministry of Education 2008).*

Principles of CIMT

CIMT is an emerging intervention to address upper extremity dysfunction in children with hemiplegia or BPI. In occupational and physical therapy, this intervention approach is underpinned by theories of motor learning and neuroplasticity *(Sakzewski, 2009 [1])*. Its use in paediatrics is based on promising research in children and a stronger body of evidence in the adult population following stroke or brain injury *(Taub, 2007[2])*. The core components of a constraint program include **use of a restraint, task grading, offering motivating tasks, and intensive and repetitive task practice** *(Hoare, et al., 2009 [1])*.

In their Cochrane review, Hoare et al. (2007) provided the following definitions related to constraint therapy.

1. *Constraint-induced movement therapy (CIMT):* restraint of the unaffected upper limb is applied and more than three hours of therapy per day (massed practice) is provided for at least two consecutive weeks.
2. *Modified CIMT (mCIMT):* restraint of the unaffected upper limb is applied and less than 3 hours per day of therapy is provided to the affected limb.

3. *Forced Use:* restraint of the unaffected upper limb is applied but no additional treatment of the affect upper limb is provided.

Summary of Evidence

CIMT has shown promising results for children with hemiplegia *(Eliasson & Gordan, 2008 [5], Gilmore, 2010);* however, there continues to be a need for high quality research in this area *(Hoare, 2009 [1], Sakzewski, 2009 [3]).* Only three studies *(Eliasson 2005 [3], Sung 2005 [2], Taub 2004 [2])* met the inclusion criteria for a Cochrane Systematic Review of CIMT use in pediatric CP *(Hoare 2007 [1]).* Prior to 2007, 20 studies of CIMT in pediatrics were identified in peer reviewed published literature, from which the original CIMT Guideline was developed (Cincinatti 2009) (see Appendix 9). All of these studies reported some positive outcomes of constraint used with children. However, small sample size and/or lack of randomization were limitations. In addition, many studies reported diverse constraint protocols (methods of constraint, intensity of use, inclusion or exclusion of supervised practice) and used a variety of outcome measures, all of which have strengths and weaknesses.

This updated guideline includes study results reported between 2007 and 2010. Three additional studies, published after 2010, were included in this guideline as they were studies based on protocol papers published between 2007 and 2010. There were 28 new studies of CIMT in pediatrics identified; two of which were systematic reviews *(Hoare, 2009 and Huang, 2009 [1]).* Studies included a multi-centre RCT *(Facchin et al., 2009 [1])* and two RCTs examining the use of CIMT with adjunctive interventions, such as botulin toxin a and bimanual therapy *(Boyd et al., 2010 [2]; Hoare et al., 2010[2]).* There were also eight new studies using a control group *(De Brito et al., 2010 [2]; Aarts et al., 2010 [2]; Smania et al., 2009 [2]; Psychoulli et al., 2010 [2];Saczewski et al., 2010 [3];Eliasson et al., 2009 [3];Park et al., 2009 [3]; Kuhnke et al., 2008 [3]),*six cohort studies without a control group *(Cope et al., 2010 [4]; Stearns et al., 2009 [4]; Wallen et al., 2008 [4]; Juenger et al., 2007 [4]; Sutcliffe et al., 2007 [4]; Charles et al., 2007 [4]*), four case series and case reports *(de Bode et al., 2009 [4];Buesch et al., 2009 [4]; Fergus et al., 2008 [5]; Bollea, 2007 [5])*; four single subject research designs *(Dickerson et al., 2007 [4]; Coker et al., 2009 [4]; Martin et al., 2008 [4]; and Cope et al., 2008 [5]),* and one qualitative study *(Gilmore et al., 2010).* See the CIMT Evidence Table (accompanying document) for a complete list of articles reviewed for this guideline.

A recent multi-centre RCT found that both CIMT and bimanual training resulted in significant improvements in hand function when compared to standard treatment alone in children with cerebral palsy *(Facchin et al., 2010 [1]).* In addition, Sakzweski and colleagues compared CIMT and bimanual therapy implemented in a group setting and found both treatments resulted in significant improvement in occupational performance and participation *(Sakzewski et al., 2011a [2]).* They also found that children with more severe levels of hemiplegia demonstrated the greatest gains in unimanual capacity after participating in CIMT or bimanual therapy *(Sakzewski et al., 2011c [2]).* In an earlier study, Sakzewski et al., (2010), found a strong relationship between unimanual capacity and bimanual performance; however, the direction of this relationship remains unknown. Current research is exploring if gains in unimanual capacity will result in improvements in bimanual performance. The use of CIMT has also recently been investigated in combination, or in series, with botulin toxin A and bimanual therapy, with positive results *(Aarts et al., 2010 [2]; De Brito et al., 2010) [2]).*

More recently, researchers have begun to study CIMT delivered in a group setting and found promising results *(Sakzewski et al., 2011 [2]; Aarts et al., 2010 [2]; Boyd et al., 2010 [2]; Eliasson et al., 2009 [3] Charles et al., 2007 [4]).* For example, Aarts et al. (2010) found groups enhanced motivation and provided a meaningful and challenging environment for participants. In addition, a qualitative study by Gilmore et al., (2010) showed a group environment provided higher levels of engagement, motivation and fun.

Some therapists, doctors, and families are hesitant to engage in CIMT due to concerns related to the possible negative effects on the child. Potential risks associated with constraint use in pediatrics, including the possibility of increased frustration impacting self esteem, and "increased family burden and safety concerns" have been reported *(Gordon 2005 [X]).* Two studies specifically looked at the effect of immobilizing the unaffected arm: Sung, et al. found "no decline in hand function ... or any cases of joint stiffness or skin problems *(Sung 2005 [2])* and Willis and colleagues (2002) reported "there were no medical complications to casting"; however, found that some children experienced "irritability and or complaints about wearing the cast" *(Willis 2002 [2]).* In our pilot experience, the vast majority of children appear to accommodate to the constraint in less than 24 hours *(Cincinatti Consensus [5], Local Consensus [5]).*

A qualitative study by Gilmore et al., (2010) identified children perceived frustration, discomfort and effort required as barriers to participation in CIMT. However, enhancers such as team atmosphere, personal rewards of individual

goal achievement, group motivation and a supportive camp environment outweighed the barriers to participation. Research has shown that family focused interventions emphasizing engagement in goal selection promote positive outcomes with CIMT *(Smania et al., 2009 [2]; Aarts et al., 2010 [2], and Wallen et al., 2008 [4]).*

In the original Cincinnati guidelines, only three studies in pediatric CIMT literature assessed the use of CIMT with children diagnosed with conditions other than CP: two studies were conducted with children following traumatic brain injury causing hemiparesis *(Miller 2005 [5], Karman 2003 [4])* and one following ischemic stroke *(Gordon 2007 [4]).* Since 2007, six low level studies have emerged, exploring other populations: one following hemispherectomy *(De Bode, 2009 [4]);* four case studies following children aged 7-24 months after stroke *(Coker et al., 2009 [4]; Fergust et al., 2008 [5]; Cope et al., 2008 [5]; and Dickerson et al., 2007 [4]);* and a single case series study on brachial plexus (*Beusch, 2010 [4])* found slight improvement (not significant).

Overall, the use of constraint in pediatrics appears beneficial yet further evidence is still required. Specifically, the evidence does not yet answer many questions:

- What type of constraint should the child wear?
- How many hours should the constraint be worn daily?
- What is the ideal duration of constraint therapy in order to support lasting functional gains?
- Should therapeutic activities be completed while wearing the constraint and if so, should these activities be supported by a therapist, a caregiver, or some combination?
- At what ages is constraint therapy most beneficial?
- Are there ages or levels of functioning for which constraint therapy is not beneficial?
- What is the benefit of adjunctive therapies with CIMT on upper extremity outcomes?
- Is there greater benefit to carry out CIMT in group vs. individual intervention?

It will likely be many years until these questions are adequately addressed in the research. While we await answers, we need to provide the best possible care to our current patients with hemiplegia or BPI. Prior to the implementation of this guideline, CIMT has been offered to many children with hemiplegic CP, brain injury, and BPI receiving occupational or physical therapy services at CCHMC and in BC. However, the implementation of CIMT varies greatly among therapists. For example, the method of constraint, wearing schedule, duration of treatment, intensity of structured practice, and frequency of therapy services has been determined solely based on the judgment of the therapist and/or referring physician.

Guideline Recommendations

Assessment

1. It is recommended that therapist(s) determine if the child meets eligibility criteria for CIMT. Alternative therapy options should be considered for children not meeting the inclusion criteria for this guideline. *(Local Consensus [5].*
2. It is recommended that in-depth education be provided to families prior to implementing CIMT regarding the time and effort required. This ensures that families and participants are prepared and well motivated for successful completion of the CIMT program (*Eliasson et al., 2009 [3]).*
3. It is recommended that only an occupational therapist/ physiotherapist that has skills and knowledge in CIMT theory, EBP, clinical guidelines, assessments, goal setting, and development of home programming materials provide CIMT assessment and treatment *(Local Consensus[5]), Cincinnati Consensus [5], Cerebral Palsy International Research, 2007 [5]).*
4. It is recommended that a baseline assessment be completed within one month prior to initiating CIMT by an occupational therapist/ physiotherapist *(Cincinnati Consensus [5], Local Consensus [5]).*
    - This assessment should include participation and activity measures (i.e. COPM or GAS) to engage the child and parent and allow for individualized goals relevant to the child's daily context *(Gilmore et al., 2009 [1])*
    - Assess upper extremity function using standardized tools that measure impairment and activity levels when appropriate, based on the child's age (see Table 2 and Appendices 1-8).

Method and Fabrication of Restraint

5. It is recommended that the therapist try one or more methods of constraint with the child and parents to determine the least restrictive method that prevents the ability to grasp while allowing the child to use the arm for support *(Cerebral Palsy International Research 2007 [5], Cincinnati Consensus [5], and Local Consensus [5]).*

    - Various constraints have been studied in the literature but there is insufficient evidence to support the use of a specific type *(Hoare 2007 [1]).* A recent level IV study by Psychouli et al., (2010) found that mid-arm splints were most effective and most preferred by families, when compared to a mitt and long arm splint.
    - The protocols are based on studies that used either a glove or a mitt as their method of constraint *(Eliasson et al., 2005 [3]; Smania et al., 2009 [2], and Boyd et al., 2010 [2]).* Eliasson et al. (2005) specified their goal of the constraint was to prevent "the ability to grasp" while allowing the child to "use the hand for support or for breaking a fall".
    - In our experience, some young children do well with Tensor wrapping their unaffected arm or wearing a Pedi-wrap. However, some children require a more robust constraint from which they cannot slip out. These children will likely benefit from a hand splint with a cover (i.e. puppet/sock) or a removable cast. Older children who are able to understand the reason for constraint use may be able to use less restrictive constraints such as a tensor bandage to the unaffected arm *(Cincinnati Consensus [5], Local Consensus [5]).* Some BC therapists have found parents prefer a non-removal cast to increase their child's compliance.

6. It is recommended that the fabrication of removable casts for constraint be completed by an occupational therapist/physiotherapist with specific training in their fabrication *(Cincinnati Consensus [5], Local Consensus [5]).*

    - **Note**: Cast fabrication is a skill that, done incorrectly, has potential to cause harm to the child's arm. In our experience, the risk of skin breakdown or discomfort is minimized when fabricated by therapists with training in fabricating casts for constraint *(Cincinnati Consensus [5], Local Consensus [5]).*

Intervention

Frequency of therapy

7. It is recommended that therapists engage in shared decision making and provide education to parents on the following:

- the three CIMT treatment protocols described in Table 1, presenting the evidence and discussing the risks and benefits of the different protocols and availability of resources for group intervention *(Adams 2006 [5], Campbe1l 2001 [5], Chen* 1999 *[4]. Stenstrom* 1997 *[3])*
- the option of not implementing CIMT or waiting for implementation at a future date *(Cincinnati Consensus [5], Local Consensus [5]).*
    - The choice to not implement CIMT may be viewed as conservative management and is often difficult for families to choose *(Elwyn 2001 [4]).*
    - "Clients who perceive that they are actively involved in treatment decisions generally have better outcomes." *(Adams 2006 [4], Stewart 2001 [4], Greenjield 1988 [1])*
    - Parents may benefit from both verbal and written education about the protocols.

8. It is recommended that therapy sessions occur on at least a weekly basis throughout the CIMT program *(Eliasson 2005 [3], Willis 2002 [2]).*

    - Treatment subjects in Eliasson 2005 (from which Protocol 1 is based) received weekly intervention with occupational therapists. Treatment subjects in Smania 2009 (from which Protocol 2 is based) received 2 visits to physical therapy per week. Treatment subjects following the day camp model in Protocol 3 had involvement with therapists 5 times per week.

Treatment Sessions

9. It is recommended that treatment (both therapy sessions and structured practice with caregiver) should be based on the following principles, taking into consideration that the **most important factor is likely intensity of practice** *(Eliasson & Burtner, 2008).*

- use of individualized goals to guide treatment ***establishing clear goals maintained a focus for the intervention and their commitment to carrying out the therapy*** (*Wallen, 2008, [4])*
- provide motivation to use the impaired hand by using the child's inner drive to play *(Eliasson 2005 [3]) [*for example: a themed day camp environment enhanced motivation through fun experiences and positive

connections with others *(Gilmore et al., 2010)].*

- select activities of an appropriate level of difficulty so that child can be successful while developing new skills *(Eliasson 2005 [3]).*
- provide many opportunities for repetition *(Eliasson 2005 [3]).*

10. It is recommended that the treating therapist incorporate the following into each treatment session:

- update home program recommendations to guide structured practice with caregiver
- problem solve concerns with caregiver
- model interventions
- check fit and function of constraint, modifying if needed *(Cincinnati Consensus [5], Local Consensus [5]).*

11. It is recommended that group CIMT intervention be considered whenever possible *(Gilmore et al., 2010).*

Features of a group program can include:

- Social interaction and modeling with peers
- Participation in meaningful activities (i.e. mealtimes, crafts, games, cooking, sports)
- Use of a theme to enhance motivation
- Parent support and education

12. It is recommended that the treating therapist consider simultaneous use of other therapeutic techniques that may complement CIMT with caution *(Cincinnati Consensus [5], Local Consensus [5]).*

- The use of Botox with CIMT intervention is an emerging area of research. Results thus far have been inconclusive *(Park et al., 2009 [3]; Eliasson et al., 2009 [3]).*
- Current research is evaluating the use of CIMT and Bimanual therapy as stand alone and combined interventions *(Hoare et al., 2010 [2]; De Brito et al., 2010 [2]; Boyd et al., 2010 [2], and Facchin et al., 2009 [1]).* A recent study by Aarts et al., 2010 showed significant improvement for four out of five treatment outcomes with CIMT followed by Bimanual therapy.

Note: Research has not been conducted to assess the simultaneous use of some other therapeutic techniques with CIMT. Our clinical experience suggests considering the simultaneous use of orthoses, kinesiotaping, neuromuscular electrical stimulation, or other therapeutic interventions.

Home Program

13. It is recommended that the development of a home program be a family focused, collaborative process between the family and therapist. The home program should be updated weekly to guide caregivers' daily structured practice with the child *(Novak et al., 2009 [2]; Wallen et al, 2008[4]; Eliasson 2005 [3]).* The following are recommended features of a home program:

- it is based on mutually agreed upon family and child goals *(Novak et al., 2009 [2])*
- ongoing education and progress updates with child and family to sustain motivation *(Novak et al., 2009 [2])*
- it is guided by the principles detailed in recommendation 9 *(Eliasson 2005 [3])*
- it includes specific functional activities of interest to the family and child *(Novak et al., 2007 [4],Cincinnati Consensus [5], Local Consensus [5])*
- it focuses on one specific skill each week (e.g. grasp/release or shoulder flexion) *(Cincinnati Consensus [5], Local Consensus [5])*
- emphasis on five activities that target the chosen skill to be practiced during structured practice with the caregiver *(Cincinnati Consensus [5], Local Consensus [5]).*
- be provided in the form of an activity log to encourage daily follow through with program *(Cincinnati Consensus [5], Local Consensus [5]).*

Re-Assessment Following CIMT

14. Re-assessment is recommended within 1 week following completion of the CIMT program (using the same measures as in baseline assessment) in order to measure the outcome of CIMT with the child. In addition, follow up assessment may be conducted to determine if gains have been maintained *(Local Consensus [5]).*

Follow-Up

15. It is recommended that the therapist and family determine the child's future treatment plan after the completion of CIMT.

- The plan for continued therapy will need to be individualized and may be influenced by family and patient's goals and interests, the therapist's assessment of potential for progress, and the availability or resources. *(Cerebral Palsy International Research 2007 [5], Cincinnati Consensus [5], Local Consensusus [5]).*

- Taub et al. 2007 [2] found that children retained and further improved on the use of their affected limbs when parents follow through with at least 30 minutes per day of structured practice following CIMT intervention.

- Studies have demonstrated positive results when following CIMT with bimanual interventions *(Aarts et al., 2010 [2], De Brito et al., 2010 [2]).*

16. Therapists are recommended to discuss with families the potential for cumulative improvement through repeated trials of CIMT with *(Charles et al. 2007 [4]).*

Considerations for Community Implementation within the BC context:

- CIMT is carried out in a variety of settings
- Providing CIMT within home and school programs, alongside therapist-guided sessions, may produce better outcomes and improved participation in CIMT. This may also help to significantly reduce the overall costs associated with this intensive intervention *(Hoare et al., 2009 [1]).*
- In regions where children and families do not have weekly access to therapy services, Protocol 3 offers an alternative method for service delivery. This may be relevant in remote regions of the province, where a therapist may visit infrequently.
- The implementation tools accompanying this guideline can be used to support therapists, particularly those working in a sole charge position or with limited access to resources.

Key Messages

- Use the most effective child friendly form of restraint.
- Add intensity with daily structured practice.
- If possible, motivate the child by involving peers.
- Provide therapy involvement at least 1x/week.
- Family focused care is the key to engagement in CIMT.
- CIMT requires intensive family involvement and a large time commitment.
- The enhancers need to outweigh the barriers to participation.

Future Research Agenda

- In children with hemiplegia or BPI, is one protocol more effective than the other?
- In children with hemiplegia and BPI, what is the impact of severity on CIMT outcomes?
- In children with unilateral impairments other than hemiplegia, is CIMT effective?
- Are there specific characteristics of certain children (such as age, physiology, personality) that make them better candidates than other children to benefit from CIMT?
- In children who have used CIMT, would a period of intensive bilateral upper extremity therapy following CIMT improve long term outcomes?
- Does Botox offer additional benefits when combined with CIMT?
- Is CIMT beneficial for children less than 1 year old?
- What are the optimal environmental and social variables within a CIMT protocol?

Table 1: CIMT Protocols

	Protocol 1 (Based on Eliasson et a1 2005)	Protocol 2 (Based on Smania et al., 2009)	Protocol 3 (Based on Sakzewski et al, 2011a)
Duration of Intervention	8 weeks	5 weeks	2 weeks
Daily Constraint Wear	2 hours per day	8 hours per day	6h/day x 5 d/week (during day camp-circus theme)
Daily Structured Practice with Caregiver	2 hours per day while wearing constraint	(No structured practice required but 2 hours daily practice with caregiver encouraged)	No additional practice
Method of Constraint	Tensor Bandage; Pedi-wrap; Splint; Glove/Mitt; Removable Cast; Sling		
Frequency of Therapy	1 time per week	1-2 times per week	Daily
Setting	*Individual	*Individual	Group

* Based on the allocation of therapy resources within British Columbia, it may be more feasible to carry out protocols 1 and 2 in a group setting.

Barriers to implementation of the guideline may include:

1) the need for additional time to allow for individualized or group programming within this service delivery format

2) the need for additional personnel to allow for individualized or group programming

3) geographical barriers due to dispersion of clients throughout BC.

Possible facilitators to implement the protocols may include:

1) collaboration between disciplines to implement treatment and follow up (i.e. between treating physiotherapist and occupational therapist)

2) CIMT delivery by rehab assistants, therapy students, and trained volunteers under therapist supervision (following individualized assessment and program design by a therapist)

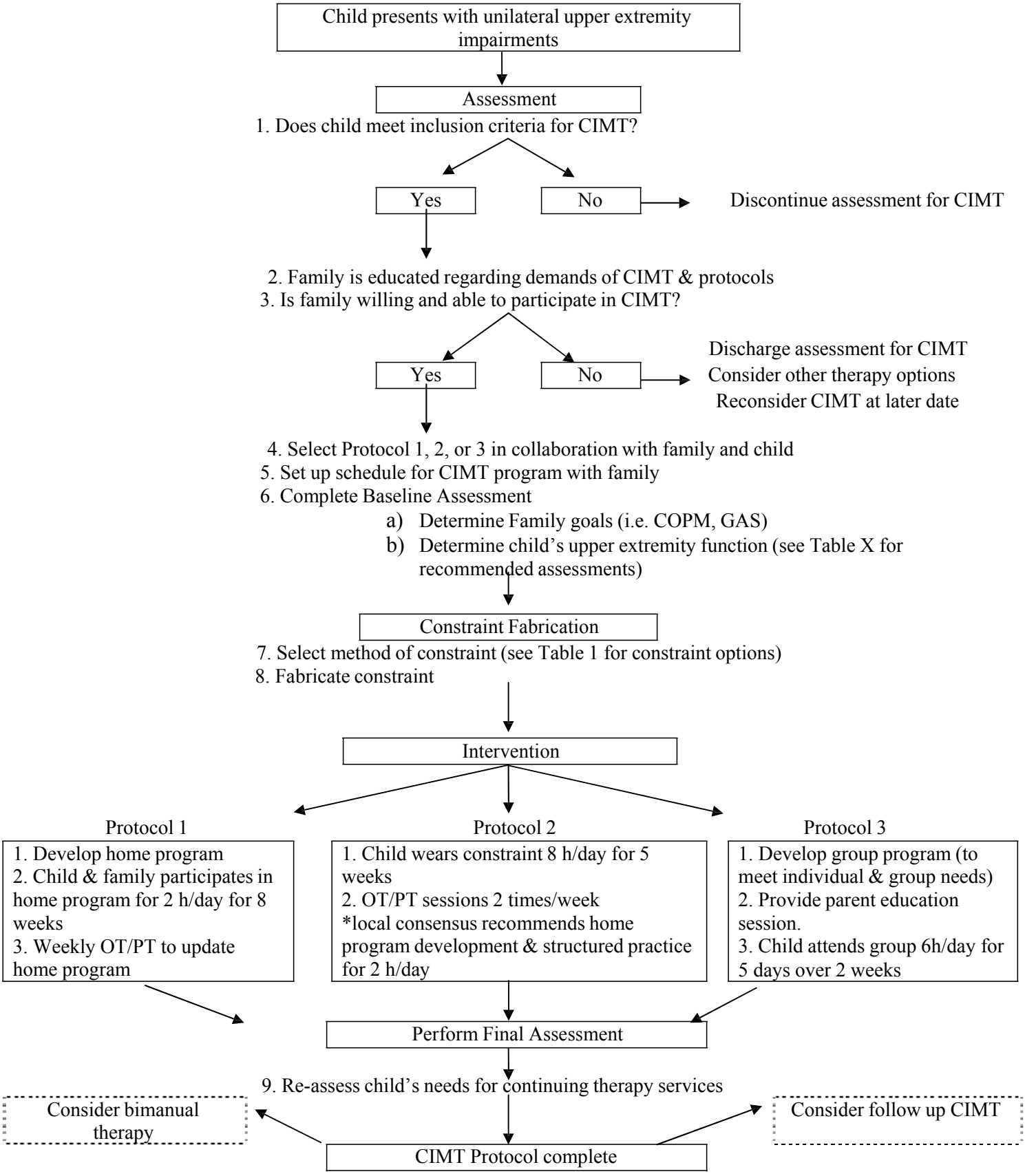
3) the use of the implementation tools accompanying the guideline.

Table 2: Recommended Measurement Tools by Age Group

Test	Recommended Age Group	Level of ICF	Resources
Canadian Occupational Performance Measure (COPM) Law2005 [X]	Recommended for all age groups, above age of 8 have child answer if possible otherwise parent report	Activity, Participation	http://www.caot.ca/copm/
Goal Attainment Scale (GAS)	Recommended for all age groups	Activity	http://www.tvcc.on.ca/images/stories/All_PDFs/OurServices/Research/gasmanual2007.pdf http://www.therapybc.ca/eLibrary/docs/Resources/Goal%20Attainment%20Scaling.pdf
Confidence Scale (Lorig 2003 [X], Holden 1991 [X])	Recommended for all ages	Body Structure and Function	
Manual Ability Classification System for Children with Cerebral Palsy (MACS) (Eliasson 2006 [X])	For ages 4-18	Activity	http://www.macs.nu/
Shriner's Hospital Upper Extremity Evaluation (SHUEE) (Pandyan 2003 [X], Bohannon 1987 [X])	For ages 3-18	Activity	http://jbjs.org/data/Journals/JBJS/904/JBJA0880203260E01_revised.pdf
Assisting Hand Assessment (AHA)	For ages 18 months to 12 years	Activity	http://www.ahanetwork.se/ * must be trained for administration of test
AbilHAND-Kids	For ages 6 to 15	Activity	http://www.rehab-scales.org/abilhand-kids.html
P-MAL (Revised)	For ages 2-8	Activity	http://www.uab.edu/citherapy/images/pdf_files/CIT_PMAL_Manual.pdf

*See Appendices 1-8 for details of assessment tools.

Algorithm for CIMT



Appendix 1
Canadian Occupational Performance Measure, 4th edition
(COPM) *(Law 2005 [X])*

Overview:

- Criterion-referenced, individualized outcome measure that can be used with clients of all ages and conditions.
- Client or caregiver is interviewed, using the test form as a guide, in order to determine problem areas in occupational performance.
- Assists in treatment planning and goal setting
- Measures change in client/caregiver perception of performance and satisfaction with performance

Assessment focus:

- Self-care including personal care, mobility, community management
- Productivity including paid/unpaid work, household management, school, and play
- Leisure including quiet recreation, active recreation, and socialization

Administration:

- Requires approximately 30 minutes to initially administer; requires approximately 10 minutes to administer at follow-up
- Asks the client to list problems using structure of performance areas
- Asks the client to rate (1-10) the importance of the problems
- Asks the client to rate (1-10) his/her present level of performance and level of satisfaction with that performance
- Supports the notion that all clients are responsible for their health and therapeutic process
- Allows input from family and/or caregiver if client is under the age of eight and/or unable to answer on his/her own behalf.

Validity:

- Study completed with evidence supporting content, criterion, and construct validity of the COPM.
- The COPM has been validated against several other measures with support for its validity while supporting that the assessment provides information that cannot be obtained with other standardized instruments.

Reliability:

- lnter-rater agreement of the prioritized problems was moderate.
- Test-retest reliability has been shown to be acceptable with various health conditions although it has not been assessed with CP.
- The reproducibility of the mean performance and satisfaction scores was moderate but it was poor for the scores of the separate problems. Therefore, the mean scores should be used for individual assessment.

Reason for Use:

- Measures effectiveness of intervention
- Helpful in developing client centered goals and intervention
- Motivational interviewing offers health care professionals a potentially effective strategy for increasing a patient's readiness to change health behaviours

Appendix 2
Goal Attainment Scale (GAS)

Overview:

- Evaluative – can be used to measure progress in heterogeneous populations with a variety of treatment goals
- Measures performance or capacity
- Goals should be written in SMART language (specific, measurable, acceptable, relevant, and time-related), and set in collaboration with client/family
- Provides clear goals and priorities for intervention and reflects a client-centred perspective to service delivery
- Teams of therapists and parents are very satisfied about working with GAS
- First introduced in 1968 to evaluate mental health services. Has now been used in a variety of settings and for many purposes.

Assessment focus:

- Measures individual progress towards individual goals
- ICF: activity and participation; also could be used for body function/structure

Administration:

- Individual SMART goals set with client/family
- Goals scored at review time on a 5-point scale from -2 to +2, with 0 representing the expected level of success
- Generally assumed that training should occur prior to use of the GAS to ensure reliability
- Procedures available for transforming several scales per client into a single *T* score , in which each goal is weighted and an average correlation is determined

Reliability:

- Reported to be largely unknown
- Potential source of therapist bias in scoring as clinical judgment of treating therapist is used to determine the expected level of attainment for each goal

Validity:

- Reported to be 'ambiguous' – concurrent validity is low, but the GAS can measure exactly what needs to be measured

Responsiveness:

- Assumed to be better than that of the common standardized activity and participation measures, despite the questions about reliability

References:

Steenbeek D, Ketelaar M, Galama K, Gorter JW. Goal attainment scaling in paediatric rehabilitation: A critical review of the literature. 2007 DMCN 49: 550-556.

Appendix 3
Confidence Scale

Overview:

- 10 point scale used to measure self efficacy and to help empower families in follow through with home programming

Assessment focus:

- Caregiver/Client confidence in ability to complete home programming

Administration:

- After development of home program activity log (and prior to fabrication of CIMT), ask the patient and family to report their confidence in their capability of the home program using a rating scale from I to 10 (0 = totally unconfident, 10 = totally confident).
- If the answer is 7 or higher, based on self-efficacy theory, there is a good chance that the home program will be accomplished.
- If the answer is less than 7, problem solving and a more realistic plan might be appropriate to avoid failure.

Validity/Reliability:

Studies have shown benefit of utilizing this method to determine readiness for home program adherence

Appendix 4

Manual Ability Classification System for Children with Cerebral Palsy

(MACS)

(Eliasson 2006 [X])

Overview:

- Systematic method to classify how children with cerebral palsy use their hands when handling objects in daily life
- Intends to describe which level best represents the child's usual performance at home, school, and community settings
- Classification based on child's actual performance in daily life. It should not be done as a specific assessment but by asking someone who knows the child and how that child performs typically.
- The child's ability to handle objects is considered from an age-related perspective
- Intends to report the performance of both hands working together in activities, not an assessment of each hand separately

Assessment focus:

- Handling objects in daily activities for play, leisure, and selfcare

Administration:

- Children with cerebral palsy ages 4-18 years
- Ask someone who knows the child about how the child performs typically, observe.
- Determine which of five levels most accurately describes the child's performance. A distinction between levels is provided.
- About 5 minutes are required to determine classification.

Reliability:

- The intraclass correlation coefficient between therapists was 0.97 (95% confidence interval 0.96-0.98), and between parents and therapist was 0.96 (0.89-0.98), indicating excellent agreement.

Validity:

- Validation was based on the experience within an expert group, review of the literature, and through analysis of children across a spectrum of function.

Appendix 5

Shriners' Hospital Upper Extremity Evaluation (SHUEE) *(Shriners 2005 [X])*

Overview:

- Video-based tool for assessment of upper extremity function in children with hemiplegic cerebral palsy
- Outcome measure to assess effectiveness of intervention on functional performance
- Standardized assessment kit as well as standardized positioning of the video camera
- Assists in goal setting
- Also includes assessment of active and passive upper extremity ROM, tone, and ADLs

Assessment focus:

- Spontaneous use of involved extremity
- Dynamic positional analysis (position of thumb, fingers, wrist, forearm, and elbow during functional activities) of involved extremity
- Grasp and release with wrist in flexion, neutral, and extension
- Active and passive range of motion from shoulder to fingers
- Spasticity (evaluated using the modified Ashworth Scale)
- Caregiver or subject report of independence in selected activities of daily living

Administration:

- Requires approximately 15 minutes to administer, scoring is done separately when time is available to review the video
- Requires a videographer in order adjust camera angles to capture body segment being assessed.
- Evaluation consists of AROM, PROM, spasticity, selected ADLs, client/caregiver goals, spontaneous use of involved extremity, assessment of the segmental alignment of the involved extremity during performance of 16 selected tasks, grasp and release with the wrist held in flexion, neutral and extension.
- Numerical scoring is done to facilitate comparison over time

Reliability:

- Study establishes clinical reliability *(Davids 2006 [B])*

Validity:

- Study established concurrent validity and construct validity *(David 2006 [B])*

Appendix 6

Assisting Hand Assessment (AHA)

Overview:

- Evaluative and descriptive assessment that is based on observations of actions performed in an activity that is relevant and motivating for the individual, and is videotaped
- Measures performance
- Standardized criterion-referenced test
- Should be administered by a certified rater who has attended a training course
- Enables comparison of data for the same child on different occasions, or between different children

Assessment focus:

- Measure and describe how effectively children who have a unilateral disability use their affected hand (assisting hand) in bimanual activity performance
- ICF: activity

Administration:

- Children with cerebral palsy hemiplegia or brachial plexus injury 18 months to 12 years
- Observation of actions with the affected hand/arm during a semi-structured play session of about 15 minutes duration
- Scoring through review of videotaped activities, using six categories: general usage, arm use, grasp-release, fine motor adjustment, coordination, and pace. Scoring is on a 4-point scale, which rates the quality of performance

Reliability:

- Excellent inter- and intra-rater reliability

Validity:

- Demonstrated evidence that AHA is valid for children with hemiplegic cerebral palsy and brachial plexus injuries

Responsiveness:

- Evidence of sensitivity to change

References:

Krumlinde-Sundholm L, Holmefur M, Eliasson A-C. AHA Manual, English version 4.4. 2007

Krumlinde-Sundholm L, Holmefur M, Kottorp A, Eliasson A-C. The assisting hand assessment: Current evidence of validity, reliability, and responsiveness to change. 2007. DMCN 49: 259-264.

Appendix 7

AbilHANDS-Kids

(Arnould 2004)

Overview:

- Measures ability to perform daily activities that require use of upper limbs in children with upper limb impairments.
- Parent completed questionnaire. Child is **never** asked to perform the activities in front of the evaluator.
- Answers to the ABILHAND-Kids questionnaire can be submitted online and instantly get a Rasch evaluation report

Assessment focus:

- Measures how much difficulty the child has independently performing a daily activity that uses one or both upper extremities regardless of how they perform the task.

Administration:

- Children with cerebral palsy ages 6-15 years
- Activities are presented in a **random order** to avoid any systematic effect.
- 21 manual activities perceived by the children parents.
- Each item is answered by parent on a 3-level scale (impossible, difficult, easy).
- The item difficulty increases with bimanual involvement.
- activities not attempted in the last 3 months are not scored

Reliability:

- Separation reliability: 0.94 in a sample of 113 children with cerebral palsy.
- Test-retest reliability: R=0.91 after a delay of (25 +/- 13) days.

Validity:

- 4 expert Occupational Therapists demonstrated test valid for children with cerebral palsy when questions completed by parents.

References:

Arnould C, Penta M, Renders A, Thonnard JL Neurology 2004; 63: 1045-1052. ABILHAND-Kids: A measure of manual ability in children with cerebral palsy.

Arnould C, Penta M, Thonnard JL Journal of Rehabilitation Medicine 2007; 39(9): 708-14. Hand impairments and their relationship with manual ability in children with cerebral palsy.

Appendix 8
Pediatric Motor Activity Log (PMAL) -Revised

Overview:

- Structured interview with primary caregiver to measure frequency and quality of use of child's involved upper extremity (UE) in their natural environment outside the therapeutic setting
- Used with CIMT protocol before, during and post treatment
- Initial test (MAL) for adults was developed in 1986 by Edward Taub and Karen McCulloch and later modified for the pediatric population

Assessment focus:

- Parent's perception of how often and how well child uses affected upper extremity.

Administration:

- **Valid for children aged 2-8 Years**
- List of 22 items rated on a 6 point scale for how often child carries out each activity with more involved arm and on a 6 point scale about how well child uses the more involved arm for that activity

Reliability and Validity

- Research by Whallen et al (2009) concluded the revised PMAL was both valid and reliable except for children at the extremes of upper limb functioning.
- Test–retest reliability of both scales on revised PMAL was high (the intraclass correlation coefficient for the How Often scale was 0.94, and for the How Well scale 0.93).

References:

PMAL originally developed by: Taub E et al. (2004) Efficacy of constraint-induced movement therapy for children with cerebral palsy with asymmetric motor impairment. *Pediatrics, 113,* 305-312.

Revised by: Wallen M et al. (2009) Psychometric properties of the Pediatric Motor Activity Log (PMAL) used for children with cerebral palsy. *Developmental Medicine and Child Neurology*, *51*(3), 200-208. .

Appendix 9
Articles Reviewed for Cincinnati Guideline (2009)

Articles Reviewed in Cincinnati Guideline (2009)*
Studies using a control group
Taub et. al, 2007
Charles et al., 2006
DeLuca et al., 2005
Eliasson et al., 2005
Sung et al., 2005
Taub et al., 2004
Willis et al., 2002
Cohort Studies
Charles et al., 2007
Gordon et al., 2006
Case Series & Case Studies
Gordan et al., 2007
Sutcliffe et al., 2007
Bonnier et al., 2006
Miller et al., 2005
Naylor et al., 2005
DeLuca et al., 2003
Karman et al., 2003
Clover et al., 2002
Pierce et al., 2002
Charles et al., 2001
Cracker et al., 1997

* Please see Cincinnatti Guideline for complete references.

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Development Process

In 2009, the Cincinnati Pediatric Constraint Induced Movement Therapy Guideline was originally developed by the Evidence Based Practice Team in the Division of Occupational Therapy and Physical Therapy at Cincinnati Children's Hospital Medical Center. Rehabilitation professionals at Sunny Hill Health Centre for Children (SHHCC) and BC Centre for Ability (BC-CFA) located in Vancouver, British Columbia did not have documented evidence-based guidelines for the selection and use of constraint-induced movement therapy for children with hemiplegia. The absence of documented guidelines may result in variation in the selection and use of CIMT within each centre as well as variation in the information shared with students and colleagues. The Cincinnati guideline developers have indicated that the guidelines may be adapted or adopted with acknowledgement and notification. As such, Sunny Hill Health Centre for Children and BC Centre for Ability received permission to update the guidelines with evidence from 2007-2010 and adapt them for the BC context. The recommendations in this guideline were formulated by an interdisciplinary working group, which performed a systematic and critical literature review using the grading scales developed in the American Academy for Cerebral Palsy and Developmental Medicine (AACPDM) Methodology to Develop Systematic Reviews of Treatment Interventions (Revision 1.2) and examined current local clinical practices. This is in contrast to the original guideline, which used the

Cincinnati Children's Hospital Medical Centre Grading Scale. Please see the grading scale comparison table that was used to guide the reviewers in critical appraisal and literature review process.

ACCPDM Level	CCHMC Grading Scale
1	M, A,
2	B,
3	C (control group)
4	C (no control group), D
5	E, F, S,O, Q, L,
No evidence	X

CCHMC Grading Scale

M – Meta-analysis or Systematic Review
A- Randomized controlled trial (large sample)
B- Randomized controlled trial (small sample)
C- Prospective trial or large case series
D- Retrospective analysis
S- Review article
O- Other evidence
E- Expert opinion or consensus
F- Basic Laboratory Research
L- Legal Requirement
Q- Decision analysis
X- No evidence

Sackett's Levels of Evidence for Group Designs (ACCPDM adaption December 2008)

Level 1: Systematic review of randomized controlled trials (RCTs); Large RCT (with narrow confidence intervals) (N>100)
Level 2: Smaller RCTs (with wider confidence intervals) (N<100); Systematic Reviews of cohort studies; "Outcomes research" (very large ecologic studies)
Level 3: Cohort studies (must have concurrent control group); Systematic reviews of case control studies
Level 4: Case series, before-after; Cohort study without concurrent control group (e.g. with historical control group); Case control study
Level 5: Case study or case report, expert opinion, bench research

To update the existing guideline, evidence for critical appraisal was selected by searching Medline, Embase, CINAHL, Ovid EBM Reviews (includes Cochrane), Web of Science, and PedRO databases using the following terms as both keywords and subject headings.

- Constraint induced therapy
- Forced use
- Unimanual forced treatment
- Unilateral upper extremity impairment
- Neurological disorders
- Brain Injury
- Cerebral Palsy
- Brachial plexus injury

Database searches were filtered with the following limiters: "English Language", "All Child", "human", and years 2007-2010. Eliminating duplicates reduced the citations further.

As part of the evidence search for this guideline update, we requested A Canadian Agency for Drugs and Technologies in Health (CADTH) Rapid Response Report. CADTH produced "Constraint-Induced Movement Therapy for Children: Clinical Effectiveness and Clinical Practice Guidelines" in response.

Tools to assist in the effective dissemination and implementation of the guideline may be available online on the Child Development and Rehabilitation website at http://www.childdevelopment.ca/Home.aspx .

To view a copy of the original guideline developed by the Evidence Based Practice Team at Cincinnati Children's Hospital Medical Centre please visit http://www.cincinnatichildrens.org .

An external review process was undertaken with both families and clinicians to evaluate if the revised guideline was appropriate for the BC context and met the objectives outlined.

Family Feedback: Four families provided feedback through either an online survey or telephone interview. All families reported that the guideline provided a clear explanation of what CIMT is and felt the guideline would help therapists and themselves to determine collaboratively the appropriateness of CIMT for their child. All families felt that they could use a constraint for therapy and were most comfortable with using a splint or a glove or mitt. Out of the protocols outlined, families felt they would be most able to complete protocol 1, carried out over 8 weeks with 2 hours of structured practice at home or protocol 3 (2 weeks of day camp). Protocol 2 was reported as the least feasible of the three protocols. All families agreed with the home program recommendations. Families reported the following would help them carry out CIMT with their child: (1) individualized activities, (2) involvement in a group, and (3) a homework kit with activities to work on.

Clinician Feedback: Eight clinicians with expertise in treating upper limb impairments reviewed the guideline and provided initial input about the clarity, readability and organization of the guideline, the utility of the recommended outcome measures to the BC context, the appropriateness of the types of constraints and protocols recommended, and the types of implementation tools that would assist clinicians when carrying out this intervention. Based on initial feedback from clinicians, the guidelines were modified and implementation tools were developed. In addition, two external reviewers appraised the final revised guideline to determine if it adhered to standards set out in the AGREE II Instrument.

A Motor Management Evidence Based Practice Team at Sunny Hill Health Centre will review alerts to new CIMT research literature to identify the need for potential revisions to the guideline. At the three-year point the CIMT Team will reconvene to explore the continued validity of the guideline. This phase will be initiated at any point that the team finds evidence that indicates a critical change is needed. Feedback received for this version during the external review process will be taken into full consideration at that time (see AGREE II results below).

The adapted guideline was externally appraised by 2 reviewers using the AGREE II instrument and the results by domain are:

- Scope and Purpose 93%
- Stakeholder Involvement 88%
- Rigor of Development 88%
- Clarity and Presentation 93%
- Applicability 77%
- Editorial Independence 96%

Recommendations have been formulated by a consensus process directed by best evidence, patient and family preference and clinical expertise. During formulation of these recommendations, the team members have remained attuned to differences in opinion and evidence related to the management of patients with unilateral upper extremity impairment. Consensus was used to resolve controversial issues when possible and when not possible, optional approaches have been provided through information that includes the best supporting evidence of efficacy for alternative approaches.

The guideline has been reviewed and approved by clinical experts not involved in the development process, distributed to senior management, and to other parties as appropriate for their intended purposes.

The guideline was developed without external funding. All team members declare no conflict of interest.

Copies of this Evidence Based Care Guideline may be distributed by any organization for the global purpose of improving child health outcomes. Please see the following website address for the guideline: http://www.childdevelopment.ca/Home.aspx .
Copies may be provided to patients and clinicians who manage their care.

Note: These recommendations result from review of literature and practices current at the time of their formulations. This guideline does not preclude using care modalities proven efficacious in studies published subsequent to the current revision of this document. This document is not intended to impose standards of care preventing selective variances from the recommendations to meet the specific and unique requirements of individual patients. Adherence to this guideline is voluntary. The clinician in light of the individual circumstances presented by the patient must make the ultimate judgment regarding the priority of any specific procedure.

For more information about this guideline, its supporting evidence and the guideline development process, contact the Therapy Department at Sunny Hill Health Centre for Children at 604-453-8302.

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