



# HEIGHTEN

*Study Program Manual  
for Clinicians*



# Table of Contents

<b>DISCLAIMER</b> .....	<b>4</b>
<b>STATEMENT OF PURPOSE</b> .....	<b>5</b>
<b>THE HEIGHTEN TRIAL</b> .....	<b>6</b>
Section Summary .....	6
HEIGHTEN Summary .....	6
Research Questions .....	6
HEIGHTEN Therapy .....	6
Constraint-Induced Movement Therapy (CIMT) .....	7
Bimanual Training .....	7
Therapy Dose .....	7
Caregiver-led Home-based Therapy .....	8
Supporting Caregivers .....	8
Weekly Therapy Content .....	9
Hybrid Format: In-Person and Virtually Delivered Sessions .....	9
<b>CLINICIAN TRAINING &amp; EDUCATION</b> .....	<b>10</b>
Section Summary .....	10
HEIGHTEN Study Training .....	10
CIMT Training .....	10
Coaching Education .....	10
<b>PARTICIPANTS</b> .....	<b>11</b>
Section Summary .....	11
Participants .....	11
Eligibility Criteria .....	11
Enrolment Processes .....	12
<b>WEEKLY SESSIONS</b> .....	<b>13</b>
Section Summary .....	13
Session Content .....	13
Hybrid Delivery Model .....	13
Clinician Schedule .....	14
<b>PRACTICAL CONSIDERATIONS FOR THERAPY</b> .....	<b>15</b>
Section Summary .....	15
Constraining the Preferred Arm .....	15

Child Positioning .....	15
Caregiver Positioning .....	16
Home Practice Timing .....	16
Home Practice Location .....	16
Safety .....	16
<b>CREATING HOME PROGRAM .....</b>	<b>17</b>
Section Summary .....	17
Home Program Overview .....	17
Family-centred, Individualized Therapy .....	17
Therapist-identified Goals .....	18
Target Movements .....	18
Play-based Format .....	18
Developmentally Appropriate Activities .....	19
Promoting Motor Learning .....	19
Repetitive Practice .....	19
Progressive Activities .....	19
Variety of Activities .....	20
Toys and Objects .....	21
<b>SUPPORTING CHILD ENGAGEMENT .....</b>	<b>22</b>
Section Summary .....	22
Child Engagement .....	22
Intervention Fidelity .....	22
Signs of Engagement and Disengagement .....	23
Adjusting to Child's Cues .....	23
Teaching Loop .....	24
Follow Child's Lead .....	24
Just Right Challenge .....	24
Feedback and Praise (Reinforcement) .....	25
Behavioural Challenges .....	25
<b>COLLABORATIVE GOAL SETTING .....</b>	<b>26</b>
Section Summary .....	26
Collaborative Goal Setting .....	26
SMART goals .....	26
Updating Goals .....	27

<b>COACHING USING MOTIVATIONAL INTERVIEWING .....</b>	<b>28</b>
Section Summary .....	28
Motivational Interviewing .....	28
Principles of Motivational Interviewing .....	28
Skills .....	28
<b>THE APPLIED COACHING MODEL (ACM) .....</b>	<b>31</b>
Section Summary .....	31
The Applied Coaching Model (ACM) .....	31
Clinician Actions .....	31
<b>ASSESSMENTS .....</b>	<b>34</b>
Section Summary .....	34
Implementation Outcomes .....	35
Assessment Schedule .....	36
Assessment Content .....	36
Completed by OT .....	37
Collected by Research Team .....	37
Caregiver Questionnaires .....	38
<b>STUDY FORMS .....</b>	<b>39</b>
Recruitment Flyer .....	39
Consent to Contact .....	40
Phone Screening .....	41
Screening Form .....	42
Fidelity Checklist .....	43
The GAS Process .....	44
<b>APPENDIX .....</b>	<b>46</b>
Development of Fine Motor Skills .....	46
Types of Grasps in Infancy and into Toddlerhood .....	47
Skill Progressions for Grasping .....	48
Skill Progressions (other than grasp) .....	51
Activity Ideas .....	54
Summary of recent trials .....	57

# DISCLAIMER

This manual contains recommendations based on recent evidence and clinical experience with constraint and bimanual therapy for children with hemiplegic cerebral palsy.

This manual was developed for caregivers and healthcare providers to use as a guide to provide practical suggestions to implement constraint and bimanual therapy and does not constitute professional clinical advice. Healthcare providers are required to exercise their own clinical judgment in using the manual and application of any information contained in this manual should be based on individual/client/patient needs, the relevant circumstances, and local context. Caregivers are encouraged to seek professional advice to ensure the suggestions within are appropriate. Neither University of Calgary nor any of the authors and/or contributors of the manual are providing treatment services through the information contained in this manual. Moreover while every effort has been made to ensure the accuracy of the content of the Manual at the time of publication, neither University of Calgary, nor any of its agents, appointees, directors, officers, employees, contractors, members, volunteers or related parties: (i) give any guarantee to the completeness or accuracy of the information contained herein; and (ii) TO THE EXTENT PERMITTED BY APPLICABLE LAW, ACCEPT ANY LIABILITY OR RESPONSIBILITY FOR THE USE OR MISUSE OF THE MANUAL BY ANY INDIVIDUAL OR ENTITY, INCLUDING FOR ANY LOSS, DAMAGE, OR INJURY (INCLUDING DEATH) ARISING FROM OR IN CONNECTION WITH THE USE OF THE MANUAL IN WHOLE OR IN PART.

# STATEMENT OF PURPOSE

This manual was created for occupational therapists and therapy assistants providing therapy to young children with asymmetric hand use and cerebral palsy. The therapy outlined is specific to the HEIGHTEN study ([ClinicalTrials.gov Identifier: NCT05346887](https://clinicaltrials.gov/ct2/show/study/NCT05346887)). The manual is intended to guide clinicians in designing an individualized therapy program, and in coaching caregivers to deliver home-based therapy.

The manual is also meant to be informative. Recent evidence is summarized and references to published manuscripts are listed at the end of the manual. Clinicians are encouraged to provide feedback about the manual. Please share any ideas or suggestions with the research team.

# THE HEIGHTEN TRIAL

## Section Summary

- HEIGHTEN is a research study for children from 3 months to 2 years old with a hand asymmetry and confirmed or suspected cerebral palsy (CP).
- Caregivers deliver home-based therapy 30-minutes per day for 18 weeks.
- The program begins with constraint-induced movement therapy (CIMT), and bimanual therapy introduced is in the final five weeks if child is >9 months old.
- Clinicians provide support during weekly therapy sessions.
- Weekly sessions may be in-person or virtually delivered.

## HEIGHTEN Summary

Early rehabilitation interventions are essential to improve the long-term health and wellbeing of young children with cerebral palsy (CP). Yet evidence-based interventions are not consistently offered to children under two years old. A multidisciplinary team was formed to assess an upper extremity early intervention to identify necessary changes to promote intervention effectiveness and successful clinical implementation. Intervention effectiveness and implementation will be assessed over a 12-month period in two Canadian cities. We will enroll twenty children aged 3 to 24 months with a hand asymmetry due to CP. The home-based, caregiver-delivered intervention involves 18-weeks of daily 30-minute therapy supported by weekly visits with a therapist. Outcomes will be assessed before, after, and 8 weeks after the intervention. Changes in individualized goal achievement, hand function, and caregiver well-being will be assessed. Program satisfaction of both caregivers and therapists will inform implementation, along with tracked data in areas including cost and feasibility. By systematically studying effectiveness and implementation at two sites, implementation solutions will be identified to trial nationally. Results will support lasting change in clinical practice to optimize lifelong outcomes for young children with CP.

## Research Questions

1. Is an intensive upper extremity home-based intervention for infants and toddlers with cerebral palsy acceptable to caregivers and therapists?
2. Is an intensive upper extremity home-based intervention effective for attainment of caregiver-identified functional goals and for improvement of arm/hand function for infants and toddlers with cerebral palsy?

## HEIGHTEN Therapy

The home-based caregiver-delivered intervention involves 18 weeks of daily 30-minute home-practice with one weekly session with an Occupational Therapist (OT) or Therapist Assistant

(TA). The weekly session will be delivered over video call (virtual) or at the local rehabilitation centre (in-person). Home practice time will be distributed across the day as necessary to facilitate integration into daily routines. Intervention content will be individualized based on child age, ability, and interests.

HEIGHTEN begins with constraint-induced movement therapy (CIMT). Bimanual therapy in Week 13 is introduced based on child age. Both approaches are grounded in motor learning principles, namely repetition, progressive challenge, and a variety of activities in a real-life setting.

For both CIMT and bimanual training, the infant/toddler will be in a supported position to limit postural degrees of freedom and facilitate focus on upper extremity movements.

### *Constraint-Induced Movement Therapy (CIMT)*

There is not an established upper extremity evidence-based early intervention for children with CP, but early Constraint Induced Movement Therapy (CIMT) trials are promising.<sup>1,2</sup> CIMT involves constraining the child's preferred hand to encourage use of the affected hand. In this manual, the affected hand will be referred to as the assisting hand.

Importantly, research has shown that constraining the preferred hand is not harmful. The development of the child's preferred side will not be negatively impacted by constraint.<sup>2</sup>

### *Bimanual Training*

For bimanual training, both hands will be free of constraint and activities will focus on involvement of both hands.<sup>3</sup> Evidence from school-aged children suggests that bimanual practice may encourage carry-over into everyday activities and may be effective for infants aged 8-18 months.<sup>4</sup> As coordinated bimanual movements emerge throughout the first years of life, a concentrated focus on bimanual practice may not be suitable for young infants. Introduction of bimanual skills in the last five weeks, with therapy time split between CIMT and bimanual training, may be an appropriate solution.

### *Therapy Dose*

The HEIGHTEN study has a therapy dose of 60 hours total: 30 minutes per day for 18 weeks.

Published CIMT protocols vary in schedule and dose. A summary of recent trials is provided in the Appendix. A well-known protocol is baby-CIMT.<sup>5</sup> A manual was published online in 2015, which facilitated adoption at many clinical sites. Baby-CIMT has a dose of 36 hours, achieved in two six-week periods of daily 30-minute practice with a six-week break in the middle. An initial randomized controlled trial of baby-CIMT resulted in greater improvements in hand function



than baby massage, as assessed by the Hand Assessment for Infants.<sup>6</sup>

More recent trials are investigating higher doses, based on evidence in school-aged children that higher doses may result in greater gains. For example, the ongoing iACQUIRE trial is comparing high dose (120 hours total: 6 hours/day, 5 days/week for 4 weeks) to moderate dose (60 hours total: 3 hours/day, 5 day/week for 4 weeks). The ongoing REACH trial has a total dose of >70 hours, achieved with daily practice for 20-40 minutes for >6 months.

However, these intensive and lengthy schedules can be challenging in clinical settings. HEIGHTEN was designed to maximize dose with a schedule that is feasible for families and therapists. In current clinical programming of baby-CIMT, caregivers have not reported treatment fatigue at 12 weeks. An 18-week program has an intervention dose of >60 hours, a dose used by other early intervention studies<sup>2</sup> which may be the minimum required dose for meaningful improvements in school-aged children.<sup>7,8</sup>

### *Caregiver-led Home-based Therapy*

Caregivers deliver HEIGHTEN at home for 30-minutes each day. Caregiver involvement in therapy delivery and decision-making is increasingly recognized as imperative for early intervention success,<sup>9</sup> with practice in the home environment identified as a facilitator.<sup>10</sup> Home-based programs have been successfully completed with children and infants with CP.<sup>6,11,12</sup> Home-based therapy is attractive for potential benefits such as higher therapy doses at lower cost, increased accessibility for families, and caregiver empowerment.<sup>11</sup> The home setting is a convenient, familiar environment, and use of home toys may facilitate daily practice. Observing the home environment also allows clinicians to demonstrate or suggest different ways home toys and objects can be used therapeutically.

### *Supporting Caregivers*

In a home-based model, trained clinicians coach caregivers in therapy delivery. The therapist's role shifts from therapy delivery to supporting caregivers in therapy delivery through education and problem-solving. The therapist is a key part of HEIGHTEN, as success of caregiver-delivered early interventions may be contingent upon effectively supporting and empowering caregivers.<sup>13</sup>

Clinicians involved in HEIGHTEN will receive coaching training. When coaching, the relationship between therapists and caregivers is not a traditional directive relationship.<sup>9,14</sup> A coaching approach fosters equal partnership and collaboration,<sup>15</sup> which is especially important for goal-setting and therapy planning in the home environment.<sup>9,10,13</sup>

In addition to a supportive relationship with the therapists, caregiver manuals and an online

resource will be available to HEIGHTEN participants. The focus of these materials will go beyond intervention purpose and implementation to include information such as positive caregiver-infant interactions and child development.<sup>9,13</sup>

### Weekly Therapy Content

All weekly sessions with the therapy team will be 45-minutes to allow for set-up/troubleshooting and 30-minutes of active practice and reflection/summary of new strategies. The first 13 weeks of the program will be exclusively CIMT. Weeks 14-18 will be tailored to the child’s age and develop of manual skills as follows:

Age	Program Week	Daily Practice
Under 9 months	1-18	30 minutes CIMT
9 to 18 months	1-13 14-18	30 minutes CIMT 20 minutes CIMT + 10 bimanual
18 to 24 months	1-13 14-18	30 minutes CIMT 10 minutes CIMT + 20 bimanual

### Hybrid Format: In-Person and Virtually Delivered Sessions

HEIGHTEN allows for weekly sessions to be in-person or virtually delivered over video call. In March 2020, therapists began virtual delivery of weekly visits over video call to ensure care was not interrupted during the COVID-19 pandemic. Benefits and challenges of virtual delivery were observed. Virtual delivery allows therapists to see the home environment and may make therapy more accessible, suggested by excellent program attendance. However, maintaining focus during virtual delivery can be challenging for some children and certain elements of therapy are best coached hands-on.

The ideal delivery mode, whether in-person or virtual, is likely child-specific and should be selected by the family and therapist. For these reasons, HEIGHTEN will be delivered in a hybrid format with some sessions in-person and some sessions virtual.

# CLINICIAN TRAINING & EDUCATION

## Section Summary

- Clinicians will be trained in three areas: HEIGHTEN protocol, CIMT, and coaching
- Clinicians will have this manual and continued support from experienced clinicians and the research team

## HEIGHTEN Study Training

All clinicians will receive this program manual, designed to guide the OT/TA. A 30-minute video will train OTs and TAs on the HEIGHTEN protocol. The study training will be designed by a research team member and an experienced OT and TA. An additional hour of training has been allocated for therapists to discuss individual questions with the research team.

## CIMT Training

Clinicians (OTs or TAs) who have less than one-year experience with early intensive intervention and CIMT will receive training on therapy delivery. This will involve an initial one-hour meeting to discuss the program with an experienced clinician with >3 years' experience (termed "trainer"). The clinician will attend a baseline assessment completed by the trainer. Following the assessment, the clinician and trainer will discuss GAS goal setting, target movement identification, and session content, as appropriate based on clinical designation. The trainer will observe initial therapy sessions, with time allocated for collaborative session planning and debrief. The trainer will be available to answer questions over phone or email for the duration of the program.

## Coaching Education

Before starting the study, OTs and TAs will complete a two-hour asynchronous online course on the Applied Coaching Model. The Applied Coaching Model was developed by therapists at the Alberta Children's Hospital to provide education and training for clinicians on coaching in pediatric rehabilitation settings. After completing the online course, therapists will use the Applied Coaching Tool to intentionally practice and reflect on their coaching development and skills with one participant each week for four weeks. Intentional practice may occur during regular clinical sessions or study sessions. A trained Applied Coaching Model assessor will check-in with OTs/TAs to support their learning and implementation of the Applied Coaching Model. After training is complete, a videotaped session will be documented for use of the Applied Coaching Model actions using the therapist checklist.

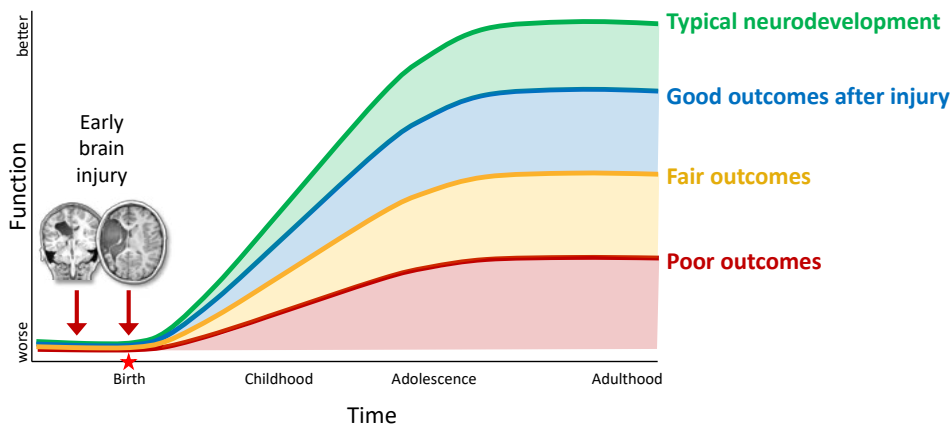
# PARTICIPANTS

## Section Summary

- Participants are under 2 years old to target a period of increased potential for brain plasticity
- Eligible children are 3 to 24 months with a clinician identified hand asymmetry and suspected/confirmed CP
- Enrolment follows four steps: 1) Identification and screening 2) Consent to contact 3) Research contact 4) Scheduling of baseline assessment and weekly therapy sessions

## Participants

The HEIGHTEN study focuses on children under the age of 2 years old. Children under the age of 2 years may have increased potential for brain plasticity.<sup>16</sup> With increased brain plasticity, there may be greater improvements in how the brain controls movement. By improving hand and arm function early, children may have an improved developmental trajectory. Therapy may 'boost' a child's developmental trajectory to be closer to typical development.



## Eligibility Criteria

Twenty children in total will be recruited from Pediatric Community Rehabilitation (Calgary, AB) and Glenrose Rehabilitation Hospital (Edmonton, AB) in a 12-month period.

### Eligible children will:

- (i) be aged three to 24 months (corrected, if premature).
- (ii) have a clinician-identified hand asymmetry with suspected/confirmed cerebral palsy.
- (iii) be willing to withhold other formal upper limb focussed treatment during the study intervention (including splinting, botulinum toxin A injections).
- (iv) commit to completing 18 weeks of daily home practice and attending weekly therapy sessions.

**Exclusion criteria include:**

- (i) participation in formal CIMT within last six months.
- (ii) brachial plexus injury.
- (iii) lower motor neuron dysfunction.
- (iv) upper limb congenital limb difference.

*Enrolment Processes*

Enrolment processes may differ between sites. In general, four steps are followed.



1. Identification & Screening: when an OT identifies/receives a referral for a potentially eligible child, they will complete the screening questions with the family. See Appendix for screening form.
2. Consent to Contact: If eligible, the OT will then complete the Consent to Contact (see Appendix). This is a simple form to obtain consent for researchers to contact the family.
3. Research Contact: If consent is obtained, the researchers will contact the family and share more information. If the family is interested, the researchers will share the consent with the family and will inform the assessing and treating OT.
4. Scheduling: The OT(s) will then begin scheduling the assessment and therapy sessions the same way that is typically done for clinical patients. The family will be asked to sign the study consent form at the baseline assessment.

# WEEKLY SESSIONS

## *Section Summary*

- Weekly sessions are for coaching the caregiver
- Sessions may be in-person or virtually delivered
- OTs conduct sessions every four weeks and at any transition point (e.g., CIMT to bimanual)
- All other sessions are delivered by a TA

## *Session Content*

The weekly sessions are an opportunity for clinicians (occupational therapists and/or therapist assistants) to problem-solve with the caregiver, not for clinicians to deliver therapy.

Start the session by asking the caregiver to share challenges and successes from the previous week. This discussion will likely guide the session.

Clinicians can observe the caregiver delivering therapy and provide feedback. It may be appropriate to demonstrate something to the caregiver, and then observe them practicing. Note that sometimes the child may not be interested or available (e.g., sleeping) for the session.

End the session by asking caregiver to summarize what has been discussed and reinforce any plans that were made.

## *Hybrid Delivery Model*

A hybrid delivery model is used in HEIGHTEN, with weekly sessions delivered in-person or virtually over video call. There should be some sessions in each format. Reasons for session format will be documented each week. Examples of reasons for in-person delivery may be a need for demonstration or assessment. Examples of reasons for virtual delivery may be to avoid travel time or to observe the home environment.

## Clinician Schedule

The weekly schedule is outlined below. OTs will conduct sessions every four weeks, and at any transition point (e.g., when ending CIMT and beginning bimanual therapy). A focus of week 18 will be preparing for continued autonomous practice without weekly coaching.

Week	Focus	OT/TA	Content
1	CIMT	OT	Introduce CIMT
2	CIMT	TA	
3	CIMT	TA	
4	CIMT	TA	
5	CIMT	OT	Reassess target movements + goals
6	CIMT	TA	
7	CIMT	TA	
8	CIMT	TA	
9	CIMT	OT	Reassess target movements + goals
10	CIMT	TA	
11	CIMT	TA	
12	CIMT	TA	
13	CIMT	OT	Reassess target movements + goals Assess for bimanual
14	CIMT + Bimanual	OT	Introduce bimanual
15	CIMT + Bimanual	TA	
16	CIMT + Bimanual	TA	
17	CIMT + Bimanual	TA	
18	CIMT + Bimanual/transition	OT	Transition: plan practice post-study

# PRACTICAL CONSIDERATIONS FOR THERAPY

## Section Summary

- Constrain the preferred arm in a manner than is tolerable for the child
- Position child in a supported position
- Caregiver is comfortably positioned, facing child
- Start practice when caregiver has at least 10 minutes to dedicate to therapy
- Practice in a calm and quiet environment

## Constraining the Preferred Arm

Time wearing a restraint on the preferred arm and purposefully practicing target movements will be recorded as CIMT practice. The restraint will not be worn outside of the prescribed CIMT time.

During CIMT practice, a neoprene mitt will be the first option for constraint. If a child's skin becomes irritated by the mitt, suggest other methods of constraining the hand. Ideas include:

- Large mitt or sock
- Clipping the end of a sleeve, using a bag clip
- Wrapping the arm against the torso with a scarf
- Caregiver gently holds down preferred hand (for young children)

## Child Positioning

It is important that children are in a stable position. The child should feel secure when moving his/her assisting hand and arm. This means being in a position where the child does not have to work on head control or sitting/standing balance. Suggested positions are listed below.

### 1. Children with limited head or trunk control:

- Lying supine on the floor
- Side lying with the assisting arm on top
- Rolled towels, customized pool noodles, or small pillows can be used if needed to create an ideal position.

### 2. Children developing head and trunk control:

- Car seat
- Bouncer seat, positioned so that it doesn't bounce



3. Children with good head control and/or good or developing trunk control:

- Floor seater with tray (feet supported on floor)
- Supportive highchair with tray and foot support

4. Children with good head and trunk control:

- Sitting on the floor
- In a chair that provides an upright and stable seating position
  - \* Rolled towels, customized pool noodles, or small pillows can be used if needed to create an ideal position.
- Highchair with tray

### *Caregiver Positioning*

Teach the caregiver how to be in a position where they can make eye contact with their child. This will help them observe their child's reactions. The caregiver should also be in a comfortable position to present different toys to their child. Generally, the caregiver will want to be positioned in front of the child or on the assisting hand side.

### *Home Practice Timing*

Discuss daily routines with caregivers to identify times that may be easier to practice. Advise the caregiver to pick times when their child is alert (not sleepy). Practice can happen during play time, mealtime, and/or bath time. Before attempting a practice block, the caregiver needs at least 10 minutes of time when they can fully focus on their child.

### *Home Practice Location*

A space that is quiet and calm is best. Anything that is distracting for the caregiver or the child needs to be removed or turned off, like a TV, radio or cell phone. Both caregiver and child need to be able to really focus.

### *Safety*

The treating OT/TA will document any safety issues during sessions and/or home practice. Adverse events are not anticipated as infants/toddlers will be securely seated during practice, and caregivers will be coached on ergonomic positioning when delivering the intervention at home. Importantly, previous studies of CIMT in babies with the same CIMT dose have shown no adverse effects on the preferred hand.<sup>6</sup>

# CREATING HOME PROGRAM

## *Section Summary*

- The home program is a guide for caregivers in delivery of home-based therapy
- Therapy should be family-centred and individualized based on caregiver-identified Canadian Occupational Performance Measure (COPM) goals
- Therapy-specific goals will be identified using Goal Attainment Scaling (GAS)
- Up to four target movements will be selected
- Therapy content should be play-based, developmentally appropriate, repetitive, and progressive
- Activities must be simple to set-up, using toys and objects that are readily available

## *Home Program Overview*

The treating OT will create a home program for each participant. This document will provide suggestions on movements and activities to practice each week. The home program is a guide, with flexibility for caregivers to modify activities as needed.

The home program includes a practice diary for caregivers to track practice time. Caregivers will be encouraged to write notes to share with their therapy team. This includes any questions, challenges, or successes experienced while practicing at home.

The Appendix has examples of home programs.

## *Family-centred, Individualized Therapy*

Caregiver-identified goals will be used to tailor therapy to each child and family's needs and desires for therapy. Using the Canadian Occupational Performance Measure (COPM), caregivers will identify three to five individualized functional goals. These goals will be set at the baseline assessment with the assessing OT.

Every four weeks, the treating OT will revisit goals with the caregiver. New goals can be added as needed. For example, new movements may become more important as the child makes gains and/or ages. Or perhaps the child has achieved a score of 10/10 on the baseline goals. As goals change and gains are made, the home program changes as well.

The section on Collaborative Goal Setting discusses how to set goals with caregivers.

## Therapist-identified Goals

Use of GAS goals in tandem with COPM goals is a strong approach to goal scoring in pediatric rehabilitation interventions.<sup>17</sup> COPM goals are very useful for individualizing therapy content for each child and family. However, the COPM goals may be generic and more focused on participation. Goal Attainment Scaling (GAS) goals will be set by the treating OT to tie the goals to the possibilities of the therapy.

If appropriate, the COPM goals can be used as GAS goals, or the OT can identify goals that are precursors to accomplishing the COPM goals. These can be impairment-focused goals based on the child's limitations or strengths and the potential of the intervention.

See the Appendix for directions on setting and scoring GAS goals.

## Target Movements

Up to four individual movements to be targeted in the intervention will be identified for each child at the baseline assessment. The assessing OT will suggest movements, to be finalized by the treating OT at the first session. Target movements will be updated every four weeks by the treating OT as required. These target movements should consider COPM and GAS goals, typical development, and individual impairments.

Movements that are often challenging for children with CP are:

- Finger extension
- Thumb extension/abduction
- Index point
- Elbow extension
- Forearm supination
- Wrist extension
- Shoulder flexion

## Play-based Format

Target movements will be practiced while playing. Toys and games are key components of HEIGHTEN therapy. Designing a home program with playful activities is key to supporting therapy enjoyment for both caregiver and child. Being playful and creative doesn't always come easily to caregivers. As the therapy team learns about each caregiver/child pair, they will be able to suggest more ways to support caregivers in fun and playful therapy delivery.

## Developmentally Appropriate Activities

When selecting activities for the home program, the child's age and skill level need to be considered. The Appendix includes resources on fine motor development for children. Children with CP may not achieve milestones at the same age as typically developing peers. Assessments provide important information for determining the skill level of each child, and determining what activities are appropriate.

## Promoting Motor Learning

Motor learning broadly refers to changes in movement performance due to changes in the brain's control of movement. Motor learning is necessary for sustained skill improvements. To promote motor learning, practice should be repetitive and progressive, with a variety of activities in a real-life setting.

Brainstorming strategies to reinforce target movements and emerging skills with caregivers is important for generalization and translation of skills beyond therapy sessions. For example, selecting a sippy cup with handles and offering it on the assisting side may encourage supination with grasp during mealtimes.

## Repetitive Practice

Repetition is a key ingredient for motor learning. The more a movement is practiced, the greater the opportunity for the brain to improve and strengthen control of that movement. The home program should focus on promoting as many repetitions of target movements as possible. This may require suggestions of different activities that elicit the same movement, as young children may or may not engage when asked to do the exact same movement multiple times.

## Progressive Activities

Increasing the challenge promotes continued improvements in the brain's control of movement. Activities can be progressed by targeting the "just-right" challenge. Motor learning is incremental; as a result, careful grading of activities is important for optimal child engagement and ultimately for therapy to be successful.

Targeting the just-right challenge will require suggestions for the caregiver to grade activities up or down. Some ideas include changing the object (e.g., size, texture, weight), changing where the object is presented (e.g., closer or farther away, from a surface or dangling, object orientation). Another way to adjust the challenge is for the caregiver to be more or less involved in the activity. For example, helping a child move a rattle (i.e., physical support) decreases task difficulty compared to pointing at the rattle as a cue for the child to grasp it (i.e., gesture).

Here is an example for the target movement of sustained grasp. The activity is squeezing sponges filled with water.

Ideas to grade up (progress):

- Caregiver prompts the child to squeeze sponges with forearm in neutral rather than in pronation
- Child uses smaller sponges or harder sponges
- Number of sponges to squeeze is increased

Ideas to grade down:

- Child stabilizes forearm on a table
- Caregiver positions wrist in neutral to slight extension to provide active assisted facilitation for a power grasp
- Child uses sponges that are easier to squeeze
- Caregiver places sponge in child's hand

More examples can be found in the Appendix.

### *Variety of Activities*

Practicing movements in a variety of real-life activities can promote motor learning transfer (generalization). Transfer is the application of a learned skill in a new context. If a child learns a skill in only one context, it will be more challenging to transfer that skill. If they learn the skill in a variety of contexts, the skill will be more easily transferred.

Selected activities in the home program will depend on the child's interests, age, and skill level. Activities should be easy to do, so caregivers don't need a lot (or any) set-up or clean-up time. The best activities are simple things that the caregiver may already know how to do. This will make it easier for the caregiver to teach their child.

Sensory activities may be appropriate, as sensory processing can be more challenging for children with CP. Often the focus is on senses of touch, sight, and sound. Children need practice using their senses to learn how adjust movements for a variety of objects. Sensory activities also help increase awareness of the assisting hand, which can in turn increase use. Sensory play may include things like water play, handling textured balls, or poking play doh.

The Appendix includes a list of some possible activities.

## Toys and Objects

For ease of practice, ensure the home program doesn't require any special toys or objects. Household items are often great objects for therapy. All toys/objects need to be safe (not choking hazards).

Discuss toys and objects with the caregiver to identify things that are appropriate and interesting for their child. Suggest that the caregiver collect a bin of these things to keep handy for practice times. Reserving selected toys for therapy sessions (and not free play) is one way to maintain engagement as toys remain novel longer. As their child grows and learns new movements, toy preferences will change. Update toy suggestions based on the child's current skills and developmental preferences.

Below is a list to give you an idea of things that could be used in therapy:

### Toys

- Blocks
- Bubbles
- Duplo pieces
- Toy people, animals, food
- Balloons, balls
- Stickers
- Pompoms
- Sensory balls (noise, textures)
- Shakers, rattle
- Push and go toys
- Chunky/knob puzzles
- Drum/ drum sticks
- Light wands/finger lights
- Paper and highlighters, markers, and/or crayons
- Toy xylophone or piano
- Play dough
- Story board/bath books

### Food

- Shredded cheese or cheese strings
- Small cereal (e.g., puffs, O cereal)
- Fruit (e.g., banana, blueberries)
- Vegetables (cut to shape and size to elicit desired movement)
- Peas, corn, cooked pasta
- Teething biscuits/ crackers
- Fruit puree or yogurt pouch

### Household objects

- Foil paper
- Tissues in tissue box
- Bin of dry rice
- Foam soap
- Ice cube tray/egg carton
- Squirt bottle
- Cardboard tubes (e.g. from toilet paper)
- Empty food containers
- Plastic cups
- Straws
- Bag clips
- Toothbrush
- Spoon/scoop/spatula/chopsticks
- Brush/comb
- Body lotion
- Tape
- Pots and pans
- Necklaces, hats, scarves
- Laundry basket
- Sponges
- Wash cloth/ cleaning rag
- Paint brush
- Coasters
- Photo album
- Piping bag (can make own with a plastic bag and bag clip)

# SUPPORTING CHILD ENGAGEMENT

## Section Summary

- Children will be more engaged if their caregiver is engaged, and if therapy makes them feel successful and challenged
- Children may use non-verbal cues to indicate whether they are engaged
- Caregivers need support learning how to modify activities to promote engagement
- Encouraging caregivers to use the four steps of the teaching loop may be helpful: 1) Watch & wait; 2) Follow & model; 3) Let the child perform and play; 4) Provide feedback and praise.

## Child Engagement

For therapy to be successful, children need to be engaged. Remind caregivers to be engaged themselves, and to give their child their full attention.

Toy selection and presentation is also important for keeping children engaged and motivated to use their assisting hand. Children need to feel successful as well as challenged. Here are things to teach caregivers:

- How to choose toys that are developmentally appropriate, i.e., that match their child's social and physical skills
- How to identify toys that can be easily grasped/interacted with
- How to identify toys that are just a bit challenging
- How to place toys so that their child can easily grasp/reach them
- How to show interest/excitement when their child interacts with toys

## Intervention Fidelity

In the Study Forms section, there is a copy of the Fidelity of Implementation Tool (FIRM). This is a checklist for caregiver actions during the intervention. Clinicians coach the caregiver in these actions. This section covers three actions:

- Interaction and Engagement
- Reinforcement
- Guidance, Modeling, Prompting to Elicit Movement and Target Behavior

## Signs of Engagement and Disengagement

Support caregivers in recognizing non-verbal cues that their child is engaged or disengaged. Some are more obvious than others. Below is a list of cues that many children use.

A disengagement cue can mean that it's time to change the activity, or that it's time to take a break. Remember, practice can be in short time blocks. If a child is disengaged, suggest the caregiver plan another practice block later in the day.

Engagement Cues	Disengagement Cues
<p><i>"I like this!"</i></p> <ul style="list-style-type: none"> <li>· Stops moving</li> <li>· Gazes intently at the object</li> <li>· Reaches out to the object</li> <li>· Turns head or eyes to the object</li> <li>· Stretches fingers or toes towards you/object</li> <li>· Smiles</li> <li>· Coos</li> <li>· Has eyes wide open</li> <li>· Has a brightened face</li> <li>· Raises his/her head</li> </ul>	<p><i>"I don't like this/I need a break/It's too hard or easy"</i></p> <ul style="list-style-type: none"> <li>· Turns eyes away</li> <li>· Turns head away</li> <li>· Cries or becomes fussy</li> <li>· Burps, hiccups, passes gas</li> <li>· Has droopy eyelids</li> <li>· Falls asleep</li> <li>· Squirms away</li> <li>· Yawns</li> <li>· Places hand in mouth</li> <li>· Frowns</li> <li>· Has dull-looking eyes</li> <li>· Wrinkles forehead</li> </ul>

## Adjusting to Child's Cues

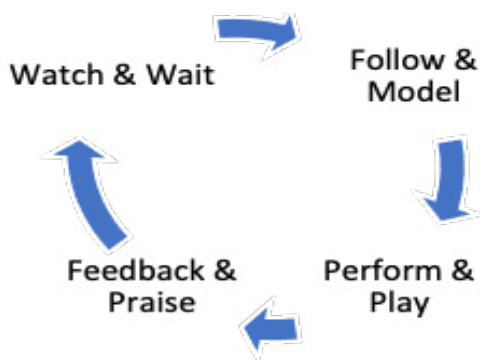
Sometimes, modifications are necessary to engage a child. Below are some examples. Caregivers may ask their therapy team to help problem-solve these situations.

Things child doesn't like	Things caregiver tried in responding to "I don't like it cues"	How child responds
Reaching for objects with her assisting hand	Caregiver reduced time of reaching activities to 5 min. instead of 20 min.	She did not cry this time
Stacking blocks with his assisting hand	Caregiver encouraged him to knock over the blocks after stacking	He did not give up stacking the blocks as quickly
Using both hands together	Caregiver sang action songs ("if you're happy and you know it")	She clapped on her own a few times



## Teaching Loop

Therapy activities have a rhythm. First, watch & wait. Then, follow & model. Next, let the child perform and play. Then provide feedback and praise on what he/she did. Repeat. This is referred to as a “teaching loop”.



## Follow Child's Lead

Therapy will be more successful and fun if the caregiver follows their child's lead. Following a child's lead will help keep him/her engaged. Teach caregivers to follow their child's lead by:

1. Watch: quietly observe child's interests and cues.
2. Wait: give child time to explore or create an activity.
3. Follow: copy what child is doing.

By following their child's lead, caregivers show their child that they are interested in the same things.

## Just Right Challenge

Teaching caregivers about the '*just right challenge*' is necessary to progress therapy content without frustrating or boring the child and caregiver.

It may be helpful to encourage caregivers to *Follow and Model* when building on activities. Have caregivers start with an activity that their child can do and likes to do. Then build on the activity, making it a little trickier. To introduce the challenge, first follow and then model:

1. Follow: caregiver copies what their child is doing.
2. Model: caregiver adds to what their child is doing by showing him/her a new action or step with the same toy or activity.

Encourage the caregiver to watch their child for cues. If the activity is now too hard, they will see disengagement cues. The caregiver will then need to respond to these cues to adjust the level of challenge.

## Feedback and Praise (Reinforcement)

Teach caregivers that feedback and praise are wonderful ways to encourage and teach their child. These verbalizations reinforce successful actions. The best time to encourage their child is promptly after their child has had a chance to try the activity.

There are different types of feedback and praise. What type of feedback/praise each caregiver chooses to use is up to them and what their child prefers, but a variety of verbalizations should be used. For young children, three common types are:

- Broad praise, like “You did it!” Broad praise is not task specific.
- Task-related feedback, like “Great throw, a little farther next time!” Task-related feedback is specific to the activity the child is doing.
- Cheerleading, like: “You can do it, don’t give up!”

## Behavioural Challenges

The beginning of therapy can be hard. The child may not like the mitt on his/her preferred hand. It can also be very frustrating having to use the assisting hand and arm. This can be hard for both the child and caregiver. Remember, each child will adjust to the mitt, and therapy will become easier. Being consistent will help with the adjustment. The therapy team needs to be ready to support caregivers with this adjustment.

# COLLABORATIVE GOAL SETTING

## Section Summary

- Collaborative goal setting supports identification of goals that are meaningful and motivating for the caregiver and child.
- Goals are identified in a conversation, where:
  - The caregiver shares their expertise in their child and their values, preferences, and motivations.
  - The occupational therapist shares their expertise in the intervention.

## Collaborative Goal Setting

Setting goals that are meaningful to the caregiver leads to increased motivation and engagement. Collaborative goal setting involves actively engaging caregivers in making decisions about goals. Goals are set in a conversation, with the caregiver sharing their expertise on their child and their values, preferences, and motivations. The occupational therapist shares their expertise on the intervention. Everyone asks questions and discusses options. For a goal to be selected, everyone needs to agree on it.

## SMART goals

Goals should be Specific, Measurable, Attainable, Realistic, and Time-bound (SMART). The occupational therapist and caregiver should discuss and agree upon each component below:

- Specific
  - What does the caregiver want their child to accomplish?
  - What level of assistance will the child need?
  - Which resources are involved?
- Measurable
  - How will I know when the child achieved their goal? Must be observable.
- Achievable
  - Is this goal realistic, considering time and intervention constraints?
- Relevant
  - Is this goal meaningful and does it address the child and caregiver's needs, priorities, and preferences at this time?
- Time-bound
  - When will the child achieve this goal?

## Updating Goals

During the 18-week intervention, new priorities and goals may emerge for the caregiver. Every four weeks, the occupational therapist should review goals with the caregiver. New goals can be added as needed.

# COACHING USING MOTIVATIONAL INTERVIEWING

## Section Summary

- The goal of coaching in the HEIGHTEN intervention is to support caregivers in prioritizing therapy and learning how to deliver therapy.
- This requires behaviour change.
- One evidence-based approach to coach behaviour change is motivational interviewing.
- Motivational interviewing may be useful during conversations with caregivers.

## Motivational Interviewing

Motivational interviewing (MI) is a way of communicating that is client-centred and engages by following (active listening) and directing (giving instruction/advice). The conversation is a balance between sharing and learning. The clinician is the expert in therapy, and the caregiver is the expert in their child.

Using an MI approach, the clinician is respectful and curious. The goal is to empower caregivers to learn to help their child in a way that is meaningful and feasible *for them*. This requires learning about the caregiver and their child and honoring their autonomy as agents of change.

## Principles of Motivational Interviewing

The four guiding principles of MI are represented by the RULE acronym:

*R: Resist the “righting reflex”, which is the urge to “fix” the caregiver and tell them how to create change.*

*U: Understand the caregiver and child. The caregiver’s reasons and capacity to prioritize and deliver therapy are most important because these will most likely trigger behaviour change.*

*L: Listen to the caregiver. MI involves as much listening as informing.*

*E: Empower the caregiver. Convey hope around the possibility of change and support patients’ choice and autonomy.*

## Skills

Following the OARS acronym facilitates getting started with MI.

- : Open-ended questions encourage the caregiver to elaborate.
  - How does your child use the assisting arm now?
  - How would you like your child to use the assisting arm?

- What are your child's favourite toys?
- When is your child most calm and ready to engage?
- What activities/tasks are most exciting/fun for your child?
- How do you like to play with your child?
- What do you noticed helps encourage your child to use the assisting arm?
- What are some things that might help/hinder doing therapy for the assisting arm?
- When do you think this might fit in your day?

**A:** Affirmations promote optimism and acknowledge the caregiver's expertise, efforts, and experience. Acknowledge beneficial practices when they happen regardless of if it is inconsistent. Note: affirmations are not about your approval of the caregiver.

- *Wow, I know there was a lot going on at the beginning of the session with siblings and doorbells, but you somehow juggled all of that and then had some focused play time with your son.*
- *You follow his nonverbal cues really well. Switching to a different toy when he started looking away and ignoring it was a good strategy.*
- *Wow, you found the magic motivator. Finding and pointing to dad in the photo album was something it seemed like she would do all day.*
- *I like how you rotated the stick to present it vertically, so she needed to turn her forearm to grab it.*
- *I like your thought about the Velcro food. It's a great bimanual activity and easier to put together and pull apart than Duplo.*
- *You have a great sense of how far you can make him reach without frustrating him; it's still fun even though he's working hard.*

**R:** Reflections use accurate empathy.

Simple reflections: paraphrase, repeat what the caregiver said:

- *You're disappointed that she didn't want to play today.*
- *The activity was too hard, but it can be tweaked for the just-right challenge.*
- *It was difficult to get him to do the target activity and make it fun.*

Complex reflections: reflect what the caregiver has said as well as what he or she is experiencing but has not yet verbalized (the meaning beneath the words):

- This kind of therapy puts a lot of responsibility on you and that's a lot to balance with also being a dad.

- Your daughter was clearly super excited when she was able to pull apart the Duplo for the first time. That is really satisfying and rewarding for a parent because it shows a bit of what is possible for her long term.

**S:** Summaries that are targeted and succinct synopses of what the caregiver said, with a focus on elements that are solution focused. The goal is to help the caregiver organize his or her experience.

- *Your son was having fun today, but it was hard to get focused practice with distractions that kept popping up. You mentioned that the bedroom had less family traffic and visual distractions along with a door that closes. Maybe that would be something to try next time.*
- *Squishing playdough for pinch lost its appeal today. He was telling us he was ready to play so it makes sense to switch up the activity. He was really interested when you pulled the pen out to take notes. Maybe he is ready for a bigger challenge, and we can try removing and replacing a pen or marker lid?*
- *I agree; reaching and grabbing an object in one motion was too hard for your daughter. You mentioned she can grasp and reaches to knock her cup off the tray. Maybe we can work on those movements separately. Interesting objects can be presented close to her trunk. We can try a Velcro mitt or cuff and lightweight objects and encourage her to reach. She also likes to knock things off the tray; we can use that to our advantage!*

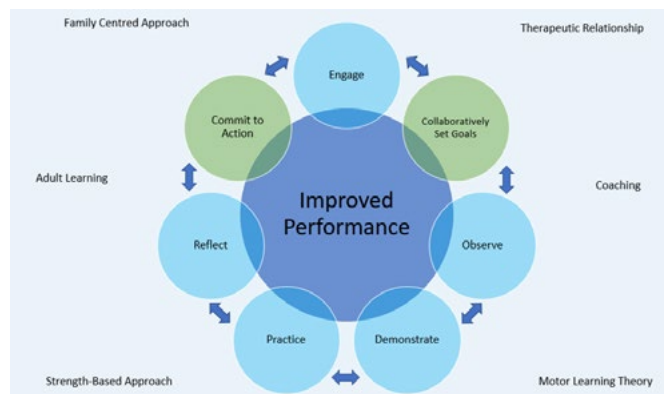
# THE APPLIED COACHING MODEL (ACM)

## Section Summary

- The Applied Coaching Model may be helpful to guide clinicians when coaching.
- Five actions are reviewed: 1) Engage; 2) Collaboratively Set Goals; 3) Observe & Demonstrate; 4) Practice & Feedback; 5) Commit to Action.

## The Applied Coaching Model (ACM)

Coaching studies in healthcare, and specifically in pediatric rehabilitation, are becoming more prevalent.<sup>15</sup> The ACM was developed to increase therapist capacity and competence to implement coaching behaviours with clients. The ACM incorporates goal-directed action, observation, instruction and demonstration, active learner participation, self-reflection, feedback, and a commitment to planned action. The model emphasizes an equal partnership and collaboration between therapists and families.



© Debra Teitelbaum BScPT, MSc.

## Clinician Actions

Below is a checklist of the clinician actions included in the ACM. The clinician selects actions that are appropriate for each session.

Note: information in this section is © Debra Teitelbaum BScPT, MSc.

### Engage (build therapeutic relationship)

- Welcome family demonstrating curiosity, commitment, and compassion.
- Actively listen to family's concerns, affirming and summarizing in a non-judgmental manner
- Set up roles and expectations of client-therapist relationship, respectfully and collaboratively
- If initial visit, explore history and context of child



- If follow-up visit, obtain child update and explore goal attainment
- Establish focus for the day with the emphasis on family's concerns

### **Collaborate a SMART Goal**

- Acknowledge the family's existing knowledge, abilities, and strengths
- Ask what the family's hopes and dreams are for their child
- Determine child's motor level through family summary, observation of child and family and direct assessment
- Guide the family to convert their long-term hopes into short-term goals
- Articulate and formalize a SMART goal together

### **Observe and Demonstrate**

- Consider the context for learning something new
- Observe caregiver's actions in order to support the development of new skills
- Provide information about the environmental setup
- Demonstrate specific activity to achieve the goal using reflective questions and clear instructions
- Confirm understanding of how the strategy helps achieve the goals

### **Practice and Feedback**

- Encourage caregiver to imitate and practice activity, providing multiple opportunities.
- Encourage trial and error through reflective questioning
- Affirm family's dedication, effort, and strengths
- Ask caregiver to reflect on their practice and identify concerns using active listening and reflective questions
- Supplement caregiver's reflection with relevant feedback regarding their practice
- Repeat: Observe and Demonstrate, Practice and Feedback for each additional activity based on family capacity

### **Commit to Action**

- Summarize SMART goal (caregiver reflection)
- Summarize session activities (reflection)
- Connect the activities with the predetermined SMART goal
- Offer options to support recall for home practice

- Confirm commitment to planned action
- Develop a plan for who, when, what, where, and how the activity/practice will occur
- Schedule next appointment (if necessary)

# ASSESSMENTS

## Section Summary

- Outcomes linked to implementation will be collected during the intervention
- There are three assessment time points to evaluate intervention effectiveness:



- Primary outcome measure to assess HEIGHTEN implementation:
  - Caregiver and clinician satisfaction
- Co-primary outcome measures to assess therapy effectiveness:
  - Canadian Occupational Performance Measure (COPM)
  - Age-appropriate hand assessment (HAI/mini-AHA/AHA).
- Secondary outcomes measures include assessment of caregiver well-being

## Implementation Outcomes

Implementation of HEIGHTEN will be assessed during the 12-month program. A taxonomy of implementation outcomes<sup>18,19</sup> was used to organize indicators and ensure a comprehensive approach to assessment (see table below).

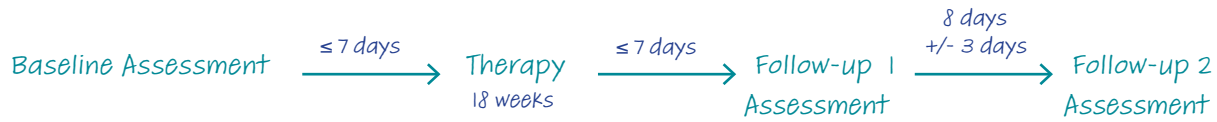
The primary implementation outcomes will be acceptability (perceived benefit and satisfaction) of caregivers and clinicians, assessed via a study-built questionnaire with Likert scale response options. Study-built measures were created with caregiver partners to ensure wording is appropriate and pertinent questions included.

Category	Outcome	Indicator	Criteria
Efficiency	Recruitment	a) time to recruit n=20 b) time from receiving referral to baseline Ax	a) ≤2 years b) <1 months >80% positive
Safety	Adverse events	# minor/moderate/severe AE	0
Cost	Clinician time	Hours beyond allocated time: a) Ax b) Session	<2 hours total time <45mins total time
Acceptability	Perceived preparedness Perceived benefit & satisfaction  Session format	Caregiver questionnaire (study-built) Caregiver/clinician questionnaire (study-built) # in-person sessions	>80% positive >80% positive  <13 sessions
Reach	Recruitment  Participation	# decline participation Reasons for declining participation Geographic location of participants	<10% <30% same reason <30% same postal code
Feasibility	Retention Attendance Missing data Accessibility Technology	% complete data Attendance logs Incomplete Ax data # families needing devices/data a) # sessions interrupted/canceled b) Time spent troubleshooting per session	>90% <2 missed sessions <10% <10% a) <10% b) <5mins
Fidelity	Clinician attendance Caregiver attendance Fidelity	# sessions rescheduled/canceled # sessions rescheduled/canceled FIRM <sup>20</sup> from one filmed session Caregiver diaries	none <10% a) All items ≥ 4 b) <10% incomplete

FU1/2: Follow-up 1 (FU1) or 2 (FU2); Ax: assessment; FIRM: Fidelity of Implementation Measure; AE: adverse events; COPM: Canadian Occupational Performance Measure; GAS: Goal Attainment Scaling; HAI: Hand Assessment for Infant; mini-AHA: mini-Assisting Hand Assessment; AHA: Assisting Hand Assessment.

## Assessment Schedule

There are three assessments, each 1.5 to 2 hours. The assessments happen at a rehabilitation centre. Appointments will be booked Monday to Friday during work hours. Both the OT and TA may attend the assessments to facilitate data collection and provide childcare when needed. The baseline assessment will include a discussion of the families' weekly schedule to identify moments to practice.



## Assessment Content

All outcome measures will be administered by a trained OT at time points outlined in the table below. Questionnaires may be mailed or emailed to caregivers in advance of the assessment time point, if preferred by the caregiver(s). All measures have strong psychometric properties and are appropriate for young children with CP and/or their caregiver(s).

The co-primary outcome measures to assess therapy effectiveness are the Canadian Occupational Performance Measure (COPM) and the age-appropriate hand assessment (HAI/mini-AHA/AHA).

Baseline (≤7 days before wk 1) In-person administration	Mid-session (wk 5/9/13/14) Virtual or in-person	FU1 (≤7 days after wk 18) In-person administration	FU2 (8 wks ± 3 days after wk 18) In-person administration
COPM	COPM	COPM	COPM
GAS	(assess, add)	GAS	HAI/mini-AHA/AHA
HAI/mini-AHA/AHA	GAS (assess, add)	HAI/mini-AHA/AHA	Actigraphy
Mini-MACS		Actigraphy	Video analysis
Referral Data		Video analysis	HADS
Actigraphy		Perceived preparedness	PSS
Video analysis		HADS	PSOC
Perceived preparedness		PSS	Review of demographics
HADS		PSOC	
PSS		Caregiver satisfaction	
PSOC		Clinician satisfaction	
ASQ-3			
Demographics			
MRI			

FU1/2: Follow-up 1 (FU1) or 2 (FU2); Ax: assessment; COPM: Canadian Occupational Performance Measure; GAS:

Goal Attainment Scaling; HAI: Hand Assessment for Infant; mini-AHA: mini-Assisting Hand Assessment; AHA: Assisting Hand Assessment; Mini Manual Ability Classification System (MACS); HADS: Hospital Anxiety Depression Scale; PSS: Perceived Stress Scale; PSOC: Parenting Sense of Competence scale; ASQ-3: Ages and Stages Questionnaire-3 (ASQ-3).

### Completed by OT

1. Canadian Occupational Performance Measure (COPM): Using the COPM, three to five individualized goals will be identified by caregivers in collaboration with the treating OT. Goals are ranked and then scored by the caregiver on a scale of 1 to 10 for both Performance (how well the goal is performed) and Satisfaction (how satisfied caregivers are with goal performance).<sup>21</sup> Goals will be scored every four weeks during the intervention, and caregivers will have opportunity to add new goals. Considering developmental changes are occurring during the intervention, new goals may become a priority to caregivers. Goal descriptions will also be reviewed to avoid ceiling effects.<sup>22</sup>
2. HAI/Mini-AHA/AHA: These assessments employ a short, structured play session to provide a logit-based measure of bimanual function for children with hemiparetic CP. The Hand Assessment for Infants (HAI) is for infants aged 3 to <12 months,<sup>23</sup> the Mini-Assisting Hand Assessment (AHA) for ages 8 to <18 months,<sup>24</sup> and the AHA for children  $\geq 18$  months.<sup>25</sup> In this study, the HAI will be used for children aged 4-  $\leq 8$  months at baseline, the mini-AHA for children aged  $\geq 8$  -  $\leq 18$  months at baseline, and the AHA for children aged  $\geq 18$  months at baseline. These three assessments examine hand function in a video-recorded play-based session lasting 10-15 minutes. All videos will be scored by a separate certified OT or research team member.
3. Goal Attainment Scaling (GAS): The treating OT will transform the COPM goals into objectively measurable goals that can be targeted by the intervention. GAS goals are scored on a standardized -2 to +2 scale, with -2 being much less than expected, 0 being expected outcome post-intervention, and +2 being much greater than expected. Criteria for each score will be set at baseline, and then scored post-intervention. Scores are transformed into a T-score for statistical analysis.<sup>26</sup>
4. Mini-MACS: For children >12 months old, the Mini Manual Ability Classification System (MACS)<sup>27</sup> will be used to classify children based on manual ability from level 1 to 5, with 1 being the highest functional level.
5. Referral Data: Basic information on referral source, referral timing (both when sent and received), and clinical exams (if completed) will be collected.
6. Clinician Satisfaction: a study-built questionnaire will assess clinician satisfaction with the intervention and mode of delivery for each child.

### Collected by Research Team

1. MRI: Clinical scans will be used to confirm cerebral palsy diagnosis. Scans for children with MRI-confirmed stroke will undergo standardized scoring and diagnostic classification.

2. Actigraphy: Actigraphy will be used to assess real-world differences in bilateral hand/arm use.<sup>28</sup> Infants/toddlers will wear actigraphy wristbands on both wrists for a continuous 48-hour period.<sup>29,30,31</sup> A diary will be provided to caregivers to track times when the wristbands are removed (e.g., for bathing) as well as sleep/wake times.
3. Video Motion Analysis: Videos of children performing a reach movement will be analyzed using MediaPipe to extract two-dimensional kinematic variables. The holistic solution in Mediapipe will be used for pose estimation of hand and arm movements.<sup>32</sup> MediaPipe has been successfully used to recognize sign language,<sup>33</sup> and a validation study is underway comparing kinematic variables extracted from MediaPipe and 3-D motion capture during reaching movements.

### Caregiver Questionnaires

1. Demographics: a study-built questionnaire will be used in combination with chart review (if necessary) to document birth history and family demographics. This will be completed at baseline and reviewed at FU2 to document any additions (e.g., comorbid diagnoses).
2. Hospital Anxiety Depression Scale (HADS): HADS will be used to assess caregiver anxiety and depression within the past week on a 14-item scale.<sup>34</sup>
3. Perceived Stress Scale (PSS): PSS measures perceived stress over the past month on a 14-item scale.<sup>35,36</sup> Caregivers will complete the PSS.
4. Parenting Sense of Competence scale (PSOC): The PSOC is a 17-item caregiver-report scale to assess perceptions of parenting abilities.<sup>37</sup> The PSOC has been used for caregivers of children with CP,<sup>38</sup> including infants.<sup>6,12</sup>
5. Ages and Stages Questionnaire-3 (ASQ-3): The ASQ-3 is a developmental screening tool that can be completed in 10-15 minutes by a caregiver.<sup>39,40</sup> Completed at baseline, scores that warrant further clinical evaluation will be shared with the child's primary care provider.
6. Perceived Preparedness: a study-built questionnaire will assess caregivers' perceived preparedness to deliver the intervention. This questionnaire will be completed before the intervention, and again at completion to collect any feedback for improvement of caregiver training and support.
7. Caregiver Satisfaction: a study-built questionnaire will assess perceived benefit and satisfaction with the intervention and mode of delivery. Questions will be adapted from the Generic Short Patient Experiences Questionnaire (GS-PEQ).<sup>41</sup>

# STUDY FORMS

## Recruitment Flyer



## HEIGHTEN

### Home-based Early Intensive Hemiparesis Therapy: Engaging Nurture

#### What is this study about?

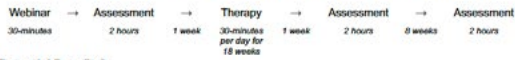
This study involves home-based upper limb therapy for babies and toddlers who have a less preferred hand/arm. The child's caregiver delivers therapy, supported by weekly visits with a therapist. These visits may be in-person or virtual (video call). The study will investigate whether the therapy is feasible and effective for improving hand/arm use.

#### Who can participate?

- Children 3 to 24 months old (corrected, if premature).
- Children with Cerebral Palsy who have a hand preference (i.e., they use one arm noticeably less often).

#### What's involved?

- 30 minutes of daily arm therapy at home for 18 weeks (*see next page for details*).
- 30-minute visit with a therapy team each week, either in-person or virtual (video call).
- Three 2-hour assessments: before therapy, after therapy, and 8-weeks after therapy.
- One 30-minute webinar about play-based therapy, before starting HEIGHTEN therapy.



#### Potential Benefits?

- Your child may have noticeable improvements in arm and hand function.
- You will learn how to help your child use the less preferred hand.
- This study will help the researchers learn more about hand/arm therapy for infants and toddlers to help treat children in the future.
- Participants will receive a small token of appreciation to thank them for their time.
- We will reimburse parking or transit fare costs.

#### Potential Risks?

- Your child may be frustrated sometimes when playing with the less preferred hand.

#### Interested in participating?

If you are interested in participating or have any questions, please contact: Alicia Hilderley at [alicia.hilderley@ahs.ca](mailto:alicia.hilderley@ahs.ca)

This study has been approved by the University of Calgary Conjoint Health Research Ethics Board (REB21-1981).

Ethics ID: REB21-1981

Study Title: Home-based Early Intensive Hemiparesis Therapy: Engaging Nurture (HEIGHTEN)

Principal Investigator (PI): Dr. Adam Kirton

Version 1.0 & Version date: 2022-03-30

Page 1 of 2



### More about HEIGHTEN Therapy

#### Overview

- The HEIGHTEN therapy aims to increase the functional use of a child's less preferred, or "assisting" hand and arm through repetitive, structured practice.
- Research suggests that 60 hours of therapy leads to meaningful improvements. The HEIGHTEN program is 60 hours total over 18 weeks.
- Caregivers deliver therapy at home for 30-minutes each day.
- The 30-minute practice sessions may be divided into smaller time blocks (e.g. two 15 minutes sessions).
- Practice sessions can occur during daily activities like play or meals.
- Weekly visits with a therapy team will support the caregiver in therapy delivery.

#### Therapy content

Children receiving HEIGHTEN therapy work on goals identified by the therapist and caregiver(s) together. For the first 13 weeks, children wear a soft mitt on their more preferred hand during therapy. By "hiding away" the preferred hand, the assisting hand is used more. This type of therapy is called Constraint-Induced Movement Therapy (CIMT). After 13 weeks of CIMT, children may begin practicing two-handed skills. This is called Bimanual Therapy.

#### What are the therapy goals?

The overall therapy goal is to achieve improvements that are meaningful to the child and their family. Specific to the assisting hand and arm, therapy may focus on:

- Improving awareness of the hand and arm.
- Increasing spontaneous use and amount of time the hand and arm are used.
- Improving quality, strength, and/or coordination of hand and arm.
- Learning new movement patterns.
- Improving the use of two hands in two-handed activity.
- Build parent confidence in delivering home therapy through parent education and support.

#### Why this therapy?

Repetitive, structured practice can help improve movement skills, and may lead to lasting changes. This is because of brain plasticity, the ability of the brain to change itself. With repetitive practice, children's brains may change to improve movement control of the less preferred hand and arm.

#### Will the preferred hand be damaged by being constrained?

Research has shown that constraining the preferred hand is not harmful.

#### Does age matter?

Hand preference before 2 years old is an early indicator that a child may need therapy. Starting therapy early may be beneficial, because children under the age of 2 years may have increased potential for brain plasticity. For this reason, HEIGHTEN therapy focuses on young children. Importantly, children of all ages have the potential for brain plasticity and can improve hand and arm function.

Ethics ID: REB21-1981

Study Title: Home-based Early Intensive Hemiparesis Therapy: Engaging Nurture (HEIGHTEN)

Principal Investigator (PI): Dr. Adam Kirton

Version 1.0 & Version date: 2022-03-30

Page 2 of 2



## Consent to Contact



### CONSENT TO CONTACT FOR RESEARCH PURPOSES

**TITLE:** Home-based Early Intensive Hemiparesis Therapy: Engaging Nurture (HEIGHTEN)

**SPONSOR:** University of Calgary.

**FUNDER:** University of Calgary, CHILD-BRIGHT Network.

**PRINCIPAL INVESTIGATOR:** Dr. Adam Kirton (Phone: 403-955-7424)

You are being invited to give consent for Dr. Adam Kirton, or a qualified member of his study team to contact you at some time in the future to invite you to participate in a research study.

Are you willing to learn more about the HEIGHTEN study? (Circle one)

YES          NO

If yes, you will be contacted at a later date. Please include your contact information below.

**Telephone:** \_\_\_\_\_

**E-mail:** \_\_\_\_\_

You authorize your health service provider to share your name, telephone number, and email address with the research team for the purpose of being contacted to learn more about the research study, HEIGHTEN.

Every effort will be made to safeguard your contact information. Although access to this information will be limited, there is a small chance that this information could be inadvertently disclosed or inappropriately accessed.

You have been made aware of the reasons why the contact information is needed and the risks and benefits of consenting or refusing to consent.

This consent is effective immediately. Your consent to be contacted can be revoked by you at any time.

**Patient's Signature:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**Health Services Provider's Name:** \_\_\_\_\_

**Ethics ID:** REB21-1981

**Study Title:** Home-based Early Intensive Hemiparesis Therapy: Engaging Nurture (HEIGHTEN)

**PI:** Dr. Adam Kirton

Version 1.0 & Version date: 2022-03-11

Page 1 of 1

# Phone Screening



## UNIVERSITY OF CALGARY ORAL CONSENT TO PARTICIPATE IN RESEARCH

Hi, my name is [name] and I am a [researcher/occupational therapist]. I am calling to ask questions to determine whether your child is a possible participant for the HEIGHTEN study.

Your child was identified as a possible participant in this study because he/she is between 3 and 24 months of age and has a less preferred hand and arm. Your participation in these questions is voluntary.

The purpose of the HEIGHTEN research study is to investigate whether home-based upper limb therapy is feasible and effective for young children with cerebral palsy. The therapy program is 18-weeks, with home-based practice 30 minutes per day.

If your child is eligible for the HEIGHTEN study and you would like to participate, we will schedule an in-person visit and we will provide you with the full study consent form.

If you agree to participate today, I will ask you a few questions to determine whether your child is eligible for the HEIGHTEN study. Your answers will be recorded. We are recording this information to learn why or why not children are eligible for the HEIGHTEN study.

If you are not sure how to answer the questions, I will ask your occupational therapist or physician. They may review your child's medical chart to answer the questions.

Participation today will take a total of about 10 minutes.

Any information you share will be kept confidential. Identifiable information will not be collected. I will assign a code to the information you share today.

The de-identified data that is collected will be kept indefinitely. Data collected for this study may be shared with other researchers for future studies that are unknown at this time. Any future use of this research data is required to undergo review by a Research Ethics Board.

You may contact Dr Adam Kirton at 403-955-7424 with any questions or concerns about the research or your participation in this study.

**Ethics ID:** REB21-1981  
**Study Title:** Home-based Early Intensive Hemiparesis Therapy: Engaging Nurture (HEIGHTEN)  
**PI:** Dr. Adam Kirton  
**Version 1.1 & Version date:** 2022-03-31

Page 1 of 2

If you have any questions concerning your rights as a participant in this research, please contact the Chair, Conjoint Health Research Ethics Board, University of Calgary at 403-220-7990.

Do you have any questions or would like any additional details?  
*[Answer questions.]*

Taking part in this study is your choice. You can choose whether or not you want to participate. Whatever decision you make, there will be no penalty to you. You have a right to have all of your questions answered before deciding whether to take part. Your decision will not affect the medical care you receive. If you decide to take part, you may leave the study at any time.

In no way does your agreement to take part this study waive your legal rights nor release the investigators or involved institutions from their legal and professional responsibilities.

Do you agree to participate in this study?

*[If yes, begin the study.]*

*[If no, thank the participant for his/her time.]*

**Ethics ID:** REB21-1981  
**Study Title:** Home-based Early Intensive Hemiparesis Therapy: Engaging Nurture (HEIGHTEN)  
**PI:** Dr. Adam Kirton  
**Version 1.1 & Version date:** 2022-03-31

Page 2 of 2

# Screening Form

Screening ID: \_\_\_\_\_

OT: \_\_\_\_\_

Date: \_\_\_\_\_

## HEIGHTEN Screening Form

1. Child Age Today: \_\_\_\_\_ months (corrected, if premature)
2. Clinician-identified hand asymmetry with suspected/confirmed cerebral palsy?  
 YES                       NO
3. Does the child have:  
 Brachial plexus injury  
 Lower motor neuron dysfunction  
 Upper limb congenital limb difference
4. Is the caregiver willing to commit to completing 18 weeks of daily home-practice, attending weekly therapy sessions, and three assessments?  
 YES                       NO

If no, why not:

5. Is the caregiver willing to withhold other formal upper limb focussed treatment during the study intervention?  
 YES                       NO

If no, why not:

6. In the last 6 months, has the child:  
 Participated in a formal CIMT program  
If yes, date of completion: \_\_\_\_\_

- Received upper limb botulinum toxin A injections  
If yes, date of most recent injection: \_\_\_\_\_

7. If caregiver declines participation, reasons why:

**Ethics ID:** REB21-1981

**Study Title:** Home-based Early Intensive Hemiparesis Therapy: Engaging Nurture (HEIGHTEN)

**PI:** Dr. Adam Kirton

Version 1.0 & Version date: 2022-03-11

# Fidelity Checklist

Participant ID: \_\_\_\_\_

Date: \_\_\_\_\_ Week #: \_\_\_\_\_

## HEIGHTEN Fidelity of Implementation Tool (FIRM)

### CORE COMPONENTS

Constraint of the assisting hand meets the standards for the type and amount specified by the protocol.	Yes	No
Intervention is based on principles of progressive and repetitive practice with appropriate feedback.	Yes	No
Caregiver education and support provided.	Yes	No
Describe environment therapy delivered in (e.g. clinic, home).		

**Length of Video:** \_\_\_\_\_ minutes.      **In Attendance:**  Caregiver    OT    TA

### Interaction between Caregiver and Child Documented via Videorecording

Score the videorecording on each of the areas labeled below as demonstrating standards and expectations that are:  
**4 = Exemplary; 3 = High; 2 = Acceptable; 1 = Not Met.**

<b>1. Choice of Tasks and Activities</b> Therapist/Caregiver selects activities appropriate for shaping. Therapist/Caregiver selects activities and tasks that can challenge the child to perform at appropriate higher levels.	<b>Rating:</b>
<b>2. Interaction and Engagement</b> Caregiver demonstrates positive affect to the child. Caregiver elicits high child engagement throughout the session.	<b>Rating:</b>
<b>3. Guidance, Modeling, Prompting to Elicit Movement and Target Behavior</b> Caregiver gives clear information and messages to the child on behaviour or actions for the targeted behaviour. Caregiver provides explicit verbal guidance, cueing, modeling and/or prompting to motivate child's action. As the child shows progress, caregiver prompts or cues a higher level of performance.	<b>Rating:</b>
<b>4. Reinforcement</b> Caregiver provides reinforcement (e.g., verbal praise, facial or physical gestures) when child demonstrates progress toward targeted behavior. Caregiver provides timely (most often immediate) reinforcement of child's efforts. Caregiver's reinforcement is appropriate to child's stage of learning. Caregiver varies the reinforcement for the child. Caregiver provides child with explicit information about performance.	<b>Rating:</b>
<b>5. Repetition</b> Caregiver actively encourages repeated practice of emerging skills. Caregiver actively encourages variation in how the child uses new or emerging skills.	<b>Rating:</b>
<b>6. Shaping and Adapting Activities</b> Caregiver appropriately fades, or lowers supports, to encourage the child's independence in performing the activity. Caregiver actively monitors the child during repetitive practice and provides guidance and reinforcement to maintain optimal child effort. Caregiver responds to child's level of interest, enjoyment, frustration, or fatigue by modifying activity or communication. If the child struggles with an activity, the caregiver adapts it to promote the child's success.	<b>Rating :</b>

**Ethics ID:** REB21-1981

**Study Title:** Home-based Early Intensive Hemiparesis Therapy: Engaging Nurture (HEIGHTEN)

**PI:** Dr. Adam Kirton

Version 1.0 & Version date: 2022-05-11

## The GAS Process

GAS goals need to be scaled and finalized after the first session. This page provides an overview, with additional details in the GAS manual that can be provided to you.

To set GAS goals, start from the COPM goals. Consider assessment findings, observations of the child, comments from the caregiver, and the potential areas of change in abilities with respect to the intervention.

The COPM goals can be used for GAS goals, or GAS goals can be precursors/foundations to accomplishing the COPM goals. There might be some impairment goals that are appropriate for GAS goals based on the child's limitations/strengths and the potential of the intervention. Ideally GAS goals are precursors/contributors to activity and participation goals in the COPM.

Each of the levels on the GAS scale should:

- Be written as clearly as possible
- Specify an observable behaviour by the client
- Be written in the present tense
- Be achievable or realistically possible

The scale as a whole should:

- Have levels that reflect meaningful gradations of improvement
- Have approximately equal intervals between goal attainment levels (i.e., the change from a -1 to a 0 is the same size as a change from a 0 to a +1). This is not always possible to do, but worth aiming for.

The Scoring Scale is as follows:

Score	Explanation of goal levels
-2	Much less than expected outcome
-1	Less than expected outcome
0	Expected outcome after intervention
+1	Greater than expected outcome
+2	Much greater than expected outcome

When setting the goal, decide who will rate the goal post-intervention. The treating OT can observe the child's skill or ask the caregiver about their abilities at time of follow-up. Who does the rating will depend on the goal.

The GAS goals should also be the centerpiece to the child's therapy and home program. It is a good idea for treating clinicians to review goals at the start of each session and remind the caregiver of the goals from time to time as well.









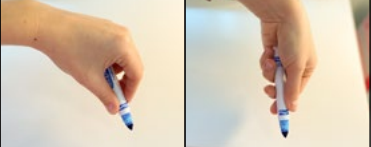
# APPENDIX

## Development of Fine Motor Skills

The table below is for reference. Not all children develop these skills in the order or at the ages listed.

<p><b>0-3 months</b></p> <ul style="list-style-type: none"><li>• Fisted hands</li><li>• Random arm movements</li><li>• Looks at own hand</li><li>• Bring hands to mouth</li><li>• Uses whole arm to swing at targets</li><li>• Begins to hold objects in hands</li><li>• Fingers close around object in response to light pressure on palm</li></ul> <p><b>3-6 months</b></p> <ul style="list-style-type: none"><li>• Hands are open most of the time</li><li>• Grasps rattle with palm</li><li>• Holds rattle for 1 minute</li><li>• Brings toys to mouth</li><li>• Shakes rattle</li><li>• Bangs 2 toys together</li><li>• Uses both arms to reach for toys</li><li>• Begins to move objects from one hand to the other</li><li>• Holds hands together</li></ul> <p><b>6-9 months</b></p> <ul style="list-style-type: none"><li>• Begins to grasp and hold objects</li><li>• Uses all fingers ('raking grasp') to move objects</li><li>• Uses index finger to poke objects</li><li>• Removed objects from containers</li><li>• Begins to hold a bottle</li><li>• Rotates wrist when shaking a rattle</li><li>• Squeezes objects with a fist</li><li>• Plays with their hands</li></ul>	<p><b>9-12 months</b></p> <ul style="list-style-type: none"><li>• Can poke or point with one finger</li><li>• Turns pages in a book, a few pages at a time</li><li>• Begins to put small objects in a container</li><li>• Starts using index finger and thumb to grasp objects ('pincer grasp')</li><li>• Moves objects between hands</li><li>• Uses a fisted grasp to hold crayons/markers</li><li>• Can hold two objects in one hand</li></ul> <p><b>12-18 months</b></p> <ul style="list-style-type: none"><li>• Claps hands</li><li>• Waves goodbye</li><li>• Stacks two blocks</li><li>• Scoops objects with a spoon/shovel</li><li>• Puts small objects in a container</li><li>• Scribbles on paper</li><li>• Begins to fit shapes into a puzzle</li><li>• Uses a pincer grasp</li><li>• Holds a marker in an upside-down position, thumb down</li></ul> <p><b>18-24 months</b></p> <ul style="list-style-type: none"><li>• Puts rings on pegs</li><li>• Begins to hold crayon with fingertips and thumb</li><li>• Marks or scribbles</li><li>• Stacks 3-4 blocks</li><li>• Opens packages</li><li>• Turns pages one at a time</li><li>• Strings 3 beads on a lace</li><li>• Begins snipping with scissors</li></ul>
--	--

## Types of Grasps in Infancy and into Toddlerhood

<p><b>Crude Palmar Grasp</b> A crude palmar grasp involves grabbing at objects with the pinkie side, or palmar side, of their hand. The thumb is not used yet.</p>	
<p><b>Palmar Grasp</b> The entire hand and thumb are used to grasp at objects.</p>	
<p><b>Radial Palmar Grasp</b> The thumb side of the hand is used more to grab at objects, although all fingers are involved.</p>	
<p><b>Raking Grasp</b> The fingers are bent (flexed) to bring objects into the hand.</p>	
<p><b>Radial Digital Grasp</b> The middle finger to thumb does the grasping. In the beginning, the pads of the fingers are used to grasp, not the fingertips.</p>	
<p><b>Inferior Pincer Grasp</b> The pads of the index finger and thumb are used to grasp.</p>	
<p><b>Pincer grasp</b> The tips of the index finger and thumb are used to grasp the object.</p>	
<p><b>Palmar Supinate Grasp</b> This is a fistful grasp, with the thumb wrapped around the top of the object.</p>	
<p><b>Digital Pronate Grasp</b> The fingers point down towards the bottom of the object. All fingers are used.</p>	



## Skill Progressions for Grasping

Development of grasping skills can be grouped into three levels:

1. Pre-grasping and reaching
2. Grasping
3. Refinement of grasping and object manipulation

These levels can be broken down into smaller skills, as described below.

### Pre-grasping and reaching

The first level focuses on reaching purposefully, or “goal-directed” reaching. This level also focusses on pre-grasping, which describes movements that children do before they can grasp toys. These are movements like touching or moving toys. To encourage these movements, it is important that your child likes the toy/object. It is also important that the toy is placed close to your child’s hand.

What child does	What caregiver does	Suggested toys/activities
Begin reaching towards toys by touching, moving, and hitting them from a close position.	Shows interesting toys and hold toys near their child’s hand where they can easily see them.	Toys that make noise (like keys, rattles, maracas), colourful strings, light up toys, toys that play music.
Holds toys placed in their hand without dropping.	Puts toys in child’s hand. Caregiver may need to help their child keep focus to keep holding.	Big plastic rings, small rattles, plastic spoons, and maracas.
Holds objects in their hand while moving their arms to wave or flap the toys around.	Gives their child time to explore the objects and their own abilities.	Big plastic rings, small rattles, plastic spoons, and maracas. Toys with noise help keep child’s attention.
Scratching, pre-grasping, and squeezing.	Holds toys in front of their child or places toys on their child’s tummy.	Hair bands, soft material (like a cloth or mitt), and tissue paper.
Trying easy grasping motions.	Places toys close to their child’s hand, increasing the distance as it gets easier for the child. Some children may reach before grasping.	Strings, sticks, spoons in different colours, positioned and adjusted close to hand to be easy to grasp.
Reaching at a distance	Positions toys at a distance where their child needs to reach for the object.	Balloons and/or tower of blocks to knock over.

## Grasping

The second level focuses on grasp ability. Children often start to grasp as they explore objects. They may grasp and then interact with a toy by doing things like banging the toy or putting it in their mouth (“mouthing”). With repetitive practice, grasping actions become more precise. The grasp will look smoother. Interacting with different shapes and sizes of toys will also help your child learn how to adjust their grasp for each object.

What child does	What caregiver does	Suggested toys/activities
Grasps easy-to-grasp objects from easy positions. Often drops the object after grasping.	Holds toys in easy positions for their child to grasp from, like right in front of his/her hands and oriented in the same direction as the palm of the hand. Expect child to drop the toy, especially when presented a new toy.	Plastic spoons, objects with thin handles, o-balls, bag-clips, and maracas.
Grasps objects in different positions, including reaching to grasp objects at different distances.	Holds toys at different distances. Increases the challenge by increasing the distance from their child.	Any toy of interest, with a size and shape that child can grasp.
Increases the frequency and speed of grasping and releasing actions.	Frequently provides toys of that their child can grasp. This encourages releasing, which is important skill linked to grasping.	Use a variety of objects from different locations to encourage many grasping repetitions.
Explores objects using different actions, like waving, banging, pressing, and mouthing.	Provides objects with different shapes, sizes, sounds, and textures.	Packages, rubber objects, and cones.
Explores objects using finger movements, like squeezing and regrasping.	Provides objects with different surfaces/textures and objects that can change shape (be squished).	Things from nature can be an option, like twigs or wrapping or tissue paper.
Increases precision in grasping, by orienting the arm/hand and adjusting grip size.	Provides objects that need to be grasped in a special way, like toys with a handle. Places them in different positions that encourage their child to open their hand and rotate their wrist.	Bigger toys, sticks. Objects with handles.

## Refinement of grasping and object manipulation

The third level focuses on grasping more precisely. This involves adjusting the hand appropriately for the object. Children need to interact with all different types of objects in different positions to learn how to adjust their hand and arm. At this level, children begin to use less awkward grasps. Object manipulation is also observed. This involves using an object for an intended purpose, like pushing buttons or pulling the lid off a container.

What child does	What caregiver does	Suggested toys/activities
Grasps, releases, and drops objects of different sizes and in different positions.	Places toys at different distances and in different locations, like on the table or in boxes. This will encourage their child to try to grasp and release objects from different positions.	Small toys, objects with small bases, and fragile things such as crackers and cereal. Baskets and boxes of different sizes for the chosen objects. Play give-and-take games to pass toys back and forth.
Positions their hand before grasping, independent of the toy's location.	Places or holds objects to promote wrist rotation and other hand adjustments.	Stickers or small toys.
Grasps with increased precision using the tips of their fingers, making it possible to handle more fragile objects.	Presents small objects in different locations.	Small toys, pearls, and buttons (can be on a string for safety) placed in bowls. Objects with small bases, such as standing dolls.
Points at pictures and presses buttons	Encourages their child to use their index finger. Shows them how by modeling the action.	Books with a lot of details/pictures, finger puppets. Toys with action buttons.
Catches moving objects.	Varies the speed of moving objects. Rolls objects along the floor or table.	Balls of different size.
Completes simple sequences of actions.	Introduces activities with sequenced steps that their child can understand. The activities may have two or more steps.	Place a spoon in a cup; remove an object from a bowl; lift an upside-down cup to grab a hidden cube; press buttons on toys to make sounds.

## Skill Progressions (other than grasp)

These examples provide an idea of skill progressions, but are not appropriate for all children. The examples are adapted from: Roberts & Shierk. A Manualized Approach to Implementing Constraint Induced Movement Therapy (CIMT) using a Camp Model. Retrieved from: <https://twu.edu/media/documents/occupational-therapy/Camp-Based-Augmented-CIMT-Manual-English.pdf>

REACH	Level 1	Level 2	Level 3
Skill Progression	Reaches with gross contact	Reaches with refined contact (index finger) and accuracy	Reaches with grasp
Activity example	Knocks block tower over	Pushes specific blocks in tower (and/or isolates index finger)	Grasps the top block off the top of the tower without the tower falling over
What caregiver does	Encourage the child to purposefully use their arm away from their body by reaching out and touching an item	Encourage child to reach and carefully touch or press an item with the hand or isolated index finger	Encourage the child to reach out and grasp an item; vary the size and weight of items grasped

CHOOSES ASSISTING HAND (AH)	Level 1	Level 2	Level 3
Skill Progression	Touches item on AH side, crosses midline to touch item on dominant side	Grasps item on AH side placed close to body	Grasps item on AH placed away from body (needs to reach)
Activity example	Painting with fingers	Painting with paint brush	Painting with paint brush
What caregiver does	Set up supplies on child's AH side; cue child to use AH to touch (finger paint)	Set up supplies on child's AH side; cue child to use AH to grasp paint brush	Set up supplies away from child's AH side; cue child to use AH to reach and grasp paint brush

STABILIZES	Level 1	Level 2	Level 3
Skill Progression	Stabilizes item with arm/body (chest, lower extremity)	Stabilizes item against a surface	Stabilizes an item using grip
Activity example	Roll ball to child		

STABILIZES	Level 1	Level 2	Level 3
What caregiver does	Place the toy for optimal stabilization, use small degrees of change to challenge stabilization (pushing, pulling)	Use different portions of the arm to stabilize (hand, forearm), vary size of object and degree of change to challenge stabilization	Item can be placed in the hand or grasped by the child, vary size, shape, weight of items stabilized and degree of change/movement to the item to challenge stabilization

RELEASES	Level 1	Level 2	Level 3
Skill Progression	Releases with help/compensatory movements	Gross release/unrefined	Puts down with accuracy
Activity example	Put the fish in the tank: place different sized toys in a plastic container with water		
What caregiver does	Start with easy-to-handle items and assist with release as needed	Encourage the child to drop the items independently into a large, designated area.	Place items into a specific location (items and targeted area are smaller), release from a variety of grasp patterns.

FINGER MOVEMENTS	Level 1	Level 2	Level 3
Skill Progression	Global flexion/extension pattern	Isolates index finger	Isolated finger movements
Activity example	Finger "soccer": move small ball across table		
What caregiver does	Moves item by starting with fingers flexed and then moves into extension; movement in primarily at the MCP joints	Moves item using flexion and extension of index finger	Moves items isolating each finger individually (flicking motion) or taps items with individual finger movements

THUMB OPPOSITION	Level 1	Level 2	Level 3
Skill Progression	Holds items placed in webspace	Inferior pincer	Pincer
Activity example	Eating cheerios		
What caregiver does	Places the item in the webspace and encourages the child to hold it in place	Encourages child to actively pick up items (from the caregiver and then from a surface) using the thumb and index finger	Encourages child to actively pick up items (from the caregiver and then from a surface) using the distal portions of the thumb and index finger

GRIP/PINCH STRENGTH	Level 1	Level 2	Level 3
Skill Progression	Needs assist to grasp; minimal pressure/strength	Active grasp; moderate pressure/strength	Active grasp; pressure/strength comparable to dominant hand
Activity example	Squish play dough ball		
What caregiver does	Assists child with holding an easy to grasp play dough ball and encourages them to squeeze	Encourages the child to grasp and squeeze using a variety of play dough balls (size, shape)	Encourages the child to grasp and squeeze using a variety of play dough balls (size, shape)

SUPINATION	Level 1	Level 2	Level 3
Skill Progression	AAROM	AROM	Strength
Activity example	Turning pages of soft book or board book		
What caregiver does	Assist with movement, use place and hold, use gravity eliminated position if needed; work on PROM as needed	Active movement with increased repetition, use gravity eliminated position if needed	Add resistance or weight (e.g., stiffer book), or caregiver provides resistance to movement

WRIST EXTENSION	Level 1	Level 2	Level 3
Skill Progression	AAROM	AROM	Strength
Activity example	Capture toy under hand, with wrist on table		
What caregiver does	Assist with movement, use place and hold, use gravity eliminated position if needed; work on PROM as needed	Active movement with increased repetition, use gravity eliminated position if needed	Add resistance or weight, or caregiver provides resistance to movement

## Activity Ideas

Below is a list of activities that may be useful to practice target movements. This list is not exhaustive. Activities have been grouped for easier review, but many activities can be used for multiple target movements.

### Reaching

- Position objects and toys above shoulder, out to side, in front
- Pop bubbles
- Play with different sized balls: rolling, throwing, catching, bouncing
- Toss bean bags
- Roll an extra-large ball
- Knock down block towers
- Hat on and off
- Knock over bowling pins on the floor or off the table

### Holding objects

- Shake rattle or O ball
- Hammer toys or xylophone
- Self-feed finger foods
- Drumming on pots with a wooden spoon
- Wave a large ribbon in the air (it can be attached to a stick)
- Wave a flashlight to watch the light move
- Hold bubble wand and wave or blow bubbles
- Move a toy underwater in the bath or a large container
- Play with a toy wand
- Coloring or painting with a crayon/marker/paintbrush/cotton balls
- Fill Tupperware with noisy objects to rattle
- Shake tambourine

### Squeezing objects

- Squeeze putty, playdough, or squeeze ball
- Squeeze sponges filled with water
- Use rubber stamps with a post to grab.
- Squeeze squeaky toys

## **Pushing**

- Press keys on a piano
- Push down on a toy with a large push buttons
- Push down a pop-up toy
- Pushing stamp into an ink pad and then on to the paper

## **Grasp & Release**

- Put small objects in an empty tissue box
- Drop objects on cookie sheet to make a noise
- Hold and release kitchen utensils
- Drop objects in muffin tin
- Play with chunky puzzles
- Play with shape sorter
- Stick and/or remove magnets on fridge
- Fill laundry bin with objects, pull out one by one
- Turn pages of book

## **Stacking objects**

- Stack blocks
- Stack cones or nesting boxes
- Place large pegs into pegboard-like toy
- Place rings on a post
- Stack Tupperware, board books

## **Bimanual**

- String beads (large or small)
- Throw a large ball that requires two hands, like a beach ball
- Tug of war with a scarf, rope, towel, sheet.
- Open a food container
- Flip a lid on a container
- Twisting cap of bottle
- Remove wrapper from food
- Clapping games like patty cake
- Rip wrapping paper, can wrap child's stuffies to be opened



- Hide objects, like small animals, in a cloth bag or small box

### **Sensory Play**

- Fill a container with dried beans, rice, pasta, etc. with small toys hidden inside. Let child move his/her hand around in the box to find their toys.
- Draw in shaving cream on mirror or bathtub wall.
- Scoop water using a cup (something easy to hold) and pour the water into another bucket.
- Touch different materials: silk, satin, pinecone, feathers etc.
- Touch ice cubes
- Water plants, dig in dirt
- Touch texture books

## Summary of recent trials

Study/ First Author	Link	Publication Year	Eligible Age	Sample Size	Therapy	Provider	Setting	Per day (hrs)	Days per week	Therapy Duration	Breaks	Total hours	Outcomes	Results
HEIGHT-EN		pending	3-24mo	20	CIMT	Care-giver	Home	0.5	7	18 weeks	none	63	COPM HAI/mini-AHA/AHA	
I-AC-QUIRE	<a href="#">Click here</a>	pending	8 - 36mo	240 (160 CIMT)	CIMT	Therapist	Home or Homelike setting	3 or 6	5	4 weeks	none	60 or 120	EBS mini-AHA	Trial on-going
REACH	<a href="#">Click here</a>	pending	3-6mo	150	CIMT vs Bimanual	Care-giver	Home	3-6mo: 20min/day 6-9mo: 30min/day 9-12mo: 40min/day	5	until 12mo	none	70 to 89.2	mini-AHA	Not yet reported
Eliasson	<a href="#">Click here</a>	2011	18mo-5yrs	25	Eco-CIMT vs wait period	Caregiver and/or Pre-school teacher	Child's usual setting	2	7	8 weeks	none	112	AHA	Significant improvement as compared to wait period. Change: 5.47 logits.
Chamudot	<a href="#">Click here</a>	2018	8-16mo	33	CIMT vs Bimanual	Care-giver	Child's usual setting	1	7	8 weeks	none	56	mini-AHA	Significant improvement over time. No group difference. Change: CIMT 14.5; Bimanual 18.7 logits.
Christmas	<a href="#">Click here</a>	2018	18mo-4yrs	62	CIMT: prolonged (24hr) vs manual constraint	Caregiver and/or Pre-school teacher	Child's usual setting	1	7	6 weeks	3 * 2 wks CIMT interspersed with 2 wk breaks	42 (30-60hrs actually completed)	AHA	Significant improvement over time. No group difference. Change: Prolonged: 9.0; Manual: 5.3 logits.
Eliasson	<a href="#">Click here</a>	2018	3-8mo	31 (18 CIMT)	CIMT vs massage	Care-giver	Child's usual setting	0.5	6	12 weeks	6 wks ON, 6 wks BREAK, 6 wks ON	36	HAI, AHA	Significant improvement as compared to baby massage group. Change (HAI): CIMT 3; massage 1 (p=0.041) Mean AHA @ 18mo: CIMT 51; massage 24 logits.
Norstrand	<a href="#">Click here</a>	2015	1-2yrs	72 (31 CIMT)	CIMT (Retrospective analysis at 2yo of children who had previously completed baby-CIMT)	Care-giver	Child's usual setting	0.5	7	12 weeks	6 wks ON, 6 wks BREAK, 6 wks ON	42	AHA	No group difference. baby-CIMT group were more likely to have a higher functional level (n=11) compared to no CIMT (n=5), defined as AHA 63-100 units
Reidy	<a href="#">Click here</a>	2017	<18mo	1 (case study)	CIMT	Caregiver and Therapist	Clinic + home	2	5	20 days	none	40	mini-AHA, QUEST	Improvements after a single block of CIMT. Change: 14 AHA units
Case-Smith	<a href="#">Click here</a>	2011	3-6yrs	18	CIMT for 18 days Bimanual for 3 days	therapist	child's usual setting	3 or 6	5 to 6	21 days	none	63 or 126	AHA, QUEST	Significant improvement over time. No group difference. AHA scores not provided.
Lowes	<a href="#">Click here</a>	2013	6-18mo	7 (5 completed study)	CIMT for 23 days Bimanual for 3 days	therapist and caregiver	child's usual setting	3	5	26 days	none	78	Bayley-3	Significant gains in fine and gross motor skills were reported after treatment with CIMT with gains maintained at a one month follow up.
Coker	<a href="#">Click here</a>	2009	<1yr	1 (case study)	CIMT	therapist and caregiver	clinic + home	1	7	30 days	none	30	Pea-body-2, GMFM-88	Clinical improvement on fine and gross motor skills of the assisting limb.
Hwang	<a href="#">Click here</a>	2020	7-36mo	24	CIMT (continuous restraint)	therapist	clinic	2	5	3 weeks	none	30	Pea-body-2, GMFM-66, wrist accelerometry	The percentage of time in moderate-to-vigorous physical activity (z = -2.24; p = 0.03) and vector magnitude average counts (z = -2.52; p = 0.01) significantly increased.

## References

1. Novak I, Morgan C, Fahey M, Finch-Edmondson M, Galea C, Hines A, et al. State of the Evidence Traffic Lights 2019: Systematic Review of Interventions for Preventing and Treating Children with Cerebral Palsy. *Curr Neurol Neurosci Rep*. 2020 Feb 21;20(2):3.
2. Walker C, Shierk A, Roberts H. Constraint Induced Movement Therapy in Infants and Toddlers with Hemiplegic Cerebral Palsy: A Scoping Review. *Occupational Therapy In Health Care*. 2021 Aug 2;1-17.
3. Boyd RN, Ziviani J, Sakzewski L, Novak I, Badawi N, Pannek K, et al. REACH: study protocol of a randomised trial of rehabilitation very early in congenital hemiplegia. *BMJ Open*. 2017 Sep 18;7(9):e017204.
4. Chamudot R, Parush S, Rigbi A, Horovitz R, Gross-Tsur V. Effectiveness of Modified Constraint-Induced Movement Therapy Compared With Bimanual Therapy Home Programs for Infants With Hemiplegia: A Randomized Controlled Trial. *Am J Occup Ther*. 2018 Dec;72(6):7206205010p1-9.
5. Eliasson AC, Sjöstrand L, Ek L, Krumlinde-Sundholm L, Tedroff K. Efficacy of baby-CIMT: study protocol for a randomised controlled trial on infants below age 12 months, with clinical signs of unilateral CP. *BMC Pediatr*. 2014 Jun 5;14:141.
6. Eliasson AC, Nordstrand L, Ek L, Lennartsson F, Sjöstrand L, Tedroff K, et al. The effectiveness of Baby-CIMT in infants younger than 12 months with clinical signs of unilateral-cerebral palsy; an explorative study with randomized design. *Res Dev Disabil*. 2018 Jan;72:191-201.
7. Gordon AM. To constrain or not to constrain, and other stories of intensive upper extremity training for children with unilateral cerebral palsy. *Dev Med Child Neurol*. 2011 Sep;53 Suppl 4:56-61.
8. Ramey SL, DeLuca SC, Stevenson RD, Conaway M, Darragh AR, Lo W, et al. Constraint-Induced Movement Therapy for Cerebral Palsy: A Randomized Trial. *Pediatrics*. 2021 Oct 14;e2020033878.
9. Harniess PA, Gibbs D, Bezemer J, Purna Basu A. Parental engagement in early intervention for infants with cerebral palsy – A realist synthesis. *Child: Care, Health and Development*. n/a(n/a).
10. Palomo-Carrión R, Romay-Barrero H, Pinero-Pinto E, Romero-Galisteo RP, López-Muñoz P, Martínez-Galán I. Early Intervention in Unilateral Cerebral Palsy: Let's Listen to the Families! What Are Their Desires and Perspectives? A Preliminary Family-Researcher Co-Design Study. *Children (Basel)*. 2021 Aug 30;8(9):750.
11. Beckers LWME, Geijen MME, Kleijnen J, A A Rameckers E, L A P Schnackers M, J E M Smeets R, et al. Feasibility and effectiveness of home-based therapy programmes for children with cerebral palsy: a systematic review. *BMJ Open*. 2020 Oct 6;10(10):e035454.
12. Basu AP, Pearse J, Watson R, Dulson P, Baggaley J, Wright B, et al. Feasibility trial of an early therapy in perinatal stroke (eTIPS). *BMC Neurol*. 2018 Jul 23;18.
13. Lord C, Rapley T, Marcroft C, Pearse J, Basu A. Determinants of parent-delivered therapy interventions in children with cerebral palsy: A qualitative synthesis and checklist. *Child Care Health Dev*. 2018 Jul 23;44(5):659-69.
14. Akhbari Ziegler S, Hadders-Algra M. Coaching approaches in early intervention and paediatric rehabilitation. *Dev Med Child Neurol*. 2020;62(5):569-74.
15. Ogourtsova T, O'Donnell M, Majnemer A. Coach, Care Coordinator, Navigator or Keyworker? Review of Emergent Terms in Childhood Disability. *Phys Occup Ther Pediatr*. 2019;39(2):119-23.
16. Brody BA, Kinney HC, Kloman AS, Gilles FH. Sequence of Central Nervous System Myelination in Human Infancy. I. An Autopsy Study of Myelination. *Journal of Neuropathology & Experimental Neurology*. 1987 May 1;46(3):283-301.
17. Ostensjo S, Oien I, Fallang B. Goal-oriented rehabilitation of preschoolers with cerebral palsy--a multi-case study of combined use of the Canadian Occupational Performance Measure (COPM) and the Goal Attainment Scaling (GAS). *Developmental neurorehabilitation*. 2008;11(4):252-9.
18. Proctor E, Silmere H, Raghavan R, Hovmand P, Aarons G, Bunger A, et al. Outcomes for Implementation Research: Conceptual Distinctions, Measurement Challenges, and Research Agenda. *Adm Policy Ment Health*. 2011 Mar 1;38(2):65-76.
19. Alberta SPOR Support Unit LHST. The Equip Tool: Evaluating QUality and ImPlementatation (EQUIP) [Internet]. The EQUIP Tool. 2020 [cited 2022 Mar 2]. Available from: <https://www.theequiptool.com>
20. Ramey SL, DeLuca S, Stevenson RD, Case-Smith J, Darragh A, Conaway M. Children with Hemiparesis Arm and Movement Project (CHAMP): protocol for a multisite comparative efficacy trial of paediatric constraint-induced movement therapy (CIMT) testing

effects of dosage and type of constraint for children with hemiparetic cerebral palsy. *BMJ Open*. 2019 Jan 15;9(1):e023285.

21. Law M, Baptiste S, McColl M, Opzoomer A, Polatajko H, Pollock N. The Canadian occupational performance measure: an outcome measure for occupational therapy. *Canadian Journal of Occupational Therapy - Revue Canadienne d'Ergothérapie*. 1990;57(2):82-7.
22. Kang M, Smith E, Goldsmith CH, Switzer L, Rosenbaum P, Wright FV, et al. Documenting change with the Canadian Occupational Performance Measure for children with cerebral palsy. *Developmental Medicine & Child Neurology*. 2020;62(10):1154-60.
23. Krumlinde-Sundholm L, Ek L, Sicola E, Sjöstrand L, Guzzetta A, Sgandurra G, et al. Development of the Hand Assessment for Infants: evidence of internal scale validity. *Developmental Medicine & Child Neurology*. 2017;59(12):1276-83.
24. Greaves S, Imms C, Dodd K, Krumlinde-Sundholm L. Development of the Mini-Assisting Hand Assessment: evidence for content and internal scale validity. *Dev Med Child Neurol*. 2013 Nov;55(11):1030-7.
25. Holmefur MM, Krumlinde-Sundholm L. Psychometric properties of a revised version of the Assisting Hand Assessment (Kids-AHA 5.0). *Dev Med Child Neurol*. 2016;58(6):618-24.
26. King GA, McDougall J, Palisano RJ. Goal attainment scaling: its use in evaluating pediatric therapy programs. *Phys Occup Ther Pediatr*. 1999 Jan 1;19(2):31-52.
27. Eliasson AC, Ullenhag A, Wahlström U, Krumlinde-Sundholm L. Mini-MACS: development of the Manual Ability Classification System for children younger than 4 years of age with signs of cerebral palsy. *Dev Med Child Neurol*. 2017 Jan;59(1):72-8.
28. Braito I, Maselli M, Sgandurra G, Inguaggiato E, Beani E, Cecchi F, et al. Assessment of upper limb use in children with typical development and neurodevelopmental disorders by inertial sensors: a systematic review. *J Neuroeng Rehabil*. 2018 Nov 6;15(1):94.
29. Schoch SF, Kurth S, Werner H. Actigraphy in sleep research with infants and young children: Current practices and future benefits of standardized reporting. *Journal of Sleep Research*. n/a(n/a):e13134.
30. Ricardo LIC, Da Silva ICM, Martins RC, Wendt A, Goncalves H, Hallal PRC, et al. Protocol for Objective Measurement of Infants' Physical Activity using Accelerometry. *Med Sci Sports Exerc*. 2018 May;50(5):1084-92.
31. Deng W, Nishiyori R, Vanderbilt DL, Smith BA. How Many Days are Necessary to Represent Typical Daily Leg Movement Behavior for Infants at Risk of Developmental Disabilities? *Sensors (Basel)*. 2020 Sep 18;20(18).
32. Holistic [Internet]. mediapipe. [cited 2021 Oct 6]. Available from: <https://google.github.io/mediapipe/solutions/holistic.html>
33. Shin J, Matsuoka A, Hasan MdAM, Srizon AY. American Sign Language Alphabet Recognition by Extracting Feature from Hand Pose Estimation. *Sensors (Basel)*. 2021 Aug 31;21(17):5856.
34. Bjelland I, Dahl AA, Haug TT, Neckelmann D. The validity of the Hospital Anxiety and Depression Scale. *Journal of Psychosomatic Research*. 2002 Feb;52(2):69-77.
35. Lessenberry BM, Rehfeldt RA. Evaluating Stress Levels of Parents of Children with Disabilities. *Exceptional Children*. 2004 Jan 1;70(2):231-44.
36. Cohen S, Kamarck T, Mermelstein R. A Global Measure of Perceived Stress. *Journal of Health and Social Behavior*. 1983;24(4):385-96.
37. Karp SM, Lutenbacher M, Wallston KA. Evaluation of the Parenting Sense of Competence Scale in Mothers of Infants. *J Child Fam Stud*. 2015 Nov 1;24(11):3474-81.
38. Irwin L, Jesmont C, Basu A. A systematic review and meta-analysis of the effectiveness of interventions to improve psychological wellbeing in the parents of children with cerebral palsy. *Research in Developmental Disabilities*. 2019 Dec;95:103511.
39. Squires J, Bricker D, Potter L. Revision of a parent-completed development screening tool: Ages and Stages Questionnaires. *J Pediatr Psychol*. 1997 Jun;22(3):313-28.
40. Lamsal R, Dutton DJ, Zwicker JD. Using the ages and stages questionnaire in the general population as a measure for identifying children not at risk of a neurodevelopmental disorder. *BMC Pediatr*. 2018 Apr 3;18.
41. Kjærandsen KS, Brøndbo PH, Halvorsen MB. Determinants of caregiver satisfaction with child neurodevelopmental assessment in neuropaediatric clinics. *BMC Health Services Research*. 2021 Feb 12;21(1):139.