Future lines of research in constraint-induced movement therapy for children: what is the next step?

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Disclosure Information
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Disclosure of Relevant Financial Relationships
I have no financial relationships to disclose.

Disclosure of Off-Label and/or investigative uses.
I will not discuss off-label use and/or investigational use in my presentation.

Guidelines for future research in constraint-induced movement therapy for children with unilateral cerebral palsy: an expert consensus


Process for development

- Literature search (up to week 4, 2012)
- Survey of consensus group members using the European network for Health Technology Assessment (EUnetHTA)
- Two day, face to face meeting
  - Consensus process to identify current knowledge gaps
  - Development of 11 questions that required further exploration

What is CIMT?

- Two key ingredients
  - Restraint of the well-functioning upper limb (irrespective of device/type)
  - Intensive structured skills practice (irrespective of type)
Definition of CIMT

- Signature constraint-induced movement therapy – Taub’s original model:
  - Restrain of the well-functioning upper limb, 90% of waking hours for at least 2 weeks, intensively training for 3 hours or more/day.
- Modified constraint-induced movement therapy (mCIMT):
  - Variations include:
    - Type and intensity of restraint of the well-functioning upper limb (sling, cast mitt/glove).
    - Type of structured skills practice (shaping/repetition, motor learning).
    - Program intensity (hours per day) and length (number of weeks).
    - Location, context and provider of skills training (home/camp, individual/group, therapist/parent).
  - Forced use therapy:
    - RestRAIN of the well-functioning upper limb but no specific structured skills practice is provided.
- Hybrid CIMT
  - The key ingredients are included in signature or modified form and bimanual training is added to different extents.

Questions to be considered

- Improving the current knowledge of the effectiveness of CIMT
  - Long-term outcomes following CIMT.
  - Effect of repeated CIMT.
  - Transfer effects to bimanual performance and activities in daily life?
- Differences in variables
  - Does type of restraint matter?
  - Does amount of practice matter?
  - Does the type of structured skills practice matter?
  - Does the environment and context of training matter?
  - Does the provider of skills training matter?

Questions to be considered

- Optimal candidates for CIMT
  - Does age influence outcome?
  - Does severity of impairment influence outcomes?
  - Does lesion characteristics and corticospinal projections influence outcome?
- Methodological considerations
  - How does variation in comparison/control group impact outcomes?
  - Implications of the variation on outcome measures
  - What is required for a test to be appropriate?
  - What should be measured?

Literature Review

- Search terms included “cerebral palsy”, “hemiplegia”, “CI therapy”, “constraint-induced movement therapy” and “forced use”.
- Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL and PsycINFO to January 2012.
- No language restrictions were applied.

- 23 randomised or controlled clinical trials.
  - 1 Signature CIMT
  - 17 Modified CIMT
  - 5 Hybrid CIMT
- 45 single group or case study designs.
- 48 different outcome measures used across studies.
State of complexity

Different types of study design
- Types of control group, addition of impairment-based interventions, different outcome measures, small sample size, inconsistent effect size calculations.

Different inclusion criteria
- Age, lesion type, severity of motor and sensory impairment, co-morbidities such as cognitive abilities and behaviour.

Different treatment approaches
- Type and intensity of restraint use, type and intensity of training, length of training programs, intervention environment, intervention provider.

Summary of literature review

- CIMT is more effective than usual care.
- CIMT is not more effective than other models of structured training (i.e., Bimanual therapy).
- All models of CIMT have shown positive effect.
- Highly variable individual response to treatment across all models of CIMT.

Summary of literature review

Longer term outcomes
- Most studies report improvements are maintained at 3 or 6 months.
- Two studies demonstrate immediate post-treatment gains are maintained at 12 months (Charles, 2007; Sakzewski, 2011).

Effect of repeated CIMT
- Knowledge of a repeated or additive effect of CIMT is limited.
  - 1 single group study (Charles, 2007)
  - 2 case studies (DeLuca, 2003; Coker, 2009)
- In a 12 month period improvement from first intervention were maintained and further gains after a second.
- Further investigation is required.
What is known about the different variables of CIMT?

**Eugene Rameckers**

- Does type of restraint matter?
- Does amount of practice matter?
- Does the provider of skills training matter?
- Does the type of structured skills practice matter?
- Does the environment and context of training matter?

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**What is known about the different variables of CIMT? Restraint type**

**Does type of restraint matter?**

- Across higher-level studies, 21 have used a sling, mitt, splint or glove, whilst five used casting.
- Casting programs ranging from 3 to 6 weeks.
- Non-removable casts: greater intensity of unstructured practice.
- Removable restraints: only during periods of structured skill practice.

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**What is known about the different variables of CIMT? Amount of practice**

**Consensus for further research**

- Whether there are superior effects using a non-removable cast needs to be investigated.
- The intensity of restraint needs to be varied between groups (e.g., 24-hr casting versus restraint only during structured skill practice).

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**Consensus for further research**

- The consensus group suggestions:
  - Take into account safety, comfort, climate, fabrics and hygiene.
  - Even if 24-hour casting results in better outcomes, can it be replaced by repeated less-invasive programs with removable restraints over a longer period?
  - The child and families’ compliance with different types of restraints needs to be investigated.
  - Understanding a family’s view about the burden of CIMT and treatment effect.

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**What is known about the different variables of CIMT? Restraint type**

**Does amount of practice matter?**

- A fundamental principle of CIMT is the provision of intensive or “massed” practice.
- Intensity:
  - the length of program (intensive 2-3 weeks versus distributed 8-10 weeks).
  - the time a restraint is worn.
  - Hours of structured skill practice.
- Not only counting hours of structured practice.
### What is known about the different variables of CIMT? Amount of practice

- **The range of hours of structured skills practice**
  - Varies greatly across the CIMT models (range 0 to 126 hours).
  - In home or school environment, training has been reported to be 40-50% below the target hours (e.g., Eliasson, 2003, 2011; Wallen, 2011; Hoare In Press).
  - In camps, it has been reported that active practice only occurred 58% (Charles, 2006) and 81% (Gordon, 2011) of the time.

- **The effect of intensity of structured training**
  - Comparing 90 hours with 60 hours of structured skills practice (Gordon, 2011).
  - In contrast, comparing 3 or 6 hours of daily training (plus forced use remainder of time) for 4 weeks, there was no difference in outcome between groups (Case-Smith 2011).
  - The length of CIMT programs varies widely (2 to 10 weeks).
  - Age from four years of age and older (e.g., Charles, 2006; Gordon, 2008, 2011; Sakzewski, 2011).
  - For children < 4 years, more distributed practice models using 2 hours/day for 6 to 8 weeks have been used (e.g., Eliasson, 2011; Al-Oraibi, 2011; Aarts, 2010).

- **Massed and distributed practice effects have not been compared.**

### What is known about the different variables of CIMT? Providers

#### Consensus for future research

- **Dosage**
  - Additional dosage studies are required to identify the potential existence of a threshold effect for structured skills practice.

- **Intensity**
  - Hours of structured skill practice or program length need to be individually varied within the same model of CIMT.

- **Interventionist ratio?**
  - Compliance and feasibility of different intensities?

#### Does the provider of skills training matter?

- **Provider of skills practice varies across studies**
  - OT, PT, other professionals, students or parents.

- **Parents/Teachers**
  - Following education and supervision, studies with evidence of large effect support the use of parents/teachers as training providers (e.g., Eliasson, 2011).

- **Difference**
  - Training provided by either qualified therapists or interventionists (no therapy training) indicate no difference in outcomes (Gordon 2008, 2011).

### What is known about the different variables of CIMT? Type of practice

#### Consensus for future research

- **Who provides skills practice is an important issue for implementation of CIMT in clinical practice.**

- **Results from existing models suggest a clear and well-structured model of CIMT combined with an education program makes it possible to use different providers.**

- **Additional studies needed.**

#### Does the type of structured skills practice matter?

- **Type of training varies significantly across models.**
  - The signature CIMT model includes shaping and repetition.
  - Modified models of CIMT also use principles of motor learning (Eliasson, 2005, 2011; Aarts, 2010; Hoare, 2013) even if shaping is not used.

- **No studies have compared effects of training concepts provided in various models of CIMT and response to treatment.**
What is known about the different variables of CIMT? Type of practice

Consensus for further research
- Type of practice may not be as important as once thought.
- The consensus group recommends:
  - Documentation of the specific methods should be clearly documented to allow comparison.
  - Integration of bimanual training in conjunction with, or immediately following CIMT based on recognition of the limitations of transfer from unimanual training.
  - Fundamental adaptations of the training concept should be carefully investigated using consistent intensity of skills practice but variations in the training models.

Consensus for future research
- Strong emphasis in making various models of CIMT child and family friendly.
  - Considerable variation in the location and context in which training is provided.
  - Group-based training programs, embedded in circus groups, pirate clubs and recreational/camp environments aim to increase engagement (Gordon, 2008, 2011; Aarts, 2010; Sakzewski, 2011).
  - Hospital or laboratory setting (Rostami & Malamiri, 2012; Gordon, 2011).

- The impact of the environment has rarely been investigated.

What is known about the different variables of CIMT? Training environment

Consensus for further research
- Variation in environment and location
  - Age dependent, practical, financial and ideological reasons.
  - The variations however ensure the possibility of implementing CIMT in a local setting, whilst maintaining the key ingredients of treatment. (Eliasson, 2005; Gordon, 2005; Aarts, 2010).

- Research:
  - How do different environments influence treatment efficacy, compliance and motivation for training?

What is known about predictive factors of outcome?

Katrijn Klingels
- Does age influence outcome?
- Does severity of impairment influence outcome?
- Do lesion characteristics and corticospinal projections influence outcome?

What is known about predictive factors of outcome? Age

Does age influence outcome?
- Mean age 2 to 7 years, total range 7 months – teenagers
  - No differences found in children 4-8 y compared to 9-13 y (Gordon, 2006).
  - Correlations between age and treatment response suggest inconsistent results (Eliasson, 2005, 2011; Sakzewski, 2011; Moore, 2013; Klingels, 2013).
  - Independent of age children respond to CIMT on group level.

Consensus for future research
- ‘The younger the better’ for initiating CIMT, based on neuroplasticity (Martin, 2012)

- Conclusion
  Need for large studies including children across a broad age range.
  Comparing groups for example 2-3y versus 7-8y versus 15-18y – clear gap between age groups.
What is known about predictive factors of outcome? Severity

Does severity of impairment influence outcomes?

- Studies have generally included children with moderately impaired hand function.
- In adults with stroke the ability to actively extend the wrist to 20° is primary predictor of successful response to CIMT.
- In children with unilateral CP no such criterion exists.
- The impact of severity on response to treatment remains unclear.

Consensus for future research

- Due to limitations in task performance, CIMT may be challenging for children with severe motor impairments.
- Children with cognitive impairments will encounter problems in maintaining attention, following instructions.

Conclusion

Existing models of CIMT may need further adaptation to included the participation of severely impaired children.

What is known about predictive factors of outcome? Lesion & CS projections

Do lesion characteristics influence outcome?

- There is evidence that the development of hand function is influenced by the type of brain lesion (Holmström, 2010; Holmefer, 2012).
- The effect on outcomes following CIMT is unknown.

Do corticospinal projections influence outcome?

- Different motor projection patterns are known to influence rate of development of hand function with correlation between preserved contralateral motor projection patterns and good hand function (Holmström, 2010).

Consensus for future research

- Different brain imaging and neurophysiological techniques need to be used in future studies of CIMT to further explain mechanisms behind the effect of treatments, and predictors of treatment (Friel, 2012).

What is known about predictive factors of outcome? Lesion & CS projections

Do corticospinal projections influence outcome?

- Children show improvement irrespective of motor projection patterns (Islam, 2014).
- The size of the corticospinal tract does not affect outcomes following CIMT (Gordon, 2012).
Methodological considerations

Assessments

- A comparison of effect between studies can only be undertaken if the same outcome measures are used.
- In the 23 RCT's - 48 different outcome measures!
- 31 of them in one of the studies only.

What should be measured as CP?

- Prioritize outcomes directly targeted by CIMT
- Primary outcome measures
  - Unilateral capacity
    - Speed and dexterity
    - Quality and precision of movements
  - Bimanual performance
- Body function level measures?
- Change not reported
- Child and parent self-report opinions
- Individualized outcome measures
- Recognize the difference between capacity and performance

Unimanual measures of Speed and Dexterity

- A unilateral timed test
- Age >5-6 years
- For children with CP?
- A strict protocol needs to be set up
  - best out of two?
- Test-retest reliability evaluation (for SDD)
- Can do - capacity

Unimanual measures of Quality of movements

- QUEST
  - Commonly only two subscales are use
    - Dissociated movements
    - Grasps
- Melbourne Assessment
  - New version; MA2 Rasch-based
    - Rates quality of movements in 16 actions/items
    - accuracy, joint position, differentiation and fluency
- Can do - capacity

Bimanual performance

- Assisting Hand Assessment (AHA)
  - Most commonly used measure in CIMT studies
- Transfer to daily life activities?
  - ABILHAND-Kids
  - CHEQ
  - PEDI
- Does do - performance

Individualized outcome measures

- Individualized goals?
  - Canadian Occupational Performance measure (COPM)
  - Goal Attainment Scaling (GAS)
- Does do - performance

Valid and reliable for children with unilateral CP?
Consensus statement

- Use measures allowing comparison of data across studies
- Use measures related to the nature and goals for CIMT
- Shown to be valid and reliable for unilateral CP
- Frequent use of an outcome measure is not synonymous with validity or reliability
- Expected effects of CIMT and the choice of instruments should be carefully matched

Are there some important questions we have not addressed?

- What is known about the effect of CIMT
  - What is known about long-term outcomes following CIMT?
  - What is known about the effect of repeated CIMT?
  - Is there transfer of effect from unilateral training to bimanual performance and activities in daily life?

- What is known about the different variables of CIMT
  - Does type of restraint matter?
  - Does amount of practice matter?
  - Does the type of structured skills practice matter?
  - Does the environment and context of training matter?
  - Does the provider of skills training matter?

- What is known about predictive factors of outcome?
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- How does variation in comparison/control group impact outcomes?
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Are there people doing some new studies?

- What is known about the effect of CIMT
  - What is known about long-term outcomes following CIMT?
  - What is known about the effect of repeated CIMT?

- What is known about the different variables of CIMT
  - Does type of restraint matter?
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