Constraint Induced Movement Therapy

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Constraint Induced Movement Therapy (CI Therapy)

- Developed by Edward Taub, PhD
- Derived from Behavioral Neuroscience Research with animals
- Based on Theory of Learned Nonuse and Use-Dependent Cortical Reorganization

Components of the CI Therapy Protocol

- Intensive training of affected extremity (or function) for many hours a day for 2 to 3 weeks
- Training by a behavioral technique termed shaping
  - Select tasks that address motor deficits, encourage patient to improve speed, help patient complete task if they struggle, and provide explicit verbal feedback with quantitative information and verbal reward.
- A "transfer package" of techniques to promote transfer of therapeutic gains from the clinic to life situation
- Prolonged restraint of use of the arm not being trained. Usually wear a mitt.

More-affected Arm Motor Training

"Transfer Package" Strategies

- Behavioral Contract
- Home Diary
- Home Skill Assignment
- Daily administration of the movement activity log (MAL)
- Home Practice – after supervised training
- Follow-up administration of the MAL

Early Work with TBI

- Shaw SE, Morris DM, Uswatte G, McKay S, Meythaler JM, Taub E. Constraint-induced movement therapy for recovery of upper-limb function following traumatic brain injury. *JRRD*, 2005;42:769-778.

Inclusion Criteria (N = 22)

- Chronic TBI (>1 year) with hemiparesis
- 19 years and older
- Motor criterion (ROM)
- Able to transfer independently and safely to/from a toilet; stand from a sitting position and maintain standing for 2 minutes (with UE support if necessary).
- Cognitive criteria (6 or better on Wechsler Memory scale.

MAL - How Well Scale (HW)

- **0 -** The weaker arm was not used at all for that activity**(never).**
- **1 -** The weaker arm was moved during that activity but was not helpful **(very poor).**
- **2 -** The weaker arm was of some use during that activity but needed some help from the stronger arm or moved very slowly or with difficulty**(poor).**
- **3 -** The weaker arm was used for the purpose indicated but movements were slow or were made with only some effort **(fair).**
- **4 -** The movements made by the weaker arm were almost normal, but were not quite as fast or accurate as normal **(almost normal).**
- **5 -** The ability to use the weaker arm for that activity was as good as before the stroke **(normal).**

UAB CI Therapy

Grade Criteria – Active Range of Motion and MAL scores

	Shoulder	Elbow	Wrist	Fingers	Thumb
Grade 2 (MAL < 2.5 for AS & HW scale)	Flexion ≥ 45° and Abduction ≥ 45°	Extension ≥ 20° from a 90° flexed starting position	Extension ≥ 20°	Extension of all MCP & IP (either PIP or DIP) joints ≥ 10°	Extension or abduction of thumb ≥ 10°
Grade 3 (MAL < 2.5 for AS & HW scale)	Flexion ≥ 45° and Abduction ≥ 45°	Extension ≥ 20° from a 90° flexed starting position	Extension ≥ 10°	Extension of MCP & IP (either PIP or DIP) joints of *at least* 2 fingers ≥ 10°	Extension or abduction of thumb ≥ 10°
Grade 4 (MAL < 2.5 for AS & HW scale)	Flexion ≥ 45° and Abduction ≥ 45°	Extension ≥ 20° from a 90° flexed starting position	Extension ≥ 10°	Extension of at least 2 fingers > 0° & < 10°	Extension or abduction of thumb ≥ 10°
Grade 5 (G4/5 MAL < 2.5 for AS & HW scale) • **Subclass A**	Flexion ≥ 30°, Abduction ≥ 30°, or Scaption ≥ 30°	Initiation* of both flexion and extension	Must be able to *either* initiate* extension of the wrist *or* initiate* extension of any digit		
• **Subclass B**	Flexion ≥ 30°, Abduction ≥ 30°, or Scaption ≥ 30°	Extension ≥ 20° from a 90° flexed starting position	No active movement required at the wrist, fingers, or thumb		

* Initiation is defined for the purposes of criteria as minimal movement (i.e., below the level that can be measured reliably by goniometer.
Note: Each movement should be repeated 3 times in 1 minute in order to meet criteria. Grade 1 patients designate a patient that has normal or near normal active range of motion and scores > 2.5 for the Amount of Use Scale and How Well Scale of the MAL.
Grade 6 patients would fall below the minimum Grade 5 criteria.

Outcome Measures

- Real World Measures
  - Motor Activity Log
    - ❖Amount of Use (AOU)
    - ❖Quality of Movement (QOM)
- Laboratory Motor Function (Capacity)
  - Wolf Motor Function Test
    - ❖Performance Time (PT)
    - ❖Functional Ability (FA)
  - Fugl-Meyer Motor Performance Assessment (F-M)

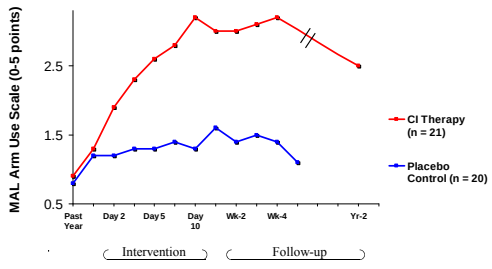
Results: Motor Activity Log (Real World Use)

Table 2.
Mean ± standard deviation for Motor Activity Log Arm Use scale scores and effect sizes for treatment changes.

Impairment Grade*	Pretreatment	Posttreatment	1-Month Follow-Up†	2-Year Follow-Up‡	Δ Posttreatment	Δ 1-Month Follow-Up	Δ 2-Year Follow-Up
All Participants (N = 22)	0.9 ± 0.6	2.4 ± 1.0	2.5 ± 1.0	1.9 ± 0.9	1.6 ± 0.8§	1.7 ± 0.8§	1.0 ± 0.8§
Effect Size¶	—	—	—	—	2.1	2.1	1.3
Grade 2 (n = 13)	1.2 ± 0.6	2.9 ± 0.9	3.0 ± 0.9	2.1 ± 0.9	1.7 ± 0.8	1.8 ± 0.8	1.0 ± 0.9
Effect Size	—	—	—	—	2.2	2.4	1.1
Grade 3 (n = 4)	0.7 ± 0.4	2.4 ± 0.7	2.8 ± 0.5	2.1 ± 0.7	1.7 ± 0.7	2.1 ± 0.6	1.4 ± 0.7
Effect Size	—	—	—	—	2.4	3.7	2.0
Grade 4 (n = 5)	0.3 ± 0.2	1.4 ± 0.8	1.3 ± 0.8	1.0 ± 0.6	1.1 ± 0.8	1.0 ± 0.9	0.7 ± 0.5
Effect Size	—	—	—	—	1.4	1.2	1.4

Note: Significance levels not indicated for each impairment grade because inadequate power existed for evaluation of changes within smaller subgroups (i.e., Grades 3 and 4).
*Grade 2, 3, and 4 participants had mild-to-moderate, moderate, and moderate-to-severe motor impairment, respectively, of more-affected upper limb prior to treatment.
†Data collected from 95% of participants.
‡Data collected from 87% of participants.
§$p < 0.05$.
¶Reported effect sizes are *d* (mean change divided by standard deviation). According to meta-analysis literature, small, medium, and large *d* values are 0.13, 0.35, and 0.57, respectively. *Source:* Benjamini Y, Hochberg Y. Controlling the false discovery rate: A practical and powerful approach to multiple testing. J R Stat Soc B. 1995;57:289–300.

REAL-WORLD ARM USE: MOTOR ACTIVITY LOG



Wolf Motor Function Test

- 0 – Does not attempt with upper extremity (UE) being tested.
- 1 –UE being tested does not participate functionally. 2 –Requires assistance of the UE not being tested for minor readjustments or change of position.
- 3 – Movement is influenced to some degree by synergy or is performed slowly or with effort.
- 4 – Does; movement is close to normal, but slightly slower.
- 5 – Does; movement appears to be normal.

Results: FMA and WMFT (Best Effort)

Table 3.
Mean ± standard deviation for laboratory motor ability test scores and effect sizes for treatment changes by impairment level.*

Motor Ability Test	Pretreatment	Posttreatment	Change	Effect Size†
Fugl-Meyer Motor Performance Assessment‡				
All Participants ($N = 21$)	38.4 ± 11.6	42.6 ± 11.9	4.17 ± 3.5§	1.4
Grade 2 ($n = 12$)	45.2 ± 8.2	50.3 ± 8.4	5.2 ± 3.7	1.4
Grade 3 ($n = 4$)	25 ± 8.3	29.5 ± 6.8	4.5 ± 4.5	1.0
Grade 4 ($n = 5$)	30.4 ± 5.8	34.4 ± 6.9	4.0 ± 2.6	1.6
Wolf Motor Function Test¶				
All Participants ($N = 20$)	4.4 ± 1.1	4.8 ± 1.0	0.4 ± 0.5§	0.7
Grade 2 ($n = 12$)	4.8 ± 1.0	5.1 ± 0.9	0.3 ± 0.6	0.6
Grade 3 ($n = 4$)	3.7 ± 1.3	4.4 ± 1.2	0.7 ± 0.5	1.3
Grade 4 ($n = 4$)	3.8 ± 1.0	4.1 ± 0.9	0.3 ± 0.7	0.5

Note: Significance levels not reported for each impairment grade because inadequate power existed for evaluation of changes within smaller subgroups (i.e., Grades 3 and 4).
*Grade 2, 3, and 4 participants had mild-to-moderate, moderate, and moderate-to-severe motor impairment, respectively, of more-affected upper limb prior to treatment.
†Reported effect sizes are d (mean change divided by standard deviation). According to meta-analysis literature, small, medium, and large d values are 0.13, 0.35, and 0.57, respectively. *Source:* Benjamini Y, Hochberg Y. Controlling the false discovery rate: A practical and powerful approach to multiple testing. J R Stat Soc B. 1995;57:289–300.
‡Total upper-limb score.
§$p < 0.05$.
¶Functional ability score.

Wolf Motor Function Test Results

Conclusions (Shaw et. al., 2005)

- CI therapy is effective in improving motor ability in persons with TBI.
- Improvements are sustained over a 2-year period.
- More significant improvements in real-world use of UE in persons with TBI (similar to persons with stroke).

Bringing Rehabilitation to American Veterans Everywhere (BRAVE)

Inclusion Criteria

- ≥ 3 months post Traumatic Brain Injury
- Mild to Moderate Motor Impairment (Grades 2 and 3)
- Other inclusion/exclusion criteria similar to past studies

Injury-related Characteristics

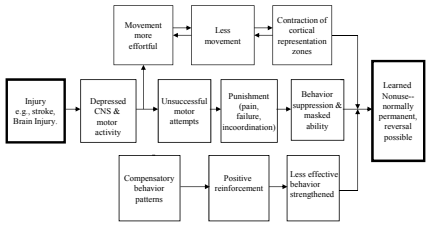
	CIMT (*n* = 19)	LEFT (*n* =21)	All (*N* = 40)
Time since last TBI (years)	11 (14)	10 (11)	10 (13)
Paresis of right arm	42%	52%	48%
Paresis of arm that was dominant pre-injury	47%	57%	53%
Severity of arm impairment			
Grade 2 (mild/moderate)	85.7%	81.8%	83.7%
Grade 3 (moderate)	14.3%	18.2%	16.3%

***Note:** Values are Mean (*SD*) or percent of total number in group. None of the differences between the groups were statistically significant.

Goal is increased arm use by two independent but linked mechanisms

- **Overcoming Learned Nonuse**
- **Use Dependent Cortical Reorganization**

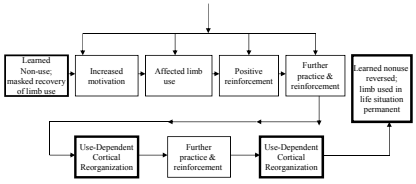
Development of Learned Nonuse



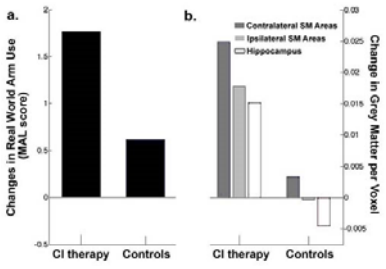
Use Dependent Cortical Plasticity (UDCP)

- The size of cortical representation of a body part depends on the amount of use of that body part.
- Cortical reorganization can be facilitated with use.

CI Therapy



Transfer Package results in a Profuse Structural Brain Change An Increase or Remodeling of Grey Matter



Barriers to Access

- CI therapy is costly because current protocols require one-on-one treatment from a highly paid therapist for many hours over several weeks.
- Only a relatively small number of therapists working at medical centers have received formal training in CI therapy.
- Insurance at this high intensity will not cover in most cases.

Keys program

- Piloting new program for patient with neurologic illness injury (Modified CI Therapy program)
  - Traumatic Brain Injury
  - Stroke
  - Multiple Sclerosis
- Called Keys Program with the idea to help unlock potential for real world function.
- Focusing on upper extremity.

Keys program

- Treatment Outpatient
  - Evidence based CI training tasks
  - Behavioral Components designed to maximize carry over of skills (Transfer package).
  - 4 weeks 4x/week at 1.5 hours per session
  - 2 weeks 2x/week at 1.5 hours per session
  - 2 weeks 1x/week at 1.5 hours per session
  - We have done 8 patents so far with good results.

Summary

- Constraint Induced Movement Therapy is an effective way to improve function.
- CI Therapy effects can be sustained over time.
- In the future there may be a cost effective/improved access version (KEYS program)to this type of therapy with a modified approach of the CI therapy program.

Questions?