

# Pediatric Constraint Induced Movement Therapy for Neuromotor Recovery

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# Seminar Objectives

Identify how Pediatric Constraint-Induced Movement Therapy (PCIMT) works:  
Protocols and Approaches

- Assess motor performance and functioning level to determine ideal candidates for participation.
- Recognize the indications, contraindications and precautions employed w/PCIMT.

# Seminar Objectives - continued

- Identify how commonly used neurorehabilitation treatment techniques compliment this “vehicle”.
- Understand general measurement and evaluation tools.

# Theory and Background

- PCIMT is a technique that supports the use of traditional neurorehabilitation and motor recovery therapies, in which constraint of the non-affected upper extremity, combined with repetitive use of the affected upper extremity, works to improve motor recovery and subsequently function and performance. PCIMT helps a child overcome developmental disregard and at the same time helps the child train the affected upper extremity.

# CIMT AKA “TAUB Therapy”

- Credit must be given to Edward Taub, PH.D.
- Dr. Taub is the Director of the Taub Therapy Clinic and the “originator” in the 1980’s of this model which incorporates traditional motor recovery therapies. Dr. Taub’s contention is, based on his extensive research, that anyone with long standing weakness on one side of the body nearly always benefits from this approach.
- He is a psychologist with the University of Alabama/Birmingham.

# Key Terms

- In trying to foster behavioral change, plasticity changes occur with this intensive rehabilitation model resulting in improved motor control and performance...and motor learning

# Continued - terms

- Constraint/Restraint Movement
- Naturalistic Forced Use
- Massed Practice
- Shaping/Forced Use: approach of a desired outcome in small, successive increments.
- Developmental Disregard
- (DeLuca, S., Echols, K. & Landesman, S.)

# Applicability to Pediatrics

- Pediatrics
- [uabmedicalcenter.com](http://uabmedicalcenter.com)
- AQUIRE Program

# Level I – Systematic Cochrane Review

- Charles, J. & Gordon, A. (2005). A critical review of constraint induced movement therapy and forced use in children with hemiplegia. *Neural Plasticity*, Vol. 12, No. 2-3.
- Monitored effectiveness of CIMT, mCIMT in treatment of kids with CP.
- Significant statistical effect

# Level II (5 articles)

- All RCT's
- Statistically significant gains in UE skills, motor activity (Deluca, Echols, Law & Ramsey, 2006)
- Improvements seen in speed and dexterity and functional use (Charles, Wolf, Schneider & Gordon, 2006)
- Significant scores in hand function and self care scores (Sung, Ryu, Pyun, Yoo, Song & Park, 2005).

# Level II Articles – Cont'd

- Large gains which were maintained at 3 and 6 months (Taub, Ramsey, Deluca & Echols, 2004).
- Forced use can be effective in children with chronic hemiparesis (Willis, Morello, Davie, Rice & Bennett, 2002).

# Level III Articles

## 4 identified

- Significant improvements in use of impaired hand of an assist that continued 6 months post intervention (Eliasson, Krumlinde-Sundeholm, Shaw & Wang, 2005).
- Gained both measurement and function in affected extremity that had been relatively non-functional (Dickerson & Eagle Brown, 2007)
- Study suggests improvement seen with statistically significant gains in use of mCIMT with kids (Naylor & Bower, 2005).
- Intensive practice can improve movement efficiency and environmental functional limitations (Gordon, Charles & Wolf, 2006) – also, efficacy is not age dependent.

# Conclusion

- All studies suggested that CIMT is effective in treating kids with chronic hemiplegia. There is no clear evidence to support a specific protocol, therefore the options should be considered by everyone involved. Other questions should be examined – ex. What effect the treatment will have on the child's general development and possible psychosocial effects. Based on various studies, positive gains were recorded in the following areas:

# Cont'd

- Increased spontaneous use of the affected arm
- Parental reports of increased activity of daily living independence
- Improved quality, speed, and dexterity of UE use
- Improved use of impaired hand as an assist in bilateral activities.
- Little-Hayes et al. (2007).

# August/September 2008

- Case Report on 12 month old. Evaluated effects of restraint/cast on non-affected arm.
- Explain

# Protocols

- ACQUIRE: 21 days, 6 hr/days, 24 hr. with cast.
- Cast is removed once every week
- Specs: From axilla, elbow 90 degrees, fingers extended and thumb palmarly abducted.
- Verbal cues: “pointer finger”, “open”....

# Continued

- Eliasson, et al. (2005)
- 2 hours day with caregiver, 1x per week with therapist x 8 weeks. Constraint worn 2 hrs. daily.
- Constraints: Removable cast, splint (compliant child), mitt, ace wrap (trial).
- No definitive research stating that skilled in-clinic therapy is any more effective than naturalistic forced use (w/children only).

# Continued

- Willis et. al., 2002; Taub et al., 2004; Deluca et al. (2006).
- 2 hrs./day w/ caregiver @ 1-2 x/wk with therapist for 3 weeks.
- Constraint is worn 90% of waking hours.

# Indications

- Motor specifications:
- Ideal 12-24 month but any age > 8 months.
- Any non-progressive neuromotor condition.

# Assessments

- Common assessments noted in the CIMT literature:
- WeeFIM
- Peabody Developmental Motor Scales
- Jebson-Taylor Test of Hand Function
- Bruininks-Oseretsky Test of Motor Proficiency
- ACQUIRE Source - MindNurture

# 10 mo – 3 y/o

- 15-20 minute increments to include: breakfast, ball play, water play, turning pages, toys to bucket, snack, weight-bearing, keyboarding, blocks – knock down, lunch, nap, snack, ball play, finger paint...note some redundancy with above activity.

# 3-5 y/o & 6-10 y/o

- 15-25 min. increments: dressing, eating breakfast, stretching, coloring, stacking blocks, computer game, snack, bean bucket, flash cards, weight bearing, eating lunch. \*Dressing, stretching, prepare breakfast, eat, brush teeth, email family/friends, arts/crafts, weight bear (push ups), pennies in bank, games (i.e. sorry), ball task, build blocks, prepare and eat lunch.

# Adolescents

- 15-25 min. increments: dressing, eat breakfast, brush teeth, fold clothes, put key in lock, computer game, turn radio on & change stations, open bottle and drink, buttoning, tying, puzzles, prep lunch and eat, clean up, weight bearing.

# Applicability to School-base

- Discussion
- ?Precautions?

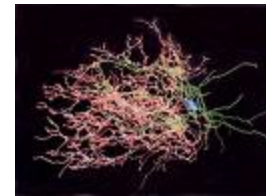
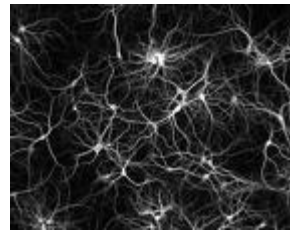
# Why CIMT Works – In Short

- Cortical Reorganization
- Dendrite branching – new connections
- Redundancy
- Synaptic strength
- [brainquest.com](http://brainquest.com)



# The Short - continued

- Obviously, due to the motor deficits, the child relies on their unaffected upper extremity...
- Problematic: \*Neurons that fire together, wire together.



# The Short - continued

- In essence, the goal is to (re)wire (new paths, dendritic branching) the hardwiring (synaptic intensity) of the motor and sensory centers of the brain. +\*Neurons that fire together, wire together.

# Motor Learning and Motor Control

## Still on 'why' CIMT works

- The 3 major aspects of motor learning (a permanent change in function) involve environmental conditions, \*cognitive processes and movement organization (Jarvis, 1994).
- \*

# Continued

- Opportunities to practice (motorically correct!)
  - results in improved synaptic activity and those long term potentials of the pathways (Asanuma & Keller, 1991).

# Motor Learning - continued

- Involves 2 stages:
- Acquisition or practice stage (relearning) and a retention and transfer stage (information is stored for retrieval and application to novel situations)
- The acquisition stage may indicate performance but it is the retention and transfer phase which is indicative of learning (Magill, 1989; Sage, 1984; Schmidt, 1988, 1999)

# Pragmatic Baseline Motor Performance

- Brunnstrom Stage 4 at minimum
- Specificity:
- Wrist extension to 10 degrees
- MCP and IP joint extension of the thumb and at least 2 additional digits 10 degrees in extension.
- The client should be able to actively complete the above 3 different times in one minute (Blanton & Wolf, 1999)

# Continued

- Other:
- Wrist extension to some degree, thumb abduction and at least extend 2 fingers to a minimum of 10 degrees.
- Be certain wrist flex is not used to provide digital extension.
- Lift wash rag off a table using any type of prehension then actively releasing it.

# Continued

- ACTIVELY...
- Shoulder flexion and abduction and external rotation 45 degrees each
- Partial elbow extension
- Forearm supination/pronation 45 degrees each

# Client Medical History

- No uncontrolled medical issues.
- No chronic conditions which could be aggravated.
- Physician approval mandated.

# How CIMT Works

- Bottom Line...
- Motor Control Therapy:
  - 1. Manipulation of the sensory mechanisms results in motor output.
  - 2. \*Repetition\* of the sensorimotor cycle will enhance voluntary movement.
  - 3. Use of therapeutic movement needs to be \*practiced\*.

# Continued

- Some basic premises to keep in mind (taken from the Neurodevelopmental Frame of Reference):
- Consider foundational skills as a foundation to make normal skill acquisition possible (foundational skills – midline symmetry, trunk rotation, postural control).
- Cannot impose normal movement on abnormal muscle tone. Coaching in CIMT terms!

# Neurophysiological Principles – Structure and Functions

- CNS – Muscle Spindle Activity/Golgi Tendon Organs –
- Functions:
- Both the m. spindle and the GTO are responsive to tonic and phasic stimuli.
- One will use techniques to effect the MS or GTO depending on what one is trying to achieve....to inhibit, to facilitate or both.

# Continued

- The neuromuscular treatment techniques will affect the phasic and tonic responses in the mm.
- A phasic response is quick and short-lived contraction, reflexive in nature (ex. Quick stretch and tapping)
- Phasic provoking stimuli are often used in early motor control therapy.

# Continued

- A tonic response involves a sustained contraction of a muscle via controlled sensory input.
- Tonic provoking stimuli are often used, such as with sensorimotor and Rood techniques, ex. Vibration, functional task performance.
- Essentially skilled movement, normal activity requires integration of tonic and phasic movements.
- As CIMT treatment proceeds, tonic activity is the emphasis.

# Continued

- The MS and GTO are also sensitive to facilitation and inhibitory techniques. Ex. GTO/MS – Deep Pressure is inhibitory and tapping is facilitatory.

# Facilitation and Inhibition

- Contraction of a muscle – facilitation  
(hypotonicity/antagonist)
- Relaxation of the muscle tone – inhibition  
(hypertonicity/agonist)
- Example: Biceps: Quick Stretch will facilitate  
and a slow prolonged stretch will inhibit.  
Typically one is trying to facilitate the extensors  
and inhibit the flexors when attempting to  
balance tone.

# Continued

- Group One and Group Two Muscles:
- Group I: Flexors, Adductors and Medial Rotators
- Group II: Extensors, Abductors and Lateral Rotators
- Spasticity often attacks the Group I muscles.
- With spasticity, the mm lose their dynamic ability to produce isolated joint movement and mm tend to work in a bound unit or synergy.

# Continued

- With spasticity, reciprocal innervation is lost.
- Therefore, facilitation methods are frequently directed toward the Group II muscles (extensors...) and inhibition toward the group I muscles.
- Ex. RIP the Group I mm (Bobath) and use the controlled sensory input with the Group II's (Rood)

# Continued

- An extensor synergy would be the opposite of what was just described.
- Facilitation of the flexors when spasticity is present will only make it worse.
- Facilitation of the flexors will also further inhibit the extensors (aka antagonist), which is obviously not good.

# 1<sup>st</sup> Step Co-Contracture

- Simultaneous contraction of the agonist (prime mover) and the antagonist.
- This is a goal with motor control therapy with hypo or hypertonicity
- Stability before mobility
- Need proximal co-contracture (balance of muscular tone around a joint) for distal mobility (reciprocal innervation)

## 2<sup>nd</sup> Step – Reciprocal Innervation

- Ultimate goal with isolated movement patterns.  
Ex. PNF UE Diagonals
- With hypertonicity, one is trying to obtain a balance between the Group 1 and Group 2 mm. so isolated functional movement patterns occur.
- One does not want the antagonist resisting the agonist, otherwise get synergistic non-isolated movement. Try to get the mm. working independently of one another so skilled isolated motor control can occur.

# Continued

- Theoretical neurodevelopmental treatment approaches (bobath, brunnstrom, rood, PNF, Affolter, etc) are more alike than they are different due to the developmental perspective.
- The theorists, as it relates to CIMT, are not so much in conflict with one another – it's at what stage of motor control they're addressing that validates their approach. There's more than one way to do something.

# CIMT Treatment

- In client treatment, the extensors should be facilitated before permitting or focusing on flexor activity; Ex. (provide example with functional reaching tasks).
- The activity of the Group II mm. is the key to functional attainment of movement at all levels of required activity.
- Inhibit agonist hypertonicity and facilitate antagonist hypotonicity. Or if an extensor synergy exists, inhibit the Group II's and facilitate the Group I's (Ex. At the elbow).

# All theoretical Approaches are the again based on...

- Manipulation of the sensory mechanisms (sensations) results in motor output.
- Repetition of the sensorimotor cycle (input→output) will enhance voluntary movement.
- \*Use of therapeutic movement needs to be practiced, and practiced **the right way**.
- Emphasize quality – practice doesn't make perfect, perfect practice makes perfect.

# Continued

- Work developmentally, proximal to distal, reflexive to voluntary to refined movement.
- Volition
- Long Term Memory is searched – previous learning (Use familiar tasks rather than new learning)
- Movement is executed and through practice and repetition it is monitored and adapted
- The Program is stored in memory for future use. (learning and generalization)

# Continued

- Meaningful occupation is important for the most practical movements are most embedded in memory.
- Therapy and learning involves practice and repetition (rote to meaningful). The incorporation of home programming with CIMT is critical (repetition; variable practice); Using improved motor skills within customary roles and routines.

# Continued

- Goals of all Motor Control Approaches:
- Maintain ROM
- Normalize M. Tone
- Normalize Movement – avoid reflexive and synergistic motions and positions and primitive reflexes in CIMT

# Relearning functional motor patterns

Proximal stability before good distal mobility  
– following a developmental sequence is often a good guide.

Developing automatic motor movement requires practice, practice and more practice.

Once voluntary control is obtained consistently, work on endurance, speed and accuracy.

# Facilitation Techniques

- Ways to increase tone:
- Early phase – “jump start”
- Tactile Stimulation for CIMT: quick swipe/light stroking or fast brushing – use few reps for mobility (phasic) and more reps/more frequent/sustained stimulation for stability (tonic). This often precedes task-oriented and other functional approaches.

# Continued

- Thermal Stimulation: Icing
- Proprioceptive Stimulation: Vibration, stretch, quick light passive stretch followed by brief phasic responses; prolonged stretch; stretch pressure over m. belly (thumb and fingers in direction of muscle fibers), and tapping.

# Continued

- Reflexes are not used in CIMT unless Brunnstrom 4 or greater function but lack scapular elevation or even forearm rotation. May consider using associated reflex.

# Inhibitory Techniques

- Techniques for decreasing tone:
- Tactile Stimulation – slow stroking (extensor tone)
- Thermal Stimulation – prolonged icing, heat
- Vestibular Stimulation –slow rolling
- Proprioceptive Stimulation – vibration at low speed; positioning (RIP's): light joint compression; pressure over insertion of tendon.

# Continued

- Need willed movement – visually attend

# Specific Sensorimotor Approaches

Proprioceptive Neuromuscular Facilitation  
(PNF)

Herman Kabat, a neurophysiologist and  
Maggie Knott, a PT

A lot of facilitation, not inhibition

# PNF Principles

- Emphasizes abilities rather than inabilities
- Normal movement development precedes proximal to distal

# Continued

- ...Developmentally, movements of flexion and extension, then flexion, the diagonal and spiral functional patterns follow.
- Isolated movements to normal functional movements, such as washing one's face. (Blocked practice to whole practice)
- Goal directed (functional movements) are made up of reversing movements, Ex. Reach into a refrigerator and reach out...get balance of agonist and antagonist...reciprocal innervation.

# Continued

- Developing motor behavior, there is an orderly developmental sequence of total movement postures, ex. Can't teach to sit, if cannot roll and so on.
- Normal motor development is orderly and sequential but lacks step by step quality.
- Improvement of motor ability is dependent on motor learning – go from simple motor tasks to more complex voluntary acts (low contextual to high contextual interference).

# Continued

- Need practice, or frequency of stimulation, and repetition of activity for motor learning.
- Need to use goal directed activity and not just rote exercise or movement. Tap into the association areas of the brain where motor output and purposeful movement come together.

# PNF Treatment Procedures

- Diagonal Patterns, D1 and D2...
- --emphasize these because motor development proceeds this.
- Five reasons why diagonals are used:
  - - patterns agree with spiral and diagonal characteristics of normal movement.
  - - voluntary movement consists of mass movement patterns rather than individual mm.

# Continued

- - Diagonal movement occur last in the developmental sequence and is the most advanced movement. Must have good diagonal movements to function.
- - All diagonals cross midline – good for perceptual motor function and interaction of both sides of the body.
- - Diagonals incorporate a rotational component.

# Neurodevelopmental (Bobath) Approach

- Karl and Berta Bobath
- Principles:
- Handling
- Positioning
- Use of Adaptive Equipment
- Key Points of Control
- Use of Sensory Input

# Continued

- Motor Learning Strategies
- Encourage Voluntary Control
- Encourage total body integration, bilateral UE usage, crossing midline and facilitate the affected side (weight bear during AM ADL; proper mobility).

# Neurodevelopmental Concepts

- During the acquisition of functional motor skills, the therapist encourages the individual to focus on the goal rather than specific movement components of the task.
- Learning and adaptation of motor skills involves practice (experience) & repetition.
- Do not feed into spasticity

# Continued

- RIP's; opposite of synergy pattern; facilitate scapular protraction, isolated elbow extension, etc.
- Work on affected side of the client
- Use good bed mobility, supine → sidelying — sitting...

# Neurophysiological/Rood Approach

- Margaret Rood
- Development to include co-contraction and reciprocal innervation through controlled sensory input.
- Discussed motor performance with phasic and tonic terms
- Uses inhibitory and facilitory techniques
- Heavy work as inhibitory
- See previous motor control discussion

# Brunnstrom Movement Therapy

- Signe Brunnstrom
- 6-7 Stages of Recovery, depending on source
- Some treatment strategies may be 'considered outdated' (based on stage of recovery and other factors) in early treatment especially with those who have expected good prognosis for motor recovery.

# Continued

- Primitive reflexes produce responses in mm – perhaps use in treatment selectively
- Uses sensory input (vibration, stretch, etc.) and exteroceptive input such as pressure, temperature and touch.
- Necessary to use motivation; visual feedback.
- Necessary to use repetition.

# Continued

- UE Stages 4-5 (CIMT candidates!)
- Goal: \*\*Promote voluntary movement which deviates from the synergy...trying to facilitate isolated control
- Developmental: Spherical and cylindrical and gross grasp → lateral prehension.
- \*\*Treatment deviates from synergistic patterns – uniplanar to more complex movement.

# Continued

- Stage 6: Work on strength (not so much tone issues), endurance, speed and precision and all forms of prehension (within context!)

# Task Oriented Approach and Functional Training Approaches

- Normal functional movement emerges as an interaction among many systems
- Individuals attempt to solve problems inherent in a functional task rather than just repetitively practicing normal tasks.
- In context and variable/whole
- Transfer of training – involve caregivers – important part of home programming

# Continued

- Top down v. Bottom up

# Affolter Approach – (altered)

- Guiding Principles – “to produce normal movement one needs to feel what normal movement feels like”.
- Used in tx and lunch. Used with STP.
- Traditionally used for perceptual-motor dysfunction
- Used when client at Brunnstrom 4 stage when isolating each motion but needs assistance when collectively putting all the motions together with a functional task.

# Overall Approach with CIMT

- Focus on practicing the missing or problematic performance skills; practice the whole task and transference to generalized situations. Home Program important.

# A Review of the Literature

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