

## Upper Limb rehabilitation after stroke

Prof Sheila Lennon  
Head of Physiotherapy  
School of Health Sciences

[sheila.lennon@flinders.edu.au](mailto:sheila.lennon@flinders.edu.au)

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Dr Dave Morris-UAB, USA  
Dr Katy Pedlow-Belfast, Northern Ireland  
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## Workshop objectives

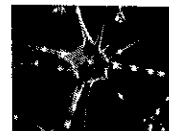
- Review recovery & conventional therapy for the UL post stroke
- Understand how CIMT is delivered according to the signature protocol
- Practice shaping & the MAL
- Gain ideas how to implement CIMT in practice

## Recovery/Prognosis UL (Coupar et al, 2012)

- Recovery is non-linear
- Up to 85% of patients show an initial deficit in the arm. Three to six months later, problems remain in 55% to 75% of patients
- 33-86% with a paretic UL do not gain hand capacity
- Presence of finger extension and shoulder abduction at 72 hours predicts functional recovery (Nijland 2013; EPOS study)
  - 98% probability-indicates preservation of CST
- Who regains hand capacity? (Houwink et al, 2013)
  - proximal sh & elbow control also important
  - slide object with (A) hand across the table
- Patient selection is critical

## Neural Plasticity Cortical Reorganisation

- Functional reorganisation of cerebral cortex
  - Changes at individual synapses reorganise connected networks within the brain
  - Cortical representations (maps) modified by:
    - Sensory inputs
    - Experience
    - Learning
    - Immobilisation
    - Brain injury
    - Skilled motor task training



## Principles of Experience-Dependent Neural Plasticity (Kleim and Jones, 2008)

- Use it or Lose it
- Use it and Improve it
- Specificity
- Repetition matters
- Intensity matters
- Time matters
- Salience matters
- Age matters
- Transference
- Interference

## Are our rehab techniques contributing to disability?

- Not working on the UL during early rehab
- Considering UL movement: not just task specific practice
  - scapula/trunk/legs/vision
  - transport & grasp & release components (Jeannerod; Van Vliet)
- Shifts in thinking: neuroplasticity/intensity/behaviour change
- Neuroplasticity (neurons take on new functions)
- Rehabilitation (intensity/type of training)
- Modification of environment (may lead to further functional gains)

## New directions to drive UL recovery (adapted from Ward et al, 2015)

- Dose (time devoted to UL activity) is too low
- Intensity (amount/no of reps) is too low
- Is there a need for specialist UL clinics?
  - 2-3 hrs per session over 2 weeks (daily) to 10 weeks (3 x per week)
  - use technology for severely affected patients



## Evidence for Upper limb rehabilitation (National Stroke Foundation, 2010)

### 6.3.5 Upper limb activity

- a) People with difficulty using their upper limbs should be given the opportunity to undertake as much tailored practice of upper limb activity (or components of such tasks) as possible. Interventions which can be used routinely include:
- constraint-induced movement therapy in selected people **A<sup>++</sup>**
  - repetitive task-specific training **B<sup>++</sup>**
  - mechanical assisted training **B<sup>++</sup>**
- b) One or more of the following interventions can be used in addition to those listed above:
- mental practice **B<sup>++</sup>**
  - EMG biofeedback in conjunction with conventional therapy **C<sup>++</sup>**
  - electrical stimulation **C<sup>++</sup>**
  - mirror therapy **C<sup>++</sup>**
  - bilateral training **C<sup>++</sup>**

## Repetition/Dosage

- 30-40 UL repetitions performed by an average stroke patient in a session (Lang et al 2007,2009; Kimberly et al 2010)
- 100-300 reps/session needed to produce significant neuroplastic changes on TMS (Birkenmeier et al, 2010)
- Time spent performing movements in a session range from 5% to 40% of total therapy time  
arm training dosage in sub-acute rehab setting  
4mins/session (PT), 17 mins/session (OT)  
(Hayward and Brauer 2015)



## Evidence-based practice

- Explosion of evidence-how do we keep up?
- Pedro database
- Cochrane reviews
- Guidelines
- [www.viatherapy.com](http://www.viatherapy.com)
- Flinders stroke filter project (Hayman, Lennon ...Tiemann et al, under review)



## Key Principles for Conventional therapy

(adapted from McCluskey & Schurr workshops; Lennon & Bassle, 2009)

- Detailed movement analysis:
  - deviations from normal (missing components)
  - identify compensations (trunk & limbs)
- Address impairments
- Establish postural control
- Elicit muscle activity
- Train essential components that are missing
- Train everyday tasks repetitively (300+ reps)
- Modify tasks: part vs whole task practice
- Prevent & manage secondary complications
- Promote independent practice



## Therapeutic/ Rehabilitation Handling

- "Activities which involve handling as part of the patients rehabilitation programme. This may include the handling that is undertaken by the key treating Physiotherapist themselves and staff, relatives or carers who are delegated to, or advised on handling procedures....it may include guiding, facilitating, manipulating or providing resistance by hand or body."

Ref: Guidance on Manual Handling in Physiotherapy. 4th edition, 2014, CSP



## Key Upper Limb Functions

- Support /stabilise
- Reach
- Grasp & release
  - power grasp
  - pincer grip
- Manipulate objects
- Bilateral activities vs Unilateral activities



## Essential Movement Components for the UL post stroke (Carr & Shepherd 1998)

- Shoulder
  - Forward flexion
  - Ext. rotation
  - Protraction
- Elbow
  - extension
  - supination
- Wrist
  - Extension
- Fingers
  - Extension
  - Flexion
- Thumb
  - Abduction
  - opposition

### Activity:

#### What would you do to encourage arm recovery and function?

Case 1 (photo) - 1 week post stroke. No active mvt, some sensory loss

Case 2- 1 mth post, some activity returning, moves in mass flexor patterns, weaker distally

Case 3-3mths post, spasticity IR, elbow flexors, wrist & fingers. Can grasp but cannot let go



### Activity 2

What techniques can you choose from to strengthen weakened muscles?

Limited: grade 0-1	Weak: grade 2	Weak: grade 3-4



### Activity: 2

What techniques will you choose to strengthen weakened muscles?

Limited: grade 0-1	Weak: grade 2	Weak: grade 3-4
<ul style="list-style-type: none"> <li>• Establish postural control (sitting balance)</li> <li>• Weight-bearing thru UL</li> <li>• Eliminate gravity</li> <li>• Eliminate friction</li> <li>• Hands on assisted movement</li> <li>• Setting the scapula (no winging)</li> <li>• Add small mid range arm movements</li> <li>• Bilateral movements</li> <li>• Use tactile/visual cues</li> <li>• Mental practice</li> <li>• FES</li> <li>• CMI</li> </ul>	<ul style="list-style-type: none"> <li>• Hold in different parts of the range</li> <li>• Eccentric before concentric</li> <li>• Reduce lever arm</li> <li>• Part practice</li> <li>• Whole task practice</li> </ul>	<ul style="list-style-type: none"> <li>• Whole task practice</li> <li>• Increase weights</li> <li>• Increase endurance</li> </ul>



## Outcome Measurement

- [www.strokeengine.ca](http://www.strokeengine.ca)
- [www.rehabmeasures.org](http://www.rehabmeasures.org)
- EDGE task force-APTA  
[www.ptresearch.org](http://www.ptresearch.org)



## Constraint-Induced Movement Therapy

**David Morris**  
**UAB.EDU**


With minor modifications by  
Professor Sheila Lennon  
sheila.lennon@flinders.edu.au

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## Session Objectives

- Discuss the theoretical rationale for CIMT
- Explain the CIMT protocol
- Discuss application in a clinical setting
- How does CIMT differ from CPT



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## UL & Hand Activity

(National Stroke Foundation Guidelines, 2010; Veerbeek et al, 2014)

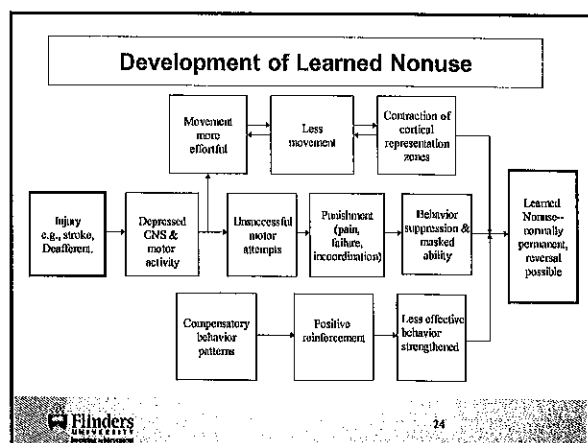
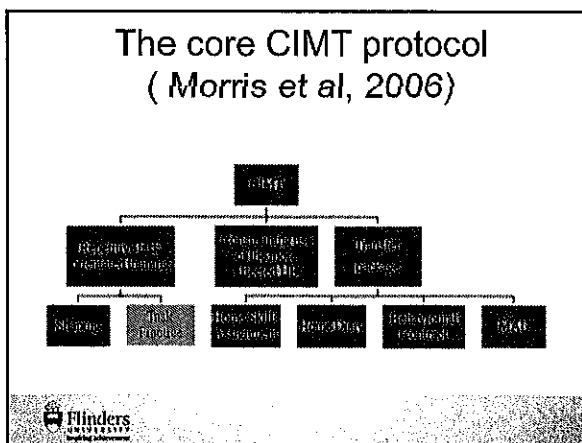
- as much tailored practice of UL activity (or components of task as possible)
  - CIMT                      Grade A
  - Repetitive TST        Grade B
- CIMT: Clear benefits for arm function, small effect hand function
- Need careful selection of patients

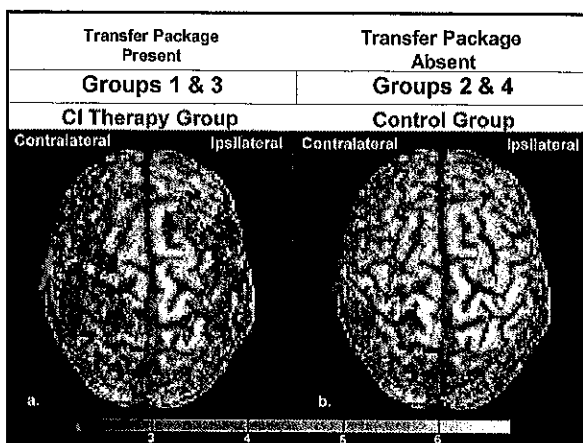
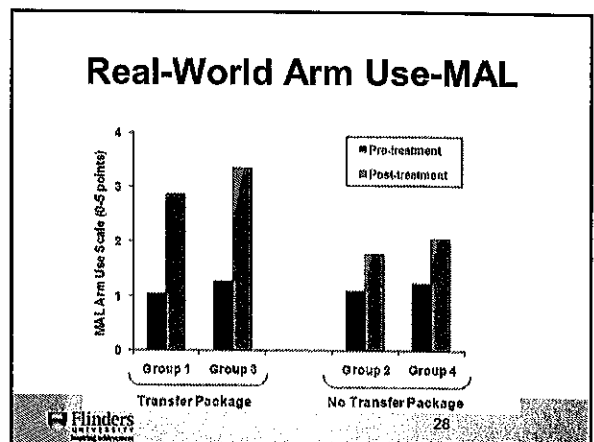
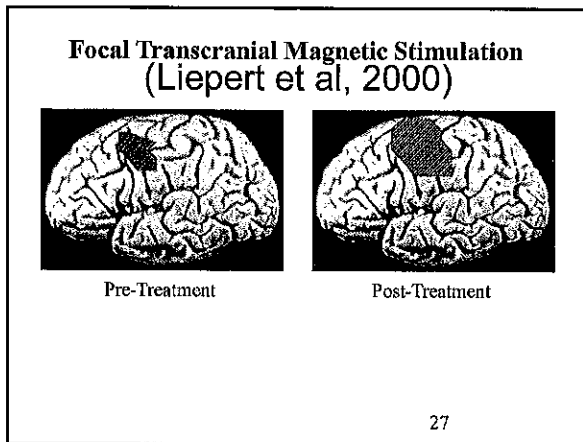
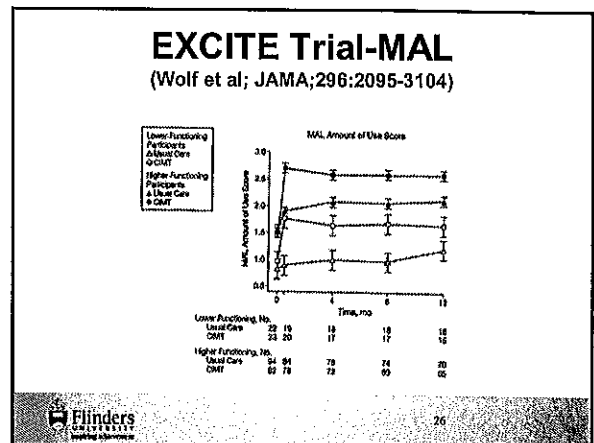
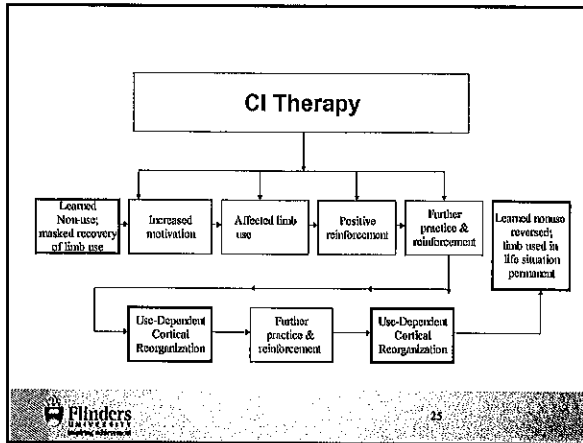
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## Activity 3: What is CIMT?

- Which components of the CIMT signature protocol are you familiar with?
- How long is it feasible to deliver the CIMT protocol for over a period of 2-3 weeks?
- Do you have any concerns about applying CIMT with your patients?

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### Minimal UL movement criteria

2	20°	20°	20° all fingers
3	10°	10°	10° 2 fingers
4	10°	10°	>0° finger

**All patients must have**

- 45° active flexion and 45° active abduction of the shoulder
- 20° active elbow extension from a 90° flexed position

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## Unsuitable patients for CIMT

- No proximal activity
- Can grasp but cannot release
- Inability to follow instructions
- Significant mood disorder
- Not motivated to use the weaker arm

## Shaping for CIMT

- Definition:  
Shaping is a TRAINING METHOD leading to motor learning, in which a motor or behavioral objective is APPROACHED in SMALL STEPS.

## Shaping for CIMT

- Guidelines:  
Shaping task should be selected for participants by considering:
  - Specific joint movements that exhibit the most pronounced deficits.
  - The joint movements that therapist believes have the greatest potential for improvement.
  - Participant's preference.
  - Can use adaptive equipment, orthotic devices, and/or assisted movement with lower functioning subjects.

## Shaping for CIMT

- Guidelines:
  - ✓ Each participant's shaping program is individualized (10-18 tasks).
  - ✓ Each task is usually performed in a set of ten trials.
  - ✓ Each task usually lasts 30- 45 seconds and does not exceed 120 seconds.
  - ✓ For experimental work the rate of performance is usually kept at 25 trials/hr.
  - ✓ The results are recorded on a data sheet and graphed by hand on a trial-by trial basis

## Shaping Strategies

- Feedback:  
Providing specific knowledge of results about a participant's performance (i.e. number of repetitions in a set period of time or time required to perform a task.)  
Track progress on a graph  
Relates to functional skills
- Coaching:  
Providing specific suggestions verbally to improve performance. This is described in the behavioral literature as priming, cueing, and prompting.  
Encouragement verbally to promote maximal effort ( good, keep trying)
- Modelling: Providing a physical demonstration of a shaping task.






## Activity 4


### Design a shaping task

- Activity description
- Progression parameters e.g. size of object
- Feedback parameters e.g. time taken
- Movements emphasised e.g. wrist ext

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### Key Progressions for Shaping


- Time
- Repetitions
- Speed
- Distance
- Height
- Object size
- Object Weight
- No of correct attempts

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### Activity 4:

Complete the table below for these shaping tasks  
Placing blocks on a box  
Turning the pages of a magazine  
Flipping dominoes

Activity description	
Progression parameters	
Feedback parameters	
Movements emphasised	

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## Activity 5

### Using the MAL

In small groups, discuss the scoring the MAL


Using the AOU scale

Using the HW scale

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## Activities for the 30 Item-MAL

<ul style="list-style-type: none"> <li>• Turn on a light with a light switch</li> <li>• Open drawer</li> <li>• Remove an item of clothing from a drawer</li> <li>• Pick up a phone</li> <li>• Wipe off a kitchen counter or other surface</li> <li>• Get out of a car</li> <li>• Open a refrigerator</li> <li>• Open a door by turning a door knob</li> <li>• Use a TV remote control</li> <li>• Wash your hands</li> <li>• Turning the water on/off with knob/lever on faucet</li> <li>• Dry your hands</li> <li>• Put on your socks</li> <li>• Take off your socks</li> <li>• Put on your shoes</li> <li>• Take off your shoes</li> </ul>	<ul style="list-style-type: none"> <li>• Get up from a chair</li> <li>• Pull chair away from the table before sitting down</li> <li>• Pull chair toward the table after sitting down</li> <li>• Pick up a glass, bottle, drinking cup, or can</li> <li>• Brush your teeth</li> <li>• Put on makeup base, lotion or shaving cream on face</li> <li>• Use a key to unlock a door</li> <li>• Write on paper</li> <li>• Carry an object in hand</li> <li>• Use a fork or spoon for eating</li> <li>• Comb hair</li> <li>• Pick up a cup by the handle</li> <li>• Button a shirt</li> <li>• Eat half a sandwich or finger foods</li> </ul>
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## Key MAL Questions

- Amount of Use=how much? (AU)
- "In the last week, have you used your weaker arm to ..(state the activity)?"
- How well? (HW)
- "Using the How Well Scale, tell me how you would rate how well you used your weaker arm to ... (state the activity)."

## Amount Rating Scale

### Amount Scale

- 0 - Did not use my weaker arm (not used).
- .5
- 1 - Occasionally used my weaker arm but only very rarely (very rarely).
- 1.5
- 2 - Sometimes used my weaker arm but did the activity most of the time with my stronger arm (rarely).
- 2.5
- 3 - Used my weaker arm about half as much as before the stroke (half pre-stroke).
- 3.5
- 4 - Used my weaker arm almost as much as before the stroke (3/4 pre-stroke).
- 4.5
- 5 - Used my weaker arm as often as before the stroke (same as pre-stroke).

## How Well Rating Scale

### How Well Scale

- 0 - My weaker arm was not used at all for that activity (not used).
- .5
- 1 - My weaker arm was moved during that activity but was not helpful (very poor).
- 1.5
- 2 - My weaker arm was of some use during that activity but needed some help from the stronger arm, moved very slowly, or with difficulty (poor).
- 2.5
- 3 - My weaker arm was used for that activity but the movements were slow or were made only with some effort (fair).
- 3.5
- 4 - The movements made by my weaker arm for that activity were almost normal but not quite as fast or accurate as normal (almost normal).
- 4.5
- 5 - The ability to use my weaker arm for that activity was as good as before the stroke (normal).

## Possible Reasons for Not Using the Weaker Arm for the Activity

- Reason A. "I used the unaffected arm entirely."
- Reason B. "Someone else did it for me."
- Reason C. "I never do that activity, with or without help from someone else because it is impossible." For example, combing hair for people who are bald.
- Reason D. "I sometimes do that activity, but did not have the opportunity since the last time I answered these questions."
- Reason E. "That is activity that I normally did only with my dominant hand before the stroke, and continue to do with my dominant hand."

## Task Practice

Goal: use the affected limb

- Functionally based, task oriented activities
- Performed continuously for 15-30 minutes
- Milt is worn throughout the task
- If task is two-handed, therapist serves as other hand.
- Trainer provides verbal encouragement and/or coaching at least once/every 5 minutes.
- Trainer provides summary feedback (KR and quality) regarding performance at end of TP session. Emphasize improvements!!!
- Should be challenging yet feasible
- Should be contextually appropriate (i.e., gender and interests)

## Transfer Package

- Behavioral Contract
- Participant/Caregiver Contract
- Home Skill Assignment
- Home Diary
- Home Practice: During and After
- Daily administration of MAL with problem solving



### ***Behavioral Contract: Points Emphasized***

- Use outside of the laboratory is just as important as in laboratory
- Safety is most important
- May be asked to perform activities in ways they would not normally
- Will be asked frequently about their adherence
- is a formal agreement

### ***Behavioral Contract: Steps to Implementing***

- Completed at end of first treatment day
- Repeated again at least once during the intervention – The Monday after the first weekend of treatment is optimal
- List all ADLs from time awaking until going to bed
  - ✓ Provide details of activities
  - ✓ State times carried out
  - ✓ Separate schedule for weekends
- Categorise ADL activities int: more-affected only vs bilateral vs less-affected UL only
- Specify when can request assistance from carer
- Contract is signed and witnessed
- Can be modified anytime during treatment

### ***Home Skill Assignment***

Encourages more-affected UE use with ADL activities outside of the clinic to try as many activities as possible

- ✓ Review list of activities provided
- ✓ Add activities if needed
- ✓ Select 10 for that evening
- ✓ Ideal balance – 5 less and 5 more difficult activities
- ✓ Goal – at least 30 minutes devoted to this activity each evening
- ☐ Reviewed every day – usually select new activities but can repeat if important to participant

### ***Home Diary: Purposes***

- Monitor adherence with mitt
- Heighten participant's awareness
- Structured problem-solving

### ***Unique Aspects of CI therapy***

- Drives neural plasticity by intense practice using shaping
- Focus on function rather than impairment (quality)
- Focus of transfer to real-world environment.
- Importance of extended, concentrated practice.
- Shaping/Task Practice as training techniques.
- Use of adherence-enhancing strategies

### ***6 hours vs. 3 hours***

- Sterr et al., 2002
- Page et al., 2002
- Dettmers et al., 2005
  
- Potential factors:
  - ✓ Less fatigue
  - ✓ Similar absolute intensity of in-lab activities
  - ✓ More time with real world practice

## *A typical session*

- Review home practice (HAS) & diary
- MAL
- Shaping
- Task practice

## *Proposed Schedule for Morning*

- 8:15-9:15 Motor Activity Log
- 9:15-10:00 Behavioral Contract
- 10:00-10:30 Home Skill Assignment
- 10:30-11:45 Shaping and Task Practice (2 of each)

Take breaks as needed

## *Benefits of treatment sessions*

- Many patients work extremely hard
- Focused on success and what they could do with their hand
- Often surprised at their capabilities
- Highly competitive and motivated by their results / feedback
- Strive to ensure they were able to progress their tasks daily
- Practice of tasks performed badly often resulted in improved performance and skill

## *Resources*

- Fits very well into current practice
- Qualified experienced therapists are required only to do the assessments and select appropriate shaping / functional tasks, assistants could complete daily practice
- Equipment: mitt, UL/hand activity equipment, documentation

### **Constraint Induced Movement Therapy (CIMT) for patients with Acquired Brain Injury** **A feasibility Randomised Controlled Trial** Pedlow K<sup>1</sup>, Lennon S<sup>2</sup>, Wheatley-Smith L<sup>3</sup>, Morris D<sup>4</sup>, Caldwell S<sup>3</sup>, Wilson C<sup>3</sup>


<sup>1</sup>Health and Rehabilitation Research Institute, University of Ulster, Belfast, Co. Antrim, Northern Ireland  
<sup>2</sup>Physiotherapy, Flinders University, Adelaide, Australia  
<sup>3</sup>Regional Acquired Brain Injury Unit, Belfast, Co. Antrim, Northern Ireland  
<sup>4</sup>University of Alabama at Birmingham, Birmingham, Alabama, United States of America

#### AIM

To explore the feasibility of delivery of CIMT within the UK clinical setting to the stroke and traumatic brain injury population.


#### OBJECTIVES

- the feasibility of patient recruitment and retention
- the application of multi-component protocol
- participant adherence to the protocol.
- stratification methods used.
- the suitability of the selected outcome measures.
- the effect size of CIMT in people 6 months to 6 years post CIMT.
- power calculation for future RCT





CIMT group  
or  
Bobath based UL group

- 1.5 hours per day
- 5 days per week
- 3 weeks
- 45 minutes OT
- 45 minutes PT
- Home skills assignment
- Mitt 90% of waking hours




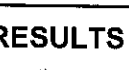
## CIMT

<b>Occupational Therapy</b> <ul style="list-style-type: none"> <li>• Daily Activity Schedule</li> <li>• Behavioural Contract</li> <li>• Motor Activity Log</li> <li>• Home diary</li> <li>• Home skills assignment</li> <li>• Functional task practice</li> </ul>	<b>Physiotherapy</b> <ul style="list-style-type: none"> <li>• Shaping Tasks</li> <li>• Home skills assignment</li> </ul>
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## RECRUITMENT

- 208 patients were on the therapy register across a 15 month period.
- 25 of these patients met the initial eligibility criteria.
- 21 participants were recruited (mean=1.75 patients per month).
- One participant in the CIMT group dropped out from the trial after day 2 of treatment due to transport issues.


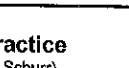
## RESULTS

- MAL QOM & AOU  
 CIMT group: 1.45 and 1.42 (mean improvement)  
 Control group: 0.84 and 0.71 (mean improvement)
- gWMFT FA score  
 CIMT group: (0.79) compared to the UL group (0.3).
- QoL  
 CIMT group: clinically important changes (0.08), the UL group did not (0.04).
- HAD  
 CIMT group: clinically important (-1.90), the control group did not (-0.55).
- Self-Efficacy  
 Both groups had a similar mean improvement (CIMT: 0.99, UL: 0.92).

## CIMT Implementation Top Tips


- Initial assessment is essential
- Simplify the behavioural contract
- Split the components across the team
- Additional time needed on days when full MAL is completed
- Consider carefully whether a mitt is necessary
- Pay particular attention to the TP
- Consider groups, self-training protocols, and home-based coaching
- Consider MAL for use as an outcome tool (download from UAB.EDU)
- Include education / awareness session for families / carers

## Key Exercises for independent practice

(adapted from Dave Morris-UAB & McCluskey & Schurr)

- Protraction-move arm in cardboard cylinder over rolling pin
- Supination-touch table with a ruler
- Practice Wolf Motor Function Test tasks
- Slide hand across a line to a cup
- Practice holding a fork
- Moving fork between tram lines
- Pick up coins with tweezers
- Folding a tea towel
- Picking up a pen
- Pouring a glass of water



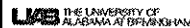
## Take home messages

- Use the hand to drive the shoulder (McCluskey & Schurr)
- Experiment with CIMT adapt to your service delivery
- Expect your patients to change
- Practice does not have to be perfect!
- No challenge, no change (Davy 2015)
- Set yourself up for success (a stroke patient!)



## UAB CI Therapy Information

- > **Taub Therapy Clinic**  
[www.taubtherapy.com](http://www.taubtherapy.com)  
1(888)654-8282
- > **CI Therapy Research Group**- Ongoing clinical trials for individuals having stroke, TBI, or multiple sclerosis  
[www.uabhealth.org/13246/](http://www.uabhealth.org/13246/) or Google CI therapy research (250)976-2177 or (205)934-9788
- > **CI Therapy Training Courses** (5 day cont ed course for OT/ PT)  
[www.uabhealth.org/13246/](http://www.uabhealth.org/13246/) or Google CI therapy research- follow link to course info: Contact David Morris PhD, PT  
[morrisd@uab.edu](mailto:morrisd@uab.edu)



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