

Mobilisation and Tactile Stimulation to enhance upper limb recovery after stroke

Investigation of acceptable dose and efficacy

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ACPIN London 7 November 2009



Upper limb and stroke

- Motor deficit of the upper limb is common after stroke with up to a third of the stroke population having severe paresis¹
- Motor deficits may persist after stroke and have a profound effect on the individual²
- Substantial neuromuscular weakness is prognostic of poor recovery³

1. Kriese et al., 2007
2. Brooks et al., 1999
3. Kwakkel et al., 2003

Upper limb and stroke

- Improvement in upper limb function after stroke is likely to be due brain recovery in the early stages, and later to the re-organisation of neural networks and to the development of compensatory movement strategies
- The upper limb may appear to recover less well than the lower limb because functional activity (eg standing and walking) may be possible despite poor recovery of the lower limb

Stroke recovery

- Brain remodelling and adaptation is dependent on a wide range of factors after stroke (size, location, and type of lesion; pre-morbid status and personal factors; medical management; environmental factors) and may be maladaptive or beneficial¹
- Experimental studies have found that afferent sensory pathways enhance activity in the motor execution system²
- The corticospinal tract originates from both sensory and motor areas of the brain³, and intact sensation is important to both feedforward⁴ and feedback⁵ mechanisms for the control of movement
- Animal model studies have found that 400 repetitions of a movement/task may be required to produce motor learning and brain reorganisation⁶

1. Kriese et al., 2007
2. Lindberg, 2007
3. Sjöbäck and Darian-Smith, 1994
4. Hesse and Franz, 2009
5. van Vliet, 2006
6. Reim and Jones, 2008

Therapy for the upper limb after stroke

- Meta-analysis indicates that CIMT, EMG biofeedback, mental practice, and robotics may have a beneficial effect on upper limb function; however no treatment had a clear benefit in terms of the recovery of hand function⁹
- Task-specific training may have a beneficial effect on upper limb recovery¹⁰, however this requires the individual to have voluntary control of active movement
- Sensory training may alleviate sensorimotor deficit after stroke^{11,12}
- Treatment is required for people with severe upper limb impairment

9. Langhorne et al., 2009
10. van Peppen et al., 2004
11. Yukawa, 1993
12. Carey and Matyas, 2005

Mobilisation and Tactile Stimulation (MTS)

- MTS treatment protocol devised by Dr Susan Hunter (Physiotherapist, Keele University) to define upper limb therapy in order to be able to evaluate it. The protocol arose from interviews and group discussions with Bobath trained specialist neuro-physiotherapists¹²
- The hypothesis upon which MTS is based is that sensory stimulation of the severely paretic limb in the early phase after stroke will enhance motor recovery of the hand and arm
- Techniques are drawn from a standardised treatment schedule with the aim of 'pump-priming the CNS' by providing afferent input to effect a change in the motor system
- MTS involves the use of a variety of 'hands-on' techniques to activate sensory receptors in the skin, muscles, and joints of the forearm and hand
- It is a module of therapy rather than a complete treatment approach

13. Hunter et al., 2006

Mobilisation and Tactile Stimulation (MTS)



Components of MTS

PASSIVE MOVEMENTS THROUGH RANGE	ACCESSORY MOVEMENTS
MASSAGE	SOFT TISSUE STRETCH
PLACING THE HAND ON	ISOLATED/SELECTIVE JOINT MOVEMENT
COMPRESSION	SPECIFIC SENSORY INPUT
PATTERNS OF CO-ORDINATED MOVEMENT UNDERLYING FUNCTIONAL ACTIVITY	Guidance to therapists <ul style="list-style-type: none"> • Treatment is of the forearm and hand only • Adapt treatment (e.g. combination of techniques) to suit the presentation of the individual

Proof-of-concept study

Initial stage in evaluating a treatment under the Medical Research Council's guidelines on the development of complex interventions

Design

- A series of six replicated single case studies (ABA design)

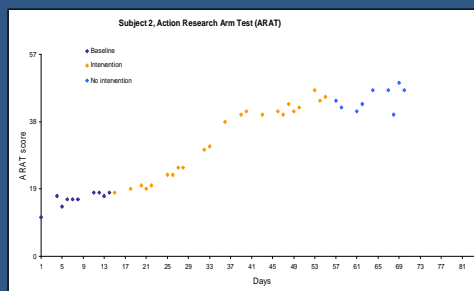
Participants

- People within three months of stroke

Results

- All participants showed improvements in outcome measures in response to MTS

Proof-of-concept study



Dose (Intensity)

- Retrospective reviews of physiotherapy in stroke suggest that increased intensity is beneficial^{15,16}
- A confounding factor of these studies is that different types of therapy are included in the analyses. The findings are equivocal when analysis controls for the type of therapy¹⁷
- Limited number of studies in which dose is evaluated
- Need for prospective studies of intensity¹⁸

15. Kwakkel et al., 1997
16. Langhorne et al., 1996
17. Cook, 2008
18. Dobkin, 2009

Dose Finding

- Essential part of the evaluation of therapy, however, rarely explicitly addressed¹⁴
- Ad hoc identification of dose
- What is rehabilitation dose?
 - Length of each treatment session
 - Number of treatment sessions
 - Duration of treatment intervention (days/weeks)
 - Number of repetitions
 - Resistance (eg weight used in strength training)
- Rehabilitation dose is often thought of as intensity (time spent in therapy)
- The present study is thought to be the first prospective Phase I dose-finding trial of a stroke rehabilitation therapy¹⁹

Aims of this dose-finding study

- To determine which dose of MTS therapy has the most beneficial effect on voluntary muscle contraction and functional ability
- To determine which dose of MTS produces the least adverse events

Participants

Characteristics

- Anterior circulation stroke 8-84 days prior to recruitment
- Paralysis or severe paresis in upper limb
- No clinically important upper limb pain
- Able to follow single stage commands

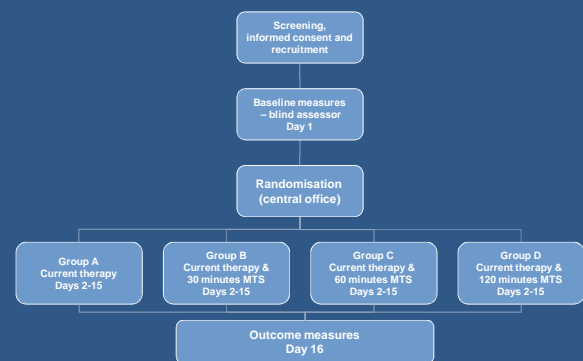
Sample size

- 76 participants at two clinical centres (in London & North Staffordshire)

Power calculation

- A power calculation was completed based on the results of the proof-of-concept study
- A sample size of 20 participants per group was expected to give 80% power at 0.05% significance to detect clinical improvement in at least 50.9% of people in the combined experimental group
- This estimate was based on the assumption that 20% of the control group would improve

Method



Experimental intervention: MTS

- A research therapist in each centre provided the experimental intervention
- Each treatment was recorded on a standard proforma
- The pattern of treatment (eg length of treatment sessions) was agreed with the participant
- Provision of the experimental intervention had to fit in around standard therapy, meals, rest periods, investigations, visitors etc

Conventional upper limb therapy

- The physiotherapists on the stroke units were asked to complete a proforma recording their treatment of the upper limb
- Upper limb interventions provided by other members of the MDT were not recorded

Primary outcome measure

Motricity Index



Pinch grip



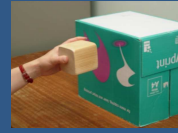
Elbow flexion



Shoulder abduction

Secondary outcome measure

Action Research Arm Test (ARAT)



Gross grip



Pronation



Pinch grip



Gross movements

Outcome Measurements

- Assessors trained together to ensure consistency of use of the outcome measures
- The Motricity Index is a clinical measure of ability to voluntarily contract paretic muscle¹⁹, and has been found to be sensitive to change in people with stroke and low level of motor function²⁰
- The ARAT is a measure of upper limb function²¹

19. Demeulisse et al., 1980
20. Jacob-Lloyd et al., 2005
21. Lyle, 1981

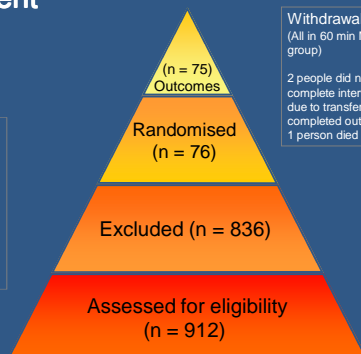
Adverse events

- Participants were monitored throughout the study for upper limb pain and deterioration of motor function
- If an adverse event had been recorded on three consecutive days then the experimental intervention would have been discontinued

Recruitment

Exclusions

Did not meet inclusion criteria (n = 675)
Out of area or discharged (n = 88)
Interpreter required (n = 7)
Already in another therapy trial (n = 41)
Declined consent (n = 15)



Withdrawals

(All in 60 min MTS group)

2 people did not complete intervention due to transfer (but completed outcomes)
1 person died

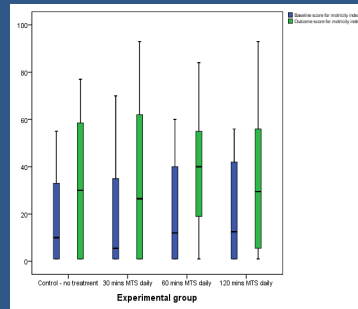
Baseline characteristics

	No MTS n=19	30 min MTS n=18	60 min MTS n=19	120 min MTS n=20
Centre				
London	7	8	9	10
Keele	12	10	10	10
Gender				
Male	10 (53%)	11 (61%)	8 (42%)	9 (45%)
Female	9 (47%)	7 (39%)	11 (58%)	11 (55%)
Age in years : mean (standard deviation)				
	74.3 (13.2)	76.2 (17.9)	72.5 (11.8)	73.5 (15.8)
Days since stroke: mean (standard deviation)				
	31.9 (14.4)	39.0 (26.9)	30.0 (19.9)	31.5 (20.1)
Motricity Index: median (interquartile range)				
	10.0 (1-40)	5.5 (1-40)	12.0 (1-40)	12.5 (1-44)

Baseline characteristics

	No MTS n=19	30 min MTS n=18	60 min MTS n=19	120 min MTS n=20
Stroke classification				
ICH	2	1	2	2
LACI	3	2	4	3
PACI	5	7	6	8
TACI	9	7	7	7
Unknown	0	1	0	0
Neglect				
Not present	14 (74%)	13 (72%)	12 (63%)	14 (70%)
Present	5 (26%)	5 (28%)	7 (37%)	6 (30%)
Hemiplegic side				
Left	11 (58%)	14 (78%)	15 (79%)	13 (65%)
Right	8 (42%)	4 (22%)	4 (21%)	7 (35%)
Dominant hand affected				
Yes	7 (37%)	5 (28%)	4 (21%)	8 (40%)
No	12 (63%)	13 (72%)	15 (79%)	12 (60%)

Results – Motricity Index



The shaded box represents the IQR, with the upper area representing the upper quartile, and the area below the line representing the lower quartile.

The horizontal line in the box represents the median value.

The whiskers stretch out to the minimum and maximum values.

Results - Motricity index

- Ordinal scale therefore non-parametric statistics completed (Freidman's Test and Kruskal-Wallis Test)
- The change in the median score of each group (including the control) was statistically significant on the Freidman's Test
- The greatest change was seen in the 60 minute MTS group
- Little evidence of a statistical trend, as assessed by the Kruskal-Wallis Test, across the groups (large inter-quartile ranges)
- All of the intervention groups contained more participants with a change of three points or more on the Motricity Index than the control group

Results - ARAT

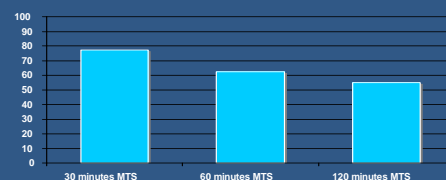
- The change in the median score of each of the intervention groups was statistically significant on the Freidman's Test (the change in the control group did not reach statistical significance)
- No statistically significant trend on the Kruskal-Wallis Test
- The baseline values were more variable across the groups than the Motricity Index scores

Results - Adverse events

- None of the participants experienced an adverse event
- One person experienced pain, however the clinical team identified that this was due to a subluxed shoulder and adjudged that it was unrelated to the intervention

Results - Dose of MTS delivered

Percentage of MTS delivered by group



Mean number of treatment sessions
12.3 11.6 22.2

Mean length of each session (minutes)
25.5 45.8 44.3

Discussion

- Significant improvement, as measured by the Motricity Index was seen in all groups. As the trial was in the sub-acute phase after stroke this may have been due to natural recovery.
- No statistically significant improvement in the control group on the ARAT, although all of the MTS groups did show a statistically significant improvement. This may suggest that the improvement on the Motricity Index was due to a learning effect as this measure was repeated on a daily basis to assess for adverse events.

Discussion

- No statistically significant trends in the results
- Insufficient power to detect changes as the control group improved more than expected
- Unable to analyse the conventional therapy as too few treatment records completed
- Unable to deliver 120 minute dose due to participant preference and logistical problems

Study Conclusions

- Improvement in motor performance can be seen in the severely impaired stroke population in the sub-acute phase after stroke
- No clear dose-related response was demonstrated, although there was a trend for better outcomes with 60 and 120 minutes of MTS

Limitations of the study

- population/recruitment
- power (in view of changes in the control)
- blinding
- outcome measures
- potential differences across the two sites
- absence of data on conventional therapy
- adverse events monitoring

Further work

- MTS
 - Further description/guidance
 - Evaluation of efficacy
 - Alternative provision (Rehab assistants/relatives)
 - Target population (severe paresis)
- Outcome measures
 - Sensitivity
 - Sensation
 - Clinically important changes
- Dose finding

Summary

- Evidence based practice requires scientifically rigorous research – the definition of interventions and dose is crucial
- It is difficult to evaluate 'complex interventions', such as physiotherapy. Appropriate outcome measures that are valid, reliable and sensitive are required.
- MTS – 60-120 minutes/day may be beneficial in the early stages after stroke for people with severe impairment (more research is needed...)
- The impact of fatigue in the stroke population should be considered when planning and delivering therapy

Should I change my practice in response to this study?

- Possibly not!
- But... there is little therapy available for people with severely impaired upper limbs after stroke and there is some experimental evidence to suggest that sensory interventions are beneficial.
- There is a danger that an assumption that those with severe impairments will not improve will become a self-fulfilling prophecy. Therapy may be limited, or people will be taught compensatory strategies from a very early stage, which may lead to learned non-use, soft tissue shortening, or disuse atrophy.

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