Neurorehabilitation &
Neural Repair

Phase II pragmatic randomized controlled trial of patient-led mirror therapy and lower limb exercises in acute stroke

Journal:	*Neurorehabilitation & Neural Repair*
Manuscript ID:	NNR-14-0293
Manuscript Type:	Original Research Articles
Date Submitted by the Author:	22-Aug-2014
Complete List of Authors:	Tyson, Sarah; University of Manchester, School of Nursing, Midwifery & Social Work Wilkinson, Jack; University of Manchester, Centre for Biostatistics ; Salford Royal NHS Foundation Trust, Thomas, Nessa; University of Manchester, School of Nursing, Midwifery & Social Work Selles, Ruud; Erasmus MC, Department of Rehabilitation Medicine McCabe, Candy; University of West England, ; Royal National Hospital for Rheumatic Diseases NHS Foundation Trust, Tyrrell, Pippa; University of Manchester, Stroke Research Centre, School of Nursing Midwifery & Social Work; Salford Royal NHS Foundation Trust, Vail, Andy; University of Manchester, Centre for Biostatistics ; Salford Royal NHS Foundation Trust,
Keyword:	stroke, patient-led, mirror therapy, exercise
Abstract:	Background and objective: Patient-led therapy has the potential to increase the amount of therapy patients undertake during stroke rehabilitation and to enhance recovery. Our objective was to assess the feasibility and acceptability of two patient led therapies during the acute stages of stroke care: Mirror therapy for the upper limb and lower limb exercises for the lower limb. Methods: A blind assessed, multicentre, pragmatic randomised controlled trial of patient-led upper limb mirror therapy and patient-led lower leg exercises. Results: Both interventions proved feasible with >90% retention. No serious adverse events were reported. Both groups did less therapy than recommended; typically 5-15 minutes for 7 days or less. Participants receiving mirror therapy (n=63) tended to do less practise than doing lower limb exercises (n=31). Those with neglect did 69% less mirror therapy than those without, which was not observed in the exercise group (p=0.02). Observed between-group differences were modest but neglect, upper limb strength and dexterity showed some improvement in the mirror therapy group. No changes were seen in the lower limb group Conclusions: Both patient-led mirror therapy and lower limb exercises during in-patient stroke care are safe, feasible and acceptable and warrant further investigation. 5 to 15 minutes practise for seven days is a realistic prescription unless strategies to enhance adherence are included.

Phase II pragmatic randomized controlled trial of patient-led mirror therapy and lower limb exercises in acute stroke

[1,2]Sarah Tyson PhD, [1,3]Jack Wilkinson PhD, [1,2]Nessa Thomas MSc, [4]Rudd Selles PhD, [5]Candy McCabe PhD, [1,3]Pippa Tyrrell MD, [1,3]Andy Vail MSc

[1] Stroke Research Centre, Manchester Academic Health Sciences Centre, University of Manchester, [2]School of Nursing Midwifery & Social Word, [3]Salford Royal NHS Foundation Trust, [4]Department of Plastic, Reconstructive and Hand Surgery and Department of Rehabilitation Medicine & Physical Therapy, Erasmus MC, Rotterdam, the Netherlands, [5]University of the West England, Bristol and Royal National Hospital for Rheumatic Diseases NHS Foundation Trust, Bath

Address for correspondence: Sarah Tyson, Stroke Research Centre, Jean McFarlane Building, University of Manchester, Oxford Rd, Manchester M13 9PL.
Sarah.tyson@manchester.ac.uk

Tel: (0)441613067781

Running title: Patient led therapy in acute stroke

4 tables and 4 figures

Word Count of text: 2857

Abstract

Background and objective: Patient-led therapy has the potential to increase the amount of therapy patients undertake during stroke rehabilitation and to enhance recovery. Our objective was to assess the feasibility and acceptability of two patient led therapies during the acute stages of stroke care: Mirror therapy for the upper limb and lower limb exercises for the lower limb.

Methods: A blind assessed, multicentre, pragmatic randomised controlled trial of patient-led upper limb mirror therapy and patient-led lower leg exercises.

Results: Both interventions proved feasible with >90% retention. No serious adverse events were reported. Both groups did less therapy than recommended; typically 5-15 minutes for 7 days or less. Participants receiving mirror therapy (n=63) tended to do less practise than doing lower limb exercises (n=31). Those with neglect did 69% less mirror therapy than those without, which was not observed in the exercise group (p=0.02). Observed between-group differences were modest but neglect, upper limb strength and dexterity showed some improvement in the mirror therapy group. No changes were seen in the lower limb group

Conclusions: Both patient-led mirror therapy and lower limb exercises during in-patient stroke care are safe, feasible and acceptable and warrant further investigation. 5 to 15 minutes practise for seven days is a realistic prescription unless strategies to enhance adherence are included.

Clinical Trial Registration Information

URL: http://www.controlled-trials.com Unique identifier: ISRCTN29533052.

Introduction

Rehabilitation of the upper limb after stroke is a challenge as many survivors suffer long-term upper limb deficits and few regain dexterity. Mirror therapy has been suggested as a treatment to improve upper limb function[1-3]. It involves the seated patient placing their sound arm in front of a table mounted mirror with their weak hand behind it. When the patient looks in the mirror, the reflected image of their sound arm moving gives the visual illusion they are watching their weak hand move. This illusion is thought to enable the patient to move their weak limb more easily although the mechanism is unclear. A recent Cochrane Review of mirror therapy for people with stroke[4] involving 14 studies and 567 participants concluded that it can improve upper limb motor function, activities of daily living, neglect and pain as an adjunct to normal rehabilitation. However most participants were in the chronic stages of stroke and there are limited data on the value of mirror therapy soon after stroke. Furthermore details of how the mirror therapy was delivered are often lacking.

These details are important when it comes to implementation in clinical practice. It is well established that most upper limb recovery occurs in the first month after stroke[5], that rehabilitation should start as early as possible[6] and intensity of the intervention is key to regain motor skills[7]. However UK stroke therapy typically involves low intensity, one-to-one interactions[8] and patients rarely receive more than 45 minutes of daily therapy per discipline[6]. Consequently intensively-supervised interventions are infeasible. The challenge to improve upper limb rehabilitation is to develop interventions that can be used in the acute stages of rehabilitation, which enable patients to work intensively without direct therapist supervision.

We undertook a pragmatic phase II feasibility trial of patient-led mirror therapy during inpatient stroke care to gather information to inform a possible Phase III trial.

Specifically we assessed completion rates, adverse events, patient adherence and gathered preliminary data concerning any impact on impairment and activity.

Methods

Design: A pragmatic assessor-blinded multi-centre controlled trial with stratified imbalanced randomisation (allocation ratio 2:1) was approved by the National Ethics Service and University Committees. Participants were recruited through the North-West Stroke Local Research Network from in-patient stroke rehabilitation services in 12 hospitals across North-West England. Eligible participants had experienced a stroke at least one week previously with no pre-morbid conditions limiting upper or lower limb function, sufficient cognitive and communication skills to give informed consent, and upper and lower limb weakness that limited activity.

As there were no previously reported data for patient-led mirror therapy during acute stroke a formal power calculation was not appropriate. Instead, we recruited sufficient numbers to enable a sufficiently precise estimate of the variability (standard deviation) of study endpoints for future sample size calculations and sufficient replications of the protocol to assess feasibility. At least 55 participants recruited to the mirror therapy would enable these objectives including a 10% drop-out. As randomisation to a control may be problematic and to allow initial evaluation of effect, we also included a control group using a 2:1 allocation ratio (mirror: control).

Following informed consent, participants undertook baseline assessments before randomisation using an independent web-based randomisation service so that allocation was concealed. The strata for randomisation were defined by upper limb weakness (Motricity

Index <48 or 48+) and the presence of neglect (<44 on the Star Cancellation Test). Random block sizes preserved allocation concealment. A blinded assessor repeated the assessments at the end of the treatment period (4 weeks) and at follow up (4 weeks after the end of treatment).

Interventions: All participants received usual care and were randomised to also receive either patient-led mirror therapy or attentional control (patient-led lower limb exercise without a mirror). Lower limb exercises were selected as the control to ensure both groups received similar attention from the trial and clinical teams, thereby balancing placebo effects. As the effects of exercise are specific to the areas exercised, exercising the lower limb would not affect the upper limb, and vice versa. Additionally, this allowed us to make a preliminary evaluation of a patient-led exercise as an intervention for lower limb deficits.

The mirror therapy intervention was based on that used by Michielsen et al[9] (Figure 1) but as the interventions needed to be 'fit-for-purpose' for acute care settings, the trial team worked with consultation groups of stroke survivors and stroke therapists throughout the trial to ensure the treatment and trial protocols were feasible and acceptable for the patients and to fit within every-day clinical practice. It is well-established that exercise needs to be feasible yet challenging to improve strength and motor control, so the therapies were individualised to each patient to accommodate the wide range of abilities. For each intervention there were four levels of exercises. For the mirror therapy the fingers, wrist and elbow movements, reaching, and at the highest level, functional activities were exercised. The lower limb exercises involved the ankles, knees and hips.

- Level 1 involved flexion, extension, abduction and adduction movements with limb fully supported.

- Level 2 involved multi-planar multiple joint movements, some against gravity
- Level 3 involved movements against gravity
- Level 4 involved functional activities.

The most appropriate exercises were selected for each patient and instructions (with aphasia-friendly photos and written instruction) on how to perform them were put in free-standing ring binder folder which the patient kept to act as an aide-memoire (Figure 2). As the patient progressed, the redundant exercises were removed and new ones were added.

For each participant a 'local clinician' was identified to take day-to-day responsibility for supervising the interventions. The trial therapists initially taught each participant and local clinician how to do the interventions through instruction and demonstrations and selected the initial exercises with them. Participants were asked to undertake up to 30 minutes of daily practice. It was unlikely that 30 minutes of concentrated practice would be tolerable and so ways in which the practice could be undertaken "a little and often" and fitted into the routine of the rehabilitation unit (e.g. identifying times in the day/ timetable for the patient to practice) were negotiated. The local clinician checked on, and encouraged the patient's practice, dealt with any problems and progressed the exercises as necessary. They also encouraged the participants to complete the practice log sheet and completed a log of their own input. Patients who were discharged before the end of the 4 week treatment were encouraged to continue with their allocated intervention. The trial therapist rang or visited the patient twice a week to monitor adherence and the patient's progression on to more advanced exercises, as necessary. Wherever possible a carer or relative was also taught about the treatment and encouraged to assist the patient as necessary and able.

Outcome Measures: We measured the upper limb to assess the mirror therapy and the lower limb to assess the lower-limb exercises as follows:

- Upper and lower limb weakness (Motricity Index[10] and grip strength[11])
- Upper and lower limb sensation (Rivermead Assessment of Sensory Perception, RASP[12])
- Spasticity of biceps and gastrocnemius for the upper and lower limb respectively (Modified Ashworth Scale[13])
- Neglect (Star Cancellation test[14])

Specifically for the upper limb we measured dexterity (Box and Block[15]) and activity (Action Research Arm Test[15]). For lower limbs, we also measured mobility (Rivermead Mobility Index[16]) and balance (Brunel Balance Assessment[17]). We monitored participants' adherence using a daily self-reported exercise log. Adverse events were monitored during the treatment phase and reported using standardised forms. We also intended to record activity in everyday life (Motor Activity Log) but human error led to uninterpretable data.

Analysis: In addition to descriptive analyses, we undertook exploratory comparisons of outcome using t-tests and 95% confidence intervals for the difference in mean change from baseline to 4 and 8 weeks. To explore whether potential responders could be identified, plausible exploratory subgroup analyses of neglect, sensory impairment, weakness and balance at each time point were undertaken. Patients were excluded from a given analysis if their corresponding measurement was missing; in other respects we employed an intention to treat analysis. Multiple linear regression identified factors influencing treatment adherence. Treatment time was log transformed to satisfy the assumptions of the regression model. The included predictors were age, side of weakness, time since stroke, treatment group, neglect and sensation.

Results

Ninety-four participants were recruited; 63 and 31 to the mirror therapy and lower limb exercises respectively. Retention rate was high (90%), detailed in Figure 3. Demographic, clinical characteristics and baseline assessments are shown in Tables 1 and 2. The cohort was representative of patients in inpatient stroke care with a wide range of abilities and no major differences between groups. No serious adverse events were reported. There were eight reports of short-lived upper and lower limb aches or limb tightness.

1801 treatment sessions were recorded. Eighty-two participants (87%) recorded at least one session; 51 (81%) in the mirror therapy and 30 (97%) in the lower limb exercises group. It is not known whether participants who did not complete the exercise logs did not do any exercise or just did not complete the log. The mean (SD) number of days when the patient-led therapies were performed was 14 (sd 10, range 1- 41) days; 12.9 days (sd =9.3) for the mirror group, and 15.2 days (sd =9.5) for the lower limb group, but this difference was not significant (p=0.294 95%CI = -6.64, 2.04). Twenty-one (26%) patients continued to exercise and record beyond the designated 28 day period but most practised for 7 days or fewer (n=29, 35%). This was slightly higher in the mirror therapy group (n= 20, 39%) than the lower limb exercises (n=10, 30%). Only two (1%) mirror therapy participants exercised for the recommended 28 days while five (15%) lower limb exercise participants achieved this. The most common duration of exercise was 5-15 minutes (n=1054, 59%) per session. Only 1% (n=21) of mirror therapy sessions and 3% (n=40) of lower limb exercise sessions lasted for the recommended 30 minutes.

Linear regression suggested participants with neglect in the mirror therapy group practised less than those without neglect. After adjusting for the other factors, mirror therapy group participants with neglect achieved only 31% (p = 0.02, 95%CI: 12, 82%) of the

practice time of those without neglect. There was an interaction between treatment group and neglect (p=0.052) indicating that this disadvantage was not present in the lower limb exercise group.

Outcome assessments at 4 and 8 weeks are shown in Tables 2, 3 and 4, and as standardised mean differences in Figure 4. Neglect, upper limb weakness and dexterity showed some improvement for the mirror therapy group compared to the control at the end of treatment, which was sustained at follow up. The mirror therapy group showed less improvement in upper limb sensation and activity than the control group. All between-group differences were small relative to the variability of the endpoints. There was no evidence of differences in the lower limb outcome measures (Table 4, figure 4).

The exploratory subgroup analyses suggested that people with neglect who received mirror therapy had less neglect at follow up than those whom received the lower limb exercises. The mean change (in Star Cancellation Test) was 23.5 (sd 11.3) and 10.0 (sd 8.0) stars respectively and the difference in means was 13.5 stars (p = 0.03, 95% CI 1.7, 25.2). All other explorations were non-significant.

Discussion

This study shows that patient-led mirror therapy and lower limb exercises are safe, feasible and acceptable to patients during inpatient stroke care. Few participants achieved the recommended 30 minutes of daily practise for 28 days. Most practised for 5-15 minutes for 7 days. The presence of neglect neglected on the amount of patient-led mirror undertaken. Differences between groups were small but neglect, upper limb strength and dexterity showed some greater improvement the mirror therapy group than the controls, while sensation and upper limb activity improved less than the control group.

As an unpowered trial, significant results would not be expected. However our sample size was larger than most previous trials, some of which have reported positive results[4]. The current trial differs from previous reports in several other methodological details. This is the first trial to specifically involve people in the acute stages of stroke. A definitive study in this population may require a large sample size as any 'signal' from the mirror therapy may be subsumed by the 'noise' of spontaneous recovery and standard care. Using the data from this trial, we calculate that a sample size of 250 patients would be required to detect clinically meaningful differences in a phase III trial.

Another methodological difference with previous studies is that most appear to involve direct supervision from trial therapists[4]. We used patient-led mirror therapy with light-touch supervision from the clinical therapy team. This provides a pragmatic indication of the potential impact of mirror therapy in every-day clinical life but meant that we had little control over clinicians' and participants' fidelity to the treatment protocol. There is a growing recognition that this is a neglected, but crucial, element of complex intervention trials[18]. Clear strategies to ensure fidelity is maintained and monitored in future trials are needed.

Participants' adherence to the intervention was less than expected, but perhaps not surprising as it was largely up to the patient when to practise. In the process evaluation accompanying this trial, some participants described how adherence tailed off as they became bored or demotivated by lack of obvious improvement. Others, particularly those with more severe strokes, struggled to complete the mirror therapy without additional help. Thus an insufficient dose of therapy may be a factor. Adherence has rarely been reported to date in mirror therapy trials and is generally assumed to be high, given that most trials use directly supervised therapy. Future trials should comment on adherence. Our therapy delivery was based on Michielsen and colleagues[8], who used patient-led mirror therapy for people with chronic stroke at home, with telephone support and weekly face-to-face contact from trial

therapists. They had excellent (self-reported) adherence. It may be that participants found mirror therapy easier to undertake at home, than the cramped and busy environment of acute stroke care, particularly while they are still very fatigued and over-whelmed by the emotional shock of the stroke. This point was highlighted by some of our participants who continued the mirror therapy after discharge from hospital. Additionally, a few of our participants raised concerns that patient-led therapy may interfere with 'main-stream' rehabilitation. Michielsen's[9] participants had completed their rehabilitation so participation was a welcome opportunity to access further therapy. This could have increased motivation and adherence.

The choice of control is another methodological difference from previous trials. Most trials chose other upper limb therapies (most commonly exercises without a mirror or a sham mirror) as the control. This provides information about whether the mirror provides an additional benefit to exercise alone, but does not indicate the potential advantage of adding mirror therapy to standard clinical care. As this was our primary interest, we chose an attentional control which did not involve the upper limb. As evaluation of mirror therapy moves from efficacy to clinical effectiveness, clinically relevant control interventions are needed.

Surprisingly, although participants with neglect undertook less mirror therapy than others, there was still a positive effect. Two recent trials have also reported a positive impact of mirror therapy on neglect (as secondary outcomes)[19,20]. This raises an interesting question about the potential mechanism of mirror therapy. Trials of intensive upper limb exercises with mirror therapy are based on motor learning theory in which intensive practice of functional tasks is key to restoring movement and function[21]. It is hypothesised that the mirror therapy promotes the neuroplasticity that underlies this process, possibly through visually guided motor imagery and the mirror neuron system. Imaging studies of healthy individuals demonstrate promotion of motor cortical activity and cortico-spinal excitation

with mirror therapy[1-3] (although a more recent fMRI study could not confirm this[22], and it has been assumed to occur in stroke survivors. However, the first imaging based evaluation of mirror therapy involving movements of both hands in people following stroke[23] found increased activity in the precuneus and the posterior cingulate cortex (which are associated with body perception and spatial attention) but not in the motor cortex or mirror neuron system, suggesting a perceptual rather than motor effect. A more recent study supports these findings finding that mirror therapy primarily affects the sensorimotor cortex in stroke survivors[24].

It is noteworthy that mirror therapy in complex regional pain syndrome (in which neglect-like symptoms may be found[25]) is thought to act in a similar way on the dysfunctional somoatosensory processing that underlies the condition, possibly by reversing learned disuse and dissociation by training sustained attention to the affected limbs and/or reconciling sensory-motor incongruence[26,27]. A similar perception-based mechanism may be possible in stroke, particularly those with neglect. Further work is needed to understand the mechanisms of mirror therapy so the most appropriate patients can be targeted and treatment protocols developed

Conclusion: Patient led mirror therapy and lower limb exercises are safe, feasible and acceptable during acute stroke care and warrant further investigation. 5 to 15 minutes practise for seven days is a realistic prescription unless strategies to enhance adherence are included.

References

1. Garry MI, Loftus A, Summers JJ. Mirror, mirror on the wall: viewing a mirror reflection of unilateral hand movement facilitates ipsilateral M1 excitability. *Exp Brain Res 2005:163:118-122.*

2. Butefisch CM, Davis BC, Wise SP et al. Mechanisms of use-dependent plasticity in the human motor cortex. *Proc Nat Acad Sci USA 2000:97:3661–3665*

3. Muellbacher W, Facchini S, Boroojerdi B et al. Changes in motor cortex excitability during ipsilateral hand muscle activation in humans. *Clin Neurophysiol 2000:111:344–349*

4. Thieme H, Mehrholz J, Pohl M et al. Mirror therapy for improving motor function after stroke. *Cochrane Database of Systematic Reviews 2012; 3; CD008449.*

5. Nakayama H, Jørgensen HS, Raaschou HO et al. Recovery of upper extremity function in stroke patients: the Copenhagen Stroke Study. *Arch Phys Med Rehabil 1995;76:27–32*

6. Intercollegiate Stroke Working Party. *National Clinical Guideline for stroke, 4th Ed.* London: Royal College of Physicians; 2012.

7. Dept of Health (2007). *National Stroke Strategy*. www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyandguidance/dh_081062 Last accessed 10th June 2014

8. Royal College of Physicians (2007). *National Sentinel Stroke Audit. Phase I (Organisational Audit) and Phase II (Clinical Audit)* 2006. Prepared on behalf of the Intercollegiate Stroke Working Party. Royal College of Physicians, London

9. Michielsen ME, Selles RW, van der Geest JN et al. Motor recovery and cortical reorganization after mirror therapy in chronic stroke patients: A phase II randomized controlled trial. *Neurorehabil Neur Repair 2011;25:223–33*

10. Demeurrisse G, Demol O, Robaye E. Motor evaluation in vascular hemiplegia. *Eur Neurol 1980;19;382-9.*

11. Sunderland A, Tinson D, Bradley L et al. Arm function after stroke. An evaluation of grip strength as a measure of recovery and a prognostic indicator. *JNNP 1989;52:1267-1272*

12. Winward C, Halligan P, Wade D. The Rivermead Assessment of somatosensory performance: standardisation and reliability data. *Clin Rehab 2002;16;523-533*

13. Bohannon R, Smith M. Inter-rater Reliability of a Modified Ashworth Scale of Muscle Spasticity. *Phys Ther 1987;67; 206-207*

14. Wilson B, Cockburn J, Halligan P. Development of a behavioral test of visuo-spatial neglect. Arch Phys Med & Rehab 1987:68;98-102

15. Platz T, Pinkowski C, van Wijck F et al. Reliability and validity of arm function assessment with standardized guidelines for the Fugl-Meyer Test, Action Research Arm Test and Box and Block Test: a multicentre study. *Clin Rehab 2005:19; 404-411*

16. Collen FM, Wade DT, Robb GF et al. The Rivermead Mobility Index: a further development of the Rivermead Motor Assessment*. Int Disabil Stud 1991;13:50–54*

17. Tyson SF, DeSouza LH. Development of the Brunel Balance Assessment: a new measure of balance disability post stroke*. Clin Rehabil 2004;18:801–10.*

18. Hennessey ML & Rumrill PD. Treatment fidelity in rehabilitation research*. J Voc Rehabil 2003:*19;123–126

19. Thieme H, Bayn M, Wurg M et al**.** Mirror therapy for patients with severe arm paresis after stroke. *Clin Rehab 2012;27:314–324*

20. Dohle C, Püllen J, Nakaten A et al. Mirror therapy promotes recovery from severe hemiparesis. *Neurorehabil Neural Repair* 2009;23:209–217.

21. Van Peppen RPS, Kwakkel G, Wood-Dauphinee S et al. The impact of physical therapy on functional outcomes after stroke: what's the evidence? *Clin Rehab 2004:18:833-862*

22. Matthys K, Smits M, Van der Geest JN et al. Mirror-induced visual illusion of hand movements: a functional magnetic resonance imaging study. *Arch Phys Med Rehabil 2009;90:675-81*

23. Michielsen ME, Smits M, Ribbers GM et al. The neuronal correlates of mirror therapy: an fMRI study on mirror induced visual illusions in patients with stroke. *J Neurol Neurosurg Psychi2011;82**:**393-398*

24. Saleh S, Adamovich SV, Tunik E. Mirrored Feedback in Chronic Stroke Recruitment and Effective Connectivity of Ipsilesional Sensorimotor Networks. *Neurorehab Neural Repair 2014:28:344–354*

25. Lewis J, Kersten P, McCabe C et al. Body perception disturbance: A contribution to pain in complex regional pain syndrome. *Pain 2007;133;111-119*.

26. McCabe C, Cohen H, Hall J et al. Somatosensory conflicts in complex regional pain syndrome and fibromyalgia syndrome. *Curr Rheumat Reports 2009:11:461-465*

27. Maihofner C, Handwerker HO, Neundorfer B et al. Patterns of cortical reorganization in complex regional pain syndrome. *Neurol 2003;61:1707–15*

Table 1: Baseline demographic and clinical characteristics

Characteristic		**Total group (n=94)**	**Mirror therapy (n=62)**	**Lower limb exercises (n=31)**
Age (years)	Median range) Mean (sd)	66 (26 to 92) 64 (14)	66 (26 to 88) 64 (15)	65 (40 to 91) 64 (13)
Sex	Male	60 (65%)	37 (60%)	23 (74%)
Time since stroke (days)	Median (range) Mean (sd)	19 (7 to 133) 28.8 (22)	18 (7 to 76) 26 (18)	29 (7 to 133) 35 (27)
Stroke type	Ischaemic	76 (82%)	50 (81%)	26 (84%)
Side of weakness	Dominant	35 (38%)	25 (40%)	10 (32%)
Side of weakness	Right	38 (41%)	27 (44%)	11 (35%)

Patient led therapy in acute stroke

Table 2: Baseline assessments of the recruited participants

Assessment		**Total group (n=94)**	**Mirror therapy (n=62)**	**Lower leg exercises (n=31)**
Upper limb				
Neglect (Star Cancellation)	Median (range)		55 (9-56)	54 (8 to 56)
	Mean (SD)	47 (14)	47 (15)	48 (12)
Weakness (Motricity Index)	Median (range)	43 (1 to 93)	44 (1-93)	43 (1 to 85)
	Mean (SD)	40 (30)	40 (32)	39 (29)
Weakness (Grip strength)	Median (range)	0 (0 to 20)	0 (0-20)	0 (0 to 12)
	Mean (SD)	3 (6)	4 (7)	2 (3)
Sensation (Rivermead Assessment of Sensory Perception)	Median (range)	19 (0 to 24)	22 (0-24)	16 (0 to 24)
	Mean (SD)	16 (9)	17 (9)	14 (8)

Spasticity (Modified Ashworth Scale of biceps)	Median (IQR) Mean (SD)	0 (0 to 2) 1 (1)	0 (0-1) 1 (1)	0 (0 to 2) 1 (1)
Dexterity (Box & Block)	Median (range) Mean (SD)	0 (0 to 36) 5 (9)	0 (0-36) 5 (9)	0 (0 to 29) 4 (9)
Actvity (Action Research Arm Test)	Median (range) Mean (SD)	0 (0 to 57) 12 (17)	0 (0-57) 13 (18)	0 (0 to 48) 10 (15)
Lower limb				
Weakness (Motricity Index)	Median (range) Mean (SD)	54 (1 to 92) 50 (27)	59 (1-92) 52 (27)	48 (1 to 92) 46 (28)
Sensation (Rivermead Assessment of Sensory Perception)	Median (range) Mean (SD)	19 (0 to 24) 16 (8)	20 (0-24) 17 (8)	19 (0 to 24) 15 (9)

Spasticity (Modified Ashworth Scale of tibialis anterior)	Median (IQR) Mean (SD)	0 (0 to 2) 1 (1)	0 (0-1) 1 (1)	0 (0 to 2) 1 (1)
Balance (Brunel Balance Assessment)	Median (IQR) Mean (SD)	4 (0 to 12) 4 (3)	4 (3- 5) 4 (3)	3 (1 to 4) 4 (3)
Mobility (Rivermead Mobility Index)	Median (range) Mean (SD)	1 (0 to 14) 3 (3)	1 (0-14) 3 (3)	1 (0 to 7) 2 (3)

Table 3: Change in upper limb outcomes at end of intervention and follow-up

Measure	Mirror therapy mean (SD)	Lower limb exercises mean (SD)	Difference (95% CI)	P value
At the end of the intervention (4 weeks)				
Neglect (Star Cancellation)	4.4 (10.8)	2 (7.4)	2.4 (-2.1, 6.8)	0.30
Weakness (Motricity Index)	9.1 (18.3)	6.8 (16.8)	2.4 (-5.8, 10.6)	0.57
Weakness (Grip strength)	1.7 (4.9)	2.8 (5.7)	-1.0 (-3.4, 1.4)	0.41
Sensation (Rivermead Assessment of Sensory Perception)	0.3 (7.7)	2.4 (6.2)	-2.1 (-5.4, 1.2)	0.21
Spasticity (Modified Ashworth Scale of biceps)	-0.0 (1.0)	-0.3 (1.1)	0.2 (-0.3, 0.7)	0.36
Dexterity (Box & Block Test)	8.2 (12.7)	6.0 (11.1)	2.2 (-3.3,7.8)	0.42
Activity (Action Research Arm Test)	6.9 (13.9)	8.3 (12.1)	-1.4 (-7.6, 4.7)	0.64
At the end of follow up (8 weeks)				

Neglect (Star Cancellation)	5.9 (11.3)	3.2 (5.4)	2.7 (-1.9, 7.4)	0.24
Weakness (Motricity Index)	12.9 (20.8)	10.5 (19.9)	2.3 (-7.2, 12.0)	0.63
Weakness (Grip strength)	2.3 (6.8)	3.6 (5.4)	-1.3 (-4.4, 1.7)	0.40
Sensation (Rivermead Assessment of Sensory Perception)	2.4 (6.5)	3.3 (7.4)	-0.9 (-4.1, 2.3)	0.56
Spasticity (Modified Ashworth Scale of biceps)	-0.1 (1.1)	0.1 (1.6)	-0.2 (-0.8, 0.4)	0.51
Dexterity (Box & Block Test)	9.3 (14.9)	7.0 (12.3)	2.4 (-4.3, 9.0)	0.48
Activity (Action Research Arm Test)	8.5 (14.5)	8.8 (13.8)	-0.3 (-7.0, 6.4)	0.93

Table 4: Change in lower limb outcomes at end of intervention and follow-up.

Measure	Lower limb exercises (n=29)	Control (n=57)	Difference (95% CI)	P value
At the end of the intervention (4 weeks)				
Weakness (Motricity Index)	13.5 (15.4)	10.5 (16.4)	3.0 (-4.5, 10.4)	0.43
Spasticity (Modified Ashworth Scale of gastrocnemius)	0.1 (2.0)	-0.5 (1.6)	0.6 (-0.1, 1.4)	0.11
Sensation (Rivermead Assessment of Sensory Perception)	1.7 (9.1)	0.4 (8.0)	1.3 (-2.5, 5.1)	0.51
Mobility (Rivermead Mobility Index)	2.4 (2.8)	3.1 (2.9)	- 0.7 (-2.0, 0.7)	0.32
Balance (Brunel Balance Assessment)	1.9 (1.9)	2.4 (3.1)	-0.4 (-1.7, 0.8)	0.48
At the end of follow up (8 weeks)				
Motricity Index (Motricity Index)	20.3 (12.5)	16.6 (15.0)	3.7 (-3.1, 10.4)	0.28
Sensation (Rivermead Assessment of Sensory Perception)	1.9 (10.6)	1.7 (6.7)	0.2 (-3.6, 4.0)	0.93

Patient led therapy in acute stroke

Spasticity (Modified Ashworth Scale of gastrocnemius)	0.1 (1.8)	-0.3 (1.7)	0.4 (-0.4, 1.2)	0.29
Mobility (Rivermead Mobility Index)	3.0 (2.7)	3.5 (3.0)	-0.4 (-1.8, 0.9)	0.52
Balance (Brunel Balance Assessment)	3.7 (4.1)	4.1 (3.7)	-0.4 (-2.2, 1.4)	0.65

Figure 1. The mirror in use

Figure 2. The exercise booklets: a) example of the exercise sheets and b) the free standing folder

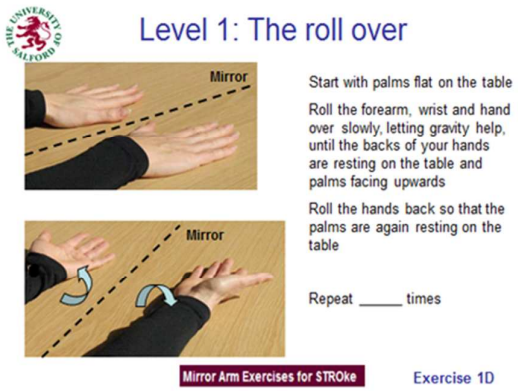

Figure 3. Consort Flow Diagram

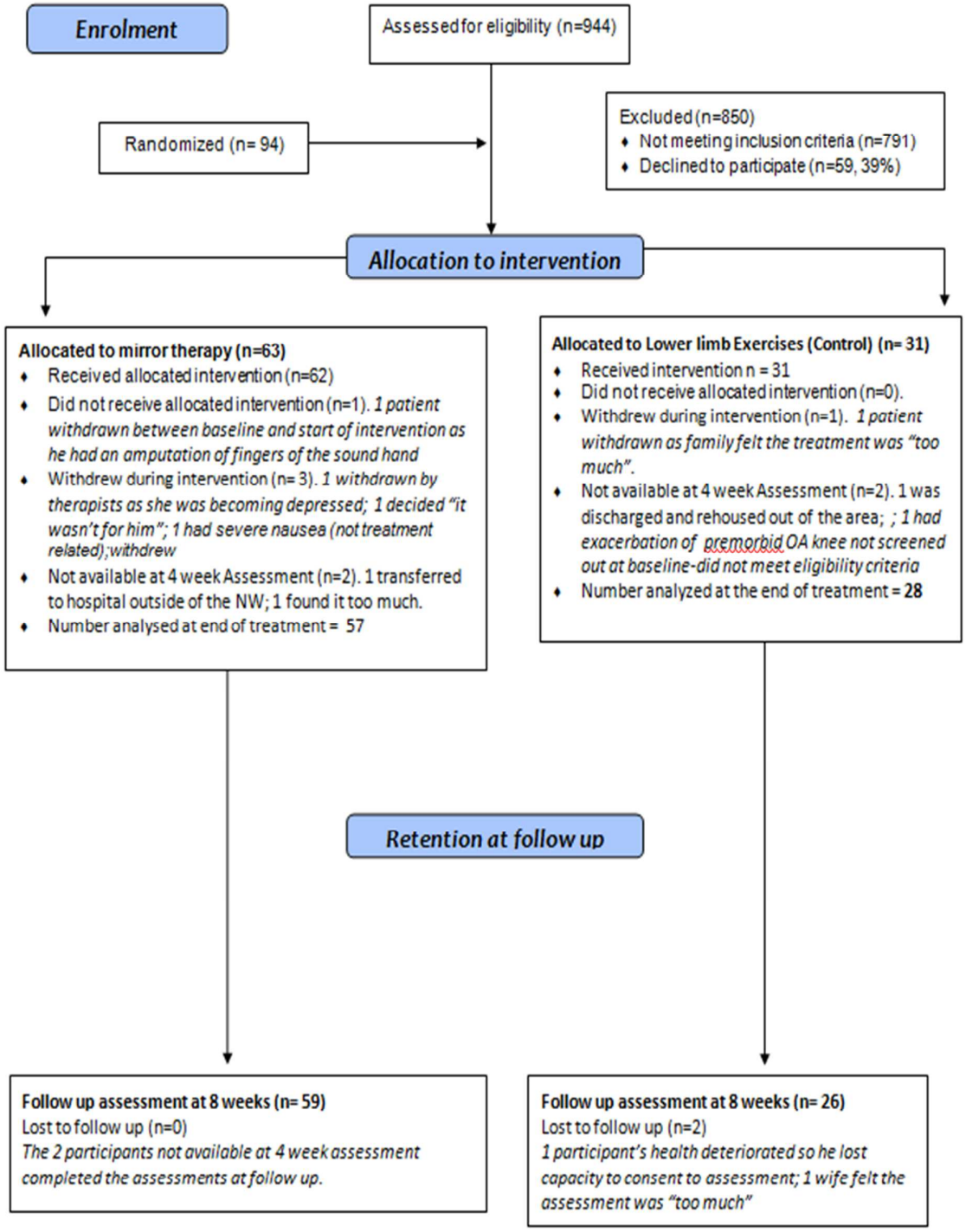

Figure 4: Standardised mean differences for upper limb outcomes (mirror therapy minus control) at A) 4 weeks and B) 8 weeks. Lower limb outcomes (lower limb exercises minus mirror therapy) at C) 4 weeks and D) 8 weeks.