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Outcome measurement of hand function following mirror therapy for stroke rehabilitation: A systematic review

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ABSTRACT

Study Design: Systematic review.
Introduction: Mirror therapy is a treatment used to address hand function following a stroke. Measurement of outcomes using appropriate assessment tools is crucial; however, many assessment options exist.
Purpose of the Study: The purpose of this study is to systematically review outcome measures that are used to assess hand function following mirror therapy after stroke and, in addition, to identify the psychometric and descriptive properties of the included measures and through the linking process determine if the outcome measures are representative of the International Classification of Functioning, Disability and Health (ICF).
Methods: Following a comprehensive literature search, outcome measures used in the included studies were linked to the ICF and analyzed based on descriptive information and psychometric properties.
Results: Eleven studies met inclusion criteria and included 24 different assessment tools to measure hand or upper limb function. Most outcome measures used in the selected studies (63%) were rated by the evaluating therapist. Thirteen outcome measures (54%) linked to the ICF body function category and 10 measures (42%) linked to activities and participation. One outcome measure was linked to not defined, and all other ICF categories were not represented. A majority of outcome measures have been assessed for validity, reliability, and responsiveness, but responsiveness was the least investigated psychometric property.
Discussion: Current studies on mirror therapy after stroke are not consistent in the assessment tools used to determine hand function. Understanding of study outcomes requires analysis of the assessment tools. The outcome measures used in the included studies are not representative of personal and environmental factors, but tools linking to body functions and activities and participations provide important information on functional outcome.
Conclusions: Integrating a combination of measures that are psychometrically sound and reflective of the ICF should be considered for assessment of hand function after mirror therapy after stroke.

Introduction

According to the World Health Organization, cerebrovascular accident is a clinical syndrome of rapid development due to a focal disturbance of cerebral function of vascular origin and of more than 24 hours of duration.[1] One of the most common sequela of stroke survivors is upper limb hemiparesis, which is often accompanied by sensory deficits.[1,2] Hemiparesis following a stroke is not uncommon and has been reported as high as 85%. Restoration of upper extremity (UE) function is both challenging and variable with long-term limitations found to be between 55% and 75% for individuals who have survived a stroke.[3,4] The undesirable outcome of not regaining functional arm use following a stroke is reported to be between one-third and two-thirds, with only a meager 5%–20% of the patients achieving complete restoration of UE function.[3,4]

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Recovery of the motor component of the hand is essential for the functional performance of activities of daily living (ADLs), although the process is often slow and unpredictable, directly affecting the patients' quality of life.[5-7] In clinical practice, there are several therapeutic techniques used to address this problem which include robotic training, functional electrical stimulation, electromyographic biofeedback, repetitive sensorimotor training techniques, and motor imagery among others. More recently, mirror therapy has been introduced as a viable treatment option for the rehabilitation of the upper limb following stroke.[1,4]

The concept of using a mirror box/therapy is adapted from the work of Ramachandran and is found to be a cost-effective intervention in stroke rehabilitation.[8]

Mirror therapy was introduced in the late 1990s for the treatment of limb-amputated patients with phantom limb pain.[8] It is described as a form of motor imagery and an action-observation technique which uses the concept of visual illusion. This technique provides visual feedback to the sensorimotor cortex through illusion, and it can be used alone or in conjunction with other treatments.[1,2,4,9,10]

Measurement of outcomes following treatments such as mirror therapy using appropriate assessment tools is crucial. Outcomes and research using assessment tools are used to determine treatment to best promote recovery following a stroke. There are many options for assessment following a stroke. Most existing scales are described in the literature, including Fugl-Meyer Assessment of Motor Recovery after Stroke,[4,11-15] Motricity Index,[16-18] Modified Ashworth Scale (for measuring hypertonia),[15,19,20] Brunnstrom Hand Manipulation,[11,20] Functional Independence Measure (FIM),[14,20,21] Barthel Index,[4,16] Box and Block Test,[14,22] Jebsen Hand Function Test,[23,24] and Action Research Arm Test (ARAT).[12,25] The outcome measures focus on measuring a special area, such as neuromuscular capacity, disability, or independence with ADL's. Although many studies on mirror therapy concluded that this technique improved motor performance in their participants following a stroke, comparing the studies is difficult due to the variation in outcome measures used in each study.[3,11,12,19,20,26]

The International Classification of Functioning, Disability and Health (ICF) is a framework for measuring a person's experience of health through a biopsychosocial philosophy.[27] It is considered a standardized and unified language suitable for comparing health information and thus has become an important reference to assist with understanding what exactly health outcome measures are assessing.[27] The ICF includes 2 main categories: the first is functioning and disability, which contains the categories of body functions, body structures, and activity and participation and the second is contextual factors, which includes environmental and personal factors.[28] Linking health outcome measures to the ICF permits improved understanding of the assessment tool.[28]

An outcome measure's psychometric properties are another important concept to consider when evaluating the clinical utility of health outcomes. The 3 fundamental properties that should be measured include reliability, validity, and responsiveness. These properties help to determine how well a measure assesses an outcome of interest.

The purpose of this study is to systematically review outcome assessments used for measurement of hand function after mirror therapy intervention following a stroke using the ICF framework and each measure's psychometric properties as a reference.

Methods

We performed a comprehensive literature search to identify studies that assessed the effectiveness of mirror therapy for recovery of upper limb function after a stroke in order to evaluate and compare the outcome measures used. (PROSPERO registration: CRD42017067335).

Selection criteria

Inclusion criteria were randomized or quasi-randomized controlled trials and studies published in the past 10 years that measured outcomes of hand function after mirror therapy with participants older than 18 years of age with a diagnosis of ischemic or hemorrhagic stroke and upper limb paresis. We selected to limit the included studies to the past 10 years in order to gather information on current practice in this area of rehabilitation. We excluded all studies with children (participants under age 18 years), studies that did not focus on mirror therapy interventions in upper limb, studies that involved treatments that cannot be provided by a physical or occupational therapist, or studies that included patients with complicating pathology or additional diagnoses that would impact their treatment outcome. We also excluded studies where we could not confirm the effects of mirror therapy because there were combinations of interventions without clearly established control and experimental groups. All mirror therapy interventions were considered, irrespective of numbers of hours of training, number of hours of performance per day, duration of treatment, and type of exercise used in training sessions.

Search methods

Potentially relevant literature was identified through computerized and manual searches. The following electronic databases were systematically searched in December 2017: PubMed, Cochrane Central Register of Controlled Trial, ClinicalTrials.gov, and CINAHL. The following MeSH heading and key words were used: "stroke" AND "cerebral vascular accident" AND "hemiparesis OR hemiplegia" AND "mirror therapy" AND "hand function" AND "upper extremity" AND "physical OR occupational" and a combination of them. See Appendix A for the PubMed search strategy according to Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guideline.

The lead author reviewed the titles of the identified references, selected the relevant studies on the basis of title and abstract, and subsequently checked if the selected studies satisfied the inclusion criteria. If a study did not provide conclusive information in the abstract, the full text was retrieved and reviewed by the lead author and the second author. Consensus was reached on which studies to include based on discussion. Selection process was according PRISMA statements, which provide an outline to assist with improving the quality of systematic reviews.[29]

Data extraction and analysis

Descriptive information was gathered on the included studies to appropriately provide readers with information on the participants, treatment, follow-up, and assessment of the subjects. All functional outcome measures used in the studies were extracted, described, and analyzed.

Linking outcome measures to the ICF

The outcome measures were linked to the ICF according to the rules described by Cieza et al.[28] The 2 authors who performed linking of the outcome measures to the ICF (N.N. and L.A.) have experience on applying the linking rules. If an outcome measure had items that fit into different categories of the ICF, the measure was linked to the category which matched the majority of the assessment tool's items.

The outcome measures could be linked to the following ICF categories: body structures (anatomical parts), body functions (physiological function of body), activities and participation (performance of tasks and involvement in life situations), environmental factors (inclusive of physical, social, and attitudinal environment), or personal factors.[27] Personal factors are currently not yet classified but are described as information specific to an individual such as demographics, coping skills, behavior patterns, and attitude.[30] In addition, if an outcome measure did not fit into the aforementioned categories but still was covered by the ICF, it could be linked to "not defined" (not defined mental health, general health, physical health, development, disability, or functioning) or linked to "not covered" (not covered health condition or not covered quality of life) if it was not a concept covered by the ICF.[27]

Determining the psychometric properties of the studies

Research studies were consulted to determine if the included outcome measures were evaluated for validity, reliability, and responsiveness to understand if the included outcome measures have been tested and found appropriate for the population being studied. Validity is considered the extent to which a measure assesses what it says it measures or the "trueness" of the measure and reliability is the repeatability of a measure.[31] Responsiveness relates to an outcome measure's ability to detect change over time.[31]

Data calculations

As part of a comprehensive systematic review, data were pulled from the studies to determine the effect of the intervention, if sufficient information was provided by the authors. In addition, the mean change scores for the functional outcome measures were extracted for both the control and the experimental groups. Statistical significance of the outcomes was also extracted from the studies' results.

Study quality assessment

For further information on the included studies, the quality of the studies was evaluated using the Structured Effectiveness for Quality Evaluation of Study (SEQES).The SEQES is a 24-item critical appraisal tool developed by MacDermid[32] and is used to evaluate the methodological characteristics of a study.[32] The SEQES score is calculated by totaling the scores of the 24 items on the tool. A score of 2 is the highest possible item score, 1 indicates a fair rating, and 0 indicates incomplete fulfillment of the criterion. Three of the authors (K.V., N.N., and R.C.) completed the scoring for each study. Each of the reviewer's SEQES scores was blinded to the other reviewer until scores were compared. Any discrepancies in the score were discussed until a consensus was reached.

Results

Search results

A total of 214 potential records were originally identified in the literature search using combinations of the terms: "stroke" OR "cerebral vascular accident" AND "hemiparesis OR hemiplegia" AND "mirror therapy" AND "hand function" AND "upper extremity" AND "physical OR occupational". When considering the criteria of hand function and mirror therapy after stroke or cerebral vascular accident, the results decreased to 35 potential studies. Through further evaluation of the titles, abstracts, and then the full text, there remained a total of 25 studies meeting inclusion criteria. After elimination of duplicates, studies that did not focus on mirror therapy, those with treatment that cannot be performed by a physical or occupational therapist, and those that did not measure hand function, 11 studies were included in this systematic review. The PRISMA flow diagram regarding studies selected is shown in Figure 1.

Subjects and interventions

Eleven studies with a total of 494 participants were included in this study. The time frame from the stroke to the start of treatment ranged from 48 hours to more than 1 year following stroke. All participants were assessed at the beginning and at the end of the treatment, with a follow-up time frame of 21 days, 4-8 weeks, 3 months, or 6 months. Table 1 provides detailed information on the included studies and treatments.

Outcome measures

The outcome measures used in each study were extracted and defined in Table 2. A number of different outcomes are described in the literature for measurement of hand function in stroke after mirror therapy intervention. Many of the outcomes used in the selected studies to determine the effects of mirror therapy are not specific for measurement of hand function, such as the Functional Index "Repty" used by Radajewska et al[21] and Fugl-Meyer Assessment of Motor Recovery after Stroke, which was used in more than a half of the studies.[3,4,11,12,24,33,34,36] Only 9 of the 24 outcome measures used in the selected studies are specifically focused on evaluation of strictly the hand/UE, whereas the other outcome measures included other aspects of functioning or the body, ie, the FIM also considers bladder control and social cognition.

Although all the studies selected include some specific assessment scales to measure hand function, there is a discrepancy between outcome measures used by the authors. Twenty-four different tools are described to measure hand or upper limb function in 11 selected studies.[3,4,11,12,15,20,21,33-36] A strong majority of the outcome measures used in the selected studies (15 out of 24 or 63%) were measures which are subjectively rated by the evaluating therapist, 5 of the 24 (21%) outcome measures used were true objective measures, and 4 of the 24 (17%) outcome measures were patient rated based on patient perception. The 5 outcome measures that are objective measures include grip strength testing with a handheld dynamometer, the stroke upper-limb activity monitor (stroke-ULAM), the Star Cancellation Test, the Line Bisection Test,

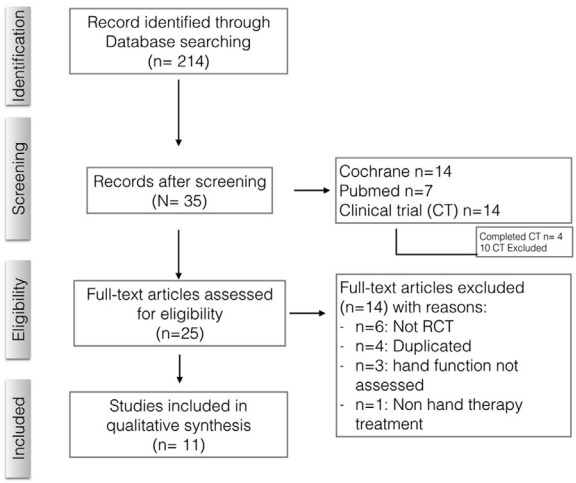

Fig. 1. PRISMA flow diagram.

Table 1
Description of selected studies

Author	Number of subjects	Mean age in years	Functional measures	Other outcome measures	Follow-up	Intervention	Outcome measure preintervention and postintervention with statistical significance	Effect size of group change scores Cohen's D
Colomer et al, 2016[33]	$N = 31$	53.6 ± 8		Fugl-Meyer Assessment of Motor Recovery after Stroke Nottingham Sensory Assessment (NSA) (Tactile, Kinesthetic and Stereognosis Subscales) Wolf Motor Function Test	8 wk	Mirror therapy vs passive mobilization, 45-min sessions, 3 × per wk for 24 sessions	WMF time Control Initial: 1492.7 Final: 1405.8 Experimental Initial: 1615.2 Final: 1539.8 WMF ability Control Initial: 10.9 Final: 12.6 Experimental Initial: 8.7 Final: 10.1 NSA tactile Control Initial: 23.9 Final: 25.1 Experimental Initial: 17.8 Final: 21.9	WMF time Control $D = 1.27$ Experimental $D = 1.07$ Between groups $D = 0.16$ Favoring control WMF ability Control $D = -0.97$ Experimental $D = 0.80$ Between groups $D = 0.17$ Favoring control NSA tactile Control $D = -0.27$ Experimental $D = -0.90$ Between groups $D = 0.67$ Favoring experimental
Dohle et al 2008[15]	$N = 36$	58.0 for one group and 54.9 for the other	Functional Independence Measure (13 items only) Action Research Arm Test	Fugl-Meyer Assessment of Motor Recovery after Stroke	6 wk	Mirror therapy vs active mobilization 30-min sessions, 5 d a wk for 6 wk.	ARAT Control Initial: 0.8 Final: 3.9 Experimental Initial: 0.6 Final: 4.7 Motor FIM Control Initial: 43.9 Final: 60.8 Experimental Initial: 48.3 Control: 66.6	ARAT Control $D = -0.54$ Experimental $D = -0.45$ Between groups $D = 0.09$ Favoring experimental Motor FIM Control $D = -1.29$ Experimental $D = -1.67$ Between groups $D = 0.12$ Favoring experimental
Gurbuz et al, 2016[34]	$N = 31$	60.9 ± 10.9 for one group and 60.8 ± 20.0 for the other	Functional independence measure	Brunnstrom stages of stroke recovery Fugl-Meyer Assessment of Motor Recovery after Stroke	4 wk	60–120 min of mirror therapy and conventional upper extremity rehabilitation vs conventional upper extremity rehabilitation program 5 times a wk for 4 wk.	Brunnstrom stages Conventional Initial: 1 Final: 2 Experimental Initial: 1 Final: 2.5 FMA Conventional Initial: 12.4 Final: 17.3 Experimental Initial: 12.8 Final: 27.1 FIM Conventional Initial: 13.1 Final: 16.9 Experimental Initial: 11.6 Control: 19.8	Brunnstrom stages Conventional $D = 1.0$ Experimental $D = 1.5$ Between groups $D = 0.50$ Favoring experimental FMA Conventional $D = -0.47$ Experimental $D = -1.22$ Between groups $D = -0.71$ Favoring experimental FIM Conventional $D = -0.56$ Experimental $D = -1.14$ Between groups $D = 0.60$ Favoring experimental

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Table 1 (*continued*)

Author	Number of subjects	Mean age in years	Functional measures	Other outcome measures	Follow-up	Intervention	Outcome measure preintervention and postintervention with statistical significance	Effect size of group change scores Cohen's D
Lee et al, 2012[11]	$N = 28$	57.1	Manual function test	Fugl-Meyer Assessment of Motor Recovery after Stroke Brunnstrom stages of stroke recovery	4 wk	Mirror therapy program of 25-min sessions twice a d for 4 wk vs standard rehabilitation program for 30 min twice a d 5 times a wk for 4 wk.	Brunnstrom stages: Upper limb control Initial: 1.4 Final: 2.5 Experimental Initial: 1.8 Final: 3.5 Brunnstrom stages: Hand control Initial: 1.6 Final: 2.2 Experimental Initial: 1.7 Final: 3.6 Manual Function Test: Upper limb control Initial: 7.1 Final: 9.3 Experimental Initial: 6.4 Control: 11.4 Manual Function Test: Hand Control Initial: 1.4 Final: 1.8 Experimental Initial: 0.7 Final: 3.8	Brunnstrom stages: Upper limb Control $D = -0.91$ Experimental $D = -1.5$ Between groups $D = 1.1$ Favoring experimental Brunnstrom stages: Hand Control $D = -0.51$ Experimental $D = -1.89$ Between groups $D = 1.5$ Favoring experimental Manual function test: Upper limb Control $D = -0.51$ Experimental $D = -1.6$ Between groups $D = 1.26$ Favoring experimental Manual Function Test: Hand control $D = -0.16$ Experimental $D = -1.58$ Between groups $D = 1.54$ Favoring experimental
Lim et al, 2016[3]	$N = 60$	65.3 for one group and 64.5 for the other	Modified Barthel Index (MBI)	Brunnstrom stages of stroke recovery Fugl-Meyer Assessment of Motor Recovery after Stroke	4 wk	Mirror therapy with functional tasks with both hands for 20 min vs conventional therapy With functional tasks with both hands without mirror therapy, 5 times per wk for 4 wk.	FMA Control Initial: 26.90 Final: 37.40 Experimental Initial: 6.93 Final: 41.40 MBI Control Initial: 26.77 Final: 51.37 Experimental Initial: 28.67 Final: 59.63	FMA Control $D = -1.34$ Experimental $D = -4.41$ Between groups $D = 0.42$ Favoring experimental MBI Control $D = -1.97$ Experimental $D = -2.52$ Between groups $D = 0.39$ Favoring experimental
Michielsen et al., 2010[12]	$N = 40$	57	Action research arm test ABILHAND questionnaire	Fugl-Meyer Assessment of Motor Recovery after Stroke Tardieu scale Grip force (Jamar handheld dynamometer) Pain (Visual Analog Scale ranging from 0 to 100 mm) EQ-5D Stroke ULAM	6 mo	Bimanual exercises with mirror therapy program vs bimanual exercises 5 times a wk, 1 h per d for 6 wk.	FMA Control Initial: 36.4 Post: 36.6 Experimental Initial: 39.97 Post: 43.5	FMA Control $D = 0.01$ Experimental $D = 0.25$ Between groups $D = 0.25$ Favoring experimental

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Table 1 (*continued*)

Author	Number of subjects	Mean age in years	Functional measures	Other outcome measures	Follow-up	Intervention	Outcome measure preintervention and postintervention with statistical significance	Effect size of group change scores Cohen's D
Pandian et al, 2014[35]	$N = 48$	63 ± 11 in one group and 64 ± 12 in the orther	Functional Independence measure Modified Rankin scale	Line Bisection test Picture Identification test Star Cancellation test	1, 3, and 6 mo	Mirror therapy sessions for 1 h followed by 1 h of limb activation exercises and then 15–30 min of functional and goal-oriented activity versus the same without the mirror on the mirror box	SCT Control Initial:18 Post: 12 Experimental Initial: 18 Post: 35 Picture Identification test Control Initial: 4 Post: 10.4 Experimental Initial:5 Post: 19 Line Bisection test Control Initial:0.4 Post: 2 Experimental Initial:1.9 Post: 5.2	Unable to calculate
Radajewska et al, 2013[21]	$N = 60$	60.7	Functional Index "Repty" (FIR) Frenchay Arm Test (FAT)	Motor Status Score (MSS)	21 d	Mirror therapy sessions for 15 min, 5 d/wk, 2 sessions/d, for 21 d vs physiotherapy 5 d/wk, 2-5 h/d, for 21 d	Authors only provided SD of differences between groups	Unable to calculate
Radajewska et al, 2017[36]	$N = 60$	60.8	Functional Index "Repty" (FIR) Frenchay Arm Test (FAT)	Motor Status Score (MSS)	21 d	Mirror therapy for 15 min, 5 d/wk, 2 sessions/d, and comprehensive rehabilitation program vs comprehensive rehabilitation program without mirror therapy	Functional Index "Repty" (WRF) Control Initial: 87.59 Post: 88.9 Experimental Initial: 88.17 Post: 94.37 Frenchay Arm Test (FAT) Control Initial: 3.35 Post: 3.90 Experimental Initial: 2.00 Post: 4.56 Motor Status Score (MSS) Author does not provide information	Unable to calculate
Thieme et al, 2012[4]	$N = 60$	67.2	Action Research Arm Test Barthel Index Stroke Impact Scale	Fugl-Meyer Assessment of Motor Recovery after Stroke Modified Ashworth Scale Star Cancellation Test	5 wk	30 min of individual mirror therapy with repetitive active movements vs mirror therapy group vs active movements with a total of 20 sessions during 5 wk.	Modified Ashworth Scale Finger (median) Control Initial: 0 Final: 1 Experimental Initial: 1 Final: 2 SCT Control Initial: 42 Final: 39.7 Experimental Initial: 26 Final: 46	Modified Ashworth Scale Finger (median) Unable to calculate SCT Control $D = -0.32$ Experimental $D = 2.01$ Between groups $D = 2.09$ Favoring experimental

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Table 1 (*continued*)

Author	Number of subjects	Mean age in years	Functional measures	Other outcome measures	Follow-up	Intervention	Outcome measure preintervention and postintervention with statistical significance	Effect size of group change scores Cohen's D
Yavuzer et al, 2008[20]	$N = 40$	63.2	Functional independence measure (self-care subscale only)	Modified Ashworth Scale Brunnstrom stages of stroke recovery	6 mo	30 min of MT program vs conventional program 5 d a wk, 2–5 h a d, for 4 wk.	Brunnstrom stages (hand) Control Initial: 2.6 Post: 2.7 Experimental Initial: 2.6 Post: 3.5	Brunnstrom stage Control $D = 0.11$ Experimental $D = 0.83$ Between groups $D = 0.68$ Favoring experimental
							Brunnstrom stages (UE) Control Initial: 2.7 Post: 2.8 Experimental Initial: 2.7 Post: 3.7	Brunnstrom stage Control $D = 0.11$ Experimental $D = 0.94$ Between groups $D = 0.84$ Favoring experimental
							FIM (hand motor) Control Initial: 21.1 Post: 22.2 Experimental Initial: 23.7 Post: 29.8	FIM (hand motor) Control $D = 0.19$ Experimental $D = 4.09$ Between groups $D = 0.61$ Favoring experimental

ARAT = Action Research Arm Test; FIM = Functional Independence Measure; MT = mirror therapy; SCT = Star Cancellation Test; SD = standard deviation; UE = upper extremity; WMFT = Wolf Motor Function Test.

and the Picture Identification Test. The 4 outcome measures from the included studies that are patient rated, include pain on the Visual Analog Scale, ABILIHAND questionnaire, EuroQol instrument (EQ-5D), and the Stroke Impact Scale.

Linking outcome measures to the ICF

The majority of the outcome measures or 13 outcome measures (54%) linked to body functions (b), and more specifically 8 outcome measures linked to b7 neuromusculoskeletal function, 3 linked to b2 sensory function, and 3 linked to b1 mental function. The outcome measures linking to b7 neuromusculoskeletal function include the Fugl-Meyer Assessment of Motor Recovery after Stroke, Wolf Motor Function Test, Brunnstrom Stages of Stroke Recovery, Tardieu Scale, the Stroke-ULAM, grip strength, the Motor Status Score, and the Modified Ashworth Scale. Those linking to b2 sensory function include the Fugl-Meyer Assessment of Motor Recovery after Stroke, the Nottingham Sensory Assessment, and pain and those linking to b1 mental functions include Star Cancellation Test, Line Bisection Test, and Picture Identification Test.

Ten of the outcome measures (42%) are linked to activities and participation (d). The FIM linked to d5 self-care and d4 mobility (and also to d1 Learning and applying knowledge, d3 Communication, d7 Interpersonal interactions when the communication and social cognition questions are included in the use of the assessment tool), the ARAT, the Frenchay Arm Test, and the Manual Function Test linked to d4 mobility (but also have items that linked to b7 neuromusculoskeletal function), and the Modified Barthel Index and Barthel Index linked to d4 mobility and d5 self-care (but also have 1 item each that linked to b6 genitourinary function and b5 functions of the digestive system). The ABILIHAND questionnaire linked to d5 self-care, d4 mobility, and d6 domestic life and the Functional Index "Repty" linked to d4 mobility, d5 self-care, d1 learning and applying knowledge, d3 communication, b1 mental function, b6 genitourinary function, and b5 functions of the digestive system. The EQ-5D linked to activities and participations because it has items that link to d5 self-care, d4 mobility but also has 1 item that linked to b2 sensory functions and pain, not defined mental health, and not defined health status. The Modified Rankin Scale is a single rating of performance of all routine duties and activities, so although it linked to d activities and participation, the specific linkages are determined by patient specifics. Only 4 of the 24 outcome measures used in the selected studies are specifically for assessment of the hand or UE and also fit into the activities and participation category. These include the ARAT, Manual Function Test, ABILIHAND questionnaire, and Frenchay Arm Test.

One of the outcome measures (4%) linked to not defined (nd). The Stroke Impact Scale has a majority of items on the tool that link to not-defined mental health. There were no outcome measures that linked to body structures (s), environmental factors (e), or personal factors, and all outcome measures were covered by the ICF according to our linking. Refer to Table 3 for specifics on the linking of the outcome measures to the ICF.

Evaluating the psychometric properties of the outcome measures

Table 4 contains the information on the outcome measures evaluation for validity, reliability, and responsiveness. All but 2 of the 24 outcome measures used in the included studies have been found to have some level of validity for individuals who have had a stroke. The Picture Identification Test and the Functional Index "Repty" have not been evaluated for validity for the stroke population. Three of the 24 outcome measures used in the studies have not been evaluated for reliability with use for individuals who have had a stroke, and these include the Picture Identification Test, Functional Index "Repty," and the Stroke-ULAM. Fourteen of the outcome measures used in the included studies (58%) has been assessed for responsiveness, whereas 10 have not. The 14 measures that have been assessed for responsiveness include the Fugl-Meyer Assessment of Motor Recovery after Stroke, the Nottingham Sensory Assessment, the Wolf Motor Function Test, the ARAT, the FIM, the Motor Status Score, the Manual Function Test, the Brunnstrom

Table 2
Description of the outcome measures used in the selected studies

Outcome measure	Short description	Type of outcome measure	Specific to hand assessment
Functional Index "Repty" (FIR)	A universal tool for assessment of activities of daily living (ADLs) in patients with various neurological and motor system disorders. The minimum and maximum scores range from 15 to 105. This is a modification of the Functional Independence Measure (motor FIM), which consists of 15 items with a 4-level system of scoring.	Therapist-rated tool based on level of supervision required to complete items on the tool	No
Frenchay Arm Test (FAT)	A measure of upper extremity proximal motor control and dexterity during ADL performance in patients with impairments of the upper extremity resulting from neurological conditions. The FAT is an upper extremity-specific measure of activity limitation.	Therapist-rated tool based on difficulty and abnormality noted during the completion of items on the tool	Yes–specific to the upper extremity
Motor Status Score (MSS)	A tool to evaluate the motor function of the upper limb. The movement scale for the elbow/forearm consists of 6 items and a 6-level system of scoring and also has 17 items for the hand/wrist/fingers with a 3-level system of scoring; the final score ranges between 0 and 53.	Therapist-rated tool based on ability to perform requested movements	Yes–specific to the upper extremity
Fugl-Meyer Assessment of Motor Recovery after Stroke (FMA)	A stroke-specific, performance-based impairment index. This scale includes items related to movements of the shoulder, elbow, forearm, wrist, and hand in the upper extremity, as well as the hip, knee, and ankle in the lower extremity. The assessment considers motor and sensory function, balance, joint range of motion, and joint pain. The total score on the upper extremity part of the FMA ranged from 0 (hemiplegia) to a maximum of 66 points (normal motor performance).	Therapist rated based on direct observation of performance, scored based on full performance, performs partially, cannot perform.	No
Brunnstrom Recovery Stages (BRS)	A tool that measures stereotypical sequence of motor recovery of the upper limbs in the form of 7 ordinal stages based on the level of spasticity. It is a performance-based measure.	Therapist-rated based on the amount of spasticity noted	Yes- specific to the upper extremity
Manual Function Test	An instrument commonly used to measure upper limb motor function and movement ability in stroke patients during the initial stage of rehabilitation. Upper-limb assessment comprised of 4 assessment items for shoulders and 4 for hands. Affected shoulder functions assessed include flexion, extension, abduction, and adduction, and hand function assessment includes grasping, picking up, and pinching abilities.	Therapist-rated based on specific criteria related to the amount of motion or the performance of specific tasks.	Yes–specific to the upper extremity
Grip force with Jamar handheld dynamometer	Power grip is a basic grasp, whereby the fingers are wrapped around an object with the thumb in opposition. Grip strength is measured with a Jamar hand dynamometer. Maximum isometric contraction is measured 3 times on the paretic side, and the average is recorded.	Objective measure of the amount of force registered on the dynamometer in kilograms or pounds	Yes–specific to the upper extremity
Tardieu Scale	A scale that describes spasticity in people with neurological conditions. The most important components captured in the Tardieu Scale are the angle of muscle reaction at a slow velocity, the angle of muscle reaction at a fast velocity, and the quality of muscle reaction at a fast velocity. The scale is administered by applying passive stretch to a muscle group at 2 velocities.	Therapist-rated based on the quality and angle of muscle reaction	No
Pain via Visual Analog Scale	Measurement instrument that measures pain across a continuum with 2 end points and is measured in centimeters (0–10 cm) or millimeters (0–100 mm) with 0 being no pain at all and 100 or 10 being the most severe pain	Patient subjective report based on perceived pain experienced	No
Action Research Arm Test (ARAT)	The ARAT is a hierarchical scale for the evaluation of arm-hand capacity. It consists of 19 functional items that are divided into 4 subtests: grasp, pinch, grip, and gross motor function. A total score of 57 indicates normative performance.	Therapist-rated based on pass/fail of ability to complete the items on the tool	Yes–specific to the upper extremity
ABILHAND questionnaire	The ABILHAND is an interview-based assessment tool that measures a patient's perceived difficulty using his/her hands to perform manual activities in daily life. The ABILHAND assesses active function of the upper limbs. The tool measures an individual's ability to perform bimanual tasks, regardless of strategies used to complete the task.	Patient-rated interview style items, patient rates items as impossible, difficulty or easy	Yes–specific to the upper extremity
Stroke-ULAM	An instrument that consists of accelerometers placed on both arms and uses electrogoniometry to measure the amount of upper limb usage	Based on record of electrogoniometric activity for use of the involved hand/UE	Yes–specific to the upper extremity
EQ-5D	A measure to assess severity of or difficulty with mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. The EQ-5D questionnaire also includes a Visual Analog Scale (VAS) to evaluate perception of overall health status.	Patient-rated based on perceived level of severity	No

(*continued on next page*)

Table 2 (*continued*)

Outcome measure	Short description	Type of outcome measure	Specific to hand assessment
Modified Ashworth Scale (MAS)	A scale used to assess spasticity. The MAS is a 6-point scale (0, 1, 11, 2, 3, and 4), in which a score of 0 indicates no resistance and a score of 4 indicates rigidity.	Therapist rated based on muscle tone and resistance	No
Functional Independence Measure (FIM)	An 18-item instrument that measures independent performance in self-care, sphincter control, transfers, locomotion, communication, and social cognition. The FIM scores range from 1 to 7: a Score of 7 represents "complete independence," and a score of 1 is "complete dependence."	Therapist rated based on level of independence in performance	No
Barthel Index and Modified Barthel Index	An ordinal scale used to measure performance and independence with 10 activities of daily living such as feeding, bathing, grooming, and dressing, and mobility and transfers. Each performance item is rated with a given number of points assigned to each level or ranking.	Therapist rated based on level of independence	No
Stroke Impact Scale	A stroke-specific, self-report, health status measure. It is designed to assess multidimensional stroke outcomes, including strength, hand function, ADLs/instrumental ADLs, mobility, communication, emotion, memory and thinking, and participation.	Patient rated based on perception of symptoms	No
Star Cancellation Test (SCT)	A screening tool that detects the presence of unilateral spatial neglect (USN) in the near extra-personal space in patients with stroke.	Objective scoring based on the number of stars cancelled on the tool	No
Nottingham Sensory Assessment (NSA)	A sensory assessment that includes a tactile, kinesthetic, and stereognosis component.	Therapist rated based on outlined scoring system in performance or detection of stimuli	No
Wolf Motor Function Test	A 16-item quantitative index of upper extremity motor ability examined through the use of timed and functional tasks	Therapist rated based on observation of performance of tasks	Yes—specific to the upper extremity
Line Bisection Test	A quick measure to detect the presence of unilateral spatial neglect completed by placing a mark through the center of a series of horizontal lines	Objective measure scored based on the measurement of deviation from bisection of the lines	No
Picture Identification Test	Number of accurate identifications of 10 pictures	Scored based on the number of accurate identifications	No
Modified Rankin Scale	A score from 0 to 6 depending on the amount of difficulty and support needed to complete normal routine duties and activities	Therapist rated based on scoring scale and independence	No

Stages of Stroke Recovery, ABILHAND, the Modified Rankin Score, the Stroke Impact Scale, grip, pain on the Visual Analog Scale, and the EQ-5D. The EQ-5D was found valid, reliable, and responsive in a study performed on German patients undergoing rehabilitation following a stroke. We chose to accept this study for validation of the EQ-5D psychometric properties as it is reflective of the population under study in this review.

Statistically significant outcomes

Table 1 includes the statistically significant outcomes of the studies and the effect of the mirror therapy intervention. Many of the between-group differences between the studies outcomes were not statistically significant. None of the effect sizes of the between-group change score differences that favored the control group were greater than 0.20, which is considered small by Cohen.[80] When using Cohen's interpretation of effect sizes,[80] some of the between-group results fell within the large classification of greater than 0.80. Lee et al[11] found the between-group comparison of effect size calculations for all outcomes to be greater than 1.0 favoring the mirror therapy group. Yavuzer et al[20] also found a large effect size for the Brunnstrom UE score of 0.84 in favor of the mirror therapy group. Thieme et al[4] effect size calculation between groups demonstrated a large effect size of 2.09 for the Star Cancellation Test favoring the mirror therapy group. Effects size calculations could not be performed for 3 included studies[21,35,36] due to insufficient data; therefore, the effectiveness of mirror therapy intervention could not be determined for these studies.[21,35,36]

Study quality assessment

Regarding the quality of the studies, the average score was 40/48 (Table 5). None of the studies were able to blind patients or treatment providers. Many of the studies did not use a hand functional primary outcome measure.[3,4,11,12,15,33,35,36] Only Colomer et al,[33] Dohle et al,[15] and Michielsen et al[12] report size and significance of the effects when they discussed the results. Regarding outcome measures, only 4 studies (4/11)[12,20,35,36] incorporated an appropriate follow up period.

Discussion

Therapeutic valid, reliable, and responsive measures are necessary to accurately assess the efficacy of any treatment intervention. Outcome assessment became a major focus of medical care in the 1990s, as medicine and society grapple with difficult issues of access and finite resources. This systematic review found that authors used a wide range of outcome measures to evaluate the effect of mirror therapy on hand function in patients who have suffered a stroke. Although there is a consensus on the effectiveness of mirror therapy as a treatment after a stroke,[81] there is not obvious consensus in the current evidence on the most appropriate measures to determine hand function following mirror therapy intervention after stroke. Selection of the best measures to be used clinically and in research will be supplemented by understanding the linkage of the outcome measures to the ICF and knowing the psychometric properties of the measures as outlined in this systematic review.

Table 3
Linking outcome measures to the ICF

ICF category	Body functions	Body structures	Activity and participation	Environmental factors	Personal factors	Not defined
Colomer et al.[33]	Fugl-Meyer Assessment (b7 Neuromusculoskeletal functions, b2 Sensory functions and pain) Nottingham Sensory Assessment (b2 Sensory function and pain) Wolf Motor Function Test (b7 Neuromusculoskeletal function for 9 items and d4 Mobility for 7 items)		Functional Independence Measure (d5 self-care, d4 Mobility)			
Dohle et al.[15]	Fugl-Meyer Assessment (b7 Neuromusculoskeletal functions, b2 Sensory functions and pain)		Functional Independence Measure (d5 self-care, d4 Mobility) Action Research Arm Test (d4 mobility, b7 Neuromusculoskeletal functions)			
Gurbuz et al.[34]	Fugl-Meyer Assessment (b7 Neuromusculoskeletal functions, b2 Sensory functions and pain) Brunnstrom stages (b7 Neuromusculoskeletal function)		Functional Independence Measure (d5 self-care, d4 Mobility, d1 learning and applying knowledge, d3 communication, d7 Interpersonal interactions)			
Lee et al.[11]	Fugl-Meyer Assessment (b7 Neuromusculoskeletal functions, b2 Sensory functions and pain) Brunnstrom stages (b7 Neuromusculoskeletal function)		Manual Function Test (d4 Mobility and b7 neuromusculoskeletal functions-4 items fit into each category)			
Lim et al.[3]	Fugl-Meyer Assessment (b7 Neuromusculoskeletal functions, b2 Sensory functions and pain) Brunnstrom stages (b7 Neuromusculoskeletal function)		Modified Barthel Index (d4 Mobility, d5 self-care [also, b6 genitourinary function 1 item, and b5 functions of digestive system])			
Michielsen et al.[12]	Fugl-Meyer Assessment (b7 Neuromusculoskeletal functions, b2 Sensory functions and pain) Tardieu scale (b7 Neuromusculoskeletal functions) Stroke-ULAM (b7 Neuromuscular functions) Grip strength (b7 Neuromusculoskeletal functions) Pain on Visual Analog Scale (b2 sensory functions and pain)		ABILHAND questionnaire (d5 self-care, d4 Mobility, d6 domestic life) EQ-5D (d5 self-care, d4 mobility, b2 sensory functions and pain-1 item, not-defined mental health-1 item, not-defined health status-1 item)			
Pandian et al.[35]	Star Cancellation Test (b1 Mental functions) Line Bisection test (b1 Mental functions) Picture Identification Test (b1 Mental functions)		Functional Independence Measure (d5 self-care, d4 Mobility, d1 learning and applying knowledge, d3 communication, d7 Interpersonal interactions) Modified Rankin Scale (rating of completion of all duties and activities)			
Radajewska et al.[21]	Motor Status Score (b7 Neuromusculoskeletal functions)		Functional Index “Repty” (d4 Mobility [5 items], d5 self-care [6 items], d1 learning and applying knowledge [1 item], d3 communication [1 item] [also, b1 mental function 2 items, b6 genitourinary function 1 item, and b5 functions of digestive system]) Frenchay Arm Test (d4 Mobility-16 items and b7 Neuromusculoskeletal functions-3 items)			
Radajewska et al.[36]	Motor Status Score (b7 Neuromusculoskeletal functions)		Functional Index “Repty” (d4 Mobility [5 items], d5 Self-Care [6 items], d1 Learning and applying knowledge [1 item], d3 Communication [1 item] [also, b1 mental function 2 items, b6 genitourinary function 1 item, and b5 functions of digestive system]) Frenchay Arm Test (d4 Mobility-16 items and b7 Neuromusculoskeletal functions-3 items)			
Thieme et al.[4]	Modified Ashworth Scale (b7 Neuromusculoskeletal functions) Fugl-Meyer Assessment (b7 Neuromusculoskeletal functions, b2 Sensory functions and pain) Star Cancellation Test (b1 Mental functions)		Action Research Arm Test (d4 Mobility, b7 Neuromusculoskeletal functions) Barthel Index (d4 Mobility, d5 Self-Care [also, b6 genitourinary function 1 item, and b5 functions of digestive system])			Stroke Impact Scale (not-defined mental health-9 items, d1 Learning and communication, b7 Neuromusculoskeletal function-4 items)
Yavuzer et al.[20]	Modified Ashworth Scale (b7 Neuromusculoskeletal functions) Brunnstrom stages (b7 Neuromusculoskeletal function)		Functional Independence Measure (d5 Self-care)			
Totals	13	0	9	0	0	1

Table 4
Psychometric properties of outcome measures

Outcome measure	Valid	Reliable	Responsive
Fugl-Meyer Assessment of Motor Recovery After Stroke	Yes[37]	Yes[37]	Yes[37]
Nottingham Sensory Assessment	Yes[38]	Yes[39]	Yes[38]
Wolf Motor Function Test	Yes[40]	Yes[41]	Yes[42]
Action Research Arm Test	Yes[43]	Yes[43]	Yes[44]
Functional Independence Measure	Yes[45]	Yes[45]	Yes[46]
Modified Ashworth Scale	Yes[47]	Yes[48]	Not determined
Motor Status Score	Yes[49]	Yes[49]	Yes[50]
Tardieu Scale	Yes[51]	Yes[51]	Not determined
Stroke Upper Limb Activity Motor (ULAM)	Yes[52]	Not determined	Not determined
Star Cancellation Test	Yes[53]	Yes[54]	Not determined
Manual Function Test	Yes[55]	Yes[55]	Yes[56]
Brunnstrom stages of stroke recovery	Yes[57]	Yes[57]	Yes[57]
Modified Barthel Index	Yes[58]	Yes[58]	Not determined
ABILHAND questionnaire	Yes[59]	Yes[60]	Yes[61]
Barthel Index	Yes[46,62]	Yes[63,64]	Not determined
Frenchay Arm Test	Yes[65]	Yes[65]	Not determined
Modified Rankin scale	Yes[66]	Yes[66]	Yes[67]
Line Bisection test	Yes[68]	Yes[69]	Not determined
Picture Identification Test	Not determined	Not determined	Not determined
Functional Index “Repty”	Not determined	Not determined	Not determined
Stroke Impact Scale	Yes[70]	Yes[70]	Yes[71]
Grip (Jamar hand held dynamometer)	Yes[72]	Yes[73]	Yes[74]
Pain (Visual Analog Scale)	Yes[75]	Yes[75]	Yes[76]
EQ-5D	Yes[77]	Yes[78]	Yes[79]

Based on our analysis of the outcome measures and the results of this systematic review, the outcome measures used to assess hand function after stroke after mirror therapy intervention are not always what they appear after first glance or at face value. For instance, Michielsen et al[12] reported that they assessed quality of life with the EQ-5D, but when performing linking of this outcome assessment tool to the ICF, the majority of items link to activities and participation as the questionnaire asks about mobility, self-care, and usual activities in addition to an item on anxiety/depression. In addition, the Manual Function Test has an equal number of items that fit into the body functions and the activities and participation categories despite its name suggesting it is a functional assessment.

The linking of the outcome measures to the ICF revealed that a majority (13 of 24) linked to the body functions category. These 13 outcome measures covered many categories within body functions including neuromusculoskeletal function (mostly for range of motion and strength), sensory function, pain, and mental function, which are typically considered important to hand functioning. Upper limb spasticity and limited coordination and muscle movement have been found to be associated with reduced arm function following stroke[82] and some form of these variables was assessed in all but one[35] of the included studies. Six of the included studies assessed spasticity via the Brunnstom Stages of Motor Recovery, Modified Ashworth Scale, and Tardieu Scale. There was only 1 outcome measure (the Nottingham Sensory Assessment), which was used in only one of the included studies that considered sensibility; however, the adverse impact of sensory deficit on stroke functional outcome has been well documented.[83-87] In addition, there was also only 1 study that assessed grip strength as an outcome measure. Grip strength in particular is an important outcome measure in stroke rehabilitation because measurement of grip over a 6-month period has been found to be a sensitive method of charting intrinsic neurological recovery following a stroke and the presence of voluntary grip at 1 month suggests that there will be some functional recovery at 6 months after stroke.[88]

Pain is another factor that links to body functions and is important to hand function following a stroke, but pain itself was only assessed in one of the included studies.[12] Previous research describes hemiplegic shoulder pain as one of the most common complications after acute stroke and confirms a significant relationship between pain and hand function.[26,89-91] Likewise, Paci et al[90] found a strong correlation between shoulder pain and UE motor recover, and Huang et al[91] describe the negative effect shoulder pain has on functional recovery, ADLs and quality of life following a stroke.[91] It should be noted that the Fugl-Meyer Assessment of Motor Recovery after Stroke was used in 7 out of the 11 included studies, and the EQ-5D was used in 1 included study and these both contain an item related to pain.

The activities and participation category also had many linkages as 10 of the 24 outcome assessment tools used in the included studies linked to this category. In a previous study that tried to identify stroke outcome measures that assess activities and participation and then link them to the ICF, it was found that even though the instruments were selected based on their expected focus on activities and participation, 27% of the constructs in these measures addressed body functions.[92] Likewise, the ARAT, the Manual Function Test, the Modified Barthel Index, the Barthel Index, the EQ-5D, the Functional Index Repty, and the Frenchay Arm Test all have items that link to body function, but at least 50% of their items link to the activities and participation category.

Table 5
SEQES: Structured Effectiveness for Quality Evaluation of Study scores

Author	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Colomer et al. 2016[33]	2	2	2	2	2	1	1	1	1	2	0	2	2	2	2	1	2	1	2	2	2	2	2	2	40
Dohle et al. 2008[15]	2	2	2	2	2	1	1	2	2	2	2	1	2	2	2	1	2	1	2	2	2	1	2	2	41
Gurbuz et al. 2016[34]	2	2	2	2	2	1	1	2	1	2	2	2	2	2	2	2	2	1	1	2	1	2	1	2	41
Lee et al. 2012[11]	2	2	2	2	2	1	1	1	1	2	0	2	2	2	2	1	2	1	1	2	1	1	1	2	35
Lim et al. 2016[3]	2	2	2	2	2	1	1	1	1	2	0	2	2	2	2	1	2	1	1	2	1	2	1	2	37
Michielsen et al. 2011[12]	2	2	2	2	2	1	1	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1	2	2	44
Pandian et al. 2014[35]	1	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	2	42
Radajewska et al. 2013[21]	2	2	2	2	2	1	1	1	1	2	0	2	2	2	2	2	2	1	1	2	1	2	2	2	39
Radajewskw et al. 2017[36]	2	2	2	2	2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2	44
Thieme et al. 2012[4]	2	2	2	2	2	1	1	1	1	2	2	1	2	2	2	1	2	1	2	1	1	2	1	2	38
Yavuzer et al. 2008[20]	2	2	2	2	2	1	1	2	2	2	2	2	2	2	2	1	2	2	2	2	1	1	1	2	42

There was only 1 tool that linked to the not-defined ICF category, and all other ICF categories were not represented by the outcome measures used in the included studies. The ICF can assist a clinician or researcher determine if they have comprehensively assessed an individual by choosing measures that cover the categories found within the ICF.

The categories of personal factors and environmental factors were not represented in the outcome measures that were used in the included studies. A previous cross-sectional study[93] investigated the relationship between environmental factors and the occurrence of handicap following a stroke. This investigation found that increased level of impairment and disabilities, advanced age (a personal factor), and perceived barriers in the physical and social environment contribute to the handicap creation process following a stroke.[93] The Measure of the Quality of the Environment is used to determine the perceived influence of environmental factors on the accomplishment of a person's daily activities in relation to his or her abilities and limits.[94] This is a patient-rated outcome measure and includes the topics of social network, attitudes of people around you, commercial services, judicial services, community organization services, and physical accessibility.[94] In addition, poorer health-related quality of life has been found for individuals after stroke related to increased age and nonwhite race (both personal factors).[95] Health-related quality of life was determined using the Stroke Impact Scale in the aforementioned study.[95]

Our systematic review of the outcome measures used in the included studies found that the majority of the outcome measures were found to be valid and reliable for use with individuals who have sustained a stroke. However, only 14 of the 24 outcome measures were assessed for responsiveness. Responsiveness testing is an important psychometric property as this helps clinicians and researchers to know if the tool is actually able to measure a change in what is being measured over time. A previous critical review[96] of measurement properties for commonly reported instruments in stroke rehabilitation found that measurement qualities were relatively consistent but that far less information was available on responsiveness of these measures. These authors[96] concluded that a reader should carefully examine the nature and scope of outcome measurement used in the reporting of evidence following stroke rehabilitation because there is a significant diversity in the measures used.

Ball et al[97] report that hand function is best assessed by a combination of physical measures and patient-rated outcome measures related to orthopedic injury; however, we found that only 4 of the 24 included outcome measures were patient-rated options. Patient-rated assessment can be challenging depending on symptoms present after stroke, ie, symptoms such as unawareness of disabilities can limit usability of patient-rated questionnaires.[98]

We believe that it is best to use several outcome measures that are valid, reliable, and responsive to determine hand function following mirror therapy intervention after stroke. All the authors of the included studies involved more than 1 outcome assessment tool. The use of the ICF can assist in determining a method of comprehensive assessment of hand function. Based on the analysis of our results in relation to related research evidence, we recommend that a comprehensive hand function assessment after stroke include tools to assess the body functions of range of motion and spasticity, sensibility, grip strength, and pain and a tool to assess activities and participation. The Stroke Impact Scale and the Measure of the Quality of the Environment are a complement to these tools to allow coverage of the not-defined mental health category and environmental factors, respectively.

Limitations

This systematic review included only randomized controlled or quasi-randomized controlled trials published in the past 10 years, so it is not inclusive of all possible assessment tools that can be used following mirror therapy after stroke.

Conclusion

Outcome measures assessing hand function in the stroke population vary widely in the current literature on mirror therapy. The identified tools were most often therapist rated, assessed items that linked to body functions or activities and participation, and most tools had established psychometric properties. Due to the heterogeneity of the assessment tools, integrating a combination of measures should be a consideration to best represent hand function following a stroke and fully capture the unique essence of each patient. Moreover, the chosen measures should have established psychometric properties and reflect the multidimensional nature of the ICF.

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Quiz: # 614

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#1. The study design is
   a. qualitative
   b. a case series
   c. a systematic review
   d. RCTs

#2. According to the WHO the effects of a cerebral vascular incident must persist for at least _____ to meet their definition of a CVA
   a. 24 hours
   b. 48 hours
   c. 12 hours
   d. 2 weeks

#3. Mirror box therapy is adapted from the original work of
   a. Lundborg
   b. Mennell
   c. Chinchalkar
   d. Ramachandran

#4. The purpose of the study was to review _____ following mirror box therapy post CVA
   a. the functional effectiveness of the technique
   b. the cost effectiveness of the technique
   c. outcome assessments for hand function
   d. current descriptions of the clinical technique in operational detail

#5. The authors recommend that clinicians use a number of assessment tools rather than a single “best one” due to the heterogeneity of currently recognized instruments
   a. false
   b. true

When submitting to the HTCC for re-certification, please batch your JHT RFC certificates in groups of 3 or more to get full credit.

Appendix 1

Full electronic search strategy on PubMed database for a systematic review of outcome measurement of hand function following mirror therapy for stroke rehabilitation

Key words	Results	Limits	Hits (# after limits)	Obtains	Search details
Mirror therapy	243	CT; last 10 y; humans	44	10	"mirror therapy"[All Fields]
Stroke, cerebral vascular accident	262,895	CT; last 10 y; humans	10,120		"stroke"[All Fields] OR "cerebral vascular accident"[All Fields]
Stroke, hemiparesis, hemiplegia	17,212	CT; last 10 y; humans	527		"stroke"[All Fields] AND "hemiparesis"[All Fields] OR "hemiplegia"[All Fields]
Stroke, mirror therapy	132	CT; last 10 y; humans	36	8	"stroke"[All Fields] AND "mirror therapy"[All Fields]
Stroke, cerebral vascular accident, hand function	552	CT; last 10 y; humans	90	6	"stroke"[All Fields] OR "cerebral vascular accident"[All Fields] AND "hand function" [All Fields]
Stroke, cerebral vascular accident, upper extremity	2501	CT; last 10 y; humans	461		"stroke"[All Fields] OR "cerebral vascular accident"[All Fields] AND "upper extremity" [All Fields]
Stroke, cerebral vascular accident, physical therapy, occupational therapy	27,808	CT; last 10 y; humans	1575		"stroke"[All Fields] OR "cerebral vascular accident"[All Fields] AND "physical therapy" [All Fields] OR "occupational therapy"[All Fields]
Stroke, cerebral vascular accident, hemiparesis, hemiplejica, hand function	70	CT; last 10 y; humans	11	0	"stroke"[All Fields] OR "cerebral vascular accident"[All Fields] AND "hemiparesis"[All Fields] OR "hemiplejica"[All Fields] AND "hand function"[All Fields]
Stroke, cerebral vascular accident, hemiparesis, hemiplegia, mirror therapy	22	CT; last 10 y; humans	5	0	"stroke"[All Fields] OR "cerebral vascular accident"[All Fields] AND "hemiparesis"[All Fields] OR "hemiplejica"[All Fields] AND "mirror therapy"[All Fields]
Stroke, cerebral vascular accident, hemiplejia, hemiparesis, upper extremity	350	CT; last 10 y; humans	65	0	"stroke"[All Fields] OR "cerebral vascular accident"[All Fields] AND "hemiparesis"[All Fields] OR "hemiplejica"[All Fields] AND "upper extremity"[All Fields]
Mirror therapy, upper extremity	67	CT; last 10 y; humans	26	6	"mirror therapy"[All Fields] AND "upper extremity"[All Fields]
Mirror therapy, hand function	11	CT; last 10 y; humans	6	2	"mirror therapy"[All Fields] AND "hand function"[All Fields]
Mirror therapy, hand function, stroke, cerebral vascular accident	570	CT; last 10 y; humans	9	2	"mirror therapy"[All Fields] AND "hand function"[All Fields] AND "stroke"[All Fields] OR "cerebral vascular accident"[All Fields]
Mirror therapy, hand function, stroke, cerebral vascular accident, upper extremity	17	CT; last 10 y; humans	4	2	"mirror therapy"[All Fields] AND "hand function"[All Fields] AND "stroke"[All Fields] OR "cerebral vascular accident"[All Fields] AND "upper extremity"[All Fields]
Mirror therapy, hand function, stroke, cerebral vascular accident, upper extremity, occupational, physical therapy	68,458	CT; last 10 y; humans	4325		"mirror therapy"[All Fields] AND "hand function"[All Fields] AND "stroke"[All Fields] OR "cerebral vascular accident"[All Fields] AND "upper extremity"[All Fields] AND "occupational therapy"[All Fields] OR "physical therapy" [All Fields]
Mirror therapy, occupational therapy, physical therapy	68,475	CT; last 10 y; humans	4328		"mirror therapy"[All Fields] AND "occupational therapy"[All Fields] OR "physical therapy" [All Fields]
Mirror therapy, hemiparesis, hemiplegia	14,626	CT; last 10 y; humans	333		"mirror therapy"[All Fields] AND "hemiparesis" [All Fields] OR "hemiplegia"[All Fields]
Mirror therapy, hand function, hemiparesis, hemiplegia	14,601	CT; last 10 y; humans	328		"mirror therapy"[All Fields] AND "hand function"[All Fields] AND "hemiparesis"[All Fields] OR "hemiplegia"[All Fields]