Effectiveness of Interventions to Improve Occupational Performance of People With Motor Impairments After Stroke: An Evidence-Based Review

Dawn M. Nilsen, Glen Gillen, Daniel Geller, Kimberly Hreha, Ellen Osei, Ghazala T. Saleem

We conducted a review to determine the effectiveness of interventions to improve occupational performance in people with motor impairments after stroke as part of the American Occupational Therapy Association’s Evidence-Based Practice Project. One hundred forty-nine studies met inclusion criteria. Findings related to key outcomes from select interventions are presented. Results suggest that a variety of effective interventions are available to improve occupational performance after stroke. Evidence suggests that repetitive task practice, constraint-induced or modified constraint-induced movement therapy, strengthening and exercise, mental practice, virtual reality, mirror therapy, and action observation can improve upper-extremity function, balance and mobility, and/or activity and participation. Commonalities among several of the effective interventions include the use of goal-directed, individualized tasks that promote frequent repetitions of task-related or task-specific movements.

Motor impairments are a common consequence of stroke. These deficits often compromise a person’s ability to engage in meaningful occupations. Currently, occupational therapists use multiple interventions to remediate motor impairments. However, no consensus has been reached regarding which interventions are most effective for improving occupational performance. The purpose of this review was to answer the following focused question: What is the evidence for the effectiveness of interventions to improve occupational performance for those with motor impairments after stroke?

Background Literature and Statement of Problem

Motor deficits are one of the most common and challenging consequences of a stroke (Nakayama, Jørgensen, Raaschou, & Olsen, 1994). A longitudinal community-based study that evaluated 108 participants who experienced an ischemic stroke found that 50% had hemiparesis, 30% were unable to walk without assistance, and 25% were dependent for activities of daily living (ADLs; Kelly-Hayes et al., 2003). Thus, a clear need exists for evidence-based rehabilitative strategies that address motor impairments to improve a stroke survivor’s occupational performance. In addition, the stroke population is one of the largest groups treated by occupational therapists in the physical disability setting (National Board for Certification in Occupational Therapy, 2012), and it is important that the strategies used in the clinic be supported by evidence-based research (American Occupational Therapy Association [AOTA], 2007). The last evidence-based review of stroke interventions for occupational therapists,
published by AOTA in 2008, included an appraisal of studies conducted through 2003 (Sabari, 2008). Since then, several systematic reviews and meta-analyses have investigated the effectiveness of specific interventions, for example, constraint-induced movement therapy (Peurala et al., 2012), mental practice (Nilsen, Gillen, & Gordon, 2010), and strengthening (Ada, Dorsch, & Canning, 2006). Additionally, guidelines synthesizing data related to multiple interventions (Duncan et al., 2005) have been published. However, these reviews did not emphasize a specific focus on improving occupational performance. Therefore, to ensure best practice in stroke rehabilitation, it is vital that an updated appraisal of existing interventions be done.

Method for Conducting the Evidence-Based Review

Detailed information regarding the methodology for the entire review can be found in “Method for the Evidence-Based Reviews on Occupational Therapy and Stroke” in this issue (Arbesman, Lieberman, & Berlanstein, 2015). Because the main focus of this review was to document the interventions that improve occupational performance for people with motor deficits after stroke, we paid particular attention to choice of outcome measures. If a study did not include at least one outcome measure that addressed occupational performance, that is, improvement in the ability to participate in areas of occupation (ADLS, instrumental activities of daily living, rest and sleep, education, work, play, leisure, and social participation; AOTA, 2014), the study was excluded. We also included measures that focused on upper-extremity (UE) function or balance and mobility using simulated ADLs.

Data were evaluated with reference to three primary outcomes: UE function, balance and mobility, and activity and participation. Although not a complete list, examples of included outcome measures are, for UE function, the Action Research Arm Test, Box and Block Test, Chedoke Arm and Hand Activity Inventory, Frenchay Arm Test, Jebsen–Taylor Test of Hand Function, Motor Activity Log, and Wolf Motor Function Test; for balance and mobility, the Berg Balance Scale, 6-Minute Walk Test, and Timed Up and Go test; and for activity and participation, the Barthel Index, Canadian Occupational Performance Measure, FIM™, and Stroke Impact Scale.

Results

We reviewed 4,930 titles and abstracts and selected 485 studies for full review. Of these, 149 studies met the established criteria for inclusion in the review; 129 articles were rated as providing Level I evidence, 18 studies were rated as providing Level II evidence, and 2 studies were rated as providing Level III evidence. Data from each article were categorized according to intervention type, extracted and put into evidence table format, and later summarized and appraised in a Critically Appraised Topic (see Nilsen et al., 2014). Given space limitations, we briefly describe and highlight the key findings of the following select interventions: repetitive task practice (RTP), constraint-induced and modified constraint-induced movement therapy (CIMT and mCIMT, respectively), mental practice (MP), virtual reality (VR), mirror therapy (MT), action observation (AO), and strengthening and exercise. Supplemental Table 1 (available online at http://otjournal.net; navigate to this article, and click on “Supplemental”) summarizes select studies that highlight the major findings related to these interventions (see Wolf & Nilsen, 2015, for the full evidence table).

Repetitive Task Practice

RTP is an overarching term used to describe training approaches that include performance of goal-directed, individualized tasks with frequent repetitions of task-related or task-specific movements (French et al., 2008). Eighteen Level I studies (Allison & Dennett, 2007; Arya et al., 2012; Chan, Chan, & Au, 2006; Cirstea & Levin, 2007; Cirstea, Pito, & Levin, 2006; English & Hillier, 2011; Feyes et al., 2004; French et al., 2008, 2010; Harris, Eng, Miller, & Dawson, 2009; McClellan & Ada, 2004; Michaelsen, Dannenbaum, & Levin, 2006; Platz et al., 2009; Thielman, 2010; Thielman, Dean, & Gentile, 2004; Thielman, Kaminski, & Gentile, 2008; Tung, Yang, Lee, & Wang, 2010; Yelnik et al., 2008) and six Level II studies (Buschfort et al., 2010; Byl, Pitsch, & Abrams, 2008; Harris, Eng, Miller, & Dawson, 2010; Kawahira et al., 2010; Schneider, Münthe, Rodriguez-Fornells, Sailer, & Altenmüller, 2010; Schneider, Schönle, Altenmüller, & Münthe, 2007) reported on the effectiveness of various types of RTP (e.g., task-specific training, task-related training, repetitive task training, repetitive motor practice, circuit training) in improving aspects of occupational performance after stroke. Seventeen studies included outcome measures related to UE function, with 13 studies reporting positive findings favoring RTP (Arya et al., 2012; Buschfort et al., 2010; Byl et al., 2008; Cirstea & Levin, 2007; Feyes et al., 2004; French et al., 2008; Harris et al., 2009; Michaelsen et al., 2006; Platz et al., 2009; Schneider et al., 2007, 2010; Thielman, 2010; Thielman et al., 2004). Nine studies included outcome measures addressing balance and mobility. Seven of these studies (Allison & Dennett, 2007; Byl et al., 2008; Chan et al., 2006; English & Hillier, 2011; French et al., 2008, 2010;
McClellan & Ada, 2004) reported positive effects of RTP for improving balance and mobility. Six studies included outcome measures related to activity and participation, with 4 studies (Chan et al., 2006; French et al., 2008, 2010; Yelnik et al., 2008) reporting RTP had a positive effect on activity and participation.

### CIMT and mCIMT

CIMT is a method of training that involves restraint of the unaffected limb for ~90% of waking hours, forcing use of the affected limb during daily activities. The other components of CIMT include shaping and intensive and repetitive task training using the affected limb for 6 hr/day for 2 wk (Taub et al., 2006). mCIMT is a shortened version of the original CIMT. During mCIMT, the amount of time for intensive training of the affected limb, the restraint time of the nonaffected limb, or both are decreased and/or distributed over a longer period of time. For example, the intensive training sessions in mCIMT range from 30 min to 3 hr/session, session frequency ranges from 2 days/wk to 5 days/wk, restraint of the unimpaired limb is generally ≤6 hr/day, and the length of the intervention ranges from 2 to 10 wk (Shi, Tian, Yang, & Zhao, 2011). mCIMT is believed to decrease issues related to compliance, as well as any dangers that may be associated with prolonged restraint time (Shi et al., 2011). Sixteen Level I studies (Bonaïuti, Rebasti, & Sioli, 2007; Brogårdh & Lexell, 2010; Brogårdh & Sjölund, 2006; Corbetta, Sirtori, Moja, & Gatti, 2010; Hakkennes & Keating, 2005; Hayner, Gibson, & Giles, 2010; Kim et al., 2008; Lin et al., 2010; Peurala et al., 2012; Shi et al., 2011; Sirtori, Corbetta, Moja, & Gatti, 2009; Wang, Zhao, Zhu, Li, & Meng, 2011; Wolf et al., 2010; Woodbury et al., 2009; Wu, Chuang, Lin, Chen, & Tsay, 2011; Yen, Wang, Chen, & Hong, 2005) and 4 Level II studies (Azab et al., 2009; Barzel et al., 2009; Taub et al., 2006; Uswatte, Taub, Morris, Barman, & Crago, 2006) examined the effectiveness of CIMT, mCIMT, or both in improving aspects of occupational performance.

Nineteen (Barzel et al., 2009; Bonaïuti et al., 2007; Brogårdh & Lexell, 2010; Brogårdh & Sjölund, 2006; Corbetta, Sirtori, Moja, & Gatti, 2010; Hakkennes & Keating, 2005; Hayner et al., 2010; Kim et al., 2008; Lin et al., 2010; Peurala et al., 2012; Shi et al., 2011; Sirtori, Corbetta, Moja, & Gatti, 2009; Wang, Zhao, Zhu, Li, & Meng, 2011; Wolf et al., 2010; Woodbury et al., 2009; Wu et al., 2011; Yen et al., 2005) of 20 studies included outcome measures related to UE function. All of these studies reported positive findings on at least one outcome measure, indicating that CIMT or mCIMT improved UE function. Seven studies included outcome measures addressing activity and participation, with 6 of them (Azab et al., 2009; Hayner et al., 2010; Peurala et al., 2012; Shi et al., 2011; Sirtori et al., 2009; Wolf et al., 2010) reporting positive effects of CIMT or mCIMT on at least one outcome measure related to activity and participation. Several studies reported that improvements in UE function (e.g., Taub et al., 2006; Wolf et al., 2010) and activity and participation (e.g., Azab et al., 2009) attributed to CIMT are maintained over time. Moreover, Barzel et al. (2009) compared a 4-wk home-based mCIMT program (intensive practice 2 hr/day, 5 days/wk, with restraint of the unimpaired limb for 60% of waking hours) with the original CIMT protocol in chronic stroke survivors. They found that both groups improved significantly on measures of UE function with no between-group differences; these improvements were maintained at 6-mo follow-up for both groups, suggesting the benefits gained from the protocols were comparable.

### Mental Practice

**Mental practice** is a training method during which a person cognitively rehearses a physical skill in the absence of actual movements (Jackson, Lafleur, Malouin, Richards, & Doyon, 2001). Most often, this type of training is coupled with traditional task-oriented practice. Nine Level I studies (Barclay-Goddard, Stevenson, Poluha, & Thalman, 2011; Bovend’Eerdt, Dawes, Sackley, Izadi, & Wade, 2010; Braun et al., 2012; Ietswaart et al., 2011; Liu, Chen, Lee, & Hui-Chan, 2004; Liu et al., 2009; Nilsen et al., 2010; Nilsen, Gillen, DiRusso, & Gordon, 2012; Page, Dunning, Hermann, Leonard, & Levine, 2011) investigated the effectiveness of this type of training. Seven studies included outcome measures addressing UE function. Of these 7 studies, 3 (Barclay-Goddard et al., 2011; Nilsen et al., 2010, 2012) reported positive findings favoring MP on outcome measures related to UE function.

Seven studies included outcome measures related to activity and participation. Three (Barclay-Goddard et al., 2011; Liu et al., 2004, 2009) of the 7 studies reported positive findings in favor of MP on at least outcome measures related to activity and participation. Additionally, results of 1 study suggest improvements in activity and participation attributed to MP may be maintained over time (Liu et al., 2004).

### Virtual Reality

During **virtual reality**, participants take part in various goal-directed activities in a computer-based, interactive, multisensory simulated environment designed to replicate real-world experiences. VR environments can be immersive (in which the individual has a strong sense of presence in entering the computer-generated world) or nonimmersive (e.g., video gaming systems such as the Wii).
Four Level I studies (da Silva Cameirão, Bermúdez I Badía, Duarte, & Verschure, 2011; Henderson, Korner-Bitensky, Levin, & Roth, 2007; Laver, George, Thomas, Deutsch, & Crotty, 2011; Saposnik & Levin, 2011) and 1 Level II study (Mouawad, Doust, Max, & McNulty, 2011) investigated the effectiveness of this type of training. All of the included studies reported positive findings favoring VR on at least one outcome measure related to UE function, and 1 of 2 studies that included outcome measures related to activity and participation reported positive findings in support of VR (Laver et al., 2011).

**Mirror Therapy**

During mirror therapy, a mirror or mirror box is placed in the midsagittal position between the extremities of interest. The individual is then encouraged to concentrate on the midsagittal position between the extremities of involvement. During mirror therapy, a mirror or mirror box is placed in the midsagittal position between the extremities of interest. The individual is then encouraged to concentrate on the midsagittal position between the extremities of interest. The individual is then encouraged to concentrate on the midsagittal position between the extremities of interest. The individual is then encouraged to concentrate on the midsagittal position between the extremities of interest.

The procedure creates a visual illusion whereby the activities of the uninvolved extremity are attributed to the involved extremity (Ramachandran & Altschuler, 2009). Movements performed range from simple isolated joint movements to functional movements with objects, and active engagement of the unseen impaired limb is often, but not always, encouraged during the treatment.

Three Level I articles (Lee, Cho, & Song, 2012; Thieme et al., 2013; Thiem et al., 2013) investigated the effectiveness of this type of training. All of the studies included outcome measures related to UE function, with 2 studies reporting positive findings in favor of MT (Lee et al., 2012; Thiem et al., 2012). Additionally, Thiem et al. (2012) reported that improvements in UE function attributed to MT were maintained at 6-mo follow-up. Two studies included outcome measures addressing activity and participation, with 1 study reporting positive findings in favor of MT (Thieme et al., 2012).

**Action Observation**

During action observation, participants watch another person performing common functional actions (most often by watching a prerecorded video) with the intention of imitating the observed actions (Ertelt et al., 2007). Accordingly, AO is followed by actual task performance.

Two Level I articles investigated the effectiveness of this type of training (Ertelt et al., 2007; Franceschini et al., 2012). Ertelt et al. (2007) reported a significant effect favoring AO on measures of UE function and activity and participation in chronic stroke survivors, and these improvements were maintained at a 2-mo follow-up. Franceschini et al. (2012) investigated the effects of AO on UE recovery in acute stroke survivors. A significant effect favoring AO on one outcome measure related to UE function was noted; this improvement was maintained at 4- to 5-mo follow-up.

**Strengthening and Exercise**

All forms of strengthening and exercise, including yoga and tai chi, were combined into the intervention category of strengthening and exercise. Fifteen Level I studies (Ada et al., 2006; Au-Yeung, Hui-Chan, & Tang, 2009; Brazzelli, Saunders, Greig, & Mead, 2011; Galvin, Murphy, Cusack, & Stokes, 2008; Harrington et al., 2010; Harris & Eng, 2010; Hart et al., 2004; Holmgren, Gosman-Hedström, Lindström, & Wester, 2010; Langhammer, Stanghellini, & Lindmark, 2008, 2009; Mead et al., 2007; Olney et al., 2006; Pak & Patten, 2008; Pang, Harris, & Eng, 2006; Schmid et al., 2012) and 1 Level II study (Stuart et al., 2009) provided evidence regarding the effectiveness of strengthening and exercise. Six studies included outcome measures related to UE function, with 5 studies (Ada et al., 2006; Harris & Eng, 2010; Langhammer et al., 2009; Pak & Patten, 2008; Pang et al., 2006) reporting positive findings in favor of strengthening and exercise for improving UE function. Eight of 11 studies reported positive effects of strengthening and exercise on outcome measures related to balance and mobility (Ada et al., 2006; Brazzelli et al., 2011; Langhammer et al., 2009; Mead et al., 2007; Olney et al., 2006; Pak & Patten, 2008; Schmid et al., 2012; Stuart et al., 2009).

Thirteen studies included measures related to activity and participation, with 11 studies (Ada et al., 2006; Galvin et al., 2008; Harrington et al., 2010; Hart et al., 2004; Holmgren et al., 2010; Langhammer et al., 2008, 2009; Mead et al., 2007; Olney et al., 2006; Pak & Patten, 2008; Stuart et al., 2009) reporting positive effects of strengthening and exercise on improving activity and participation.

**Discussion and Implications for Practice, Education, and Research**

On the basis of our review, a variety of evidence-based interventions are effective at improving occupational performance of people with motor impairments after stroke. For example, the results of the review suggest evidence exists for the effectiveness of RTP, CIMT, and mCIMT for improving UE function and activity and participation. Consistent with previous practice guidelines that suggested providing “task-based practice opportunities” for stroke survivors with residual motor capacities (Sabari, 2008, p. 49), both of these interventions stress training of the impaired arm and hand using goal-directed, individualized tasks that promote frequent repetitions of task-related or
On the basis of this review, task-oriented training may be considered the foundation of interventions focused on improving occupational performance for those with motor impairment after stroke. However, evidence has suggested that various forms of strengthening and exercise can improve occupational performance as well. Although in the past the use of resistance was considered inappropriate for this population, it appears that strengthening interventions can be useful in improving UE function, balance and mobility, and activity and participation.

In summary, evidence has shown that a variety of interventions can improve aspects of occupational performance in stroke survivors who have residual motor impairments. Future individual systematic reviews with pooled data analysis would prove useful in determining the effectiveness of each of the presented interventions.

Limitations to this review include the following: Many of the included studies had small sample sizes; some studies were heterogeneous in terms of participant characteristics, intervention protocols, and outcome measures; long-term effects are not well studied; our search was limited to journals published in English; and the possibility of missing studies or duplication of evidence remains because of combinations of search terms and variations in terminology. Lack of systematic grading of the methodological quality of the included studies and lack of pooled data analysis are additional limitations.

Acknowledgments

We thank Marian Arbesman and Deborah Lieberman for their support and guidance during the evidence-based review process.

References


*Indicates studies included in this review.


