Generalization of Stroke Rehabilitation from an Occupational Therapy Perspective

The American Occupational Therapy Association (AOTA), representing the interests of over 140,000 occupational therapists, occupational therapy assistants and students of occupational therapy, appreciates the opportunity to provide comments about the generalization of stroke rehabilitation to the National Institute for Neurological Disorders and Stroke.

In occupational therapy, generalization has been approached from three paradigms: reach, sensory, and cognitive. A systematic review of occupational therapy interventions focused on stroke patients' personal activities of daily living found beneficial effects: (1) significantly increased performance scores of activities of daily living (ADL), (2) significantly more independent in instrumental activities of daily living, and (3) reduced the risk of poor outcome (death, deterioration, or dependency) (Legg et al., 2007).

Reach. With regard to improving reach, therapy which incorporates **goal-directed** reaching behaviors promotes more typical reaching patterns than non-goal-directed interventions in individuals who have hemiparesis following a stroke (Urton, Kohia, Davis, & Neill, 2007). More specifically, goal-directed action results in significantly smoother, faster, more forceful, and more preplanned movement compared to rote exercise (Trombly & Wu, 1999)..

A critical component of producing goal-directed actions is the use of **real and functional objects** in occupational therapy intervention programs. Wu and colleagues (2000) found that the use of real objects produced better reaching movements (shorter movement time, less total displacement, higher peak velocity, greater percentage of reach where peak velocity occurs, and fewer movement units) in persons with and without stroke. A systematic review of occupational therapy interventions after stroke found that training of ADL skills produced a beneficial effect on primary ADL and extended ADL (Steultjens et al., 2003).

Patients with chronic stroke who received **constraint-induced movement therapy (CIMT)** improved their use of their more affected arm in life situations compared to those who received comparison therapy (Gauthier et al., 2008). Correspondingly, the CIMT patients showed increases in gray matter in sensory and motor areas as well as the hippocampus. Most importantly, the "magnitude of the observed gray matter increases was significantly correlated with amount of improvement in **real-world arm use**" (Gauthier et al., 2008, p. 1520)

Although the evidence to support CIMT for motor recovery post-stroke is impressive (Wolf et al., 2008), CIMT is only appropriate for stroke patients with mild motor impairments. Thus, research is needed to develop and test interventions for individuals with moderate to severe hemiparesis. Another issue concerning the CIMT literature is whether the training is too similar to the measures, thus explaining improvements. A significant limitation of the generalization research is that many of the measures purported to measure function are measuring performance at the **impairment level** of the ICF model. Commonly used measures such as the Fugl-Meyer Assessment and Wolf Motor Function Test provide information about arm and hand movements and some task-related movements such as picking up a pencil or turning a key with the more affected arm, but these tests do not tell us if our rehabilitation clients can bathe/shower, dress themselves, cook, or do the laundry – occupations of daily living. The often utilized Functional Independence Measure (FIM) measures level of ability or burden of care, not the quality and extent of using a hemiparetic arm during functional activities. We urgently need psychometrically sound performance-based **tests that measure performance of daily activities**

and participation in communities. Related to this issue is the need to train researchers in instrument development, optimally working with clinicians and clients to ensure that the tests are feasible and ecologically relevant.

Motor recovery from stroke appears to involve centrally generated submovements and through the recovery process, changes in submovements are expected. Participants who had experienced strokes and who were trained on point-to-point movements with the assistance of a rehabilitation robot were able to generalize their training to an untrained task (drawing circles), showing fewer submovements that lasted longer, resulting in smoother and more accurate drawing (Dipietro, Krebs, Fasoli, Volpe, & Hogan, 2009).

Cochrane's systematic review to assess the effectiveness of electromechanical and robot-assisted arm training for improving activities of daily living and arm function and motor strength of patients after stroke concluded that electromechanical and **robot-assisted therapy was not likely to improve activities of daily living**, although it may improve arm motor function and strength of the paretic arm (Mehrholz, Platz, Kugler, & Pohl, 2008). The gains in motor performance were task specific (focus of these interventions on reaching vs. distal grasp and release). Present limitations of this technology (focus on reach vs. distal grasp/release) may contribute to the Cochrane findings.

A randomized controlled pilot study to compare active-assistive reaching exercises with a robotic device to task-matched unassisted reaching in people with chronic hemiparetic stroke surprisingly found no significant differences between the groups (Kahn, Zygman, Rymer, & Reinkensmeyer, 2006). Actually, the group who performed **task-based free reaching improved the smoothness** of their reaching movements more than the robot-assisted group. Perhaps practice of reaching that is goal-oriented is effecting therapeutic changes. If so, we need more research to examine the **effects of task-based rehabilitation on the reduction of activity limitations.**

Sensory functions. The second approach to generalization involves sensory functions. Unfortunately, the evidence for efficacy of training of sensory-motor function on primary and extended ADL is lacking (Steultjens et al., 2003).

Cognitive functions. Another approach to stroke rehabilitation incorporates cognitive functions. Research suggests that **mental practice** of activities of daily living following therapy sessions, emphasizing activities of daily living, resulted in significant increases in daily function and less affected arm impairment ($p < .0001$) in a randomized placebo-controlled trial. (Page, Levine, & Leonard, 2007). Currently, a randomized clinical trial is underway to compare mental practice-based rehabilitation and bimanual upper extremity exercise therapy on arm function and daily activity performance (Verbunt et al., 2008).

Although visual perception training has improved visual scanning and visual-spatial ability, the training has not generalized to performance of primary ADL (Carter, Howard, & O'Neil, 1983).

Indeed, **cognitive strategy** training can play an important role in generalizing effects. Geusgens and colleagues (2007) reported that patients, who had sustained a stroke and apraxia, and who had received 8 weeks of cognitive strategy training, performed trained tasks and nontrained tasks at the same level of independency at the rehabilitation center as well as at home, indicating **transfer of training** effects. Furthermore, these effects remained stable over time. A systematic review of transfer of cognitive strategy training for individuals with acquired brain injury found that transfer of training occurred in most studies (Geusgens, Winkens, van Heugten, Jolles, & van den Heuvel, 2007). Another systematic review of cognitive strategy use to enhance motor skill acquisition in people post-stroke found that general cognitive strategy training results in **improved**

performance in both trained and untrained activities, compared to traditional therapy (McEwen, Huijbregts, Ryan, & Polatajko, 2009).

Summary:

We know that task-based, goal-directed activities with real objects results in improved movements and performance of people recovering from stroke who have hemiparesis. Fortunately, occupational therapists have a long tradition of using functional and task-based activities when planning stroke intervention programs. Whether motor improvements generalize to improved performance of daily activities and participation is less clear. Mental practice of activities of daily living has also helped to improve functioning of the affected arm, and cognitive strategy training appears to generalize to non-trained tasks at home. Although research has shown the effectiveness of interventions in persons who have had a stroke, many of these improvements are at the impairment level of the ICF. We conclude with a list of suggested priorities for future research in the hopes that health care professionals will be better equipped to **prevent or reduce activity limitations**, thereby promoting participation and reducing the burden of the residual effects of stroke.

AOTA recommends that future research on generalization should:

- **develop instruments that measure performance of daily activities and participation** in clinical as well as community contexts
- develop and test interventions for individuals with **moderate to severe hemiparesis**
- examine the **effects of task-based rehabilitation on the prevention or reduction of activity limitations.**
- investigate the use of **in-home telerehabilitation** medicine for people who are discharged from rehabilitation facilities, since research suggests that telerehabilitation improves self-efficacy in mobility-impaired adults (Sanford et al., 2006)
- examine if **virtual reality training** is an effective intervention for stroke patients, since a pilot study reported positive results for training individuals with right hemispheric stroke and unilateral spatial neglect to cross streets safely (Weiss, Naveh, & Katz, 2003)

Respectfully,

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