Occupational Therapy: Evidence-Based Interventions for Stroke
by Giulianne Krug, MA, OTR/L & Guy McCormack, PhD, OTR/L

Despite considerable research efforts on multiple treatment modalities, no single rehabilitation intervention has been proven to be a panacea for stroke recovery.

Abstract
Persons with stroke are commonly provided rehabilitation by occupational therapists. Occupational therapy endeavors to restore the person’s independence in activities of daily living, skills in functional performance, infuse evidence-based practice to assure that interventions are efficacious and cost effective. This article reviews the literature and describes a variety of evidence-based interventions. This review will provide physicians and other health care provider’s insights about the best practices in occupational therapy.

Introduction
Stroke is one of the most common diagnostic categories treated by occupational therapists in the United States. It is estimated there are approximately three million stroke survivors in this country, 70 percent of whom experience “significant functional disability.” A basic tenet of rehabilitation is that all activity should be purposeful and based on research evidence. The introduction of purposeful activities leading to occupation-based practice adds relevance to the rehabilitation endeavor.

Occupational therapy aims to restore functional independence in daily activities by improving underlying deficit performance skills (strength, range of motion [ROM], motor control, cognition) and/or teaching compensatory strategies when recovery of deficit performance areas are unlikely to be successful. Occupational therapists are present in all realms of acute care, rehabilitation, home health, outpatient, and specialty clinics such as spasticity management clinics. The efficacy of occupational therapy in improving functional task performance is well-documented. For example, in their 2006 Cochrane Review, Legg, Drummond, & Langhorne concluded that “Patients who receive occupational therapy interventions are less likely to deteriorate and are more likely to be independent in their ability to perform personal activities of daily living”. Further, Latham et al found that occupational therapy after stroke results in improvement of both functional task performance and
underlying performance deficits such as decreased motor function, cognition and perception. Comprehensive occupational therapy service provision, which addresses deficits on both the impairment level and specific functional task performance, was found to be more effective than either remediation of impairments alone or treatment of functional skills alone in terms of improvement of overall activities of daily living (ADL) and instrumental activities of daily living (IADL). It has been determined that occupational therapists spend the majority of their time with patients after stroke remediating impairments (motor, cognitive, perceptual), followed by specific retraining in functional activities.

**Theories of Recovery After Stroke**

Studies on animal models and neuroimaging have generated three basic theories of recovery after stroke. The first theory has to do with a process called “diaschisis” which shows that neuronal structures that are anatomically connected to a lesion or region damaged by stroke (ischemia) undergo reduced blood supply and metabolism because the communication networks with the neurons have been damaged. The second theory is based on observations of behavioral compensation in persons with stroke over time. Through interaction with the environment, these individuals may facilitate the viable neurons that surround the area of the lesion and reorganize their capacity to compensate for damaged neurons. The third theory is called “adaptive plasticity” whereby researchers have observed dendritic growth and angiogenesis or the growth of new blood vessels near damaged areas; according to this theory, dendritic growth becomes an adaptive response for the lost function. Occupational therapy interventions with individuals after stroke have evolved scientifically, in accordance with these current theories of neurologic recovery.

**Remediation of Impairments**

**Motor Impairments After Stroke**

According to research by Rodgers et al, 85 percent of stroke patients have upper limb impairments after stroke. While most stroke survivors regain their ability to walk, only 30 to 66 percent recover the ability to use their affected arm to assist in functional task performance, and only 15 percent regain hand function; it is also self-reported one year post-stroke that upper extremity (UE) limitations result in decreased well-being by self-report one year post-stroke. Occupational therapists utilize several approaches in the remediation of motor control after stroke. The selection of approach is largely dependent upon patient presentation and therapist experience and preference.

**Neurophysiological Approaches**

Neurotherapeutic approaches to treatment of motor control deficits after stroke are used in an attempt to normalize muscle tone. This is done through inhibition and/or facilitation of muscle activity using various treatment techniques and electrical and sensory modalities. It is expected, through the use of these neurophysiological approaches, that normalization of muscle tone will translate into improved ability to use the extremities during functional activities.

**Neurodevelopmental Therapy**

Historically, neurodevelopmental therapy (NDT), also known as the Bobath approach, has been the most widely used neurotherapeutic approach for remediation of motor control deficits with patients after stroke. NDT is a reflex-hierarchical theory in which the therapist, using specific patterns of sensory input as well as reflex-inhibiting positions, attempts to alter abnormal muscle tone (as often occurs after stroke) through facilitation of normal developmental sequence. To date, researchers have not found evidence that NDT is more effective than any other approach. For example, Hiraoka found that the use of NDT results in outcomes no different than “conventional” rehabilitation therapy, and Paci found no evidence either for or against the use of NDT for treatment of motor deficits following stroke.

**EMG Biofeedback**

Another means of inhibiting and recruiting muscle activity after stroke is through the use of electromyographic (EMG) biofeedback, in which surface electrodes are placed over a muscle or muscle group to measure myoelectric impulses that result from the firing of motor units. During biofeedback sessions, the patient is taught to “relax” or “activate” certain muscle groups through the use of visual and/or auditory feedback received. Through this form of operant conditioning, EMG biofeedback has been found not only to improve upper extremity (UE) function in post-stroke patients,
but also to result in improved ADL performance due to increased motor control.

**Functional Electrical Stimulation**

Functional electrical stimulation (FES) is also used by occupational therapists in post-stroke rehabilitation, both for reduction of shoulder subluxation (and associated pain), which may occur after stroke, as well as for neuromuscular reeducation of the upper extremity. In FES, surface electrodes are placed over a muscle or muscle group much like in EMG biofeedback. Low frequency electrical stimulation (typically 18 Hz) is administered to the muscle/group to stimulate muscle response, preferably during functional task performance. In their 2002 Cochrane Review, Price and Pandyan determined that FES was effective in the severity of shoulder subluxation after stroke but did not find sufficient evidence to conclude that there was a significant impact of FES on motor recovery of the shoulder. Ring & Rosenthal did find evidence that using FES for the UE during stroke rehabilitation resulted in improved AROM and strength.

**Motor Learning Approaches**

Motor learning (ML) approaches are based on systems theory, are task-oriented in nature, and include such concepts as repetitive task practice and arm ability training. Motor learning encompasses the process of acquiring a skill, adapting motor response to context, and making effective decisions regarding movement selection and context. Practice conditions are keys to motor learning approaches; intensity and patterns of performance influence speed and accuracy of motor learning. It has been found that repetitive motor activity (even very simple movements) forms the basis of motor learning and recovery by inducing changes in the cortex. This would suggest that repetitive task practice (the direct and repeated training of a movement or movements during functional tasks) as an alternate means of exercise may produce cortical changes that result in an increase in function. In their 2008 Cochrane Review, French et al. found that repetitive task practice combines functional relevance with intensity of practice, but no evidence for the effectiveness of repetitive task training on UE function was reported. The authors did, however, note that repetitive task training resulted in a small, statistically significant positive effect on ADL. Conversely, Ma & Trombly found that practice of movement to achieve a specific goal during functional task practice may improve specific impairments such as coordination and range of motion. Most of the novel, upcoming theories in stroke rehabilitation are based at least to some degree on motor learning theory.

**Novel Therapies**

**Constraint-Induced Therapy**

Constraint-induced movement therapy (CIMT), or constraint-induced therapy (CIT) is considered by some to be a behavioral approach to address learned non-use of the affected extremity. In CIT, the sound arm is restrained, typically in a sling, mitt, or both, for an established percentage of the day. During restraint, the patient performs selected activities using the weaker UE; these activities may be rote in nature, such as flipping cards repeatedly, or functional, such as folding towels. Shaping of motor response is also an important process that occurs during CIT through activity selection by the therapist. The therapist intentionally selects functional activities that increase motor demand and response. For example, the patient may initially work on grasp by placing tennis balls in a basket, then progress to blocks, then paperclips, etc. for refinement and increased precision in movement ability. It has been found that traditional CIT, comprised of two weeks of training with the affected extremity (90 percent of waking hours wearing restraint on sound UE), results in an increase in excitable motor cortex. Modified constraint-induced therapy (mCIT) utilizes the same concept of shaping, but is less intense (through use of a distributed practice pattern) and of longer duration (several hours a day for 10 weeks, for example). The efficacy of CIT and mCIT in UE motor control and use in functional activity for chronic stroke is well-documented; the research on this treatment approach is abundant.

**Robotics**

In robot-assisted therapy, movement of the entire extremity can be assisted simultaneously, as opposed to facilitation of one movement component at a time. The patient initiates the movement; the movement is detected by EMG electrodes which then trigger the robotic device to complete the movement, thereby providing sensorimotor feedback to the patient. Robotics allow for simultaneous kinematic data collection, which substantially increases their value. While robotic-assisted movement therapy has shown “confirmed benefits” in the return of motor control in patients with both acute and chronic stroke, the cost is prohibitive in most research settings at this time.
Cognitive Retraining after Stroke

Patients who at the outset appear cognitively intact after stroke may have “hidden” cognitive and/or perceptual deficits that prohibit them from safely taking meds, driving, and completing other higher-order ADLs. Cognitive and perceptual sequelae after stroke may include impairments in memory, attention, initiation, problem-solving, reasoning, apraxia, unilateral inattention or neglect, and anosia, to name a few. Occupational therapy treatment of cognitive-perceptual deficits may include both remediation of specific impairments, and/or compensation for such impairments during functional task retraining. Although Steultjens et al. concluded that there is “limited evidence” that cognitive retraining results in the improvement of cognitive skills, Ma & Trombly reported that treatment involving forced-awareness of neglected space, task-specific practice, and use of consistent strategies to accomplish functional activities improve cognitive perceptual abilities after stroke.

Compensatory/Adaptive Approach to Stroke Rehabilitation

The use of adaptation with patients after stroke is common practice in occupational therapy. Compensation is characterized by teaching the client with hemiplegia one-handed techniques during dressing or compensating for memory deficits by educating the client in the use of checklists during hygiene and grooming activities. Although it has been found that teaching adaptive strategies and compensatory techniques results in significant improvement in BADL activities, the use of compensation is not always ideal, especially when there is a chance to remediate. Higgins et al. reported findings that the use of adaptation may encourage learned non-use, which could ultimately decrease functional outcomes in affected UE.

Complementary and Alternative Approaches

In light of current neuroscience research and the knowledge that consumers are interested in complementary and alternative therapies (CATS), this section will provide an overview of some commonly used interventions. To begin, a basic assumption for the conceptual framework for using CATS is based on the neurophysiology of the arousal model involving the neuromodulatory transmitters, the autonomic nervous system, and evidence of brain plasticity. The use of various modalities to facilitate and inhibit muscle groups and motor control mechanisms is not new. Practitioners have found that relaxation training (breathing practices, guided imagery, meditation, and biofeedback) can influence muscle tone, specifically abnormal tone such as spasticity and rigidity. Conversely, persons who have abnormally low muscle tone can benefit from facilitation of muscle groups that are directed toward functional outcomes. For example vibration can be used as a proprioceptive stimulation to facilitate or inhibit muscles. Vibration has been used to increase blood supply in soft tissues, and it has been shown to dissipate pain mediating substances in tissues during acute phases of the inflammatory response; vibration has also been used over acupuncture points and myofascial trigger points to alleviate pain.

Massage Therapy

Although massage therapy is not commonly used by occupational therapists, there is evidence that a ten-minute slow stroke massage along the primary rami on elderly stroke patients relieved anxiety and reduced shoulder pain, heart rate and blood pressure. If the goal is to reduce abnormal muscle tone, massage may be used as a complement to other methods of relaxation training.

Acupuncture

The use of acupuncture for stroke rehabilitation has been studied extensively. The studies included pilot studies, survey design and systematic reviews of electronic data bases. The research methodology for many of the studies was flawed; the sample sizes have been too small and did not reach statistical significance. However, studies that have used larger sample sizes and more specific functional outcome measures such as the Fugl-Meyer (FM) and the Functional Independence Measure (FIM), demonstrated that acupuncture improved lower extremity motor function and tub/shower transfer.

Other studies have shown that acupuncture is effective for pain management and postoperative nausea.

Reiki

Reiki is a form of energy healing similar to laying on of hands that originated in Japan in the early 1900s. Shiflett et al. conducted a pilot study on functional recovery of patients in post-stroke rehabilitation. Reiki did not produce any significant effects on Functional Independence Measures (FIM) or depression scales (CES-D) measure. Qualitative positive effects noted on mood and energy were not associated with placebo effects.
Neurofeedback

New computer-based virtual reality systems are generating good efficacy studies and can simulate functional activities such as driving, sports, negotiating environments, improving attention, memory auditory discrimination, useful field of view for driving and facility in crossing a busy street. In small sample studies, neurofeedback training was found to be beneficial to persons with subacute stroke. Mahncke et al25 have reported studies on cognitive decline in aging and positive effects on brain plasticity, neuromodulatory systems, and functional outcomes with computer-based interactive programs. The data have demonstrated memory enhancement and performance across several neuropsychological measures. Virtual reality interface computer games provide approximation of real life context and can increase treatment effectiveness and generalizability to real world events. Virtual reality interface games can simulate contexts such as driving and increase safety and the effectiveness of real practice sessions in stroke rehabilitation.

Conclusion

There are many complementary and alternative approaches to health care that are outside the realm of traditional stroke rehabilitation. Many people who have had a stroke use alternative therapies in addition to conventional rehabilitation. One of the strengths of complementary therapies is that they reduce stress and anxiety which can support the more conventional interventions used in physical medicine and rehabilitation.

Despite considerable research efforts on multiple treatment modalities, no single rehabilitation intervention has been proven to be a panacea for stroke recovery. The new virtual reality computer-based brain interface intervention program holds much promise but must meet the rigors of randomized control research and evidence-based practice. Overall, it is evident that optimum content and method of delivery (frequency, timing duration) of OT services after stroke for maximal benefit remains unclear, and is an area warranting further study.

References


Disclosure

None reported.