Neurorehabilitation: Are We Doing All That We Can?

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Occupational therapists have many intervention tools available for working with clients having a neurological injury; however, some of the most innovative and effective methods have not gained acceptance by many clinicians. Emerging research and new technologies provide occupational therapists with a multitude of treatment strategies and novel devices, but incorporation of those tools into clinical practice appears to be limited by the time necessary to learn about the intervention, educational requirements associated with implementation, or lack of awareness regarding the evidence supporting the use of such tools. Strategies to combat this trend include educating clinicians on evidence-based methods for neurological rehabilitation, aligning academics with practitioners to translate evidence into practical treatment strategies, and accepting that occupational therapy can use these innovations as a means toward state-of-the-art, occupation-based practice.


As occupational therapists, we are inclined to provide the best care for our clients. It is our professional and ethical responsibility to ensure that we optimize outcomes and use the tools and strategies that will enable clients to return to functional, meaningful lives. However, the selection of specific tools and techniques to facilitate client participation varies widely among practitioners. This variability creates a dichotomous picture of occupational therapy: The art of occupational therapy can be seen in the creative and distinctly different approaches used by practitioners to treat similar diagnoses; the science of occupational therapy begs for evidence and proof that these radically diverse methods are effective.

Depending on the tools chosen or the therapeutic approach taken, each patient’s experience with occupational therapy is unique. Therapists learn to select interventions that will address the client’s goals, but intervention choices are also affected by larger issues, including cultural, social, historical, and theoretical factors (Reed, 1986). Some of the primary reasons therapists select the interventions they do are based on the professional training they receive in school or conferences or on the resources available at their worksite (Korner-Bitensky, Menon-Nair, Thomas, Boutin, & Arafah, 2007).

What is most concerning is that occupational therapists appear to have an underlying yet pervasive resistance to adopting evidence-based practice methods or to implementing new technologies that have demonstrated effectiveness. For example, a study of occupational therapy practice in Australia revealed that for upper-extremity rehabilitation after stroke, many therapists frequently use techniques not supported by empirical evidence (Gustafsson & Yates, 2008). In 1999, Dubouloz, Egan, Vallerand, and von Zweck (1999) reported that occupational therapists identified evidence-based practice as a potential threat. More recently, a questionnaire regarding preferred practice methods was given to 107 experienced occupational therapists, and 85% indicated that they were using interventions for stroke that were not scientifically supported (Natarajan et al., 2008).

Perhaps the novelty of an unfamiliar electromechanical device, the apparent theoretical complexity of a new intervention
strategy, or the time needed to be educated in the use of these treatment options are excuses occupational therapists use for their nonacceptance. Occupational therapists, however, cannot continue to reject methods that are grounded in empirical evidence. They can no longer view advances in therapeutic intervention and evidence-based knowledge as a threat; occupational therapists’ acceptance and embracement of these changes is critical for the profession to survive.

Large, multicenter clinical trials and outcome-based studies focused on effective strategies for stroke intervention have generated literature that therapists can use in selecting creative and effective interventions. Rehabilitation technology such as neuromuscular electrical stimulation (NMES), neuroprosthetics, and robotics is changing rehabilitation practice daily. In this article, I explore the emerging research and new technologies that are changing the practice of occupational therapy. I also discuss strategies to help the profession accept and embrace these changes.

Research Evidence and New Technologies

Emerging research and new technologies that are changing the practice of occupational therapy include constraint-induced movement therapy (CIMT), rhythmic auditory stimulation (RAS), visual feedback, NMES, devices such as Bioness and Saebo, and virtual reality. The following sections describe each technology and its application to occupational therapy.

Constraint-Induced Movement Therapy

CIMT is an effective intervention for stroke and head injury that is not often used in clinics but has evidence to support its use. The concept behind CIMT is quite simplistic: Constrain the stronger extremity, “force” the client to use the weaker extremity, and potentially strengthen and facilitate normal sensorimotor responses that can lead to improved function. The EXCITE (Extremity Constraint-Induced Therapy Evaluation) trials, a series of National Institutes of Health–funded, randomized, multisite clinical trials, have repeatedly demonstrated improved upper-extremity strength and motor function in the hemiplegic arm using these techniques. For example, patients who were 3–9 mo poststroke showed significant gains in movement ability and arm use after a 2-wk regimen of CIMT (Wolf et al., 2006). This same group of participants was studied 2 yr later, and functional gains had been maintained and individual ratings of quality of life were high (Wolf et al., 2008). Recently, evidence has shown that CIMT can be effective for people with chronic stroke, because similar beneficial results have been found in people who are 15–21 mo postinfarct (Wolf et al., 2010).

The drawback to CIMT is that its effectiveness is dependent on the patient’s having a moderate amount of residual movement early in the recovery process (approximately 10° of finger extension and 20° of wrist extension) to participate; unfortunately, approximately 80% of patients with stroke do not meet this criterion (Mark & Taub, 2004). However, for patients who do, CIMT is an evidence-based, function-based intervention that works. Additionally, several hours per day are needed for major gains to occur, but research has indicated that fewer hours, or what is known as modified CIMT, may be similarly effective (Leung, Ng, & Fong, 2009; Page, Levine, Leonard, Szafarski, & Kissela, 2008).

Rhythmic Auditory Stimulation

Evidence has also provided support for the use of RAS to improve motor performance. Most applications pair an auditory stimulus with a required motor action, thereby activating the cortical skills of timing, sequencing, and rhythm to facilitate and organize movement. An early pilot study using RAS and a bilateral arm-training device showed lasting improvements in strength, range of motion, and function of the affected upper extremity when this strategy was used with patients with chronic stroke over a period of 6 wk (Whitall, McCombe Waller, Silver, & Macko, 2000). Subsequent investigations involving people with stroke have demonstrated improved kinematics of upper-extremity movement with RAS, revealing that compensatory trunk motion during reaching can potentially be reduced using this method (Malcolm, Massie, & Thaut, 2009). Industry has embraced these findings, and equipment designed to enable practitioners to use this intervention method has been developed and marketed. Interactive Metronome (Sunrise, FL) has created a combined training program and auditory device with promise for improving educational efforts in children with learning disabilities (Taub, McGrew, & Keith, 2007). The cost of $6,500 may be a primary deterrent to widespread use of the system in clinics or educational settings, but the evidence is interesting and provides occupational therapists with one more intervention option if they want to try a novel approach to motor relearning after stroke.

Visual Feedback

Interactive, performance-based computer games using visual feedback have also shown evidence of maximizing patient motor, cognitive, and sensory abilities. Motor learning literature has emphasized that practice and feedback, implemented with specific guidelines, can be valuable learning tools. Expect to see more devices in occupational therapy practice settings that provide immediate real-time visual feedback for clients. Learning a task with visual feedback can foster the skills of error correction and self-monitoring while promoting functional autonomy. Neuromuscular electrical stimulation units are now available that have a visual feedback component. Electromyographic signals are clearly displayed on a screen integrated into these units. Clients can know when muscle activity occurs, and on the basis of the signal’s amplitude, they also receive feedback as to the power of the muscle activity. Zynex Medical, Inc. (Lone Tree, CO), is one of several manufacturers of the electromyograph-triggered stimulation unit (NeuroMove NM900). This tool has contributed to improvements in hand use (Barth, Herrman, Levine, Dunning, & Page, 2008) and balance and gait (von Lewinski et al., 2009) in people with chronic stroke. The REOGo by Motorika (Trussville, AL) and the Hand Mentor by Columbia Scientific (Tucson, AZ) are examples of other robotic-type devices that
use repetitive movements of the upper extremity combined with engaging visual feedback for upper-extremity rehabilitation and relearning.

**Neuromuscular Electrical Stimulation**

For some time, occupational therapists true to the profession have viewed the use of NMES as an intervention that is not occupation based and not congruent with the historical foundations of occupational therapy. Perhaps this controversy has resulted in a decreased enthusiasm for NMES. In any case, the evidence has shown that this modality is not an intervention therapists are readily willing to use (Cornish-Painter, Peterson, & Lindstrom-Hazel, 1997; Taylor & Humphry, 1991). One of the reasons occupational therapists do not use electrical stimulation as often as other modalities is that many curricula teach NMES at an introductory level, and the American Occupational Therapy Association (2008) recommends that further professional education be obtained post-graduation to acquire full proficiency. Both the Cornish-Painter et al. (1997) and the Taylor and Humphry (1991) studies reported that most therapists who were using electrical stimulation with their clients learned to do so primarily from on-the-job training. Despite its infrequent use, several studies have reported favorable outcomes when using NMES as a treatment option for upper-extremity motor recovery after stroke.

A recent study (Hsu et al., 2010) demonstrated that the addition of both low doses (30 min daily) and high doses (60 min daily) of NMES of a standard rehabilitation therapy regimen resulted in better functional outcomes in the upper extremity compared with a regimen without NMES. A systematic review of the stroke intervention literature also indicated that NMES is a viable option for treating post-stroke hemiparesis and is feasible for patients’ home use (Urton, Kohia, Davis, & Neil, 2007). Empi, Inc. (Shoreview, MN), has developed a user-friendly portable stimulator that can be used effectively in neurological applications and in orthopedic cases, but the training and education required for therapists to become skilled in NMES use may be an impediment for most practitioners. As a result, many states are moving to credentialing or certification in the use of physical agent modalities (Bracciano, 2008). The Physical Agent Modality Practitioner Credentialing Agency (www.pampca.org) offers an intensive credentialing course in physical agent modalities for occupational therapy practitioners several times a year. Clinicians who attend these seminars may be more inclined to use NMES as an option when selecting interventions for neurorehabilitation.

**Bioness**

Bioness, Inc. (Valencia, CA), has spent years developing a neuroprosthetic device for the upper extremities that facilitates hand movement using electrical stimulation. The device is known as the H200, a streamlined thermoplastic shell with embedded stimulator electrodes that trigger a normal motor sequence in paralyzed muscle to produce the forearm, wrist, and digit activation needed for grasp and release. In selected trials of use of the neuroprosthetic with stroke patients, researchers noted increases in grip strength and active finger motion, along with decreases in perceived pain and improved Fugl-Meyer scores for the upper extremity (Hill-Hermann et al., 2008; Page et al., 2008). Other researchers saw improvements in functional tasks such as lifting a pot and holding a bag when the prosthetic was used for training (Alon, Levitt, & McCarthy, 2008; Alon, McBride, & Ring, 2002). The evidence has shown that the H200 can assist patients in reducing impairment and maximizing function. The obstacle to usage in this instance is not so much the training involved but the price, approximately $6,000 per unit. Despite the success of the H200 and other similar neuroprosthetic and robotic devices, they still remain largely cost prohibitive for the consumer. Luckily, many clinics are able to purchase various sizes of the H200 to use with several patients as training devices or therapeutic interventions for their rehabilitation caseload.

**Saebolflex**

The Saebolflex (Saebolf Flex, Charlotte, NC) is a mechanical, spring-loaded upper-extremity thermoplastic orthotic that keeps neurologically flexed digits in an extended position so that people with stroke can perform an active grasp with a spring-loaded assisted release. The device, in combination with a massed repetitive practice regimen, can facilitate motor and sensory relearning while reducing learned nonuse. The enticing aspect of Saebolflex training is that unlike CIMT, most people with stroke meet the motor eligibility criteria for this system. Clients who demonstrate at least 15° of both shoulder and elbow flexion and one-quarter-range finger flexion are eligible. Saebolflex additionally offers a static positioning device for the forearm, the Saebolf Stretch, which provides a prolonged static stretch to hypertonic wrist extensors; this device allows people in the SaebolfFlex training program to receive dual rehabilitative benefits of dynamic grasp-release training and static tissue remodeling. The Saebolflex is extremely popular in clinics, but a paucity of research is available regarding its clinical effectiveness. A pilot study, however, demonstrated that the device and training can yield improved wrist extension and reduction in muscle tone (Farrell, Hoffman, Snyder, Giuliani, & Bohannon, 2007). A recent project also demonstrated that SaebolfFlex training may improve balance in people with stroke (Saebolf, Inc., 2010).

**Virtual Reality**

Virtual reality has become the ultimate patient experience for sensory modulation. Although the empirical evidence is limited, devices such as the Nintendo Wii are common in rehabilitation clinics. A few recent studies have suggested that Wii games, used as adjunctive interventions to conventional stroke rehabilitation, can result in improved upper-extremity function after stroke (Saposnik et al., 2010; Yong Joo et al., 2010) and improved balance (Clark & Kraemer, 2009; Nitz, Kuys, Isles, & Fu, 2010). In addition, client motivation and interest in the Wii tasks, games, and sports are reported to be extremely high (Anderson, Annett, & Bischof, 2010; Yong Joo et al., 2010).

Many of the Wii activities are competitive in nature, whether the participant...
compete against another individual or attempts to improve on his or her prior performances. This aspect of "Wii-habilitation" (the term often used) provides the participant with a goal, a new challenge, or a directed purpose. Historical evidence from the occupational therapy literature has shown that when tasks have added purpose or meaning, that is, when activities are multidimensional and goal oriented, motor learning improves and movement kinematics are normalized (Ferguson & Trombly, 1997; Lin, Wu, & Trombly, 1998). Automatic motor responses and typical sensory feedback patterns emerge when clients engage in meaningful and enjoyable activities. Although rigorous investigations and specific outcomes obtained with the Wii are in the early stages, preliminary evidence has indicated that the Wii may be a usable, motivating tool to add to occupational therapists’ therapeutic repertoire.

Strategies for Change

If occupational therapists continue to use ineffective strategies and outdated methods with their clients, they will soon see the consequences of failing to act. Health care spending is already being scrutinized, and professions that do not demonstrate successful outcomes will not receive health care dollars. Services that are not reimbursed will not survive. Most important, the disservice occupational therapists do their clients by not providing them with the most innovative, effective, and meaningful intervention during the limited time they have with them is unthinkable, not to mention unethical.

Occupational therapy has several options for redirecting this dangerous trend:

- **Educate:** Ensuring that an occupational therapy department is fully versed in current practice is the department manager’s or education specialist’s responsibility. Support for attendance at state and national conferences and continuing education offerings will provide the impetus for this learning. Therapists who are trained or who become familiar with novel devices or new intervention strategies will be more inclined to use these methods in daily practice. Occupational therapy programs can involve students in evidence-based practice behaviors and expose them to rehabilitation technologies that show proven effectiveness in the clinic.

- **Collaborate:** Clinicians can reach out to academics and researchers within the profession, and academics can do likewise. They are often the ones on the forefront of research evidence; they can assist practitioners in translating the literature into meaningful, effective interventions and creating evidence-based practice models within facilities.

- **Defy convention:** Accept that some of the methods occupational therapists use to enable occupation in clients will not be occupation based. Such strategies may be grounded in the medical model, but occupational therapists should not reject them merely because impairment or remediation is the focus. The medical model has served occupational therapists well, securing and validating their worth; accepting that it is a piece of who they are as occupational therapists is paramount. Additionally, these interventions are the means to an occupational end, the tools that practitioners can use to facilitate and promote healing, which can lead to clients’ successful occupational performance.

Summary

As research emerges, technology evolves, and markets grow, occupational therapists’ intervention choices will continue to expand. If we acknowledge that many of our clients have physical limitations and impairments that, when reduced or remedied, can lead to function for occupational performance, then why would we choose not to use evidence-based tools and strategies with proven effectiveness in speeding functional outcomes?

If therapists are willing to try these devices and techniques and assess their worth and effectiveness, these treatment options would potentially become more available to patients. Only with occupational therapists’ use and eventual purchase of the devices might we see these technologies as a widespread therapeutic option; only by implementing evidence-based strategies will payers recognize them as standard and effective treatments that are reimbursable. Many of these tools lend themselves easily to the measurement process, which validates occupational therapy services. With measurable outcomes, we can demonstrate the cost and benefit of services; this evidence can in turn influence policy and funding, eventually providing more access to the interventions. Devices such as these could then be accessible to more clinics and patient homes.

Health care has evolved, and we as occupational therapists must support the use of effective interventions. Our treatment choices must produce meaningful and measurable outcomes, and our results must be expedient. If tools and techniques at our disposal can begin to address impairments in such a way that our clients can improve their occupational performance, we have a professional and moral responsibility to explore them. As occupational therapists, we can then affirm the uniqueness and creativity of our therapeutic interventions, validate our practice by using evidence-based tools that produce effective outcomes, and simultaneously ensure that we are doing everything we can to enable human occupation.

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