Effectiveness of Interventions Within the Scope of Occupational Therapy Practice to Improve Motor Function of People With Traumatic Brain Injury: A Systematic Review

Pei-Fen J. Chang, Mary Frances Baxter, Jenna Rissky

MeSH TERMS
- brain injuries
- exercise therapy
- motor skills disorders
- psychomotor performance
- rehabilitation
- therapy, computer-assisted

According to the Centers for Disease Control and Prevention (2014), traumatic brain injury (TBI) accounted for 2.5 million emergency department visits, hospitalizations, and deaths in the United States in 2010. The consequences of TBI often include substantial impairments in physical, emotional, and cognitive functions. Many people with TBI experience various degrees of motor function impairment, including abnormal muscle tone, primitive reflexes, muscle weakness, ataxia, postural deficits, and limited range of motion, resulting in difficulties engaging in purposeful activities. These motor function impairments can have a significant impact on a person’s participation in all areas of occupation. Because the existing literature and evidence regarding interventions for people with TBI are limited, we undertook this review to assist occupational therapy practitioners in making informed decisions about treatment strategies to improve motor function in clients with TBI.

The objectives of this systematic review were to search the literature and critically appraise and synthesize applicable findings to address the research question “What is the evidence for the effectiveness of interventions within the scope of occupational therapy practice to improve motor function for people with TBI?” We used the phrase motor function broadly to include diverse interventions.

Method

This systematic review is one of six reviews of the TBI literature relevant to occupational therapy conducted under the auspices of the American Occupational Therapy Association (AOTA) Evidence-Based Practice (EBP) Project. The
six review questions were based on an earlier set of reviews that covered the literature from 1986 to 2008 and were updated to reflect present clinical practice. An advisory board of experts in the field and the review authors provided feedback on the development of the questions. The reviews were carried out through academic partnerships. The review team for this research question (the authors) included two faculty members and one graduate student. The methods for the reviews were specified in advance and documented in a protocol for the authors.

Search Strategy
The inclusion criteria for this review were as follows: Studies were published in peer-reviewed scientific literature between 2008 and 2013, at least 1 participant in each study sample was an adult with TBI, articles were written in English, and interventions were within the scope of occupational therapy practice. Using the evidence hierarchy described by Sackett, Rosenberg, Muir Gray, Haynes, and Richardson (1996), and because of the limited number of studies on motor function recovery, we included studies with all levels of evidence in this systematic review. The reviews excluded qualitative studies and reports from presentations, conference proceedings, non–peer-reviewed research literature, dissertations, and theses.

AOTA staff and the methodology consultant to the AOTA EBP Project identified the search terms in consultation with the review authors and the advisory group. Terms were selected in keeping with the specific thesaurus of each database included in the search. A medical research librarian with experience in completing systematic review searches further refined the search strategies and conducted all searches. The databases and sites that were searched included MEDLINE, PsychINFO, CINAHL, OTseeker, and the Cochrane Database of Systematic Reviews. The review team examined reference lists from articles that were identified for inclusion for additional potential articles and hand searched archives of selected journals to ensure that all appropriate articles were included. See Supplemental Appendix 1 (available online at http://otjournal.net; navigate to this article, and click on “Supplemental Materials”) for the electronic search strategies and search terms used for this question.

Study Selection, Data Extraction, and Risk of Bias Assessment
The EBP Project methodology consultant first eliminated references that were not related to the research question on the basis of citations and abstracts. The review team eliminated additional references on the basis of citations and a review of the abstracts. We retrieved full-text versions of the articles for the remaining references and reviewed them for relevance to the question, study quality, and levels of evidence. Each included article was abstracted using an evidence table that included the level of evidence, a summary of the study methods, and findings relevant to the review question. AOTA staff and the EBP Project consultant reviewed the evidence tables to ensure quality control before we undertook a more in-depth review and summarization.

We assessed the risk of bias of individual studies using the methods described by Higgins, Altman, and Sterne (2011). Two research team members independently evaluated the risk of bias of each included study, and the third member was consulted to resolve any disagreements.

Data Synthesis
Given the heterogeneity of the included studies, we used a qualitative approach to data synthesis. We examined the studies selected for review for similarities across participants, settings, interventions, and outcomes and grouped related studies into themes. The strength of the evidence for each theme was adapted from the system proposed by the Agency for Healthcare Research and Quality, U.S. Preventive Services Task Force (2012).

Results
A total of 2,306 potential relevant articles were identified in the original and updated searches, of which 47 proceeded to full-text review (see Figure 1). Sixteen articles met the criteria for inclusion in this review: 6 Level I randomized controlled trials (RCTs), 3 Level II two-group non-randomized controlled studies, 2 Level III one-group nonrandomized studies, 2 Level IV single-subject design studies, and 3 Level V case reports. Not all studies included occupational therapy services specifically, but all involved interventions within occupational therapy’s scope of practice. Supplemental Table 1 summarizes the study design, interventions, outcome measures, and results of each study (available online). Supplemental Table 2 presents the results of the assessment of risk of bias for each included study (also available online).

Characteristics of the Studies
In the 16 studies, the age of participants ranged from 12 yr to 76 yr, and at least half of the participants were male (range = 50%–92%). The spectrum of brain injury ranged from mild to severe, and study settings were as intensive as acute care to as informal as a community setting. Eleven studies included only participants with TBI. The other 5 studies included participants with...
acquired brain injury, and the percentage of TBI participants ranged from 12% to 88%. Four studies were conducted in the United States and 12 in other countries, including Australia, Canada, Japan, Hong Kong, Lithuania, Singapore, and Spain.

The outcome measures used in these studies were diverse. Measures included muscle tone, isolated hand movements, physical activities, mobility, motor and physical functions, psychological changes, strength and functional reach, balance, and functional ambulation.

**Multidisciplinary Rehabilitation Programs**

Four articles reported on rehabilitation programs. The types of programs included an intensive rehabilitation program, a comprehensive team approach day treatment program, a task-oriented rehabilitation program, and kinetotherapy.

One Level I RCT (Zhu, Poon, Chan, & Chan, 2007) examined whether 68 participants who received a 4-hr intensive rehabilitation program demonstrated better functional improvement than those who received a 2-hr intensive program. The researchers found no significant difference between the two groups.

Results from 2 Level II nonrandomized group comparison studies (Franckeviciute & Krisciunas, 2008; Hashimoto, Okamoto, Watanabe, & Ohashi, 2006) were similar. Franckeviciute and Krisciunas (2008) found that after kinetotherapy, a movement development strategy for balance and postural control, 131 participants in the acute stage with TBI of varying severity (21.4% moderate, 78.6% severe) showed motor function improvements in bed mobility, sitting balance, ambulation, wheelchair mobility, and hand function. Hashimoto et al. (2006) reported that 25 participants showed some improvement in productive activity after participation in a day program using a comprehensive team approach compared with the control group, which did not receive any therapy. A Level V case report (Yan, 2008) described the use of a task-oriented rehabilitation program. The participant improved in postural stability in standing and independence in ambulation after 4 wk of task-oriented balance, strength, and cognition training.

Available studies of multidisciplinary rehabilitation programs to improve motor function in people with TBI are few in number and of low strength of design. Thus, they provide limited evidence that people with TBI can benefit from such programs.

**Exercise Programs**

Six articles reported on various exercise programs for people with TBI, including 4 Level I RCTs (Blake & Batson, 2009; Driver, Rees, O’Connor, & Lox, 2006;
Ross, Harvey, & Lannin, 2009; Wilson, Powell, Gorham, & Childers, 2006), 1 Level IV single-subject design study (Killington, Mackintosh, & Ayres, 2010), and 1 Level V case report (Goldsh trom, Knorr, & Goldsh trom, 2010). These exercise programs included aquatic exercise, isokinetic strength training, rhythmic exercise, Qigong, task-specific motor training, and a functional ambulation program.

The 4 RCTs evaluated aquatic exercise (vs. vocational rehabilitation training), task-specific motor training (vs. shorter and less frequent task-specific motor training), a walking program (vs. routine care), and Qigong (vs. social and leisure activities). Participants in both the experimental and control groups experienced improved motor function; however, only one intervention, an 8-wk aquatic exercise program (Driver et al., 2006), resulted in significant differences between the treatment group and a control group who took vocational rehabilitation classes.

A Level IV single-subject design study (Killington et al., 2010) and a Level V case report (Goldsh trom et al., 2010) reported on the benefit of exercise programs. All participants demonstrated some functional improvement, such as increased strength, speed, and muscle tone.

Few high-quality studies of exercise programs to improve motor function in people with TBI have been conducted, and their samples were small. Taken together, these studies provide moderate evidence that people with TBI can benefit from exercise programs.

### Computer-Based Interventions

Six articles focused on computer-based interventions, including 1 Level I RCT (Gil-Gómez, Lloréns, Alcañiz, & Colomer, 2011), 1 Level II two-group nonrandomized study (Thornton et al., 2005), 2 Level III one-group nonrandomized studies (Mumford et al., 2012; Ustinova, Leonard, Cassavaugh, & Ingersoll, 2011), 1 Level IV single-subject design study (Bëtker, Szturm, Moussavi, & Nett, 2006), and 1 Level V case report (Rábagó & Wilken, 2011). The computer-based interventions included the Wii balance board, virtual reality (VR) exercise, VR with goal-oriented tasks, a three-dimensional immersive game, video game exercise, and optokinetic simulation postural stability exercises.

Participants in these studies showed improvements in balance, arm and hand function, and postural control. However, because of lack of consistency in study designs, small sample sizes, and the wide range of interventions, the evidence is inconclusive, and further research is required.

### Discussion

When treating clients with TBI to promote motor function recovery, occupational therapy practitioners use interventions from a wide variety of approaches, as is evident from this review. Moderate evidence supports various exercise programs to improve motor functioning after TBI, but only limited evidence supports multidisciplinary rehabilitation programs and computer-based interventions.

### Implications for Occupational Therapy Practice

There is a pressing need for occupation-based standardized outcome measures and interventions related to motor function recovery after TBI. Moderate evidence indicates that various exercise programs provide benefits for motor function, including decreased spasticity, increased isolated hand movement, increased physical activities, improved strength and functional reach, and improved balance. Limited evidence indicates that rehabilitation programs and computer-based programs can improve motor function in people with TBI. Because motor function is fundamental to most performance skills, and because motor function recovery is complicated by other impairments, including cognitive and sensory function, occupational therapy interventions must be developed and implemented that incorporate the essential areas of motor function while incorporating cognitive and sensory functions.

### Implications for Occupational Therapy Education

Occupational therapy curricula and continuing education must provide the latest evidence about the relationships among motor function, sensory function, and cognitive function. Curricula and continuing education need to be developed on ways to improve and implement occupation-based motor outcome measures and intervention programs.

### Implications for Occupational Therapy Research

More research is needed to clarify the effect of neuroplasticity on motor recovery. Occupational performance-based standardized measures for motor function need to be developed, validated, and used in both research and practice. The occupational therapy profession needs to produce more high-quality research designed to examine treatment efficacy versus effectiveness, especially for the computer-based interventions.

### Limitations

Several limitations of this systematic review must be considered when interpreting the results. Sample size was limited in 13 of the 16 studies. In addition, 5 studies were single-subject studies, case reports, or reports without comparison groups. Some studies had more participants with stroke than with TBI. The outcome measures were diverse and not occupation centered.
Conclusion

Motor function involves various aspects of performance skills, and other impairments, including cognitive and sensory function, complicate recovery; thus, the essential areas for motor function interventions and their relationship with cognitive and sensory function must be determined. Occupational therapy must meet the pressing need for occupation-based standardized outcome measures and interventions for motor function recovery after TBI. ▲

Acknowledgments

We acknowledge the contribution of Beth Allen in the preparation of the manuscript and references for this article. In addition, we thank Marian Arbesman and Deborah Lieberman for their guidance and support throughout the review process.

References


