Effectiveness of Rehabilitation in Enhancing Community Integration After Acute Traumatic Brain Injury: A Systematic Review

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KEY WORDS
- brain injuries
- human activities
- occupational therapy
- outcome assessment (health care)
- rehabilitation
- review

OBJECTIVE. We assessed evidence for post–acute traumatic brain injury (TBI) rehabilitation interventions used to enhance community integration (CI) relevant to occupational therapy.

METHOD. We conducted a systematic review of intervention studies on TBI rehabilitation from 1990 to 2007.

RESULTS. We analyzed and summarized 10 studies that met the inclusion criteria. Of 10 studies, 7 found that post–acute TBI rehabilitation benefits CI; all effective studies involved occupational therapy or involved interventions occupational therapists can do.

CONCLUSION. Many CI programs show positive results and should be studied more rigorously. Such promising programs should also be considered when decisions about post–acute TBI rehabilitation services for clients are being made. To further establish that post–acute TBI rehabilitation interventions improve CI, future studies should include intervention strategies based on injury severity, a control group, and longer term follow-up. The role of occupational therapy in these effective programs should be further explored.


Over the past decade, the average length of stay for inpatient rehabilitation after traumatic brain injury (TBI) has decreased (Canadian Institute for Health Information, 2008). Consequently, post–acute TBI rehabilitation has become vital in assisting patients to return to their homes and communities (Sander, Roebuck, Struchen, Sherer, & High, 2001). Hawkins, Lewis, and Medeiros (2005) said that although decreased inpatient length of stay does not negatively affect functional outcome, it places greater demand on outpatient rehabilitation services. The effectiveness of post–acute TBI rehabilitation programs in which occupational therapy services are integral in improving functional outcomes has, therefore, become an important area of rehabilitation research (Sander et al., 2001).

Many researchers view community integration (CI) as the goal of all rehabilitation professionals and their programs (Doig, Fleming, & Tooth, 2001; McCabe et al., 2007; McColl, 2005). Effective CI, according to McColl (2005), involves settling clients into communities where they can be happy and productive. Dijkers (1998) noted that CI also means providing opportunities for people in the least restricted environment. Following such definitions, CI is frequently applied as a discrete measure of patient rehabilitation outcomes after TBI (Cicerone, Mott, Azulay, & Friel, 2004; Minnes et al., 2003; Reistetter & Abreu, 2005). Dijkers (1998) argued that successful medical and rehabilitative services for the TBI population had increased researchers’ and policymakers’ interest in assessing and measuring CI. This shift in attention is important because people with a history of TBI have been less well integrated into their...
communities than the general population (Winkler, Unsworth, & Sloan, 2006).

In the early stages of CI’s conceptualization, Jacobs (1993, p. 226) defined it colloquially as having “something to do, somewhere to live, and someone to love.” Willer, Rosenthal, Kreutzer, Gordon, and Rempel (1993, p. 76) described CI as the “converse of handicap” and divided it into three related categories: (1) integration into a homelike setting, (2) social integration, and (3) integration into productive activities. Similarly, McColl et al. (1998) developed a four-dimensional CI model consisting of general integration, independent living, occupation, and social support. These early concepts show CI’s multifaceted nature and the difficulty in defining it. More recently, McColl, Davies, Carlson, Johnston, and Minnes (2001) described CI as the experience of being a part of the community, being accepted, and not being unduly disadvantaged because of the disability. Their definition was threefold: (1) activities to fill one’s time, (2) independence in one’s living situation, and (3) relationships with other people.

In 2006, Winkler et al. reported that CI constructs relate closely to the “participation” concept, as outlined in the International Classification of Function, Disability and Health (ICF; WHO, 2001). The ICF also described participation as an extremely important client-centered goal of rehabilitation. The participation concept is the third domain of the ICF and has been studied extensively in rehabilitation research. During the past decade, studies focusing on CI and TBI have increased, and outcome studies on TBI, specifically on CI, have provided insight into potential predictors of successful CI (Devitt et al., 2006; O’Connor, 2002). However, no systematic reviews exist of intervention programs that enhance CI for the TBI population.

Occupational therapists and researchers have contributed to the development of CI measures through the Community Integration Measure (CIM; McColl et al., 2001) and the Reintegration to Normal Living Index (RNL; Wood-Dauphinee & Williams, 1987) and through a theoretical CI model, the Consumer Model of CI (McColl et al., 1998). These measures have been useful in measuring occupational performance outcomes (Devitt et al., 2006). According to a nationwide telephone survey, occupational therapy staff were also involved in 69% of all home-based CI programs (Glenn, Rotman, Goldstein, & Selleck, 2005). This level of involvement was surpassed only by psychologists (85%). In addition, occupational therapists are often involved in discharge planning and case management for clients with TBI, during which referrals to post–acute TBI programs should be informed by the best evidence. It is, therefore, vital that occupational therapists be aware of the best evidence about interventions that can foster CI in the TBI population.

Previous Systematic Reviews of CI After Acquired Brain Injury

In recent years, three systematic reviews assessing CI after acquired brain injury (ABI), which includes TBI as well as brain injury from nontraumatic causes, have been published: Reistetter and Abreu (2005), Carlson et al. (2006) and McCabe et al. (2007). Gordon et al. (2006) also published an extensive literature review on TBI rehabilitation, one small part of which covered CI outcomes. Reistetter and Abreu’s study focused on finding the best CI measures for the ABI population, the predictors for success, and CI’s relationship to performance level. Most of the studies they reviewed were retrospective cohort, cross-sectional, and reliability studies. Their study found strong evidence supporting the Community Integration Questionnaire’s (CIQ’s) utility for CI outcome measurement and revealed major predictors of CI, such as injury severity, age, gender, education, prior work, living environment, cognition, emotional status, functional performance, and disability. However, Reistetter and Abreu did not review intervention studies in relation to CI.

Carlson et al.’s (2006) systematic review aimed to identify best practices and promising new ways to enhance participation in the ABI population. Yet the scope of their review was likely narrowed by their exclusion of both non-English publications and articles on the geriatric population. They classified CI programs as “learning to participate” or “participating to learn” and supported the latter as a useful rehabilitation model.

McCabe et al.’s (2007) systematic review focused on CI using the Downs and Black (1998) checklist and the Physiotherapy Evidence Database (PEDro) scale to assess evidence levels. McCabe et al. concluded that because of a lack of studies with strong methodological quality, only limited evidence existed to support rehabilitation interventions.

To summarize current TBI rehabilitation studies, Gordon et al. (2006) undertook a literature review that focused specifically on TBI and included a CI component. This work, however, was not based on a comprehensive literature search and did not assess each article individually for evidence levels.

All seven studies that Gordon et al. (2006) examined in their review found that the interventions studied improved employment, health-related quality of life, physical well-being, successful living in home communities, self-efficacy, and the ability to cope with depression. The range of outcome variables was great. Their review did not include...
a comprehensive synthesis of the findings, and not a single randomized controlled trial (RCT) was reviewed.

The three systematic reviews discussed earlier (Carlson et al., 2006; McCabe et al., 2007; Reistetter & Abreu, 2005) were restricted to articles published in English and to ABI populations, including those with stroke and brain tumors. One could argue that because of TBI's many clinical characteristics, such as the nature of the injury and its neurological symptoms, as well as the different acute and post–acute TBI treatment approaches, TBIs should be researched apart from all other ABIs.

Our systematic review, which synthesizes evidence from previous work, focuses on the CI outcomes of TBI survivors and includes a search for non-English articles. Also, in contrast to the earlier reviews, we expanded the inclusion–exclusion criteria to include all adult populations and made use of specific CI outcome measurements from intervention studies.

Measurements of CI

Although some consensus exists as to what constitutes CI, it is still difficult to assess and accurately measure (Gordon et al., 2006). CI measures have included the Craig Handicap Assessment and Reporting Technique (CHART; Whiteneck, Charlifue, Gerhart, Overholster, & Richardson, 1992), CIM (McColl et al., 2001), CIQ (Willer et al., 1993), RNL (Wood-Dauphinee, Opzoomer, Williams, Marchand, & Spizer, 1988), SPRS (Tate, Hodgkinson, Veerbangsa, & Maggiotto, 1999), Brain Injury Community Rehabilitation Outcome–39 (BICRO–39; Powell, Beckers, & Greenwood, 1998), and AIMS Interview (Berry, 1994), all of which informed our study’s inclusion criteria for outcome measures. These instruments were developed to assess core elements of CI: relationships with others, independence in living situation, and meaningful activities (Salter, Foley, Jutai, Bayley, & Teasell, 2008). The types of subscales that can be found in these assessments include physical and cognitive independence, mobility, occupation, social integration, economic self-sufficiency, home and social integration, productivity, daily functioning, perception of self, occupational activities, interpersonal relationships, and independent living skills, which are relevant outcomes for occupational therapists.

Study Objectives

The study’s objectives were to assess evidence for post–acute TBI rehabilitation intervention programs for adults that include community integration as an outcome measure, using a systematic literature review, and to describe these program’s characteristics. We also examined occupational therapy’s involvement in these programs and their relevance to occupational therapy.

Method

To formulate research questions and develop search strategies, we adopted an approach from a systematic review (Khan, Kunz, Kleijnen, & Antes, 2003). For appraisal and interpretation of the methodological quality of the studies, we adopted an approach used in reports from the Evidence-Based Review of Moderate to Severe Acquired Brain Injury Group (Teasell et al., 2005, 2007).

Search Strategy

We used a wide range of sources—Medline, CINAHL, EMBASE, AMED, PsycINFO, and the Cochrane Library—with the assistance of a librarian at the Toronto Rehabilitation Institute. The key words used to search the databases were brain injury, head injury, intervention, rehabilitation, therapy, treatment, community integration, community reintegration, community re-entry, and participation. We explored MeSH headings for brain injury and head injury. The concept of “community integration” did not match any MeSH terms, so we used the search keywords used in Reistetter and Abreu (2005).

No limits were placed on language. Five journals selected from the Web of Science’s “top source list” were searched manually using the terms traumatic brain injury and community integration: Journal of Head Trauma Rehabilitation, Archives of Physical Medicine and Rehabilitation, Neurorehabilitation, Disability and Rehabilitation, and Rehabilitation Psychology. We chose these journals because they contained the selected terms in their full-text articles more frequently than did other journals. In addition, we back-referenced all articles from previous systematic reviews and selected studies. Two independent reviewers read the abstracts that emerged and carefully applied the inclusion–exclusion criteria to them. When disagreement about inclusion or exclusion occurred, the two reviewers discussed the abstract until a consensus was reached.

Types of Study Design

We included both RCTs and controlled trials (CTs). We also considered high-quality observational studies, such as prospective cohort or case-control studies, which provided pretest and posttest data and detailed descriptions of interventions targeting CI improvement.

Inclusion–Exclusion Criteria

The inclusion criteria for the studies consisted of (1) a focus on TBI, (2) participants ages ≥16, (3) published
between January 1990 and October 2007, (4) rehabilitation programs at the postacute stage (e.g., community-based outreach or outpatient programs), and (5) inclusion of a CI measure. Eligible CI measures included one of the following: CIQ, CHART, CIM, RNL, SPRS, BICRO–39, or AIMS. These common measures are typically designed to measure CI (McColl, 2005; Reistetter & Abreu, 2005; Salter et al., 2008). Programs focused on inpatient rehabilitation were excluded.

**Methodological Quality Assessments**

Using the PEDro rating scale developed by the Centre for Evidence-Based Physiotherapy and the checklist developed by Downs and Black (1998), two reviewers rated the methodological quality of the included studies. Downs and Black (1998) stated that health care research must use a nonrandomized method and a checklist for non-RCT studies because current checklists lack detailed subscales and ignore the external validity of trials. Their checklist is now used for systematic reviews in rehabilitation (McCabe et al., 2007; Robbins, Houghton, Woodbury, & Brown, 2006; Teasell et al., 2007) and other fields (Hartling, Brison, Crumley, Klassen, & Pickett, 2004; Malcomson, Dunwoody, & Lowe-Strong, 2007). The Downs and Black checklist consists of 27 questions with four subscales: Reporting, External Validity, Bias, and Confounding. The maximum Downs and Black (1998) checklist score for our review is 28. Whenever there was lack of agreement between the two raters, a third rater was consulted; after discussion, a consensus was reached.

**Interpreting the Results of the Included Studies**

The PEDro scale is widely used to assess the methodological qualities of RCTs, and many systematic reviews in the rehabilitation field have adopted it. According to a methodological review on stroke rehabilitation (Foley, Teasell, Bhogal, & Speechley, 2003), the maximum PEDro score can be interpreted as 10. Thus, RCTs with PEDro scores of 9 or 10 are of “excellent” methodological quality; studies with scores from 6 to 8, “good”; studies 4 or 5, “fair”; and those <4, “poor.” This approach allows researchers to easily interpret scoring results. Studies using a nonexperimental or uncontrolled designs are considered low-level evidence.

**Summarizing the Findings: Evidence Levels**

To summarize the results of the selected studies, we used the levels of evidence developed by the U.S. Agency for Health Care Policy and Research in their document Post-Stroke Rehabilitation (Gresham et al., 1995, as cited in Foley et al., 2003). Recent systematic reviews for ABI rehabilitation also adopted this guideline (McCabe et al., 2007; Teasell et al., 2007). The guideline defined five levels of evidence to summarize findings, which Teasell et al. (2007, p. 110) defined as follows:

1. **Strong evidence**: The findings are supported by the results of two or more RCTs of at least fair quality (fair quality is defined as a PEDro score ≥4).
2. **Moderate evidence**: The findings are supported by a single RCT of at least fair quality.
3. **Limited evidence**: The findings are supported by at least one nonexperimental trial or intervention.
4. **Consensus**: In the absence of evidence, agreement was obtained from a group of experts on the appropriate treatment course. Consensus opinion is regarded as the lowest form of evidence.
5. **Conflicting**: Disagreement between findings of at least two RCTs or disagreement between two non-RCTs where RCTs are not available. Where there were more than four RCTs and the results of only one conflicted, the conclusion was based on the majority of the studies, unless the study with conflicting results was of higher quality.

**Results**

Two reviewers retrieved a total of 559 articles from the six major databases (Medline, CINAHL, AMED, EMBASE, PsycINFO, and the Cochrane Library). Seven more studies were obtained through manual searches of the five journals and back-referencing from previous reviews. Of the 566 articles, 537 did not meet the inclusion criteria on the basis of the titles and abstracts. The excluded articles were case studies, measurement studies, economic analyses or articles that did not use CI measurements for the outcomes studied. Of the 29 remaining studies, 18 were further excluded for similar reasons after the full text was thoroughly examined. Of these, 2 were considered as one complete study (Paniak, Toller-Lobe, Durand, & Nagy, 1998; Paniak, Toller-Lobe, Reynolds, Melink, & Nagy, 2000) because the original study had included a 1-yr follow-up published in a separate article. Therefore, the literature search yielded a total of 10 articles for inclusion in this systematic review. We did not find any non-English language papers.

**Characteristics of Interventions**

Table 1 presents a summary of the characteristics of the 10 selected studies, arranged by type of interventions. The studies include 2 single-blinded RCTs (Paniak et al., 1998, 2000; Powell, Heslin, & Greenwood, 2002), 2 unblinded RCTs (Bell et al., 2005; Tiersky et al., 2005),
Table 1. Summary of the Selected Intervention Studies Assessing Community Integration After Traumatic Brain Injury

<table>
<thead>
<tr>
<th>Study</th>
<th>Study Design</th>
<th>Participants</th>
<th>Intervention</th>
<th>CI Measurement</th>
<th>Results</th>
<th>Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. (2005), United States</td>
<td>Randomized controlled trial</td>
<td>Treatment group (n = 85): Age = 37 ± 16, 72% male</td>
<td>Teles rehab</td>
<td>CIQ</td>
<td>No significant difference between the two groups (p = .13)</td>
<td>PEDro scale: 6 (good)</td>
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<td></td>
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<td>Control group (n = 86): Age: 34 ± 14, 82% male</td>
<td>Intervention group: Received telephone calls at 2 and 4 wk and 2, 3, 5, 7, 8, and 9 mo. Motivational interview, counseling, education, facilitating usual care.</td>
<td>Time from injury: Not reported, follow-up: 1 yr postinjury</td>
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<tr>
<td>Cicerone, Mott, Azulay, &amp; Friel (2004), United States</td>
<td>Nonrandomized controlled trial</td>
<td>Treatment group (n = 27): Age = 37.8 ± 10.6, 63% male</td>
<td>Intensive cognitive rehabilitation</td>
<td>CIQ</td>
<td>Total CIQ improved for both groups (p &lt; .001).</td>
<td>PEDro scale: N/A</td>
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<td></td>
<td>Control group (n = 29): Age = 37.1 ± 12.0, 79% male</td>
<td>Intervention group: Structured and integrated 16-wk program. Compensation for cognitive deficits, communication skills, psychotherapy, family support, OT, PT</td>
<td>Time from injury: Treatment group = 33.9 mo, control group = 4.8 mo</td>
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<tr>
<td>Constantinidou et al. (2005), United States</td>
<td>Nonrandomized controlled study, matched design</td>
<td>Treatment group (n = 14): Age = 32.2 ± 11.4, sex: not reported</td>
<td>Intensive cognitive rehabilitation</td>
<td>CIQ</td>
<td>Improvement on total CIQ score for intervention group</td>
<td>PEDro scale: N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control group (n = 13): Did not differ from treatment group</td>
<td>Intervention group: Systematic categorization training for 3–5 hr/wk for 10–12 wk</td>
<td>Improvement on Home Integration and Productive activity scores (p &lt; .05)</td>
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<td></td>
<td></td>
<td>Injury severity: Moderate/severe</td>
<td>Control group: Noninjured participants</td>
<td>No changes in Social Integration (p = .75)</td>
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<tr>
<td>Goranson, Graves, Allison, &amp; La Freniere (2003), Canada</td>
<td>Nonrandomized case-control, pretest-posttest</td>
<td>Treatment group (n = 21): Age: 34.7 ± 12.4, 43% male</td>
<td>Multidisciplinary rehabilitation</td>
<td>CIQ</td>
<td>Intervention group had higher total CIQ scores, Home Integration, Social Integration, and Productivity subscales (p = .024)</td>
<td>PEDro scale: N/A</td>
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<tr>
<td></td>
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<td>Control group (n = 21): Age = 36.6 ± 12.5, % male: 38%</td>
<td>Intervention group: intensive outpatient rehabilitation program. OT, PT, SLP, recreation therapy, social work, psychology. 4 days/wk, 5.5 hr/day, 4 mo</td>
<td>Time from injury: Treatment group = 12.1 mo, control group = 13.5 mo</td>
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<td></td>
<td></td>
<td>Injury severity: Mild/moderate</td>
<td>Control group: No rehabilitation service</td>
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<tr>
<td>Hashimoto, Okamoto, Watanabe, &amp; Ghashi (2006), Japan</td>
<td>Nonrandomized controlled trial</td>
<td>Treatment group (n = 25): Age = 26.6 ± 9.7, 72% male</td>
<td>Multidisciplinary rehabilitation</td>
<td>CIQ</td>
<td>Social Integration and Productive activity scores were greater for intervention group (p &lt; .05)</td>
<td>PEDro scale: N/A</td>
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<tr>
<td></td>
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<td>Control group (n = 12): Mean age ± SD 28.7 ± 10.9, % male: not reported</td>
<td>Intervention group: Multidisciplinary rehab program, OT, PT, social skill training, vocational counseling for 3–6 mo</td>
<td>Time from injury: Treatment group = 527 days, control group = 487.6 days</td>
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<tbody>
<tr>
<td>High, Roebuck-Spencer, Sander, Struchen, &amp; Sherer (2006), United States</td>
<td>Prospective cohort, pretest-posttest</td>
<td>Injury severity: Moderate/severe</td>
<td>Control group: Participants who did not join the treatment program</td>
<td>CIQ</td>
<td>Total CIQ score was not significantly different.</td>
<td>PEDro scale: N/A</td>
</tr>
<tr>
<td>Paniak, Toller-Lobe, Durand, &amp; Nagy (1998, 2000), Canada</td>
<td>Randomized controlled trial</td>
<td>Injury severity: Moderate/severe</td>
<td>Comprehensive-integrated program</td>
<td>CIQ</td>
<td>Significant main effect of time was found for total CIQ score ($p &lt; .001$) and three subscales ($p &lt; .05$). There were no main group effects</td>
<td>PEDro scale: 5 (fair)</td>
</tr>
<tr>
<td>Powell, Heslin, &amp; Greenwood (2002), United Kingdom</td>
<td>Randomized controlled trial</td>
<td>Injury severity: Mild</td>
<td>Multidisciplinary rehabilitation</td>
<td>BICRO–39</td>
<td>Intervention group had significantly better BICRO–39 total scores and two BICRO–39 subscales, self-organization, and psychological well-being</td>
<td>PEDro scale: 8 (good)</td>
</tr>
<tr>
<td>Tiersky et al. (2005), United States</td>
<td>Randomized controlled trial</td>
<td>Injury severity: Severe</td>
<td>Intensive cognitive rehabilitation</td>
<td>CIQ</td>
<td>No difference between the two groups ($p = .301$)</td>
<td>PEDro scale: 5 (fair)</td>
</tr>
<tr>
<td>Willer, Button, &amp; Rempel (1999), Canada</td>
<td>Nonrandomized controlled study, matched design</td>
<td>Injury severity: Severe</td>
<td>Multidisciplinary rehabilitation</td>
<td>CIQ</td>
<td>Intervention group had lower CIQ scores at the beginning of treatment and equal to or slightly more integrated than the control group by the end of treatment. Total CIQ score was not significantly different.</td>
<td>PEDro scale: N/A</td>
</tr>
</tbody>
</table>

**Note:** Age is expressed as mean ± standard deviation. BICRO = Brain Injury Community Rehabilitation Outcome–39; CI = community integration; CIQ = Community Integration Questionnaire; OT = occupational therapy; N/A = not applicable; PT = physical therapist; SLP = speech–language pathologist; TBI = traumatic brain injury.
4 CTs (Cicerone et al., 2004; Constantinidou et al., 2005; Goranson, Graves, Allison, & La Freniere, 2003; Hashimoto, Okamoto, Watanabe, & Ohashi, 2006), 1 prospective cohort study (High, Roebuck-Spencer, Sander, Struchen, & Sherer, 2006), and 1 case-control study (Willer, Button, & Rempel, 1999). Treatment interventions were categorized into four general groups: multidisciplinary rehabilitation, intensive cognitive rehabilitation, comprehensive integrated rehabilitation, and telerehabilitation. Among the 10 studies, 6 involved occupational therapy (four multidisciplinary rehabilitation programs, one cognitive rehabilitation program, and one comprehensive integrated program) as described in Table 1; the other programs did not mention involvement by occupational therapists.

**Participant Characteristics**

Participants in the selected studies were ages ≥18 yr (mean = 35.4); no significant age differences were found between those in treatment or control groups. The proportion of male participants ranged from 43% to 87%. The percentage of men was similar among control participants; however, some studies showed 16%–21% more women (Cicerone et al., 2004; Tiersky et al., 2005). Two studies did not provide information on gender (Constantinidou et al., 2005; Hashimoto et al., 2006). Detailed information on mean ages and gender proportions are provided in Table 1.

Length of time since injury, duration of treatment periods, and length of follow-up varied across the studies. The causes of TBIs also varied: motor vehicle collisions and falls were the two main causes. The studies covered a range of TBI severity: 2 studies dealt with only mild TBI, 2 with mild to moderate TBI, 3 with moderate to severe TBI, 2 with severe TBI, and 1 with all levels of severity. The study sample size varied. Three studies had relatively small sample sizes of <40, but the mean sample size was 77 for case and control groups.

**Characteristics of Outcomes**

The most frequently used CI measure was the CIQ, which was used in 9 of 10 studies to examine CI outcome after intervention. Only one randomized trial (Powell et al., 2002) used the BICRO–39. No other CI measurement tool was used. Each study used various interventions and measured outcomes at different times throughout the research process. Because of differences in treatment interventions and goals, pooling these data for a meta-analysis was impossible.

**Quality Assessment.** The PEDro scale was used for RCTs, and the Downs and Black (1998) checklist was used for nonrandomized or observational study designs (Saunders, Soomro, Buckingham, Jamtvedt, & Raina, 2003). The four RCTs had a mean score of 6, ranging from 5 to 8, and the non-RCTs had a mean score of 3.6, ranging from 3 to 4. No studies were of excellent methodological quality as measured by the PEDro scale. Two RCTs were of good quality, and the other two were fair. All studies satisfied the baseline comparability, group comparison, and point estimate criteria; however, none met the criteria for blinded participants and therapists.

**Evidence Levels.** Each research team provided evidence to support its study conclusions. Given each study’s different research methods, populations, and measurement tools, it was not possible to pool data and synthesize the results. As Table 1 shows, our review drew on one evidence level from each study. This evidence depends on the level of TBI measured in the study and signifies a consensus within the literature review, where variables improve CI.

**Discussion**

By attempting to systematically assess intervention studies in TBI rehabilitation research and focusing specifically on CI, we took a unique approach in our research review. Our review builds on previous research by providing TBI-specific information and highlighting the contributions of recent studies. Given that the studies included in this review were conducted in various settings and included participants with a wide range of injury severity and different demographic and clinical characteristics, we advise careful interpretation of the findings. Yet, despite the methodological challenges and the variability of the clinical population, we nevertheless believe that our study highlights promising evidence, particularly regarding multidisciplinary rehabilitation and cognitive and vocational rehabilitation in moderately to severely injured adults.

Multidisciplinary rehabilitation interventions designed by Powell et al. (2002), Goranson et al. (2003), Willer et al. (1999), and Hashimoto et al. (2006) showed positive results in enhancing CI. Several of the other designs were also beneficial for CI measurements. Powell et al.’s outreach treatment program in a community setting more effectively increased CI levels than did the less structured and less intensively treated control group. When compared with a home-based program, Goranson et al.’s multidisciplinary rehabilitation program was also more successful in improving CI. Compared with a nonrehabilitation control group, the treatment group that received multidisciplinary home-based services was more likely to maintain CI scores at follow-up. Hashimoto et al.’s study also demonstrated the effectiveness of a day-
treatment program using a multidisciplinary team approach. The social integration scale score and productive activity scale score were significantly greater for participants.

With respect to cognitive rehabilitation interventions, Cicerone et al.’s (2004) intensive cognitive rehabilitation program was more effective in improving CI than were standard neurorehabilitation programs. Constantinidou et al.’s (2005) categorization training, a unique approach in cognitive rehabilitation that can be conducted by occupational therapists, produced a significant improvement in the level of CI. A comprehensive integrated program using many occupational therapy approaches improved vocational outcomes and social participation (High et al., 2006).

Not all the studies, however, yielded positive results. Paniak et al.’s (1998, 2000) intervention, which had more intensive assessments, education, and treatment as needed, failed to show any improvement in CI when compared with a control group. Tiersky et al.’s (2005) cognitive rehabilitation program, which used individual cognitive-behavioral psychotherapy and cognitive remediation, did not affect CI scores. A scheduled telephone intervention designed by Bell et al. (2005) also did not have significant positive CI effects.

Concerning injury severity, studies on the mild TBI population (Paniak et al., 1998; Tiersky et al., 2005) showed no CI improvements. These 2 studies also showed little change in mean CIQ scores (−0.52 and 0.29, respectively). In comparison, the other 8 studies had mean change scores ranging from 1.81 to 5.2. Our review found that patients with mild TBI were not likely to benefit significantly from post–acute TBI CI rehabilitation. As mentioned in Paniak et al.’s study, many participants had already returned to the workplace after being discharged from acute care hospitals. One could assume that the mild TBI patients already had higher CIQ scores and that it was not the most relevant outcome for this population. Most studies on moderate and severe TBI, however, found greater scores in treatment groups.

Although these studies showed little to no improvement in CI scores, positive changes were observed in other areas, such as functional status and cognitive or psychological outcomes (Bell et al., 2005; Paniak et al., 1998; Tiersky et al., 2005). Statements made about the effectiveness of CI without reference to other outcomes, therefore, require careful interpretation. In addition, the follow-up period studied may not capture CI as the longer term goal of some interventions.

Because the intervention studies differed significantly on treatment and outcomes, a quantitative analysis (i.e., a meta-analysis) was not possible. The lack of consistent treatment interventions and treatment goals and the inability to conduct a meta-analysis reflects the broad scope and nonspecific nature of TBI rehabilitation research. As a result, we are limited to general statements about the effectiveness of any intervention.

Within the scope of our review, occupational therapists participated in six CI programs for TBI as rehabilitation team members (Cicerone et al., 2004; Goranson et al., 2003; Hashimoto et al., 2006; High et al., 2006; Powell et al., 2002; Willer et al., 1999). All of these programs showed significant CI improvements. This finding indicates that rehabilitation teams that include occupational therapists are critical in promoting CI; however, it is difficult to assess the occupational therapists’ precise influence within rehabilitation teams.

**Limitations of This Review**

Our systematic review includes relatively high-quality studies. Not many RCTs are reviewed in CI studies, so to pool the data we broadened our inclusion criteria to cover high-quality observational studies. Many systematic review articles, even in the Cochrane Library, allow non-RCT studies when synthesizing findings. Checklists and scales have been developed to assess RCT and non-RCT evidence levels. We should also note that the systematic literature approach in relation to CI has been criticized. Some experts feel that an RCT may not be the optimal design by which to study successful CI. Greater weighting of high-quality controlled studies, for instance, would have resulted in stronger statements about CI effectiveness. Although we acknowledge this perspective, the RCTs in our review have produced interesting and useful findings.

Gray literature, such as dissertations and non–peer-reviewed papers, are not mandated sources of information and thus are often not included in systematic reviews. We acknowledge, however, that they might be explored in future reviews, and we are aware of publication bias in the inclusion of only peer-reviewed published studies.

We also recognize the potential overlap of interventions described in the studies. Many multidisciplinary interventions use combinations of cognitive rehabilitation programs. The rigid categorizations used in our review may be limiting, but they were created to help readers better understand the interventions’ characteristics. Otherwise, these categories do not need to be organized as strictly as we have done.

Some of the studies, mostly RCTs, did not focus on or aim to improve CI and may have treated it only as a global outcome measure, similar to the Disability Rating or the Glasgow Outcome Scale. Concerns also exist regarding
the CIQ’s quality. Some researchers have argued that because of the high probability of the ceiling effect, it is best not to use it in rehabilitation studies.

The studies included people with mild TBI. Research has shown that patients with mild TBI have diverse outcomes and require outcome measures different from those used with more severe injuries. Nonrobust findings also could be the result of the variability among TBI patients; depending on the brain area affected, great differences can be found in patients’ functional deficits. These differences may have reduced the beneficial CI effects observed after intervention for patients with moderate to severe brain injury (Barrett, Levy, & Gonzalez Rothi, 2007).

Conclusions

Systematic reviews allow health care professionals, clients, researchers, and policymakers to make decisions on the basis of all the available evidence, which has also encouraged advances in rehabilitation (Law & Philip, 2002). To our knowledge, our study is the first of its kind that uses a rigorous, detailed approach to focus exclusively on intervention studies assessing CI outcomes in a post–acute TBI adult population. The promising effects of programs designed by Powell et al. (2002), Goranson et al. (2003), Willer et al. (1999), Hashimoto et al. (2006), Cicerone et al. (2004), Constantinidou et al. (2005), and High et al. (2006) could be considered in future decision making and discharge planning in post–acute TBI services for adult TBI clients to enhance community integration. ▲

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References


