3. Efficacy and Models of Care Following an Acquired Brain Injury

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Figure 1: A schematic depiction of the progression of ABI management
Key Points

Care in a Level I trauma center may result in better outcomes compared to a Level II center.

Staff with more dedicated commitment to trauma care may lead to improved patient outcomes.

Reducing the time spent in acute care and rehabilitation does not have a negative effect on patient outcomes, although it can place a greater burden on the family and outpatient rehab services.

Adherence to BTF acute care guidelines may result in improved patient outcomes and decreased mortality.

Level of injury impacts the overall cost of care.

Inpatient rehabilitation improves self-care and mobility and significantly improves functional outcome, social cognition and return to work in patients with TBI and non-TBI.

Readmission to inpatient rehabilitation at more than twelve months post injury is related to statistically significant improvement.

Increasing rehabilitation intensity reduces length of stay.

High-intensity rehabilitation is associated with improved outcomes at discharge and at two and three months post-injury.

Multidisciplinary inpatient rehabilitation may be more effective than a single discipline approach.

Therapy intensity may predict motor functioning at discharge.

Early rehabilitation is associated with better outcomes.

Rehabilitation results in a higher rate of change on functional measures in younger patients than in older patients.

Transitional living setting during the last weeks of inpatient rehabilitation is associated with greater independence than inpatient rehabilitation alone.
A fitness-center based program is not better than a home-based program for improving cardio-respiratory fitness.

Varied outpatient therapy can be used to improve varied targeted outcomes.

Multidisciplinary outpatient rehabilitation may improve functional outcomes up to one year post discharge.

Neurobehavioural or neurorehabilitative programs improve behavioural and cognitive functioning post ABI.

Community-based programs for ABI patients are associated with greater independence, higher social activity levels, and less need for care support when they can be sustained for at least six months.

Participants with a dual-diagnosis of TBI and substance abuse generally do not become chemical-free.

When direct patient involvement in goal setting is employed there is a significant improvement in achieving patients’ goals.

Community-based programs for ABI patients may reduce impaired self-awareness and distress and improve societal participation.

There remains a need to provide ongoing out patient or community care and rehabilitation years post injury.

Vocational rehabilitation results in greater total taxpayer benefits than either total program operational costs or government costs.

Participants in vocational rehabilitation often have fair or good adjusted outcome, while more than half become gainfully employed or full-time students.

Individuals with significant cognitive impairments benefit the most from vocational rehabilitation services.

Supported employment results in patients being competitively employed more often than if they had not received supported employment.
Support groups generate such positive results as diminished feelings of hopelessness, improved coping with depression, and better psychosocial functioning.

There is insufficient evidence to draw any conclusions regarding the ideal structure of a complete model of ABI care.
3. Efficacy and Models of Care Following an Acquired Brain Injury

3.1 Introduction
Acquired brain injury presents unique challenges that make rehabilitation difficult to standardize. The development of best-practice principles has been hindered by limited access to adequate sample sizes and appropriate comparison groups in ABI patients within a clinical, rehabilitation environment (National Institute of Health 1998). As a result, a consensus on optimal models of care for brain injured patients has been elusive.

In October of 2007, a workshop was held by the National Institute of Neurological Disorders and Stroke (NINDS) to develop a classification system for Traumatic Brain Injury (TBI) designed to direct therapeutic interventions (Saatman et al., 2008). Traditional classification systems have been problematic given the diversity of brain injury needs. This international group of experts emphasized that we have merely begun to scratch the surface in understanding brain injury care. Nevertheless, a model of the pathway that patients should follow has evolved.

Generally, patients with an ABI receive pre-hospital care, acute care (with neurosurgical intervention if necessary), ICU management, inpatient rehabilitation, and are then discharged to the community with varying levels of support (Khan et al., 2002) (Figure 1). Additional components of this pathway may include cognitive and behaviour rehabilitation programs, community living opportunities, rehabilitation services in the home, and care management and prevention initiatives (Zygun et al., 2005). Despite effective triage programs, best-evidence-based protocols and progress in the management of secondary complications of severe TBI, significant regional differences in practice continue to exist (Zygun et al., 2005). In this chapter we hope to highlight the ways in which the various components along the continuum are being implemented. Our goal is to provide a snapshot of how the challenge of ABI care is being both here in Canada and worldwide.

Figure 1: A schematic depiction of the progression of ABI management.
Internationally, rehabilitation care of brain injured patients is extremely diverse. Care is dictated by local health care policy, local culture and resource availability. This in turn has made development of internationally applicable systems challenging. In 1965, the World Federation of Neurosurgical Societies formed an “ad hoc” Committee on Head Injuries which was followed by the formation of the Committee of Neuro-traumatology in 1977 (Teasdale et al., 1997). This provided one of the first published international discussions of brain trauma care. The formation of the International Brain Injury Association (1993) and the International Association for the Study of Brain Injury (1998) continued to expand opportunities for the sharing of information (IBIA, 2008). In 1995, the Brain Trauma Foundation developed the first Guidelines for the Management of Severe Traumatic Brain Injury which has since been revised in 2000 and 2007 (Carney and Ghajar 2007). These guidelines are maintained in conjunction with the American Association of Neurological Surgeons and the Congress of Neurological Surgeons and other stakeholders such as the European Brain Injury Consortium. Since their inception, countries as diverse as Italy, Mexico, Ireland, and Japan have adapted Brain Trauma Foundation guidelines to suit local needs (Citerio et al., 2003; Matta and Menon 1996; Espinosa-Aguilar et al., 2008; Shigemori and Tokutomi 2002). The WHO has also expanded its focus to assess the need for effective global rehabilitation programs. It has estimated that although over 80% of the world’s people with disabilities live in low to middle income countries (LMIC), only 2% have access to rehabilitation services (Hyder et al., 2007). This is especially disturbing when we consider that the highest rates of TBI due to road traffic incidents (RTIs) are in the Latin American and Caribbean regions with rates in Sub Saharan Africa not far behind (Hyder et al., 2007).

One of the most comprehensive national Brain Injury systems has evolved in the US. In 1978 the National Institute on Disability and Health Research (NIDHR, now the National Institute on Disability and Rehabilitation Research) provided funding to New York University’s Rusk Center and the Santa Clara Valley Medical Center (San Jose, California) to develop a model of dedicated, interdisciplinary, acute inpatient rehabilitation coupled with post-acute rehabilitation intervention and cognitive and behavioral approaches (Cope et al., 2005). By August 2004, ABI care in the USA included 123 accredited hospitals, 9 skilled nursing facilities (acute inpatient rehabilitation), 153 outpatient programs, 51 home and community programs, 212 long-term residential programs, 231 residential programs and 86 vocational programs (Cope et al., 2005). While there is no one body which oversees brain injury rehabilitation specifically, several organizations have developed to attempt to improve the cohesion of the system. Some of the more influential organizations include the Brain Injury Association of America which was established in 1980 and currently works with 40 state run Brain Injury affiliates (BIAA, 2008) to provide community services to brain-injured individuals. The National Association of State Head Injury Administrators developed in 1990 as a forum to provide information to State governments and policy makers regarding brain injury (NASHIA, 2008) while the Center for Disease Control collects epidemiological information and sponsors research through the Public Health Injury Surveillance and
Prevention Program (CDC, 2008). The Traumatic Brain Injury Model Systems of Care was developed in 1997 as a prospective, longitudinal multi-center study to assess rehabilitation of patients through a coordinated system of acute care and inpatient rehabilitation with a 15 year long term follow-up (TBINDSC, 2008). Although these four organizations and others like them, work together to provide guidance regarding brain injury care, ultimate decisions are still left to individual institutions and their clinicians, resulting in regional differences in care.

In Canada, brain injury rehabilitation has steadily developed in a way similar to the American system. During the 1980’s and 90’s Brain Injury rehabilitation evolved as a specialization of rehabilitation medicine. However, in Canada there are still no national standards of care (Cullen, 2007). Rehabilitation hospitals work within provincial health care systems and as a result some provinces, particularly the more scarcely populated ones, have more limited ABI rehabilitation. Moreover, within provinces there is often a disparity in services between larger urban centers and smaller rural areas. While access to care is universally available, private services can be utilized by those with private funding (Cullen, 2007). In 2003, the Brain Injury Association of Canada was established to provide a national forum for sharing brain injury information. Currently, only Prince Edward Island and the territories lack provincial/territorial level brain injury associations (BIAC, 2008). In an attempt to standardize care, Accreditation Canada, a not-for-profit organization, assesses health care institutions in Canada for quality of care and now specifically includes brain injury services (AC, 2008). The Canadian Institute for Health Information (CIHI) was established by National, Provincial and Territorial governments to collect and disseminate health information including information regarding rehabilitation facilities. Rehabilitation information is drawn from all Ontario centers as well as 17 national facilities (CIHI 2007). A separate database has also been established at the Toronto Rehabilitation Institute, which is modeled after the American Model systems. The Canadian database was expanded in 2002 to uniquely include individuals with non-traumatic brain injuries as well, which differs from the American system (Cullen, 2007).

Europe presents some unique cultural and political challenges in brain injury. The European Brain Injury Society was formed in 1989 (EBIC, 2008) and now has 152 institutional members from all nations in the European Union as well as Switzerland. The European Brain Injury Consortium (EBIC) was formed in 1994. “This reflected the realization that numbers of patients required in the design of definitive Phase III studies of severe head injury demanded European-wide recruitment” (Teasdale et al., 1997). While nations were encouraged to continue to develop their own strategies, value was placed on international collaboration. In 1997 the EBIC developed guidelines for management of severe head injury in adults to attempt to provide some clarity and standardization in brain injury care (Maas et al., 1997). With similar collaborative goals, the European Brain Council was formed in 2002 in Brussels to attempt to coordinate research in the area of brain disease, including brain injury (EBC, 2008). Despite these
attempts at standardization, national models of ABI care are still dictated by regional health care policies.

With this global perspective in mind, we chose to construct this chapter as a broad analysis of the over-riding systems of care in ABI management. Background information was drawn from the grey literature and peer reviewed articles. Papers were considered for analysis if they focused on a generalized system of care and were published in a recognized peer reviewed journal. Since our aim is to compare systems of rehabilitation and not rehabilitation itself, only papers that compare at least two distinct rehabilitation groups were included. These could include separate hospitals, separate treatment groups within one center or comparisons between patients in the same center before and after systemic changes. Papers were then subdivided into two groups: those which included an empirical, objective analysis of an outcome related to a system of care and those that provide a descriptive comparison of a component of their system. Separate tables (Individual Studies and Additional Studies respectively) were devised for each group. In order to facilitate discussion surrounding models of care, we chose to broaden our inclusion criteria to accept studies that would not have otherwise been included. Examples include descriptive papers with no statistical analysis, surveys, chart reviews, and papers related to demographic characteristics associated with models of care. All of these studies have been included in the Additional Studies tables but were not scored.

3.2 Acute Management

The most severe consequences of an acquired brain injury are often not due to the initial trauma itself. Secondary brain injury can result in edema, ischemia, elevated intracranial pressure and inadequate cerebral perfusion pressure as well as a cellular cascade resulting in calcium imbalances, excitatory amino acid release and free radical production; all of which can lead to cell death (Zasler et al., 2007). For this reason, the speed and intensity with which patients are cared for is of the utmost importance. Assessments of how to acutely treat ABI patients generally fall into one of four categories; pre-hospital care, hospital facility type, adherence to acute care guidelines, and discharge destination. Each of these areas presents a unique challenge. Chapter 16 of this systematic review reports the current evidence for acute treatment of ABI. Here
we have attempted to highlight concerns and elucidate attempts being made to improve the current system of care.

Pre-hospital care can be the difference between life and death. Concerns regarding the time to intervention are perhaps the most obvious component of pre-hospital care but debate has also arisen regarding the types of treatments that are suitable prior to hospital arrival. In 2000, the Brain Trauma Foundation released guidelines for pre-hospital management of brain injured patients. An Emergency Medical Service task force developed a consensus based algorithm (Gabriel et al., 2002). Nevertheless, Bulger et al. (2007) writes “the variability in the out of hospital treatment of patients after traumatic injury in the United States is unknown.” Similarly, this is the case in other countries that have begun to examine protocols for out-of-hospital care (Baethmann et al., 1999; Harrington et al., 2005). Research has been conducted regarding the efficiency of transfer and access to trauma centers in general (Bugler et al., 2007) but little to no research has been performed relative to Brain Injury and related sequelae specifically.

Facility type is also of prime interest relative to the specific needs of the patient. Trauma care facilities have proven to be superior to general care facilities for emergency medical care. MacKenzie et al. (2007) noted patients with an abbreviated injury score (AIS) ≥ 3 to the head showed a 90% survival rate at 12 month follow up in trauma centers compared to only 64.3% in non-trauma centers. However, the availability of trauma centers tends to be dictated by local needs and resources. In the absence of such a facility, local centers must be able to handle ABI effectively and transport them when necessary to a properly equipped center.

Guidelines have been established by organizations such as the Brain Trauma Foundation (BTF) and the EBIC to try to develop standardization of treatment and to aid in the dissemination of information. Audits of guideline implementation can help to ensure that a proper level of care is provided in all types of medical centers. In the US alone, it is estimated that a modest improvement to 50% adherence of BTF guidelines from 33% would result in 989 lives saved annually (Faul et al., 2007).

The final stage of acute care involves the transition to post-acute care. Once patients are medically stable they are transferred to one of three places: home, long term care or a rehabilitation unit. Rehabilitation units for ABI patients can consist of hospital-based inpatient rehabilitation centers or specialized rehabilitation units that often focus on behavioral issues. How and by whom this decision is made may greatly affect the type of care that is received by patients. Several factors, such as availability of rehabilitation spaces, the patient’s support needs and the patient’s financial situation may play a role in this decision. In the US, Medicaid patients were 68% and HMO patients were 23% more likely to be discharged to a skilled nursing facility than those on a fee-for-service plan (Chan et al. 2001). In Canada, patients injured in a motor vehicle accident were 1.6 times more likely to be discharged home with support services than those who were
injured in a fall (Kim et al., 2006), likely due to the greater availability of resources accompanying the former injury.

**Individual Studies**

### Table 3.1 Individual Studies of Models for Acute ABI Management

<table>
<thead>
<tr>
<th>Author/Year/Country/Study Design/</th>
<th>Methodology</th>
<th>Outcome</th>
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<tbody>
<tr>
<td>DuBose et al., (2008) USA Retrospective Cohort</td>
<td>N=16,037 Data from trauma patients with a head abbreviated injury score (AIS) ≥ 3 and no AIS ≥ 3 for any other body part was reviewed to compare outcomes between patients managed in level I and level II trauma centers. Groups were compared for mortality, complication rates, and progression of neurologic insult.</td>
<td>After adjustments for patient differences, those managed in a level 2 trauma center had increased mortality (OR 1.57, 95% CI 1.41-1.75), complications (OR 1.55, 95% CI 1.40-1.71) and greater likelihood of progression of neurologic insult (OR 1.78, 95% CI 1.37-2.31).</td>
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<td>Mains et al., (2009) USA Cohort</td>
<td>N=15,297 Patient outcomes were evaluated at a single facility over three periods of time corresponding to different trauma service staff coverage. Group 1: in-house general surgery residents and attendings, Group 2: core trauma panel with in-house trauma surgeons and Group 3: core trauma panel plus physicians assistants. Mortality, ICU LOS, and hospital LOS were compared.</td>
<td>The presence of in-house trauma surgeons decreased overall mortality (3.12% vs. 3.82%, p=0.05), mortality in the severely injured (11.41% vs. 14.83%, p=0.02) and median (but not mean) ICU LOS (3.03 days vs. 3.40 days, p=0.006). The introduction of PAs decreased overall mortality (2.8% vs. 3.76%, p=0.05) and reduced mean and median hospital LOS (4.32 vs. 4.69, p=0.05 and 3.74 vs. 3.88, p=0.02 days respectively).</td>
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<td>Harris et al., (2008) USA &amp; Jamaica Prospective Cohort</td>
<td>N=1607 Data from one trauma centre in the USA was compared to that from two Jamaican centers to identify differences between trauma care in the developed world and developing. Patient care was compared using medical intervention use, mortality, GOS, and FIM scores.</td>
<td>Patients cared for in the USA had more severe head injuries, received more CT scans (p&lt;0.0001), and were more likely to be admitted to the ICU (p&lt;0.0001). Patients in the USA were more likely to receive ICP monitoring (91 patients vs. 7). There were no statistically different differences in mortality rates between the three sites except severe patients cared for in the USA had a decreased risk of mortality (OR 0.47, p=0.04). Patients cared for in the USA had lower mean GOS scores (p&lt;0.0001) and lower FIM scores for self-feed (p=0.0003), locomotion (p=0.04), and verbal (p&lt;0.0001).</td>
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<td>Jones et al., (2008) Scotland, UK</td>
<td>N=76 Patient data was retrospectively dichotomized around the implementation of the Scottish Intercollegiate Guidelines Network (SIGN) guidelines for pediatric head injury were released,</td>
<td>After the Scottish Intercollegiate Guidelines Network (SIGN) guidelines for pediatric head injury were released,</td>
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<tr>
<td>Study</td>
<td>Design</td>
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<tr>
<td>Hawkins et al., (2005)</td>
<td>Prospective Cohort</td>
<td>115</td>
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<tr>
<td>Fakhry et al., (2004)</td>
<td>USA Retrospective Cohort</td>
<td>830</td>
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<tr>
<td>McGarry et al., (2002)</td>
<td>Retrospective Cohort</td>
<td>8,717</td>
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<tr>
<td>Bulger et al., (2002)</td>
<td>USA Retrospective Cohort</td>
<td>182</td>
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osmotic agents, hyperventilation and CT utilization by BTF guideline standards. Centers were then divided into aggressive and non-aggressive groups determined by whether or not they used ICP monitors more than 50% of the time. Mortality, functional status at discharge and length of stay were used as outcomes measures.

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<tr>
<th>Palmer et al. (2001)</th>
<th>USA</th>
<th>Pre-Post</th>
<th>N=93 Severe ABI patients (GCS 3-8) treated before AANS guideline implementation were compared with patients treated post implementation. Outcome measures included 6 month GOS scores and cost of care.</th>
<th>Guideline implementation resulted in a 9.13 times higher odds ratio of good outcome relative to the odds of poor outcome or death pre-implementation. Hospital charges increased by $97,000 per patient.</th>
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<tr>
<td>Goodacre, (2008)</td>
<td>UK</td>
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<td>Admission rates for head injury were assessed before and after implementation of the NICE head injury guidelines.</td>
<td>Admission rates increased for all adult age groups after guidelines were issued. Length of stay remained constant resulting in more patient bed days.</td>
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<td>Palchuk et al.,</td>
<td>USA</td>
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<td>Children with blunt head trauma were managed by Emergency Department physicians who documented suspicion of TBI before CT. Suspicions were compared retrospectively to a decision rule for accuracy in predicting the presence of TBI as measured by CT.</td>
<td>The decision rule had a sensitivity of 98.9% compared to versus 94.4% for clinician judgment. The decision rule had a specificity of 26.7% vs. 30.5% for clinician judgment. The decision rule would have resulted in 289 fewer CT scans but would have missed one TBI.</td>
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<td>Heskestad et al.,</td>
<td>Norway</td>
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<td>Physician compliance with guidelines was evaluated for the assessment and treatment of patients who presented to the Emergency Department. Patient treatment was classified as compliant or not based on the use of CT and hospital admission. Majority of patients data was collected from the charts of mild TBI patients.</td>
<td>Overall physician compliance was 51%. Over triage of CT examinations and hospital admissions was seen in patients with minimal and mild injuries. All patients with moderate head injuries were treated according to guideline recommendations.</td>
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<td>Myburgh et al.,</td>
<td>Australia/NZ</td>
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<td>Six hundred and thirty five patients from 16 centers were recruited prospectively and assessed for pre-hospital intervention, secondary insults, surgical and ICU management and outcome at 12 months. Outcomes were compared with3 international studies prior to the 1996 AANS guideline inception.</td>
<td>Although concordance with guideline management was generally seen, mortality and favorable neurological outcomes were similar to those seen before the advent of guidelines.</td>
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<td>Reference</td>
<td>Methodology</td>
<td>Findings</td>
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<td>Hesdorffer &amp; Ghajar (2007) USA</td>
<td>A web-based survey of 413 designated trauma centers was performed and compared to a similar survey done in 2000.</td>
<td>Level I trauma centers were more likely to have a specialized ICU for care of TBI patients (p&lt;0.0001). Level I centers were significantly more likely to adhere to guideline standards. Between 2000 and 2006, lack of guideline adherence fell from 67% to 34.5%, partial guideline adherence rose from 17% to 44.7% and full guideline adherence rose from 16% to 20.8% (p&lt;0.0001).</td>
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<td>Rusnak et al., (2007) Austria</td>
<td>A retrospective analysis of the adherence to BTF guidelines in 5 Austrian hospitals. A scoring system was developed to assess guideline usage.</td>
<td>The guideline on ICP treatment threshold was the most closely followed (89%) with pre-hospital resuscitation (84%) and early resuscitation (79%) close behind. The CPP threshold was the most poorly adhered to (30%). Only the scores on resuscitation of blood pressure and oxygenation, and CPP were significantly positively correlated with ICU survival. Overall, adherence to guidelines is predicted to result in an increase in ICU days but a decrease in LOS.</td>
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<td>Kim et al., (2006) Canada</td>
<td>Patients charts were retrospectively reviewed comparing two groups, those suffering motor vehicle accidents (MVA) and those whose injury was the result of a fall.</td>
<td>Patients in the MVA group had significantly longer lengths of stay and were significantly more likely to be discharged home with support services. They also note that age, type of injury and lengths of stay were significantly associated with discharge destination.</td>
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<td>Esselman et al., (2004) USA</td>
<td>A cohort study of 1807 TBI patients in the US examining discharge disposition of patients suffering violent and non-violent brain injuries.</td>
<td>After adjusting for injury severity and demographics, they found no bias against violently injured patients regarding access to inpatient rehabilitation. Violently injured patients were more likely to be discharged home than to inpatient rehabilitation and more likely to be referred to inpatient rehabilitation than to a skilled nursing facility.</td>
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<td>Citerio et al., (2003) Italy</td>
<td>Eighteen Italian neurosurgical hospitals participated in a prospective data collection project in the last quarter of 1997 to assess BTF guideline adherence.</td>
<td>Interesting findings included steroid use without indication 10% of the time and mannitol administration 13% of the time without clear indications for its use.</td>
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<td>Shigemori and Takutomi (2002) Japan</td>
<td>A nationwide survey of TBI management conducted by questionnaire.</td>
<td>Answers provided by more than 2/3 of respondents were: less than 20 patients in hospital/year (78%); routine monitoring of CT scan (99%), SjO₂ (77%), and brain temperature (68%); routine use of mannitol and glycerol (84%) and</td>
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<tr>
<td>Study Authors and Year</td>
<td>Study Design and Setting</td>
<td>Key Findings</td>
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<tr>
<td>Chan et al., 2001 USA</td>
<td>A retrospective cohort study of moderate to severe TBI patients enrolled in the Harborview Trauma Registry between 1992 and 1997. Charts were assessed for discharge destination and insurance type.</td>
<td>Medicaid patients were 68% and HMO patients 23% more likely to go to a skilled nursing facility than those with fee-for-service plans after adjusting for confounders.</td>
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<td>Foster et al., 2000 Australia</td>
<td>A retrospective analysis of TBI patient in two Australian centers; one regional hospital with on-site non-TBI rehabilitation and one metropolitan hospital with an on-site brain injury specific rehabilitation unit.</td>
<td>Referral to an inpatient rehabilitation unit was significantly predicted by age and place of treatment. Those who were younger and treated at the metropolitan acute care center were more likely to receive a referral to an inpatient rehabilitation facility compared to non-inpatient rehabilitation or no rehabilitation.</td>
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<td>Baethmann et al., 1999 Germany</td>
<td>A prospective analysis of the current state of preclinical care and early clinical management of TBI in 14 medical centers in rural and urban Germany. Helicopters were used as the rescue vehicle in the majority of cases.</td>
<td>In 75% of cases, the rescue team arrived at the accident in less than 11 min from dispatch center alarm, intubation was made in less than 37 min, admission to hospital was less than 74 min, the cranial CT was performed in less than 120 min and acute clinical procedures were concluded within 3.6 hrs.</td>
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<td>Matta et al., 1996 UK and Ireland</td>
<td>A questionnaire survey was completed by 35 neurosurgical referral units.</td>
<td>Patients were managed in a specialized neurosurgical ICU 66% of the time. ICU’s were coordinated by anesthesiologists 66% of the time and by neurosurgeons 23%. The mean number of beds per unit was 7.9 with a 1:1 nurse to bed ratio and 5.5 nurses per bed.</td>
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<td>Ghajar et al., 1995 USA</td>
<td>A survey of critical care management of head injured patients conducted via telephone.</td>
<td>Two hundred sixty one centers responded (94%) of which 84% (219) stated that they provided care for severely head injured patients. Thirty four percent had designated neurosurgical/neurologic units but only 24% were under the direction of a neurosurgeon or neurologist. Fifteen percent received fewer than 15 patients per month while 46% received 4-14 patients/month. ICP monitoring was employed greater than 75% of the time in only 77 of the 219 centers. Level I trauma centers monitored ICP more frequently than level II or III centers.</td>
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**Discussion**
Our search identified nine studies that empirically compared outcomes related to different acute care strategies. Three papers assessed the implementation of BTF guidelines in acute care practice (Bulger et al., 2002; Fakhry et al., 2004; Palmer et al., 2001), one assessed implementation of SIGN guidelines (Jones et al., 2008), two assessed facility structure (Mains et al., 2009; DuBose et al., 2008), one compared outcomes between centers in developed and developing countries (Harris et al., 2008), one looked at the outcomes of 2 groups patients each treated in an acute care facility then transferred to rehabilitation but for different lengths of time (Hawkins et al., 2005), and one looked at the treatment received and cost of care for TBI patients over a 2 year period (McGarry et al., 2002).

Fakhry et al. (2004) undertook a pre-post design to evaluate the benefits of BTF guideline implementation. Patients treated under guideline conditions showed improvements in Glasgow Outcome Scale score, length of stay, cost per patient and mortality rates. The use of a non-TBI control group adds credibility to these results. Similarly, Palmer et al. (2001) also performed a pre-post analysis of BTF guideline implementation. Patients in this study showed a 9.13 times greater odds ratio in favor of “good outcome” in 6 month GOS scores. The authors noted that there was a $97,000 increase in acute care costs associated with guideline care, which they claim was justifiable in light of the improved outcomes.

Bulger et al. (2002) identified ICP management as an indicator of the aggressiveness of acute care management. Centers adhering to an “aggressive” protocol were significantly more likely to administer ICP monitoring (p<0.001), provide neurosurgical consultation (p=0.001), use osmotic agents (p<0.001) and perform head CT scans (p<0.001). While these centers reported decreased mortality rates, the division was arbitrary and further study into potential confounding factors is necessary. In a similar study conducted in the UK, patient outcomes were compared after implementation of the SIGN guidelines for head injury management in 2000. Jones et al. (2008) reported that after 2000, fewer patients made full recoveries (GOS 5) and more incidences of CCP insult were recorded. They also noted significantly more children being referred from tertiary care centers and fewer from Emergency Departments.

One study looked that the outcomes and costs associated with care for those who had sustained a moderate or severe TBI (McGarry et al., 2002). As one might expect higher costs for care were associated with severity of injury, with costs being much higher for those who had sustained a severe TBI ($8,187 to $50,438). Of those included in the study, 80% had had a MRI or CT scan; nearly one third were on ventilators; and another two-thirds were treated in an intensive care unit. Mortality rates were also higher for those who had sustained a severe TBI.

In two studies evaluating facility structure, DuBose et al. (2008) evaluated hospital designation and Mains et al. (2009) assessed trauma team composition. DuBose et al.
(2008) reported that patients cared for in a Level I trauma centre showed decreased mortality rates, fewer complications, and were less likely to experience progression of neurological insult relative to patients care in a Level II trauma centre. These results were maintained even after adjusting for patient severity. They also noted that other independent risk factors for mortality were penetrating mechanism, age >55 years, ISS ≥ 20, GCS ≤ 8, and hypotension (SBP <90 mmHg). Mains et al. (2009) evaluated patient outcomes during three timeframes corresponding to systemic changes in a level I trauma center. During time 1, the ward was staffed by in-house general surgery residents and attendings. During time two, a core trauma panel was established so that the ward was staffed by in-house trauma surgeons, which remained during time three except for the addition of physician’s assistants. Patients managed during time two showed decreased mortality and median ICU LOS. Patients care for during time three saw further reductions in overall mortality and mean and median hospital LOS. The authors suggest that staff commitment to trauma care may play a role in improving patient outcomes.

Hawkins et al. (2005), looked at outcomes of two groups of patients. The first group (Group 1) underwent hospital care for a total of 82 days (36 days in acute care and 46 days undergoing rehabilitation), while the second group (Group 2) remained in hospital for a total of 51 days (26 days in acute care followed by 25 days in rehab). At time of discharge from acute care, FIM scores between the two groups were found to be different (51-Group 1 and 57-Group 2) but not significantly so. Patients in Group 1 did require more physical assistance and had significantly lower scores on the communication and social cognition subscales of the FIM then those in Group 2. When looking at FIM scores of those with GCS </=8 (n=39-Group1 and n=32-group2), those in Group 1 were found to be more independent in mobility and locomotion then Group 2 at time of discharge from rehabilitation. At the one year follow-up FIM scores between the two groups showed no significant differences overall nor were there differences on the scores of the subcomponents of the scale. Shorter lengths of stay in hospital did not adversely affect functional outcomes of patients. Age rather than GCS seemed to play a strong role in predicting who returned to work, with those in the youngest category (<30 years) returning to work faster. Overall 25% of patients were able to return to work. The reduced length of stay in hospital placed greater demands outpatient rehabilitation services and family members or primary care givers.

In the only other study that evaluated patient outcomes, Harris et al. (2008) compared outcomes of patients treated in a Level I trauma center in the United States to those of patients cared for in two Jamaican hospitals. Interventions provided to patients were significantly different between countries. Patients cared for in the USA received more CT scans, were more likely to be admitted to an ICU and were more likely to undergo ICP monitoring. Although overall mortality was the same between countries, patients who were severely injured were more likely to survive in the USA. Interestingly, patients cared for in Jamaica showed greater improvements in both GOS and selected FIM
outcomes. The authors suggest that the clinical significance of these findings are unknown and that further research is necessary.

The remainder of the studies identified provided descriptive observations of acute care management in diverse settings. Their observations can be summarized within the four groups identified earlier; pre-hospital care, hospital facility type, guideline adherence and discharge destination.

Three of the studies identified made reference to pre-hospital care of ABI patients (Baethmann et al., 1999; Citerio et al., 2003; Myburgh et al., 2008). Baethmann et al. (1999) was the only study to specifically focus on pre-hospital and early hospital care. They used medical students as observers during primarily helicopter rescues of suspected brain injured patients. In 75% of cases, the rescue team arrived at the accident scene in less than 11 minutes after dispatch center alarm; intubation was made within 37 min; admission to the hospital was within 74 min; and the CT scan was completed within 120 min. The use of helicopter rescue with an on-board emergency physician made transfers more efficient as well as referrals to neurotrauma centers more accurate. Citerio et al. (2003) found patients admitted directly from the accident site to a neurotrauma center in Italy took 79±149 min to reach the first emergency room. Those patients not admitted directly to a neurotrauma center only took 59±137 min to reach the first emergency room but averaged 300±254 min before reaching the neurotrauma center. Myburgh et al. (2008) showed variation in vital sign documentation in Australia. The mean time to admission at the first hospital was 63±58.4 min and 56.4% of these patients were admitted directly to a tertiary trauma center. No papers compared differences between groups, so no comparison of pre-hospital strategy can be made.

None of the papers further evaluated outcomes of patients admitted to trauma centers compared to non-trauma centers but many made comments regarding facility type. Patients were cared for in trauma centers or neurosurgical units in 66% (Matta & Menon, 1996) and 62% of cases (Shigemori & Tokutomi, 2002) in the UK and Japan respectively. Some key differences between neurotrauma units relative to general wards were coordination by a neurosurgeon or neurologist, presence of a specialized ICU unit for TBI patients and higher guideline adherence rates. Future study into the efficacy of neurotrauma centers relative to ABI patient outcomes is warranted.

Guideline adherence was the most highly analyzed component of acute ABI care. Most of the papers identified guideline adherence as an acute care goal. In addition to the Fakhry et al. (2004) and Bulger et al. (2002) papers, some interesting comparisons were seen. In the survey by Rusnak et al. (2007) only adherence to the recommendations regarding BP, oxygenation resuscitation, and cerebral perfusion pressure maintenance were seen to be significantly related to ICU survival in Austria (Rusnak et al., 2007).
the USA, Level I centers were significantly more likely to adhere to most AANS guideline recommendations (Hesdorffer & Ghajar, 2007). One encouraging outcome of this adherence was the decreased use of contraindicated treatments such as corticosteroids. Goodacre (2008) reported that after implementation of the NICE guidelines in the UK, admission rates increased while LOS remained the same resulting in increased costs of care. In Norway, Heskestad (2008) reported that despite guideline development, over triage of CT scans and admissions were often seen in patients with minimal and mild injuries however, 100% compliance was seen in patients with moderate injuries. In a similar study, Palchak et al. (2009) retrospectively compared a decision rule for CT scans and admissions to physician suspicion of TBI. They noted that the decision rule was more sensitive and could have resulted in 289 fewer CT scans being performed. However, the physician’s suspicion was more specific. The decision rule would have missed one TBI in a child that was discharged home from the Emergency Department. More definitive studies linking guideline adherence to beneficial outcomes need to be performed to further compare their effectiveness.

The final stage of acute ABI is the discharge of medically stable patients. Discharge destination varies significantly based on regional differences. Factors such as the health care system, regional funding, rehabilitation facility availability, and the patient’s specific needs can all play a role in the final decision. We identified four articles with descriptions of discharge disposition. Chan et al. (2001) showed these US patients with Medicaid health insurance were significantly more likely to go to a skilled nursing facility than those who were covered by HMOs or fee-for-service plans. Esselman et al. (2004) analyzed discrepancies between US patients injured violently versus those who were non-violently injured. They saw no difference in referral rates to rehabilitation or skilled nursing facilities for violently injured patients relative to non-violently injured patients even though they were more likely to be funded by Medicaid. In Canada, universal health care is designed to allow for equal access to healthcare resources but there is variability based on different provincial health care plans and the availability of additional third-party insurance funding. Kim et al. (2006) found that relative to rehabilitation, this is not always the case. Patients injured in a motor vehicle accident were 1.6 times more likely to be discharged home without support services than those injured in falls with similar injuries. This suggests that insurance supplementation can influence resource access. Finally, Foster et al. (2000) found Australian patients who were younger and treated in a designated brain injury rehabilitation unit were more likely to be referred for inpatient rehabilitation.

Conclusions

There is Level 2 evidence that patients cared for in a Level I trauma center achieve better outcomes than patients cared for in a Level II center.
There is Level 2 evidence that staff with more dedicated commitment to trauma care leads to better patient outcomes.

There is Level 2 evidence suggesting that a reduction in the time spent in acute care and in a rehabilitation facility does not have a negative impact on overall patient outcomes.

There is Level 4 evidence indicating the overall cost of care is higher for those who sustain a severe TBI versus those who sustain a moderate TBI.

There is Level 4 evidence that adherence to BTF guidelines for acute care results in improved outcomes and decreased mortality.

Care in a Level I trauma center may result in better outcomes compared to a Level II center.

Staff with more dedicated commitment to trauma care may lead to improved patient outcomes.

Reducing the time spent in acute care and rehabilitation does not have a negative effect on patient outcomes, although it can place a greater burden on the family and outpatient rehab services.

Adherence to BTF acute care guidelines may result in improved patient outcomes and decreased mortality.

Level of injury impacts the total cost of care.

The rehabilitation of acquired brain injury (ABI) patients involves a comprehensive effort by several members of an interdisciplinary team including physicians, nurses, and occupational therapists. Considering the incidence and consequences of ABI, it is important to understand the effectiveness of rehabilitation. Efficacy, as measured by functional outcome, will be assessed in this chapter across the continuum, from inpatient rehabilitation to community interventions. The question, ‘does rehab work?’ will be addressed in this chapter.
3.3 Inpatient Rehabilitation

While many ABI victims are discharged directly home or to a long term care facility, many will benefit from discharge to a dedicated inpatient rehabilitation service. These services vary from institution to institution but generally include some type of intensive therapy program for physical, social, behavioral and cognitive difficulties. However, deciding who should receive inpatient rehabilitation remains a major challenge. Patient referral decisions are inherently complex and need to be understood as a dynamic phenomenon shaped by characteristics of the individual. However, they also rely on the interactions and interpretations of health professionals who operate within unique organizational and broader health care contexts (Foster and Tilse 2003). These discrepancies are confounded by social and funding issues. For example, in the US patients insured by Medicaid or an HMO were more likely to go to a skilled nursing facility rather than inpatient rehabilitation relative to people with commercial fee-for-service plans (Chan et al., 2001). In Canada, patients aged 36 – 45 with more co-morbid conditions are more likely to end up in rehabilitation than those older than 65, rural dwellers, non-English speaking people and people with mental health, alcohol and/or drug problems (Colantonio et al., 2004). The diversity of patient needs has also led to the formation of differing systems of rehabilitation. In Calgary, for instance, the Halvar Johnson Centre for brain injured patients has established a program to treat TBI and non-TBI patients in a slow stream rehabilitation program for individuals who may require slightly extended care. According to Cullen (2007) rehabilitation in Canada, on average, discharges 80% of patients home.

Due to the unique challenges posed by ABI, the structure of inpatient rehabilitation is extremely diverse. Patients are generally rehabilitated in one of two centers; a general rehabilitation unit or a coordinated multidisciplinary neurorehabilitation unit. Some argue that an effective rehabilitation service requires a multidisciplinary team, which includes nursing care, physician monitoring, psychologist and social work intervention, physiotherapists, occupational therapists, and speech language pathologists among other things (Cifu et al., 2003). In reality, differences in care often amount simply to the availability of neuro-rehabilitative beds and facilities. Limited resources mandate decisions regarding which patients will most benefit from inpatient rehabilitation compared to community-based programs.
Debate also exists about appropriate targets of rehabilitative care. Traditional rehabilitation models in other disciplines such as stroke, spinal cord, and polio have focused on orthopedic and neuromotor impairments (Cope et al., 2005). Brain Injury rehabilitation initially followed a similar path until focus on cognitive and behavioral remediation (Mazaux and Richer 1998) as well as coma stimulation (Cope et al., 2005) gained recognition. The greater emphasis on skill development in rehabilitation has not resolved the uncertainty regarding which patient groups are best suited to inpatient care versus community-based programs. Patients in need of skill application training are increasingly being discharged to community based services while inpatient rehabilitation has focused more on intensive, short term physical or cognitive rehabilitation (Evans 1997). Furthermore, some inpatient facilities are recognizing the need to divide patients into different streams during rehabilitation. At the Toronto Rehabilitation Institute, patients have been streamed into a Neurocognitive group and a Neurophysical group since 2002 (Cullen 2007). Patients in the Neurophysical stream showed similar FIM gains in a significantly shorter length of stay when compared to similar patients before streaming began.

Inpatient rehabilitation typically begins when a patient is medically stable enough to be transferred out of acute care and into a dedicated rehabilitation unit for a defined period of interdisciplinary rehabilitation. There is a great deal of variability in the length, type, and intensity of services provided in programs throughout the world. As such, we delineate the evidence supporting the various aspects of treatment for inpatient care delivery.

**Individual Studies**

**Table 3.3 Benefits of Inpatient Rehabilitation**

<table>
<thead>
<tr>
<th>Author/Year/Country/Study design</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sahgal &amp; Heinemann (1989) USA Pre/Post</td>
<td>N=189 Outcome study of subjects discharged from a comprehensive multidisciplinary rehabilitation program.</td>
<td>After discharge from the program, improvements were noted in patients’ self-care and mobility, as measured by a locally developed functional rating scale.</td>
</tr>
<tr>
<td>Whitlock Jr., &amp; Hamilton (1995) USA Case Series</td>
<td>N=328 Retrospective study of subjects assigned to acute rehabilitation.</td>
<td>Significant improvements were noted for patients on the FIM.</td>
</tr>
<tr>
<td>Whitlock Jr., (1992) USA Case Series</td>
<td>N=23 Retrospective study of TBI subjects with an average GCS score of 8.7 admitted to an acute rehabilitation programme.</td>
<td>At 6 months post-injury, 35% (8/23) had good outcome or moderate disability, as measured by GOS scores.</td>
</tr>
</tbody>
</table>
Tuel et al., (1992) USA Case Series N=49 Retrospective study of severely head-injured subjects readmitted to inpatient rehabilitation more than 12 months after injury. 53% (26/49) showed statistically significant improvement on BI scores from readmission to discharge (p = 0.0001).

Discussion

Sahgal and Heinemann (1989) conducted a pre-post study on 189 patients with TBI admitted to a National Institute on Disability and Rehabilitation Research-Designated Center in the USA. Using a locally developed functional rating scale as the main outcome measure, the authors noted improvements in the patients for self-care and mobility after discharge from the comprehensive multidisciplinary program.

Two case series evaluated patients’ functional outcome after discharge from inpatient rehabilitation. Both used the Functional Independence Measure (FIM) as one of their main outcome measures and both noted significant improvements for patients on FIM measurement (Whitlock, Jr. and Hamilton 1995; Gray and Burnham 2000).

Two other case series assessed functional outcome after inpatient rehabilitation using the Glasgow Outcome Scale (GOS) and Barthel Index (BI) respectively. In the former, 35% of subjects experienced good outcome or moderate disability at six months post-injury, as measured by GOS scores (Whitlock, Jr., 1992). In the latter, 53% of patients readmitted to inpatient rehabilitation at more than twelve months post-injury showed statistically significant improvement (p = 0.0001) on BI scores from readmission to discharge (Tuel et al., 1992).

Conclusions

There is Level 4 evidence that inpatient rehabilitation improves self-care and mobility.

Based on the findings from two case series, there is Level 4 evidence that inpatient rehabilitation significantly improves functional outcome, as measured by the FIM.

There is Level 4 evidence that over a quarter of patients admitted to inpatient rehabilitation experience good outcome or moderate disability six months post-injury, as measured by the GOS.

Inpatient rehabilitation improves self-care and mobility and significantly improves functional outcome, social cognition and return to work in patients with TBI and non-TBI.
3.3.1 Intensity of Inpatient Rehabilitation
While patients are undergoing rehabilitation the amount of therapy provided to them is potentially an important factor in promoting neurological and functional recovery. We review the evidence for increased intensity in this section.

Individual Studies

Table 3.4 Intensity of Rehabilitation Post ABI

<table>
<thead>
<tr>
<th>Author/Year/Country/Study Design/PEDro Score</th>
<th>Methods</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhu et al., (2001) Hong Kong RCT PEDro = 8</td>
<td>N=36 Patients with moderate and severe TBI (GCS 3-12) were randomized into two groups. The intervention group received 4h of therapy 5 days a week while the control group received 2h. Patients were compared on GOS and FIM scores monthly.</td>
<td>Intervention patients saw significant improvements in overall GOS scores (p=0.037) one month into treatments and percentage of patients making “good” GOS outcomes after two months (p=0.046).</td>
</tr>
<tr>
<td>Shiel et al., (2001) RCT UK PEDro = 7</td>
<td>N=56 Moderate and severe TBI patients (GCS 3-12) at two neurorehabilitation facilities were randomly assigned to an intervention group with increased therapy intensity or a control group. FIM+FAM at discharge was used as an outcome measure.</td>
<td>Patients receiving increased intensity of therapy saw significantly better outcomes in most aspects of the FIM+FAM during admission and experienced shorter lengths of stay.</td>
</tr>
<tr>
<td>Semlyen et al., (1998) UK Cohort</td>
<td>N=51 Subjects with severe ABI were divided into two groups: n=33 (HM gr), n=18 (OR gr). The first group received a coordinated multidisciplinary rehabilitation program (nursing care, PT, speech and language therapy, OT, social work input) in a regional rehabilitation centre. The other group had single discipline rehabilitation provided in local hospitals.</td>
<td>The HM group who received multidisciplinary rehabilitation demonstrated significant functional gains (p&lt;0.05) throughout the study period and maintained those gains after rehabilitation had ended. Caregivers of those in the multidisciplinary rehabilitation group reported reduced levels of distress as measured by the General Health Questionnaire.</td>
</tr>
<tr>
<td>Cicerone et al., (2004) USA Non-RCT</td>
<td>N=56 27 subjects underwent an intensive cognitive rehabilitation program (ICRP) and 29 participated in a standard neurorehabilitation program (SRP). Both groups received about 4 months of outpatient treatment. ICRP group treatment included a variety of</td>
<td>Both treatment groups showed significant improvements on the Community Integration Questionnaire (CIQ) following treatment (p &lt; 0.001). An analysis of clinically significant improvement indicated that ICRP participants were</td>
</tr>
</tbody>
</table>
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Evidence

- Functional activities with emphasis on executive functioning, metacognitive functioning, and interpersonal group processes. SRP program clients received physiotherapy, occupational therapy, speech therapy, and neuropsychological therapy. SRP delivery of treatment was less intensive and less structured than the ICRP program, and was not offered in a group format.

<table>
<thead>
<tr>
<th>Study</th>
<th>N=491</th>
<th>Rehabilitation intensity predicted motor functioning at discharge (p &lt; .001), but did not predict cognitive gain (p &lt; .05).</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Study</th>
<th>N=98</th>
<th>Increased rehabilitation therapy resulted in a 31% decrease in length of stay.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackerby (1990) USA Case Series</td>
<td>A Case Series (n=51 completed the study) involving subjects at two hospitals who experienced increased rehabilitation therapy from 5 hours per day to 8 hours per day for 7 days per week.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Study</th>
<th>N=95</th>
<th>Patients with a long length of stay who received high-intensity rehabilitation fared better on the Rancho Scale at discharge.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spivack et al., (1992) USA Case Series</td>
<td>In the current study of TBI subjects admitted to a comprehensive inpatient rehabilitation program. Using 2 × 2 analyses of variance, the combined effects of intensity of treatment and length of stay were assessed.</td>
<td></td>
</tr>
</tbody>
</table>

PEDro = Physiotherapy Evidence Database rating scale score (Moseley et al., 2002).

Discussion

Two RCTs focused on inpatient rehabilitation of ABI patients (Zhu et al., 2001; Shiel et al., 2001). Both studies assessed the effects of increasing therapy intensity levels. In the Shiel et al. (2001) study, patients in the intervention group received additional therapy from a health care professional (a rehabilitation nurse at one centre and an occupational therapist at the other) who provided these extra services as necessary. Shiel et al. (2001) found that patients showed improvements on discharge both the FIM+FAM measures; however these improvements may be related to the size of the rehabilitation facility and the amount of staffing available to the patients. The study authors noted that patients in the larger facility received more intensive therapy over a shorter period of time and saw significant gains. In contrast, patients in the intervention group at the smaller center actually experienced a longer length of stay than their control counterparts.

In the second RCT, conducted Zhu et al. (2001), subjects were randomly assigned to either four hours (study group) or two hours (control group) of rehabilitation per day. Functional outcome was determined by monthly Glasgow Outcome Scale (GOS) and Functional Independence Measure (FIM) scores. The authors found that more subjects...
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in the study group than in the control group achieved full FIM scores and good GOS scores at two and three months post-injury; however at the sixth month time period, despite initial improvements obtained in rehabilitation, the control group had made significant gains and were seen to be “catching up” (Zhu et al., 2001). Both studies noted a trend towards improvements in functional gains with increased intensity but recommend future study into more long term effects.

Two studies examined the efficacy of the intensity of rehabilitation in relation to the length of hospital stay (Blackerby, 1990; Shiel et al., 2001). In both studies, one a prospective RCT and the other a case series, increased rehabilitation intensity resulted in decreased length of stay.

Spivack et al. (1992), conducted at study looking at the combined effects of rehabilitation intensity and inpatient rehabilitation length of stay. In their comparison of patients who had a long length of stay and received either low-intensity or high-intensity rehabilitation, the latter group fared better on the Rancho Scale outcome measure at discharge.

Semlyen et al. (1998) compared coordinated multidisciplinary inpatient rehabilitation to single discipline therapy provided in a local district hospital. Patients treated in the multidisciplinary hospital showed greater improvement in Barthel, FIM and Newcastle Independence Assessment Form scores and maintained improvement at 24 months. However, the authors point out some methodological concerns. Patients were non-randomly divided between the two groups which resulted in less severe injuries in the single discipline group as well as shorter LOS. This may have resulted in a ceiling effect for these patients that could have hindered their recovery gains.

A multicenter, prospective, nonrandomized study also assessed the relationship between therapy intensity and functional outcome. Rehabilitation intensity was found to predict motor functioning at discharge (p < .001), it did not however, predict cognitive gain (p < .05) (Cifu et al., 2003).

Intensive and structured cognitive rehabilitation therapy (group and individual) has been reported to cause significant improvements in client reported satisfaction when compared to standard multidisciplinary rehabilitation (Cicerone et al., 2004). The intensive rehabilitation program participants showed significant effects on their cognitive functioning as demonstrated on their improvement on standard neuropsychological tests (Cicerone, et al., 2004). For further discussion on Cicerone’s finding see Chapter 13.

In all of the studies identified, trends towards improved function after multidisciplinary inpatient rehabilitation were seen. Several study authors noted that they saw no ceiling effect associated with increased intensity of therapy. However, all of the authors
indicated concerns about outcome measurement tools. There seems to be consensus regarding the need for a more accurate, ABI specific measure of functionality.

**Summary**

Intuitively, it seems reasonable to assume that more therapy will result in more rapid and ultimately greater improvement in recovery from brain injury. Based on the available literature, greater intensity appears to result in quicker recovery and therefore shorter lengths of stay, but not necessarily better outcomes at six months. More studies are needed in this regard.

**Conclusions**

*Based on the findings from a single RCT, there is Level 1b evidence that increasing rehabilitation intensity reduces length of stay.*

*Based on the findings from a single RCT, there is Level 1b evidence that intensive rehabilitation improves functional outcome, as measured by FIM and GOS scores, at two and three months post-injury, but not necessarily at six months and beyond.*

*There is Level 2 evidence that multidisciplinary inpatient rehabilitation seems to be more effective than a single discipline approach.*

*There is Level 2 evidence that therapy intensity predicts motor functioning, but not cognitive gain.*

*There is a reciprocal relationship between cognitive function and community integration.*

*There is Level 4 evidence that patients with a long length of stay who receive high-intensity rehabilitation fair better on the Rancho Los Amigos Scale at discharge than those who receive low-intensity rehabilitation.*

*There is level 4 evidence that earlier time from injury onset to rehabilitation admission results in improved functional outcomes.*

*Increasing rehabilitation intensity reduces length of stay.*

*High-intensity rehabilitation is associated with improved outcomes at discharge and at two and three months post-injury.*

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3.3.2 Timing of Rehabilitation

It has long been identified that early onset of therapeutic interventions for those who have sustained a traumatic head injury is beneficial. The ideal timing of initiation of rehabilitation will maximize the usefulness of resources available to patients for a limited amount of time. At one end of the spectrum, a comatose patient may be unable to engage in therapy, while at the other end of the spectrum, someone who has made a good recovery has no need for intervention. Several studies have shown that introducing a rehabilitation program during the acute phase does assist in the overall recovery of individuals with a TBI (Heinemann et al., 1990). Cope’s (1995) review concluded that those who receive early intervention do in fact have better outcomes than those who do not. We attempted to address the question of the ideal time to start the rigors of therapy in order to maximize patients’ function.

Individual Studies

Table 3.5 Timing of Rehabilitation Post ABI

<table>
<thead>
<tr>
<th>Author/Year/Country/Study design</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandhaug et al., (2010) Prospective Cohort</td>
<td>N=55 Patients selected had sustained either a moderate (n=21) or a severe (n=34). All received individualized rehabilitation, (focusing on optimizing recovery of functional independence), given by a member of the rehabilitation team. FIM scores and number of days till individuals could be transferred to a specialized rehab unit was recorded.</td>
<td>FIM scores improved significantly over the course of treatment (p&lt;0.001). FIM-COG scores improved 6 points from admission to discharge (p&lt;0.001) with a more notable improvement being seen in those with a severe TBI. FIM-M scores also improved significantly (p&lt;0.001) over time. Again those in the severe TBI group showed the greatest improvement. Most were able to transfer to a specialized rehab unit 27 days after their injury.</td>
</tr>
<tr>
<td>Tepas et al., (2009) USA Chart review</td>
<td>N=60 Patient records were reviewed for children with severe blunt head injury (GCS ≤ 8). Linear regression was used to compare time in days between discharge from ICU and admission to rehabilitation and rehabilitation efficiency (RE; ΔFIM /LOS).</td>
<td>Delay in admission to rehabilitation was significantly correlated with rehabilitation efficiency and ΔFIM (correlation coefficient = -0.346, p=0.0068). Patients with GCS 3-5 showed correlation between delay and ΔFIM but not RE, while patients...</td>
</tr>
<tr>
<td>Study</td>
<td>N</td>
<td>Description</td>
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<tr>
<td>-------------------------------</td>
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<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Kunik et al., (2006) USA Chart Audit</td>
<td><strong>83</strong></td>
<td>Patients who had been admitted between 2003 and 2004 participated in a chart audit. FIM scores at time of admission and discharge were recorded. The number of weeks in rehabilitation was taken into account when considering the cost.</td>
</tr>
<tr>
<td>High et al., (2006) USA Non-RCT</td>
<td><strong>141</strong></td>
<td>Subjects who were enrolled in a program and comprehensive-integrated post-acute brain injury rehab (PABIR) were available for outcome analysis. Patients were divided into 3 groups depending on the time between injury and admission to the program.</td>
</tr>
<tr>
<td>Wagner et al., (2003) USA Cohort</td>
<td><strong>1866</strong></td>
<td>Using multivariate analysis, 520 patients who received an early physical medicine and rehabilitation (PM&amp;R) consultation were compared with 1346 patients who did not receive an early PM&amp;R consultation.</td>
</tr>
<tr>
<td>Edwards et al., (2003) USA Cohort</td>
<td><strong>26</strong></td>
<td>Outcome study of subjects admitted to inpatient rehabilitation more than 200 days after injury compared with 264 patients admitted to inpatient rehabilitation less than 200 days after injury.</td>
</tr>
<tr>
<td>Mackay et al., (1992) USA Cohort</td>
<td><strong>38</strong></td>
<td>Retrospective comparative study of subjects: 21 were treated at hospitals without a formalized early intervention program (average of 23</td>
</tr>
</tbody>
</table>
days to initiation of therapy) and 17 were treated at a hospital with a formalized early intervention program (average of 2 days to initiation of therapy). and had a greater likelihood of being discharged to home.

Cope and Hall, (1982) USA Case/Control N=34 Subjects with TBI were assigned to an early or late intervention group. Both groups reached equivalent levels of functional recovery at discharge and social stages at 2 years post injury. Those in the early intervention group had significant reduction in length of hospital stay both in the acute and rehabilitation phase.

Aronow, (1987) USA Non-RCT N=129 subjects were selected: (n=68 treatment group, n=61 control group). Experimental subjects received PT, OT, speech and cognitive therapy, social work management and a psychological evaluation. Differences in independence in self-care activities and memory problems were statistically significant between the two groups, favoring the non-experimental group (p<0.05). Differences on the symptom of tiredness favored the experimental group (p<0.05). No other differences were noted between the two groups. Overall there was a cost savings of $11,949/yr for those with up to one month of posttraumatic amnesia.

Discussion:
Sandhaug et al. (2010) looked at the benefits of having individuals who had sustained either a moderate or severe TBI participate in a sub-acute rehabilitation program. On average patients were transferred to a specialized rehab program 27 days after being admitted to sub-acute rehab. Those with a severe TBI remained in rehab longer than those with moderate injuries and were discharged either to a rehab hospital or nursing homes for further treatment. FIM scores improved significantly (p<0.001) for all who participated regardless of the level of injury. Those diagnosed with a severe TBI showed a significantly (p<0.001) greater improvement in their overall FIM scores. When looking at the subcategories of the FIM scale, the greatest improvement, for both groups, was seen in the motor scores. Improvement on the FIM-COG subscale was also noted but in both groups the score improved by only 5 points. The authors suggest that the FIM score at admission to rehabilitation, together with the GCS and PTA, were positive predictors of functional level at discharge (Sandhaug et al., 2010).

Wagner et al. (2003) examined the proper timing for physical medicine and rehabilitation consultation. Using multivariate analysis, the authors found that when PM&R consultations occurred earlier (< 48 hours after hospital admission) patients
experienced significantly better FIM scores with transfers and locomotion and significantly shorter lengths of stay \( (p = 0.001) \).

In the other outcome study, Edwards et al. (2003) compared 26 patients admitted to inpatient rehabilitation more than 200 days after injury to 264 patients admitted to inpatient rehabilitation less than 200 days after injury. Discharge BI and FIM scores were lower in the former group than in the latter (11 vs. 14 and 77 vs. 92 respectively). However, the differences were not significant. Rehabilitation length of stay was also similar for the two groups.

Mackay et al. (1992) assessed the timing of inpatient rehabilitation during the earlier phase of recovery in their cohort study. They compared a formalized program (average of 2 days to initiation of therapy) with a non-formalized program (average of 23 days to initiation of therapy) using co-relational analysis. Number of days in coma, length of stay, cognitive levels, and discharge disposition were used as the main outcome measures. Overall, starting rehabilitation early was associated with shorter comas and lengths of stay, higher cognitive levels at discharge, and a greater likelihood of being discharged to home.

In the High et al. (2006) study of TBI patients the authors examined the amount of time that lapsed from diagnosis of injury to the start of rehabilitation and its effect on outcomes of rehabilitation. They found that those who began treatment within six months of their TBI scored higher on the disability rating scale indicating a decrease in their disability. These results were not noted for the other two groups. The supervision rating scale scores decreased for all groups indicating that they required less supervision after admission to rehabilitation and when tested again at follow up post discharge, again a decrease in supervision was noted. When analyzing the results of the community integration questionnaire an increase in scores could be seen from admission to discharge from the program for all groups.

Mackay et al. (1992) and Cope and Hall (1982) found that those who were involved in rehabilitation earlier in the recovery stage were discharged from hospital earlier than those who were not involved in the early rehabilitation program. Aronow (1987), found that although there was no statistically significant differences on the individual outcomes there was a cost savings favoring those who were subjected to early interventions.

Tepas et al. (2009) retrospectively reviewed patient charts to evaluate the effect of delays for admission to rehabilitation on functional outcomes. They report that delays in admission to rehabilitation resulted in significant decreases in total FIM gains as well as reductions in rehabilitation efficiency. These findings were similar to those reported by Kunik et al. (2006). In this study individuals admitted sooner into rehabilitation (<1 week to 3 weeks post insult) were admitted with higher FIM scores (~59.8) than those...
admitted later (4 week or more post insult - FIM scores (48.29)). Overall those admitted sooner to rehabilitation were released on average 19 days post admission. Those admitted later to rehabilitation were released on average 26 days post admission. Kunik et al., (2006) suggest that those who are admitted into rehabilitation sooner after injury perform better and faster and their overall cost of stay is less.

The studies available on the timing of rehabilitation demonstrate that earlier rehabilitation is associated with better outcomes than later rehabilitation. Patients who have had recent brain injuries typically need much greater medical and nursing support in order to meet their basic care requirements. This evidence is consistent with theories of neuronal plasticity, which suggest that challenging the nervous system by means of therapy results in increased neuronal compensation and/or regeneration. However, delayed rehabilitation may reflect more severe or complicated brain injuries. There is an obvious need for an RCT to address this question.

**Conclusions**

*Based on the findings from several non-RCT studies, there is Level 2 evidence that early rehabilitation is associated with better outcomes such as shorter comas and lengths of stay, higher cognitive levels at discharge, better FIM scores, and a greater likelihood of discharge to home.*

---

**3.3.3 Factors Affecting the Timing of Inpatient Care**

**3.3.3.1 Etiology and Inpatient Rehabilitation**

In a retrospective, descriptive, case-matched study by O’Dell et al. (1998), forty patients with brain tumors were compared with 40 patients with TBI. They all underwent inpatient rehabilitation on a freestanding brain injury unit. Change in FIM scores, length of stay, and discharge disposition were used as the main outcome measures. Overall, the TBI patients made significantly greater gains in total FIM change (34.6 vs. 25.4), self-care (12.3 vs. 8.5), and social cognition (5.2 vs. 3.6). However, there were no statistically significant differences between the two groups regarding FIM efficiency (1.9 vs. 1.5 FIM points per day) and length of stay (22.1 vs. 17.8 days). See table 3.6 for details.

**3.3.3.2 Age and Inpatient Rehabilitation**

In Cifu et al. (1996) DRS, FIM, and RLAS scores were compared at inpatient rehabilitation discharge for 50 patients greater than or equal to 55 years of age and 50 patients aged
18 to 54. In this case-control study, subjects in the latter group showed a higher mean rate of change on functional measures than subjects in the former group.

3.3.3.3 Occupation and Inpatient Rehabilitation

In describing only one treatment arm of a RCT, Braverman et al. (1999) evaluated military service members’ return to work and return to duty after multidisciplinary inpatient rehabilitation. Multidisciplinary inpatient rehabilitation consisted of eight weeks of group and individual therapies geared towards returning the soldiers to duty. The rehabilitation team included a physiatrist, neurologist, neuropsychologist, and occupational therapist. The authors found that of the sixty-seven subjects who participated in the study, 96% and 66% had returned to work and duty respectively at follow-up of one year.

3.3.3.4 Transitional Living Setting and Inpatient Rehabilitation

In the study by McLaughlin and Peters (1993) the effects of a transitional living setting during the last weeks of inpatient length of stay were evaluated using cognitive (Rancho) and functional (Barthel) levels as main outcome measures. Results from a follow-up survey showed that patients who participated in both inpatient rehabilitation and a transitional living setting reported greater independence in activities of daily living than patients who received inpatient rehabilitation alone.

Individual Studies

Table 3.6 Inpatient Care Post ABI

<table>
<thead>
<tr>
<th>Author/Year Country/Study design</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>O’Dell et al., (1998) USA Case-Control</td>
<td>N=80 Retrospective, descriptive, case-matched study of 40 subjects with brain tumors and 40 subjects with TBI who underwent inpatient rehabilitation on a freestanding brain injury unit.</td>
<td>Patients with TBI made significantly greater gains than patients with brain tumors regarding total FIM change (34.6 vs. 25.4), self-care (12.3 vs. 8.5), and social cognition (5.2 vs. 3.6). Also, there were no statistically significant differences between the two groups regarding FIM efficiency (1.9 vs. 1.5 FIM points per day) and length of stay (22.1 vs. 17.8 days).</td>
</tr>
<tr>
<td>Braverman et al., (1999) USA Case Series</td>
<td>N=67 Treatment arm of a RCT of active duty military service members who participated in an 8-week multidisciplinary inpatient rehabilitation programme that consisted of both individual and group therapies.</td>
<td>At a follow-up of 1 year, 96% (64/67) and 66% (44/67) had returned to work and duty respectively.</td>
</tr>
<tr>
<td>Cifu et al., (1996)</td>
<td>N=100 of 50 Subjects ≥ 55 years of age and 50 Subjects aged 18-54 who received inpatient rehabilitation.</td>
<td>Patients aged 18-54 averaged a higher rate of change on DRS, FIM,</td>
</tr>
<tr>
<td>USA Case-Control</td>
<td>and RLAS scores than patients ≥ 55 years of age.</td>
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<tr>
<td>McLaughlin and Peters (1993) USA Cohort</td>
<td>N=31 Descriptive study of subjects, of which 19 participated in a transitional living setting during the last weeks of inpatient rehabilitation and 12 participated in inpatient rehabilitation alone. Patients who participated in a transitional living setting during the last weeks of inpatient rehabilitation reported greater independence in activities of daily living than patients who participated in inpatient rehabilitation alone, as measured by Rancho and Barthel scores.</td>
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</table>

**Summary**

Previous reviews in addition to literature presented here have delineated the extent of knowledge of the efficacy of inpatient rehabilitation, which is limited at best. There is reasonable evidence to support the use of interdisciplinary rehabilitation followed by a transitional living environment to assist in maximizing recovery. This suggests that a gradual return to the community is preferable to a sudden discharge from hospital to home. Not surprisingly, younger patients tend to make greater gains in rehabilitation than their older counterparts.

**Conclusions**

*There is Level 3 evidence that inpatient brain injury rehabilitation results in significantly greater gains in total FIM change, self-care, and social cognition for patients with TBI than patients with brain tumors. However, there are no statistically significant differences between the two groups regarding FIM efficiency and length of stay.*

*There is Level 3 evidence that inpatient rehabilitation results in a higher rate of change on functional measures in patients aged 18-54 than patients aged 55 years or older.*

*There is Level 2 evidence that readmission to inpatient rehabilitation at more than twelve months post-injury is related to statistically significant improvement on the BI at discharge for over 50% of patients.*

*Based on the findings from one case series, there is Level 4 evidence that inpatient rehabilitation results in successful return to work and return to duty for the majority of military service members.*

*There is Level 2 evidence that a transitional living setting during the last weeks of inpatient rehabilitation results in greater independence in activities of daily living than inpatient rehabilitation alone.*
Rehabilitation results in a higher rate of change on functional measures in younger patients than in older patients.

Transitional living setting during the last weeks of inpatient rehabilitation is associated with greater independence than inpatient rehabilitation alone.

3.4 Outpatient Rehabilitation

Outpatient care is often the least organized branch of ABI care. Patients discharged home often receive no therapy or minimal support depending on their level of need and payment status. In a well-structured outpatient facility in Canada patients typically attend therapy 2-3 times/week and have access to OT, PT, SLP, SW, physiatrist, neuropsychology and neuropsychiatry (Cullen, 2007). At a similar facility in Hamilton, Ontario patients also receive the services of a rehabilitation counselor which has been reported to be effective. However, access to programs like these often relies on funding. Patients with private insurance from motor vehicle accidents are 1.6 times more likely to be discharged home with supportive services than those without (Kim et al., 2006). A survey conducted in the United States was conducted to identify the availability of community information resources post ABI in the US (Sample and Langlois 2005). The authors made three recommendations for improvement: expand the population targeted for linkage to services, improve access to information about available services, and increase the availability of services. In a similar study by Leith et al. (2004), focus groups of patients and families were questioned regarding their perceived post-discharge needs in South Carolina, USA Consensus agreement surrounded five areas of need; early, continuous, comprehensive service delivery; information and education; formal and informal advocacy; empowerment of persons with TBI and their families; and human connectedness and social belonging.

Residential care facilities are generally not-for-profit, government sponsored agencies that offer access to support in a secure environment with staff specifically trained in ABI
care. Resources often include rehabilitation therapists, behavior therapists, social workers and case managers with supervision by certified psychologists (Cullen 2007, Powell et al., 2002). These facilities aim to allow ABI patients an extended system of support with opportunities for long-term rehabilitation. However, they are generally expensive and access is often limited by the patient’s ability to pay for care. Alternatives include hospital based outpatient facilities where patients drop in several times a week for care (Cullen 2007) or mobile rehabilitation teams which visit patients at home (Ponsford et al., 2006).

Other programs aim at aiding less severely injured patients in community reintegration and independence. These services involve specifically targeted goals including social interaction (Cope et al., 2005), driving (Rapport et al., 2008) and competitive employment (Willer et al. 1999). They generally take place on a one-to-one basis in home or in the community and patients often rate these final steps as the most important in returning to normalcy (Evans1997).

Individual Studies

Table 3.7 Well Being Post Rehabilitation

<table>
<thead>
<tr>
<th>Author/Year Country/Study Design</th>
<th>Methods</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Braunling-McMorrow (2010) Non-RCT</td>
<td>N=205 Individuals were divided into 2 groups, those receiving neurorehab (NR) services and those requiring specialized neurobehavioural (NB) services due to behavioural or psychiatric issues. Both groups participated in behavioural and cognitive therapy programs. Programs included personal goal setting, social skills training, orientation to the community and world around them, relaxation training, cognitive group, self-advocacy, functional activity group, substance awareness and complications related to substance abuse, educational and vocational support. All programs were geared toward a successful return to their home communities. The Functional Area Outcome Menu (FOAM) was used to assess changes in behaviour.</td>
<td>Assessments were completed ~6 months into the program, between 6 and 12 months and post 12 months. Individuals in both groups showed significant functional gains from admission to discharge (p&lt;0.001). This improvement was also noted at 1 yr follow up (p&lt;0.001). Those in the NB group, at one year post intervention, although they benefited, their gains were not as great as those in the NR group. Gains made by both groups were noted at the one year follow up, but the NB group continued to make gains even though the program had been completed. Results also found that those with the greatest impairments, if admitted within 6 months of injury made the greatest improvement.</td>
</tr>
<tr>
<td>Turner et al., (2009) Australia</td>
<td>N=52 Patients (n=26) and caregivers (n=26) were assessed at three time periods (pre discharge from</td>
<td>Results of the MPAI-4 completed at discharge from care by both caregivers and patients showed</td>
</tr>
<tr>
<td>Case-Control</td>
<td>rehabilitation, 1 and 3 months post discharge from). Changes that occurred during various transitional periods (from rehab to home) were evaluation using various the following scales: Mayo-Portland Adaptability Inventory-4 (MPAI-4); Sydney Psychosocial Reintegration Scale, EQ-5D, Depression and Anxiety and Stress Scales.</td>
<td>patients reported significantly fewer problems than their caregivers at each assessment period. Results from the psychosocial reintegration scale showed improvement on occupational activities and living skills domain; however patients tended to rate their functioning abilities higher than caregivers. Results from the depression, anxiety and stress scale indicated, over time, patients were less likely to fit into the “normal” depression domain as feeling of depression increased. While anxiety levels appeared to drop, stress levels increased from time 1 to time 3.</td>
</tr>
<tr>
<td>Ponsford et al., (2006) Australia Cohort</td>
<td><strong>N=77</strong> Severe TBI patients treated in a community based rehabilitation program were matched with TBI patients who attended the hospital for outpatient rehabilitation. Patients were individually matched for gender, age, education, occupation, PTA duration, GCS score, and time in inpatient rehabilitation.</td>
<td>Patients treated in the community were significantly more dependent on support from close others (p=0.008), less independent in mobility (p=0.005), had more difficulty with motor speech (p=0.005) and following conversations (p=0.001) and displayed more inappropriate social behaviours (p=0.009). Community patients did show increased physical independence (p=0.004).</td>
</tr>
<tr>
<td>Cusick et al., (2003) USA Cohort control</td>
<td><strong>N=66</strong> Patients enrolled in the Medicaid Waiver Program to receive home based outpatient services were individually matched with TBI database patients receiving no formal outpatient MEDICAID support. Controls were matched on GCS at injury, age, gender, receipt of inpatient rehabilitation, and number of years post-injury that interviews were conducted. Interviews were conducted using CHART, SIP-AB, SF-12, and the SWLS as outcome measures.</td>
<td>Sixty-two of 78 variables exhibited no significant differences between groups. Waiver recipients showed significantly better scores in SF-12 mental health (p=0.006), SF-12 mental health subscale (p=0.032), alcohol use (p=0.003), and risk of using alcohol (p&lt;0.001). They were also more likely to use case management (p=0.005), physical therapy (p=0.038), second rehabilitation admission (p=0.013), and group home stay (p=0.008). Non-waiver groups showed significant improvements in CHART-SF physical independence sub-scale (p&lt;0.05), cognitive independence sub-scale (p&lt;0.001), mobility sub-scale (p&lt;0.05), occupational sub-scale (p=0.01), total CHART-SF score (p&lt;0.01), competitive employment (p&lt;0.01), full-time competitive employment (p&lt;0.01), and needed less IADL help (p=0.002).</td>
</tr>
</tbody>
</table>
**Discussion**

Four non-randomized control trials were also located which assessed outpatient care. Ponsford et al. (2006) compared patients treated in the community post-discharge to patients who returned to hospital for care. They found that patients who received hospital care were significantly less dependent on support from close others, more independent in mobility, displayed fewer inappropriate social behaviours and had less difficulty with motor speech and following conversations. However, community patients showed increased physical independence. Cusick et al. (2003) matched patients receiving MEDICAID waiver community support to patients from a TBI database. They found very few differences within 4 outcome measurement scales. Patients in the waiver program showed higher levels of resource use as well as improved mental health status and less substance abuse. Patients not receiving waiver support showed increased levels of predominantly independence based measures (ie. physical, cognitive, and mobility independence). Similarly, Willer et al. (1999) compared patients receiving residential inpatient rehabilitation to a control group receiving in-home outpatient services. They found patients treated in a residential center improved in motor and cognitive function, but patients treated at home showed improvements in independence and social integration levels. All three studies identified differences in pressures placed on ABI patients. As would be expected, patients receiving care tend to improve in the skills targeted by that care while those receiving less structured care, or no care at all, improve in independence skills. Further study regarding appropriate target groups for differently structured programs is necessary.

Braunling-McMorrow et al. (2010) looked at the benefits of participation in a weekly program that included both behavioural and cognitive therapies that would teach
participants to respond to various life events appropriately and allow for greater independence. Individuals who participated were placed in two groups: those requiring neurorehabilitation (NR) and those requiring neurobehavioural (NB) treatment. Results from the FAOM (functional area outcome menu) indicated that both groups improved significantly pre to post assessment (p<0.001). Scored on the FAOM at the one year post discharge time period, indicate that those in the NB showed the greatest change.

Individuals who were admitted to the program within the first 6 months of injury did better than those admitted later. The study authors suggest that perhaps the severity of deficits may have played a role in the time of admission to rehabilitation with those with more severe deficits being admitted to rehabilitation sooner than those with fewer deficits. Those who entered rehabilitation at a later date may have already made improvements, thus those made in the program were not as significant (Braunling-Mcmorrow et al., 2010).

We located one other study which focused on comparisons of outpatient rehabilitation services. Malec and Degiorgio (2002) assessed three different outpatient intervention groups for competitive employment rates after one year. Patients were not randomly assigned, which led to those who were less severely injured and more independent initially being referred more often to a less intensive outpatient program. They noted that all three groups of patients reached the same level of employment at the end of the study after undergoing therapies of different intensity. The authors suggest that patients with diverse levels of disability can make similar gains with different intensities of therapy. However, too many confounding factors exist to draw such a conclusion from this study.

Conclusions

There is Level 3 evidence that multidisciplinary outpatient rehabilitation may improve functional outcomes up to one year post discharge.

There is level 2 evidence that varied outpatient therapy can be used to improve varied targeted outcomes.

There is Level 2 evidence that behavioural and cognitive skills post ABI can be improved by participating in neurorehabilitation or neurobehavioural programs.

A fitness-center based program is not better than a home-based program for improving cardio-respiratory fitness.

Varied outpatient therapy can be used to improve varied targeted outcomes.
Multidisciplinary outpatient rehabilitation may improve functional outcomes up to one year post discharge.

Neurobehavioural or neurorehabilitative programs improve behavioural and cognitive functioning post ABI.

3.5 Community Rehabilitation

Following discharge from inpatient rehabilitation unit patients with moderate to severe brain injury typically receive ongoing therapy at a lesser intensity. While most patients move back to their former living environment with therapy intervention provided for them in the home or community, some go on to other facilities that may provide longer duration treatment for the slow-to-recover patient. The effectiveness of these interventions is reviewed in this section.

Individual Studies

Table 3.9 Community Rehabilitation Post ABI

<table>
<thead>
<tr>
<th>Author/Year Country/Study design/PEDro Score</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hassett et al., (2009) Australia RCT PEDro = 8</td>
<td><strong>N=62</strong> Patients with severe TBI (PTA &gt; 1 week) who could walk faster than 1 m/sec on brain injury unit discharge were randomly assigned to receive either a fitness center-based therapy program or a home-based program. Patients were evaluated for fitness improvements and psychological functioning at the end of intervention and follow-up.</td>
<td>Patients in both groups improved in cardio-respiratory fitness but there were no significant differences between groups.</td>
</tr>
<tr>
<td>Ownsworth et al., (2008) Australia RCT PEDro = 8</td>
<td><strong>N=35</strong> Patients with a mean time of 5.29 years post injury were randomly assigned to one of 6 groups involving intervention or waiting list controls. Patients received either group-based support, individual occupation-based support or a combined group and individual intervention. Outcomes were assessed at 3 and 6 months on Canadian Occupational Performance Measure, Patient Competency Rating Scale, and BICRO-39.</td>
<td>The individual intervention component contributed to gains in performance in goal-specific areas, the combined intervention was associated with maintained gains in satisfaction and performance. The group and individual interventions were more likely to result in gains in behavioural competency and psychological well being.</td>
</tr>
<tr>
<td>Reference</td>
<td>N</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------------------------</td>
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<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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<tr>
<td>Powell et al., (2002) UK PEDro=8</td>
<td>N=110</td>
<td>Experimental group (n=54), who participated in an outreach program, was exposed to 2 hr sessions per week for about 27.3 weeks in community setting. During this time the group was given assistance individually by a multidisciplinary team. The information (control) group (n=56) received a specially collated booklet with resources highlight that were of relevance to the subject.</td>
</tr>
<tr>
<td>Webb and Glueckauf (1994) USA RCT PEDro =5</td>
<td>N=16</td>
<td>Pre-post control group design of 16 participants randomly assigned to have high involvement in their neurorehabilitation goal setting or low involvement in their neurorehabilitation goal setting.</td>
</tr>
<tr>
<td>Malec (2001) USA Pre-Post</td>
<td>N=113</td>
<td>Subjects with ABI, of which 96 completed comprehensive day treatment and 17 dropped out.</td>
</tr>
<tr>
<td>Malec and Moesssner (2000) USA Pre-Post</td>
<td>N=62</td>
<td>nonparametric analyses subjects (48 men and 14 women) who participated in a comprehensive day treatment program (CDTP).</td>
</tr>
<tr>
<td>Wood et al., (1999) UK Pre-Post</td>
<td>N=76</td>
<td>Retrospective study of a group of TBI subjects who underwent community-based social and behavioural rehabilitation.</td>
</tr>
<tr>
<td>Klonoff et al., (2006) USA Cohort</td>
<td>N=93</td>
<td>Following their TBI, individuals were asked to complete and return questionnaires. Those who participated were 1 to 7 years post rehabilitation.</td>
</tr>
<tr>
<td>Study</td>
<td>Sample Size</td>
<td>Details</td>
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<tr>
<td>-------------------------------</td>
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</tr>
<tr>
<td>Olver et al., (1996)</td>
<td>N=103</td>
<td>Subjects were asked to complete a questionnaire 5 years post rehabilitation.</td>
</tr>
<tr>
<td>Blackerby &amp; Baumgarten (1990)</td>
<td>N=7</td>
<td>Subjects with TBI and substance abuse problems who participated in a dual diagnosis treatment program known as RELATE (Rebound Lifestyle Adjustment Team).</td>
</tr>
</tbody>
</table>

PEDro = Physiotherapy Evidence Database rating scale score (Moseley et al., 2002)

**Discussion**

Three randomized controlled trials were found that assessed outpatient rehabilitation strategies (Hassett et al., 2009; Ownsworth et al., 2008). Hassett et al. (2009) randomized patients to receive a fitness center-based exercise program or a home-based program and evaluated patient improvements in cardio-respiratory fitness using the 20-meter shuttle test. They found that although patients in the fitness center-based program showed better compliance, there were no significant differences seen between groups in fitness level or psychosocial functioning. However, both groups improved from baseline.

Ownsworth et al. (2008) compared performed a randomized trial to compare individual, group, and combined interventions for goal attainment and psychosocial functioning. Each group showed improvements in different areas. The individual intervention component contributed to gains in performance in goal-specific areas. The combined intervention was associated with maintained gains in satisfaction and performance,
while the group and individual interventions were more likely to result in gains in behavioural competency and psychological well being.

Powell et al. (2002) randomly assigned TBI patients to an outpatient support program where patients received 2-6 hrs of therapy a week at home or in another community setting from a team comprised of two OTs, a PT, an SLP, a clinical psychologist and a half time social worker. Control patients received an information session at home following discharge where they received written information regarding regional support programs. Follow-up was conducted an average of 24.8 months after initial allocation. The intervention group showed significant improvements on the Barthel Index and Brain Injury Community Rehabilitation Outcomes - 39 (BICRO-39) total scores as well as self-organization and psychological wellbeing. The authors comment that this multidisciplinary outpatient approach was highly successful. Patients in the intervention group showed improvements in many clinically significant areas including cognitive functioning, mobility, and personal wellbeing. While areas such as socializing and competitive employment rates showed no relative difference between groups, the authors suggest that this reflects external influences beyond the control of the rehabilitation team. The authors recommend that this type of outpatient approach be applied to a broader range of ABI patients in a larger trial to confirm their results.

In a retrospective cohort study by Wood et al. (1999) data related to dependency, social activity, and care support were collected on seventy-six subjects who received community-based social and behavioural rehabilitation. They found that rehabilitation of at least six months led to greater independence, higher social activity levels, and less need for care support.

Blackerby and Baumgarten (1990) conducted a series of single subject intervention studies on seven persons with TBI and substance abuse problems. In this study, the intervention was a dual diagnosis treatment program known as RELATE (Rebound Lifestyle Adjustment Team) that took place within a community-based Alcoholics Anonymous or Narcotics Anonymous group. Complete abstinence from chemical substances was the program’s ultimate goal. The authors discovered that both of the clients who followed recommendations for additional rehabilitation or psychiatric treatment at discharge from the program remained drug-free. On the other hand, only one of the five clients who did not follow recommendations remained drug-free at follow-up, while three continued their chemical dependency and one’s follow-up status was unknown. The authors concluded that this program was relatively unsuccessful due to an inability to keep clients in the program for the six-month period desired and the clients’ failure to follow discharge treatment recommendations.

In the RCT conducted by Webb and Glueckauf (1994) the effects of direct patient involvement in neurorehabilitation goal setting was evaluated. Sixteen subjects were randomly assigned to one of two groups: high involvement (HI) in goal setting or low
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involvement (LI) in goal setting. The main difference between the two groups was that subjects in the HI group were encouraged to be directly involved in their goal setting, while subjects in the LI group were not. At post-test, as compared to pre-test, both groups made significant improvements in obtaining their goals. However, only subjects in the HI group maintained the improvements at a two-month follow-up.

Two studies examined the effects of a comprehensive day treatment program (CDTP). While the former looked at its effects on impaired self-awareness (ISA) and distress, the latter evaluated its impact on societal participation. Using nonparametric analyses, Malec and Moessner (2000) discovered that after participation in the CDTP patients experienced reduced ISA and distress. With regards to societal participation, Malec (2001) found that at one year after participation in the program 72% were living independently, 39% were working independently, 10% were in transitional placements, and 18% were involved in supported or volunteer work.

Two studies examined the outcomes of those who had previously participated in rehabilitation (Klonoff et al., 2006; Olver et al., 1996). In the Olver et al. (2006) study, patients reported no mobility issues, improved communication skills and completed basic daily activities independently; however two-thirds reported still having some cognitive issues. Many reported feelings of anger, irritability, and aggression. Of the 103 who completed the surveys, only 34 were employed and 12 were in school, suggesting that ongoing support is needed. Findings reported by Klonoff et al. (2006) indicate that approximately one third were in long term relationships and of those who had returned to work, the majority were younger and of higher education. The income of participants decreased significantly post injury with fewer patients returning to full or part-time work.

Summary
Continuity of rehabilitation strategy includes a community-based program following inpatient rehabilitation that is tailored to individuals’ needs in order to maximize their recovery. It is generally accepted as neither safe nor prudent to allow patients to be discharged from a rehabilitation setting without adequate follow through on the issues that they continue to face in the course of their recovery. Given that most patients will continue to make gains for two or more years, it is reasonable to ensure that they continue to receive therapeutic intervention for this period of time. When looking at patients years post injury, although gains were made there was still a need for continued support. However, the evidence to support or refute remains insufficient.

Conclusions
There is Level 1b evidence that a fitness center-based program is not better than a home-based program for improving cardio-respiratory fitness.
There is Level 1b evidence that structured multidisciplinary rehabilitation in community setting can improve social functioning.

There is Level 4 evidence that community-based social and behavioural rehabilitation of at least six months results in greater independence, higher social activity levels, and less need for care support.

There is Level 4 evidence that patients with a dual-diagnosis of TBI and substance abuse who participate in a community-based treatment program generally do not become chemical-free. This is due to both an inability to keep them in the program for the six-month period desired and the failure of clients to follow recommendations for additional rehabilitation or psychiatric treatment at discharge.

There is Level 2 evidence from one RCT that direct patient involvement in neurorehabilitation goal setting results in a significant improvement in obtaining goals from pre-test to post-test that are then maintained at a follow-up of two months.

Based on the findings from two pre-post studies, there is Level 4 evidence that participation in a comprehensive day treatment program reduces impaired self-awareness and distress. It also improves societal participation at one-year follow-up.

There is Level 2 evidence suggesting rehabilitation issues regarding communication and employment are present years post rehabilitation.

<table>
<thead>
<tr>
<th>Community-based programs for ABI patients are associated with greater independence, higher social activity levels, and less need for care support when they can be sustained for at least six months.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants with a dual-diagnosis of TBI and substance abuse generally do not become chemical-free.</td>
</tr>
<tr>
<td>When direct patient involvement in goal setting is employed there is a significant improvement in achieving patients’ goals.</td>
</tr>
<tr>
<td>Community-based programs for ABI patients may reduce impaired self-awareness and distress and improve societal participation.</td>
</tr>
<tr>
<td>There remains a need to provide ongoing out patient or community care and rehabilitation years post injury.</td>
</tr>
</tbody>
</table>
3.7 Vocational Rehabilitation

Returning to work following ABI is probably the most challenging task that a patient will face in the course of their recovery. The work environment often produces stresses on their physical body, cognitive challenges, and emotional strain. However, given the financial burden of not being able to work for most individuals, it is a very important aspect of full reintegration into society and return to independent living. The research on assisting patients in their goal of returning to work is explored in the following section.

**Individual Studies**

**Table 3.10 Vocational Rehabilitation Post ABI**

<table>
<thead>
<tr>
<th>Author/Years</th>
<th>Country/Study Design</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrams et al., (1993) USA Case series</td>
<td>N=142 Cost-benefit analysis of subjects with TBI who participated in an individualized work reentry program.</td>
<td>During the first year of the program, 65% (92/142) obtained employment. During the entire observation period from October 1988 to June 1992, 75% (106/142) obtained employment. This resulted in a 2:1 ratio of total taxpayer benefit to total program operational cost and a 4:1 ratio of total taxpayer benefit to state cost.</td>
<td></td>
</tr>
<tr>
<td>Johnstone et al., (1999) USA Case series</td>
<td>N=110 Subjects were separated into 3 groups: successfully employed, services interrupted, and no services provided. The two former groups received services from the Missouri Division of Vocational Rehabilitation.</td>
<td>Individuals with the most significant TBI-related cognitive impairments benefited the most from vocational rehabilitation, and showed the most successful vocational outcomes.</td>
<td></td>
</tr>
<tr>
<td>Klonoff et al., (1998) USA Pre-Post</td>
<td>N=64 Subjects of various brain injury etiologies and severities treated at the ADHNR assessed. This study utilized two novel scales: Outcome rating Scale and the Functional Severity Index to assess outcome status and adjusted outcome accounting for such variables as working alliance and work readiness/eagerness.</td>
<td>At discharge, 89.5% showed a fair or good adjusted outcome, 62% were gainfully employed of full time students, with 15.6% returning to the same level of work or school as before the injury. Patient and family working alliance during treatment correlates with level of successful outcome.</td>
<td></td>
</tr>
<tr>
<td>Wehman et al., (1989) Case Series</td>
<td>N=20 Outcomes of subjects who sustained a severe head injury and their work histories pre and post injury</td>
<td>Findings suggest that 50% of participants remained in their first placement. No significant differences were noted for the number of jobs held (p=0.307) and hours worked per week (p=0.0841). Differences were noted in the hourly rates (pre to post injury) p=0.0491 and in the employment rations (pre to post injury) p&lt;0.001.</td>
<td></td>
</tr>
</tbody>
</table>
Discussion
There were three studies that dealt with the intervention of vocational rehabilitation. Amongst these, there was a cost-benefit analysis, a single group intervention and an outcome study.

In the cost-benefit analysis by Abrams et al. (1993), an individualized work reentry program was evaluated. Of the 142 persons with TBI who participated in the program, 65% obtained employment during the first year of entering the program and 75% obtained employment during the entire observation period. This resulted in a 2:1 ratio of total taxpayer benefit to total program operational cost and a 4:1 ratio of total taxpayer benefit to state cost.

Klonoff et al. (1998) looked at the adjusted outcome of sixty-four subjects who participated in the Adult Day Hospital for Neurological Rehabilitation Work/School Re-entry program. Adjusted outcome was defined as discharge productivity level modified by staff ratings of functional impairment severity at program admission. At discharge, 89.5% of the subjects displayed fair or good adjusted outcome and 10.5% of them displayed poor adjusted outcome. With regards to being gainfully employed or full-time students at discharge, 62.5% were, while 15.6% returned to the same level of work or school as pre-injury.

Johnstone et al. (1999) examined the relationship between receiving services from the Missouri Division of Vocational Rehabilitation and neuropsychological variables and vocational outcomes. They separated 110 patients into the following three groups: successfully employed, services interrupted, and no services provided. The results from Johnstone et al. (1999) suggest that even individuals with significant cognitive deficits can benefit from vocational rehabilitation services, and individuals should not therefore be deemed ineligible for such services based solely on neuropsychological test scores. Johnstone et al. (1999) also point out that individuals with less severe cognitive deficits may have successfully obtained employment on their own and did not require the assistance of vocational rehabilitation services. Thus, the subjects of their sample were for the most part individuals with significant cognitive deficits who needed the vocational rehabilitation services to successfully return to work.

Wehman et al. (1989) looked at the success of 20 individuals who had been referred for supported employment. Several others were initially referred but due to their age at injury they were not included in the final analysis. Employment specialists provided participants in the program with on the job support. Of the 20 that were included, at total of 24 placements were made of which 50% of participants remained in their first placement. Overall there were no significant differences in the number of jobs held by the group or in the numbers of hours the individuals worked across the 3 phases of employment (pre-injury work, post-injury work, supported employment). Differences
were noted in the hourly wages (with significant differences noted between the pre and post injury wages) and employment ratios (number of hours worked per week) with the post-injury employment ratio being significantly different from the pre and supported employment ratios. Overall Wehman et al. (1989) found that supported employment did help improve the vocational capacity of severely head injured individuals.

Summary

There is good reason to believe that vocational programs are useful in assisting patients with moderate to severe brain injury with their vocational goals. In doing so, the benefits to the individual financially and in terms of their self-esteem are great. In addition, there is an obvious savings to the taxpayer to have programs designed towards assisting patients with returning to work.

Conclusions

There is Level 4 evidence that vocational rehabilitation results in greater total taxpayer benefits than either total program operational costs or government costs.

There is Level 4 evidence that after vocational rehabilitation the majority of subjects have fair or good adjusted outcome, while more than half become gainfully employed or full-time students.

There is Level 4 evidence that individuals with the most significant cognitive impairments benefit the most from vocational rehabilitation services.

There is Level 4 evidence that individuals with severe head injury do benefit from supported employment services.
3.8 Supported Employment

Once a patient with brain injury has returned to competitive employment they are at a high risk for failure because of the lingering effects of their brain injury. Available evidence for assisting patients who are with coping with work-related stress due to their disability is reviewed in this section.

Individual Studies

Table 3.11 Supported Employment Post ABI

<table>
<thead>
<tr>
<th>Author/Year/Country/Study design</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gamble and Moore (2003) USA Case-Control</td>
<td>N=78 Subjects with TBI who received supported employment (treatment group) and 995 patients with TBI who did not receive supported employment (control group) during vocational rehabilitation were compared.</td>
<td>At the time of closure, 67.9% of the treatment group and 47% of the control group were competitively employed (p &lt; 0.003). However, the control group had significantly higher earnings per week than treatment group and the control group worked substantially more hours per week than treatment group. Additionally, both groups were equally employed in miscellaneous occupations at closure (43.4% of the treatment group versus 42.3% of the control group).</td>
</tr>
<tr>
<td>Wehman et al., (1990) USA Case series</td>
<td>N=53 Retrospective review of TBI individuals who were accepted for supported employment programs</td>
<td>Monthly employment ratio was 74.64% for 19 individuals who were employed 100% of the time.</td>
</tr>
</tbody>
</table>

Discussion

Only one study examined the effectiveness of supported employment (Gamble and Moore 2003). In this study, seventy-eight patients with TBI received supported employment (treatment group), while 995 patients with TBI did not receive supported employment (control group) during vocational rehabilitation. Supported employment consisted of on-the-job training and support for as long as the client needed. Closure status (competitive employment versus not working), occupational placements, weekly earnings, and hours worked each week were used as some of the main outcome measures. Overall, the authors found supported employment significantly improved the level of competitive employment as 67.9% of those who received supported employment versus 47% of those who did not receive supported employment were competitively employed at the time of closure (p < 0.003). Both groups were equally employed in miscellaneous occupations at closure (43.4% of the treatment group versus 42.3% of the control group). Gamble and Moore (2003) found that the provision of supported employment services contributed to competitive employment outcomes,
particularly for clients with 12 or more years of education, clients over 35 years of age, male clients, clients without prior work experience, and clients with severe TBI.

Wehman et al. (1990) found that 41 of the 53 patients enrolled in the program were placed in competitive employment. They also noted that the average number of hours worked per week for the group was 31.2 hours. Wehman et al. (1990) also found that most of the patients had reached a point of stability and independence on the job within 20 weeks of working. Even though there were successes (although no statistically significant findings were reported) with this program, they did note that their findings did provide reason for cautious optimism.

Summary
The evidence favoring the utilization of supported employment programs in order to maximize the earning potential of these individuals is limited. There is a clear need for more data in this area to delineate the most appropriate strategies to facilitate job retention, maximizing earnings, and achieve vocational success.

Conclusions

There is Level 3 evidence, from one case-control study and Level 4 evidence from one case series that supported employment improves the level of competitive employment outcomes particularly for ABI survivors who are older, have more education, have no prior work experience or who have suffered more severe injuries.

3.9 Support Groups
Living in the community following brain injury can often result in isolation and depression in individuals who no longer possess the capacity to seek help via appropriate means. Support groups are frequently organized in the community in order to diminish these feelings of isolation and provide assistance through group discussion forums.
Individual Studies

Table 3.12 Efficacy of Support Groups Post ABI

<table>
<thead>
<tr>
<th>Author/Year/Country/Study design</th>
<th>Methods</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armengol (1999) USA Case Series</td>
<td>N=6 Single group of Spanish-speaking high-level functioning persons with TBI who participated in a 10-week multimodal, culturally sensitive support group focusing on TBI sequelae education, relaxation techniques, coping skills development, behavioural goal setting and monitoring, and family participation.</td>
<td>Participants experienced a sense of personal destiny and improved feelings of hopelessness. These gains were maintained 1 year later and most participants were vocationally active.</td>
</tr>
<tr>
<td>Hibbard et al., (2002) USA Case Series</td>
<td>N=20 11 subjects with TBI (and 9 family members) who participated in a community-based peer support group program. Trained in a mentoring program. Measured Quality of Life, in a variety of areas.</td>
<td>82% reported enhanced feeling of empowerment. 67% enhanced Quality of Life. 36% major impact on communication skills. 46% some impact on communication skills. 18% enhanced family support.</td>
</tr>
<tr>
<td>Ownsworth et al., (2000) USA Pre-Post study</td>
<td>N=21 ABI subjects who participated in a 16-week group support programme that involved cognitive rehabilitation, cognitive-behavioural therapy, and social skills training.</td>
<td>At post-intervention, participants experienced significantly improved self-regulation skills and psychosocial functioning. These gains were maintained at a follow-up of 6 months.</td>
</tr>
</tbody>
</table>

Discussion

Three studies focused on the efficacy of support groups. While Armengol (1999) specifically examined a support group for Hispanic TBI survivors, Hibbard et al. (2002) evaluated a community-based support program for individuals with TBI and their family members and Ownsworth et al. (2000) evaluated a sixteen week group support program for twenty-one patients with ABI. In all three cases, significant results were found regarding improving feelings of hopelessness and being vocationally active in the first study, improving quality of life and coping with depression in the second study, and improving psychosocial functioning in the final study.

Summary

There is limited data to suggest that support groups are an appropriate means of providing a structure for individuals with brain injury to diminish feelings of isolation and depression. They appear to be an excellent vehicle for dissemination of information regarding living in the community with an ABI and provide direction to other resources if warranted. There is a need for further evaluation of these groups in order to define the most effective design of these programs.
Conclusions

Based on the findings from three non-experimental studies, there is Level 4 evidence that support groups generate positive results such as improving feelings of hopelessness, coping with depression, and improving psychosocial functioning.

Further research is required to evaluate the efficacy of brain injury rehabilitation in experimental studies.

Support groups generate such positive results as diminished feelings of hopelessness, improved coping with depression, and better psychosocial functioning.

3.10 Complete Care Pathways

The ultimate goal in any rehabilitation stream is to provide seamless care from the onset of injury to the ultimate recovery. As this chapter has demonstrated, the continuum of ABI care involves acute interventions with a transition to some combination of rehabilitation therapies. This section aims to identify studies which have compared pathways of care combining several rehabilitation strategies.

Individual Studies

Table 3.13 Complete Care Pathways for ABI

<table>
<thead>
<tr>
<th>Author/Year/Country/Study Design</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harradine et al., (2004) Australia</td>
<td>This paper describes the New South Wales statewide Brain Injury Rehabilitation Program and compares outcomes of rural patients compared with urban ones. Injury severity was comparable between groups. Similar scores were seen on the Disability Rating Scale, Mayo-Portland Adaptability Index, General Health Questionnaire, and Short Form 36</td>
</tr>
<tr>
<td>Author/Year/ Country/Study Design</td>
<td>Summary</td>
</tr>
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</tr>
<tr>
<td><strong>Data from patients enrolled in the Colorado Traumatic Brain Injury Registry and Follow-up System was accessed to determine care pathways followed by TBI patients. Six groups were identified; rehabilitation then home, rehabilitation then home with outpatient services, rehabilitation then LTC, LTC, home and home with patient services.</strong></td>
<td>The vast majority (64.5%) of patients were discharged directly home. Those with severe injuries and moderate injuries were 36 and 3 times more likely to undergo inpatient rehabilitation respectively. Being older, female and not a member of a minority group were also predictive of rehabilitation. Factors predicting an LTC pathway included injury severity, older age and having a governmental funding source. Older people and those with government funding sources were less likely to receive outpatient services. Participation in rehabilitation was associated with poor performance outcome except physical FIM scores. Finally, having been working at the time of injury predicted more favorable outcomes while being female, from a minority group or government funded were associated with poorer outcomes.</td>
</tr>
<tr>
<td><strong>Researchers implemented an integrated TBI program at a Montreal based trauma center and charted LOS and cost savings over a 6 year period. The integrated program included 5 stages; pre-hospital care, neurosurgical evaluation and procedure, ICU care, interdisciplinary TBI ward care and finally long-term rehabilitation at a rehabilitation facility, long term care facility or home.</strong></td>
<td>Over the 6 year period the integrated program decreased LOS from 30.5 to 12 days. After factoring in a $250,000 initial investment, the integrated program saved $21,798,923 over 6 years. An increase from 15.8% to 35% in the number of patients transferred to rehabilitation facilities was seen.</td>
</tr>
</tbody>
</table>

**Discussion**

These studies re-affirm many of the concerns already noted in this chapter. Brain injury displays significant heterogeneity and direct comparison of complete systems is difficult. All three papers identify similar foci for model of care design. Continuity and accessibility of services is crucial to allow a patient the greatest opportunities for rehabilitation while a multidisciplinary approach to rehabilitation with communication between stages is ideal. Also, regional differences in resource availability need to be
taken into consideration along with patient demographics so that the correct pathway decisions can be made.

Unfortunately, no matter what health care system is assessed, budgetary concerns play a role in the accessibility of care. As a result, difficult decisions need to be made regarding resource allocation. Mellick et al. (2003) list those being female, older, severely injured and not a member of a minority group as less likely to receive rehabilitation. While this is clearly the product of larger social issues, these facts need to be addressed when decisions regarding ABI care systems are being made. In a similar fashion, Khan et al. (2002) provide encouraging news regarding decreases in LOS and fiscal savings brought on by an integrated ABI system in Canada. The author points out that care needs to be taken to ensure that savings do not arise from sacrifices in quality of care but rather from the improvement of systematic inefficiencies. Finally, Harradine et al. (2004) note that co-ordination of regional facilities resulted in an equal availability of resources despite geographic challenges in New South Wales, Australia.

Conclusions

*There is insufficient evidence to draw any conclusions regarding the ideal structure of a complete model of ABI care.*
3.11 Summary

1. There is Level 2 evidence that patients cared for in a Level I trauma center achieve better outcomes than patients cared for in a Level II center.

2. There is Level 2 evidence that staff with more dedicated commitment to trauma care leads to better patient outcomes.

3. There is Level 2 evidence suggesting that a reduction in the time spent in acute care and in a rehabilitation facility does not have a negative impact on overall patient outcomes.

4. There is Level 2 evidence indicating the overall cost of care is higher for those who sustain a severe TBI versus those who sustain a moderate TBI.

5. There is Level 2 evidence that adherence to BTF guidelines for acute care results in improved outcomes and decreased mortality.

6. There is Level 4 evidence that inpatient rehabilitation improves self-care and mobility.

7. Based on the findings from two studies, there is Level 4 evidence that inpatient rehabilitation significantly improves functional outcome, as measured by the FIM.

8. There is Level 4 evidence that over a quarter of patients admitted to inpatient rehabilitation experience good outcome or moderate disability six months post-injury, as measured by the GOS.

9. Based on the findings from a single RCT, there is Level 1b evidence that increasing rehabilitation intensity reduces length of stay.

10. Based on the findings from a single RCT, there is Level 1b evidence that intensive rehabilitation improves functional outcome, as measured by FIM and GOS scores, at two and three months post-injury, but not necessarily at six months and beyond.

11. There is Level 2 evidence that multidisciplinary inpatient rehabilitation seems to be more effective than a single discipline approach.

12. There is Level 2 evidence that therapy intensity predicts motor functioning, but not cognitive gain.
13. There is a reciprocal relationship between cognitive function and community integration.

14. There is Level 4 evidence that patients with a long length of stay who receive high-intensity rehabilitation fair better on the Rancho Los Amigos Scale at discharge than those who receive low-intensity rehabilitation.

15. There is level 4 evidence that earlier time from injury onset to rehabilitation admission results in improved functional outcomes.

16. Based on the findings from several non-RCT studies, there is Level 2 evidence that early rehabilitation is associated with better outcomes such as shorter comas and lengths of stay, higher cognitive levels at discharge, better FIM scores and a greater likelihood of discharge to home.

17. There is Level 3 evidence that inpatient brain injury rehabilitation results in significantly greater gains in total FIM change, self-care, and social cognition for patients with TBI than patients with brain tumors. However, there are no statistically significant differences between the two groups regarding FIM efficiency and length of stay.

18. There is Level 3 evidence that inpatient rehabilitation results in a higher rate of change on functional measures in patients aged 18-54 than patients aged 55 years or older.

19. There is Level 2 evidence that readmission to inpatient rehabilitation at more than twelve months post-injury is related to statistically significant improvement on the BI at discharge for over 50% of patients.

20. Based on the findings from one case series, there is Level 4 evidence that inpatient rehabilitation results in successful return to work and return to duty for the majority of military service members.

21. There is Level 2 evidence that a transitional living setting during the last weeks of inpatient rehabilitation results in greater independence in activities of daily living than inpatient rehabilitation alone.

22. There is Level 1b evidence that a fitness center-based program is not better than a home-based program for improving cardio-respiratory fitness.

23. There is Level 1b evidence that multidisciplinary outpatient rehabilitation may improve functional outcomes up to one year post discharge.
24. There is level 2 evidence that varied outpatient therapy can be used to improve varied targeted outcomes.

25. There is Level 2 evidence that behavioural and cognitive skills post ABI can be improved by participating in neurorehabilitation or neurobehavioural programs.

26. There is Level 1 evidence that structured multidisciplinary rehabilitation in community setting can improve social functioning.

27. There is Level 4 evidence that community-based social and behavioural rehabilitation of at least six months results in greater independence, higher social activity levels, and less need for care support.

28. There is Level 4 evidence that patients with a dual-diagnosis of TBI and substance abuse who participate in a community-based treatment program generally do not become chemical-free. This is due to both an inability to keep them in the program for the six-month period desired and the failure of clients to follow recommendations for additional rehabilitation or psychiatric treatment at discharge.

29. There is Level 2 evidence from one RCT that direct patient involvement in neurorehabilitation goal setting results in a significant improvement in obtaining goals from pre-test to post-test that are then maintained at a follow-up of two months.

30. Based on the findings from two pre-post studies, there is Level 4 evidence that participation in a comprehensive day treatment program reduces impaired self-awareness and distress. It also improves societal participation at one-year follow-up.

31. There is Level 2 evidence suggesting rehabilitation issues regarding communication and employment are present years post rehabilitation.

32. There is Level 1b evidence that a fitness center-based program is not better than a home-based program for improving cardio-respiratory fitness.

33. There is Level 1 evidence that multidisciplinary outpatient rehabilitation may improve functional outcomes up to one year post discharge.

34. There is level 2 evidence that varied outpatient therapy can be used to improve varied targeted outcomes.
35. There is Level 2 evidence that behavioural and cognitive skills post ABI can be improved by participating in neurorehabilitation or neurobehavioural programs.

36. There is Level 1 evidence that structured multidisciplinary rehabilitation in community setting can improve social functioning.

37. There is Level 4 evidence that community-based social and behavioural rehabilitation of at least six months results in greater independence, higher social activity levels, and less need for care support.

38. There is Level 4 evidence that patients with a dual-diagnosis of TBI and substance abuse who participate in a community-based treatment program generally do not become chemical-free. This is due to both an inability to keep them in the program for the six-month period desired and the failure of clients to follow recommendations for additional rehabilitation or psychiatric treatment at discharge.

39. There is Level 2 evidence from one RCT that direct patient involvement in neurorehabilitation goal setting results in a significant improvement in obtaining goals from pre-test to post-test that are then maintained at a follow-up of two months.

40. Based on the findings from two pre-post studies, there is Level 4 evidence that participation in a comprehensive day treatment program reduces impaired self-awareness and distress. It also improves societal participation at one-year follow-up.

41. There is Level 2 evidence suggesting rehabilitation issues regarding communication and employment are present years post rehabilitation.

42. There is Level 4 evidence that vocational rehabilitation results in greater total taxpayer benefits than either total program operational costs or government costs.

43. There is Level 4 evidence that after vocational rehabilitation the majority of subjects have fair or good adjusted outcome, while more than half become gainfully employed or full-time students.

44. There is Level 4 evidence that individuals with the most significant cognitive impairments benefit the most from vocational rehabilitation services.

45. There is Level 4 evidence that individuals with severe head injury do benefit from supported employment services.
46. There is Level 3 evidence, from one case-control study and Level 4 evidence from one case series, that supported employment improves the level of competitive employment outcomes particularly for ABI survivors who are older, have more education, have no prior work experience or who have suffered more severe injuries.

47. Based on the findings from three non-experimental studies, there is Level 4 evidence that support groups generate positive results such as improving feelings of hopelessness, coping with depression, and improving psychosocial functioning.

48. Further research is required to evaluate the efficacy of brain injury rehabilitation in experimental studies.

49. There is insufficient evidence to draw any conclusions regarding the ideal structure of a complete model of ABI care.
3.12 Reference List


