



ORIGINAL RESEARCH

How Do Intensity and Duration of Rehabilitation Services Affect Outcomes From Severe Traumatic Brain Injury? A Natural Experiment Comparing Health Care Delivery Systems in 2 Developed Nations

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Abstract

Objective: To determine the effects of inpatient and outpatient treatment intensity on functional and emotional well-being outcomes at 1 year after severe traumatic brain injury (TBI).

Design: Prospective, quasiexperimental study comparing outcomes in a U.S. TBI treatment center with those in a Denmark (DK) center providing significantly greater intensity and duration of rehabilitation.

Setting: Inpatient and outpatient TBI rehabilitation.

Participants: Persons with severe TBI (N=274).

Interventions: Inpatient rehabilitation interventions were counted daily by discipline. Outpatient treatments were estimated per discipline using a structured interview administered to patients, caregivers, or both, at 12 months.

Main Outcome Measures: FIM, Glasgow Outcome Scale—Extended, Disability Rating Scale, Participation Assessment with Recombined Tools—Objective, Perceived Quality of Life, Medical Outcomes Study 12-Item Short-Form Health Survey, Brief Symptom Inventory—18-item version.

Results: Despite identical inclusion criteria, patient severity on admission was greater at the DK site. After adjustment for patient/injury characteristics, there were no site differences in either functional or emotional outcome at 12 months. Significantly more inpatient plus outpatient treatment was administered to DK patients than to those in the U.S. For functional but not emotional treatments, more severely impaired patients received higher doses. One-year outcomes were predicted by admission severity, age, employment, and other baseline characteristics.

Conclusions: Contrary to expectation, DK patients who received significantly more rehabilitation services during the year after severe TBI did not differ in outcome from their less intensively treated U.S. counterparts, after adjusting for initial severity. The negative association of functional treatment dose with extent of early disability suggests that dose was driven by unmeasured factors reflecting need for services. Improved measures of injury-related factors driving treatment allocation are needed to model the independent effects of treatment on outcomes.

Archives of Physical Medicine and Rehabilitation 2016; ■: ■ ■ ■ - ■ ■ ■ ■

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Supported by the Department of Education, National Institute on Disability and Rehabilitation Research (grant nos. H133A070040, H133A120037). However, these contents do not necessarily represent the policy of the Department of Education, and you should not assume endorsement by the Federal Government. Also supported by the Danish Nurses Association and the Novo Nordisk Foundation. The funders had no role in the design and conduct of the study; collection, management, analysis, or interpretation of the data; preparation, review, or approval of the manuscript, and decision to submit the manuscript for publication.

Disclosures: none.

Severe traumatic brain injury (TBI) often leads to potentially lifelong functional and psychosocial limitations.¹ Thus the need for specialized health services is great, from emergency care to inpatient and outpatient rehabilitation. In the U.S., the duration of inpatient TBI rehabilitation has dropped sharply, from a mean of about 23 days in 2000 to 17 days in 2007, a 26% decrease, with corresponding decreases in FIM gain, FIM discharge scores, and the proportion of patients discharged to the community.² Inpatient rehabilitation is progressively limited to fewer patients: people with moderate TBI may receive only outpatient services, and many with severe TBI receive less intensive rehabilitation at skilled nursing facilities because of regulations limiting admission to those who need and can tolerate 3 hours of therapy daily.³ Moreover, the caps on outpatient services for many survivors of TBI may limit outcomes and place additional responsibilities on families to provide care.

How can research illuminate the relationship between the amount or intensity of rehabilitation services, and the ultimate outcomes of TBI? For ethical reasons, it is difficult to mount a randomized controlled trial comparing shorter to longer lengths of stay in a rehabilitation hospital. Previous randomized controlled trials comparing different intensities or durations of rehabilitation have been limited in power⁴ or scope—for example, concerned with only 1 discipline.⁵ Observational studies are typically confounded because variations in patient need drive much of the variation in services. Since patients with greater service needs also tend to have greater disability, one may reach the spurious conclusion that more rehabilitation leads to worse outcomes.⁶⁻⁸ Even in large observational studies, such as those using the practice-based evidence methodology that has recently been applied to TBI,⁹ it is presumably not possible to measure and control for all the decision factors that lead clinicians to select treatment contents or intensities for individual patients.

Cross-national studies may offer a solution, if services vary among nations for reasons other than differences in patient needs. A study¹⁰ attempting to compare TBI rehabilitation outcomes in the U.S. and Argentina also highlighted the need to compare nations with similar cultural values and expectations about patients' return to community life.

The current study was conceived as a "natural experiment"—that is, a quasiexperimental design—comparing 1-year outcomes of patients with severe TBI treated in a specialized U.S. inpatient rehabilitation facility with those of a similar specialized TBI service system in Denmark (DK), where the continuum of acute and postacute health care services is funded by the government. Discussions focused on site comparison before beginning the study revealed that the 2 centers admitted roughly comparable patients, attempted to practice evidence-based

rehabilitation, had similar teams and mixes of therapies, and shared cultural expectations for return to maximal independence. The key difference was that the DK center afforded inpatient rehabilitation services more than twice as long, on average, to patients with severe TBI, in addition to outpatient services. We reasoned that if patients were comparable in terms of initial severity of TBI, we could attribute differences in 1-year outcomes to the longer inpatient rehabilitation stay, in addition to other differences in service organization. To this end, we measured as precisely as possible every inpatient and outpatient treatment received by participants from inpatient rehabilitation to the 1-year outcome evaluation. We compared 1-year functional outcomes and emotional well-being outcomes between the 2 sites, adjusting for case mix and using the detailed treatment information in an attempt to relate treatment type and intensity to outcomes. We hypothesized that DK patients would experience superior adjusted outcomes, and that increased intensity/duration of treatments during the year after TBI would mediate this relative advantage.

Methods

Participants

Patients with TBI consecutively admitted for inpatient rehabilitation at MossRehab's Drucker Brain Injury Center in the U.S. and Clinic of Neurorehabilitation/TBI Unit in Copenhagen, DK from October 2007 to October 2012 were screened for inclusion. Inclusion criteria were as follows: (1) diagnosis of nonpenetrating TBI; (2) age ≥ 16 years; (3) Glasgow Coma Scale score ≤ 8 during the first 24 hours (not caused by sedation); and (4) direct transfer from acute care to inpatient rehabilitation. All Moss participants were enrolled in the TBI Model Systems longitudinal database.¹¹ Exclusion criteria were as follows: (1) intentional injury (because of an expected overrepresentation of such injuries in the U.S.); (2) likelihood of discharge to a different country; and (3) serious preinjury neurologic or psychiatric disability (eg, schizophrenia, stroke, or Parkinson disease). The reason for the latter exclusion is that the existence of a serious brain disorder before TBI could limit the ability to benefit from rehabilitation and thus confound the interpretation of results. A total of 274 patients were enrolled, 145 from the U.S. and 129 from DK.

Measures and procedures

Demographics included age, sex, education, and employment status at the time of injury. Injury severity was measured by time to follow commands (TFC), defined as the number of days from injury until the patient is able to follow simple commands on 2 consecutive occasions within 24 hours. For 5 participants who never followed commands during the rehabilitation stay, we used the days between injury and rehabilitation discharge + 1 as a gross estimate of TFC. Time from injury to rehabilitation admission was recorded, along with 4 medical complications at rehabilitation admission: pressure ulcers, limitations in range of motion, tracheostomy, and feeding tube. These were each scored as present or absent, meaning that complication scores ranged from 0 to 4. We also captured the rehabilitation admission FIM that was routinely scored by the interdisciplinary teams.

Social history was determined by interview with participants, or proxies if necessary, and included an alcohol history assessed with the Brief Michigan Alcohol Screening Test¹² and whether or

List of abbreviations:

BSI-18	Brief Symptom Inventory—18-item version
DK	Denmark
DRS	Disability Rating Scale
GOS-E	Glasgow Outcome Scale—Extended
PART-O	Participation Assessment with Recombined Tools—Objective
PQOL	Perceived Quality of Life Scale
SF-12	Medical Outcomes Study 12-Item Short-Form Health Survey
TBI	traumatic brain injury
TFC	time to follow commands

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