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ORIGINAL RESEARCH

Effects of Patient Preinjury and Injury Characteristics on Acute Rehabilitation Outcomes for Traumatic Brain Injury

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Abstract

Objective: To examine associations of patient and injury characteristics with outcomes at inpatient rehabilitation discharge and 9 months postdischarge for patients with traumatic brain injury (TBI).

Design: Prospective, longitudinal observational study.

Setting: Inpatient rehabilitation centers.

Participants: Consecutive patients (N=2130) enrolled between 2008 and 2011, admitted for inpatient rehabilitation after index TBI, and divided into 5 subgroups based on rehabilitation admission FIM cognitive score.

Interventions: Not applicable.

Main Outcome Measures: Rehabilitation length of stay, discharge to home, and FIM at discharge and 9 months postdischarge.

Results: Severity indices increased explained variation in outcomes beyond that accounted for by patient characteristics. FIM motor scores were generally the most predictable. Higher functioning subgroups had more predictable outcomes then subgroups with lower cognitive function at admission. Age at injury, time from injury to rehabilitation admission, and functional independence at rehabilitation admission were the most consistent predictors across all outcomes and subgroups.

Conclusions: Findings from previous studies of the relations among patient and injury characteristics and rehabilitation outcomes were largely replicated. Discharge outcomes were most strongly associated with injury severity characteristics, whereas predictors of functional independence at 9 months postdischarge included both patient and injury characteristics.

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A plethora of rehabilitation investigations have examined how outcomes of traumatic brain injury (TBI) are affected by preinjury differences among patients and characteristics of the injury itself. These factors are immutable sources of variance in outcomes and must be accounted for to appreciate the contribution of time, treatment, environment, and other modifiable aspects of the rehabilitation process. Although the severity of the TBI holds considerable variance that can be captured via multiple direct and indirect measures, concomitant injuries and the health and well-being of the individual at time of injury have been found to contribute important, independent variance to outcomes. However, to date, studies have not comprehensively examined the amount of variance explained when the full range of potential predictive factors is considered together.

Severity of the index TBI has been measured via multiple behavioral observation scores that capture the extent of altered consciousness (eg, Glasgow Coma Scale, time to follow commands, length of loss of consciousness, length of posttraumatic amnesia)[1-8] and via indicators of the structural integrity of the brain (eg, skull fracture, hemorrhage, hematoma, intracranial pressure, midline shift).[1,4-8] Treatments required during acute trauma care (eg, chemical paralysis, craniotomy, time in the intensive care unit) also may predict later outcomes; however, the amount of variance is often small and only evident if indicators of posttrauma status are not included in prediction models. Cause of injury often contains variance related to injury severity because, in general, different causes involve greater (eg, vehicular collisions) or lesser (eg, falls) energy exchange with the brain. Cause of injury is also related to age (eg, very young and very old are the most likely to fall) and socioeconomic status (eg, violence-related injuries).[9] Intoxication at time of injury has been found to both be associated with greater injury severity and to be protective of it—a puzzling finding made complicated by the influence of intoxication on the behavioral presentation used to judge injury severity.[10] Several variables that capture the patient's status on admission to rehabilitation appear to be a proxy for the severity of the index injury and hold considerable predictive power for rehabilitation outcomes (eg, time from injury to rehabilitation admission, functional independence at admission, presence of agitation or other pathognomonic signs).[2,11,12]

Injuries to other parts of the body also contribute to outcomes, including facial fractures, injuries to extremities, and organ damage.[4,13] The Comprehensive Severity Index (CSI) is a disease-specific severity assessment system that combines indices of the index TBI, concomitant injuries, and preinjury morbidities. The CSI generates severity scores using physical examination findings, vital signs, and laboratory results at specified levels of abnormality found in a patient's chart. In the current study, the CSI score was segmented into signs and symptoms directly related to the brain injury versus all remaining severity symptoms.[14]

Among patient preinjury characteristics, age at injury has always accounted for the most variance in outcomes.[1-3] For adolescents and adults, generally worse outcomes are associated with older age, a relation that appears to accelerate among older adults.[15,16] Premorbid compromise to the central nervous systems also contributes to outcomes, particularly prior acquired brain injuries, intellectual impairment, or developmental disability.[17]

List of abbreviations:

CSI **Comprehensive Severity Index**
LOS **length of stay**
TBI **traumatic brain injury**

Among premorbid issues, behavioral health problems in particular appear to contribute to later outcomes, including psychiatric and substance use disorders.[18-20] The integrity of the brain preinjury adds to outcomes, with education often used as an indicator of one's cognitive reserve.[21,22]

Another class of preinjury characteristics that contributes to outcomes is financial and social capital—one's social, financial, and environmental resources that may mitigate the impact of TBI. Factors that reflect these resources include preinjury employment, household income, marital status, and primary insurance.[23] Socioeconomic status is a component of this class of variables and is associated with access to resources, health status, and behavioral predispositions. Socioeconomic status has been studied extensively as a driver of health disparities, which in rehabilitation outcomes research is often inferred from a patient's source of primary insurance.[4,24]

A detailed account of the design and methods of the Traumatic Brain Injury−Practice Based Evidence study are provided in the initial article in this supplemental issue.[14] The current study addressed the question: When considered together, how much do nonmodifiable preinjury and injury characteristics explain variations in outcomes at discharge (discharge FIM motor and cognitive scores, length of stay [LOS], discharge to home) and 9 months after discharge (FIM motor and cognitive scores)? We were not trying to build prediction models for future use, but we were trying to understand the importance of patient and injury factors related to outcomes in this sample.

Methods

Patients with a primary diagnosis of TBI who were consecutively admitted to 10 acute inpatient rehabilitation facilities between October 2008 and September 2011 were enrolled in the Traumatic Brain Injury−Practice Based Evidence study. The methodology of the study is fully described elsewhere, including participating facilities, patient selection criteria, validity and reliability of data collection instruments, and a detailed description of the cohort.[14] The 10 rehabilitation programs from which participants were recruited constituted a convenience sample; however, the sample for the study closely resembled the U.S. population of persons aged ≥16 years receiving acute rehabilitation for a primary diagnosis of TBI.[14] The institutional review board at each center approved the study, and informed consent was solicited from each participant or his/her proxy.

Participants

All participants in the study (N=2130) had (1) sustained a TBI, defined as damage to brain tissue caused by an external force and evidenced by loss of consciousness, posttraumatic amnesia, skull fracture, or objective neurologic findings; (2) received inpatient care at 1 of the 10 participating facilities; and (3) were at least 14 years of age on entry into the facility. Homogenous patient subgroups were formed using the FIM cognitive score on admission to rehabilitation. The 5 subgroups were as follows: scores ≤6 (n=339), 7 to 10 (n=374), 11 to 15 (n=495), 16 to 20 (n=408), and ≥21 (n=504). Ten patients missing admission FIM cognitive scores were not included in the analyses. More details about these subgroups are presented elsewhere.[14]

All variables reflecting patient and injury characteristics that were eligible for inclusion in prediction models are shown in table 1. Only variables actually included in at least 1 final model are described here. Data were primarily abstracted from the