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ORIGINAL ARTICLE

Do Rehospitalization Rates Differ Among Injury Severity Levels in the NIDRR Traumatic Brain Injury Model Systems Program?

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Abstract

Objective: To compare the rate and nature of rehospitalization in a cohort of patients enrolled in the National Institute on Disability and Rehabilitation Research Traumatic Brain Injury Model Systems (TBIMS) who have disorders of consciousness (DOC) at the time of rehabilitation admission with those in persons with moderate or severe traumatic brain injury (TBI) but without DOC at rehabilitation admission.

Design: Prospective observational study.

Setting: Inpatient rehabilitation within TBIMS with annual follow-up.

Participants: Of 9028 persons enrolled from 1988 to 2009 (N=9028), 366 from 20 centers met criteria for DOC at rehabilitation admission and follow-up data, and another 5132 individuals met criteria for moderate (n=769) or severe TBI (n=4363).

Interventions: Not applicable.

Main Outcome Measures: Participants and/or their family members completed follow-up data collection including questions about frequency and nature of rehospitalizations at 1 year postinjury. For the subset of participants with DOC, additional follow-up was conducted at 2 and 5 years postinjury.

Results: The DOC group demonstrated an overall 2-fold increase in rehospitalization in the first year postinjury relative to those with moderate or severe TBI without DOC. Persons with DOC at rehabilitation admission have a higher rate of rehospitalization across several categories than persons with moderate or severe TBI.

Conclusions: Although the specific details of rehospitalization are unknown, greater injury severity resulting in DOC status on rehabilitation admission has long-term implications. Data highlight the need for a longitudinal approach to patient management.

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With ongoing advances in health care service delivery, a greater number of those with the most neurologically devastating brain injuries are surviving. These severely injured patients include those with disorders of consciousness (DOC), including coma, vegetative state (VS), and minimally conscious state (MCS). Although mortality rates vary for the DOC subpopulations, there is sparse scientific knowledge regarding the longitudinal medical course of individuals with DOC.[1-9] Patients with moderate to severe traumatic brain injury (TBI) experience higher rates of complications such as pneumonia, seizures, and suicide.[10,11] Studies of all TBI rehabilitation admissions demonstrate an annual incidence of rehospitalization of approximately 15% to 20% for the first 5 years after injury.[12,13] Common readmission reasons in declining order of frequency include orthopedic or reconstructive procedures, general health maintenance, infections, seizures, and psychiatric disorders. However, these studies did not differentiate the rate or nature of complications experienced by patients with TBI and persistent DOC.

Speculation exists that individuals with greater TBI injury severity (ie, persistent DOC) may require specialized expertise in acute and postacute stages of recovery. Ongoing recovery as well as medical complications may require rehospitalization to access specific specialties. However, it is not clear whether patients with DOC have unique medical and rehabilitation needs. A better understanding of the incidence and types of rehospitalization for different levels of injury severity would help elucidate the unique needs for those with the greatest level of injury severity to optimize their long-term care, to minimize complications, and to enhance functional recovery.

This cross-sectional investigation uses a secondary analysis of a prospective, multicenter, longitudinal dataset to assess rate and types of rehospitalization in the first year postinjury for individuals with moderate, severe, and DOC TBI admitted to inpatient neurorehabilitation. Additionally, rehospitalization rates were examined for the DOC cohort during years 2 and 5 postinjury, with anticipation that individuals with DOC have greater utilization of services. Lastly, implications for further research and clinical management are discussed.

Methods

Participants

Participants were enrolled prospectively in the National Institute on Disability and Rehabilitation Research (NIDRR) TBI Model Systems (TBIMS) national database, a multicenter longitudinal study of TBI outcomes. Currently, there are 16 sites across the country enrolling subjects in the database, which has been in existence since 1988. Criteria for the NIDRR TBIMS program include the following: (1) medically documented TBI; (2) treatment at an affiliated level I trauma center within 24 hours of injury; (3) receipt of inpatient rehabilitation within the Model System; (4) admission to inpatient rehabilitation within 72 hours of discharge from acute care; (5) age $\geq$16 years at the time of injury; and (6) provision of informed consent by the person with injury or a legal proxy.[14] Study-specific inclusion criteria included moderate to severe TBI. Individuals with moderate TBI were defined by an emergency department (ED) Glasgow Coma Scale (GCS) score of 9 to 12, and the ability to follow commands on rehabilitation admission. Individuals with severe TBI were defined by an ED GCS score of 3 to 8, and the ability to follow commands on rehabilitation admission. To identify persons with DOC, the following previously published criteria[15] were used: (1) unconscious on rehabilitation admission (ie, no prior observation of 2 consecutive days of command-following from acute care record review); (2) GCS motor score <6 on rehabilitation admission (item derived from the Disability Rating Scale [DRS] assessment obtained on rehabilitation admission); and (3) eligibility for at least 1 year of follow-up. Exclusion criteria for DOC included (1) individuals with missing command-following data (ie, duration of unconsciousness) from acute care records; and (2) individuals with missing GCS motor scores on rehabilitation admission. Additional exclusion criteria included (1) mild injury (ED GCS score, 13−15); and (2) no follow-up interview with TBI survivor or family member. A follow-up interview was attempted for participants living in alternative settings (eg, nursing homes) to maximize the representativeness of the follow-up data. All TBIMS participants provided informed consent directly or by legal proxy.

List of abbreviations:

CI	**confidence interval**
DOC	**disorders of consciousness**
DRS	**Disability Rating Scale**
ED	**emergency department**
GCS	**Glasgow Coma Scale**
IRR	**incidence rate ratio**
LSM	**least squares mean**
MCS	**minimally conscious state**
NIDRR	**National Institute on Disability and Rehabilitation Research**
TBI	**traumatic brain injury**
TBIMS	**TBI Model Systems**
TFC	**time to follow commands**
VS	**vegetative state**

Measures

TBIMS form 2 follow-up question regarding rehospitalization (2004−2012)

The wording varied depending on the timing of the follow-up call. At the 1-year injury anniversary, the participant was asked, "Since your discharge from the rehab center have you stayed overnight in a hospital because you were ill or injured?" while on the subsequent year 2 and 5 follow-up interviews the individual was asked, "In the past year, have you stayed overnight in a hospital because you were ill or injured?" Before 2004, the TBIMS made annual calls as opposed to skipping from year 2 to year 5, and thus, at that time the participants were asked, "Since your last evaluation (data collection call) have you stayed overnight in a hospital because you were ill or injured?"

If the answer to the question is "yes," ask for each admission: "What was the reason for your admission?"

Examples within each rehospitalization category are provided in table 1. Trained research assistants then code hospitalizations into the following categories: 0, rehabilitation (inpatient); 1, seizures; 2, neurologic disorder (nonseizure); 3, psychiatric; 4, infectious; 5, orthopedic; 6, general health maintenance; 7, other (not specified elsewhere); 8, not applicable (no rehospitalization/no further rehospitalizations); 9, rehospitalized (reason unknown); 99, unknown.

Procedure

Trained TBIMS research assistants collected information regarding injury severity (GCS, time to follow commands [TFC]) from hospital and emergency medical service records. Demographic