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ORIGINAL RESEARCH

Readmission to an Acute Care Hospital During Inpatient Rehabilitation for Traumatic Brain Injury

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Abstract

Objective: To assess the incidence of, causes for, and factors associated with readmission to an acute care hospital (RTAC) during inpatient rehabilitation for traumatic brain injury (TBI).

Design: Prospective observational cohort.

Setting: Inpatient rehabilitation.

Participants: Individuals with TBI admitted consecutively for inpatient rehabilitation (N = 2130).

Interventions: Not applicable.

Main Outcome Measures: RTAC incidence, RTAC causes, rehabilitation length of stay (RLOS), and rehabilitation discharge location.

Results: A total of 183 participants (9%) experienced RTAC for a total of 210 episodes. Of 183 participants, 161 patients experienced 1 RTAC episode, 17 had 2, and 5 had 3. The mean time from rehabilitation admission to first RTAC was 22±22 days. The mean duration in acute care during RTAC was 7±8 days. Eighty-four participants (46%) had ≥1 RTAC episodes for medical reasons, 102 (56%) had ≥1 RTAC episodes for surgical reasons, and 6 (3%) participants had RTAC episodes for unknown reasons. Most common surgical RTAC reasons were neurosurgical (65%), pulmonary (9%), infection (5%), and orthopedic (5%); most common medical reasons were infection (26%), neurological (23%), and cardiac (12%). Any RTAC was predicted as more likely for patients with older age, history of coronary artery disease, history of congestive heart failure, acute care diagnosis of depression, craniotomy or craniectomy during acute care, and presence of dysphagia at rehabilitation admission. RTAC was less likely for patients with higher admission FIM motor scores and education less than high school diploma. RTAC occurrence during rehabilitation was significantly associated with longer RLOS and smaller likelihood of discharge home.

Conclusions: Approximately 9% of patients with TBI experienced RTAC episodes during inpatient rehabilitation for various medical and surgical reasons. This information may help inform interventions aimed at reducing interruptions in rehabilitation for RTAC. RTACs were associated with longer RLOS and discharge to an institutional setting.

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Individuals with traumatic brain injury (TBI) are at risk for a range of medical complications,[1-8] which may result in the need for readmission to an acute care hospital (RTAC) after the original acute care hospital discharge to acute inpatient rehabilitation. Some rehopitalizations may be planned for elective procedures (such as cranioplasty, orthopedic surgery, or reconstructive surgery), whereas others may be unplanned and disrupt the intended course of acute inpatient rehabilitation. Some RTACs that occur soon after acute care discharge are considered "potentially preventable" and an indicator of substandard quality of care by some payer sources and quality-monitoring organizations.[9] Identifying "potentially preventable" disorders that cause RTAC during acute

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rehabilitation and reducing these RTAC occurrences are of particular relevance under the Affordable Care Act.[10] In accordance with the Affordable Care Act, the Centers for Medicare and Medicaid Services (CMS), a primary payer for acute and rehabilitation services in the United States, has established a goal to reduce inappropriate readmission rates while improving quality of care and safety.[11]

In a general inpatient rehabilitation sample (mixed diagnoses) from 1980 to 1986, Siegler et al[12] found that 33% of patients admitted to rehabilitation developed acute complications and 44% of those (or 14.7% of the entire rehabilitation sample) were severe enough to warrant RTAC, with the most common conditions noted as surgical (23%), infection (17%), and thromboembolic events (16%). In a more recent study, Faulk et al[13] (2009−2011) observed 10.9% RTACs, with top causes being respiratory (27%), infections (22%), and cardiac (11%). Comorbid medical conditions, such as those that may lead to RTAC, may affect rehabilitation outcome,[14,15] length of stay,[14,16] and treatment costs.[17]

Published studies of RTAC rates and causes during inpatient rehabilitation for TBI are sparse. Deshpande et al[18] reported that 22 of 100 patients with TBI returned to acute care at least once during inpatient rehabilitation. Of note, this single-site study reviewed cases from 1992 to 1994 when the mean rehabilitation length of stay (RLOS) for individuals had only recently decreased by several months because of greater attention by insurance payers on RLOS. Each year from 2005 to 2008, the Uniform Data System for Medical Rehabilitation of inpatient brain injury rehabilitation observed a range of 10.1% to 10.9% discharges to acute care and 1.0% to 1.3% program interruptions.[19] Deshpande found statistically significant associations with a recent history of pneumonia or recent surgery during the acute care hospital stay. After TBI, the common medical complications noted in the acute care setting include sepsis, respiratory infections, hypertension, severe respiratory failure, acute kidney injury, diabetes, cardiac arrhythmias, fluid and electrolyte disorders, and extremity fractures,[1-4] and during inpatient rehabilitation common disorders include hydrocephalus, seizures, paroxysmal autonomic dysfunction, ventricular dilatation, abnormal liver function, hypertension, thrombophlebitis, respiratory infections, heterotopic ossification, fractures, and pituitary-hypothalamic dysfunction, psychiatric and behavioral disturbances, and problems with eyes, ears, nose, and throat.[5-8,18,20]

In individuals with disordered consciousness receiving acute inpatient rehabilitation for severe TBI, Whyte et al[21] found that patients admitted to rehabilitation (who were deemed medically stable for a research trial) on average experienced a rate of 0.4 complications per week per patient, with >80% experiencing at least 1 new medical complication during the 6-week observation period during inpatient rehabilitation. Newly documented medical complications included hypertonia, agitation/aggression, urinary tract infection, and sleep disturbance, and new complications that were considered severe included hydrocephalus, pneumonia, gastrointestinal problems, and paroxysmal sympathetic hyperactivity. In addition to potentially causing RTAC, these medical conditions can pose significant barriers to successful rehabilitation as well as lead to increased RLOS, cost of care, and mortality.[22,23]

The potential costs, disrupted rehabilitation progress, and effect on outcome that may stem from RTAC make it critical to identify and understand the medical factors, resources, and processes that contribute to RTAC after admission to inpatient rehabilitation. The relation between medical complications and other factors leading to RTAC is complex, with potential contribution from underlying TBI severity, acute medical complications, chronic medical conditions, functional status, and patient care processes.[12,13,17,18,24] The primary aim of this study was to describe the medical complications that prompted an RTAC episode during inpatient rehabilitation for TBI by assessing the incidence of, reasons for, and factors associated with RTACs. A secondary aim was to evaluate the relation between RTACs and outcomes at rehabilitation discharge as measured by rehabilitation disposition and RLOS.

List of abbreviations:

BMI	**body mass index**
CMS	**Centers for Medicare and Medicaid Services**
GCS	**Glasgow Coma Scale**
PBE	**practice-based evidence**
RLOS	**rehabilitation length of stay**
RTAC	**readmission to an acute care hospital**
TBI	**traumatic brain injury**

Methods

This study is based on the prospective observational TBI-PBE (practice-based evidence) Project. The TBI-PBE Project was a 5-year, multicenter investigation of the TBI inpatient rehabilitation process for 2130 patients.[25] The introductory article[25] in this series of articles about the TBI-PBE Project describes the study design, including the PBE research methodology, inclusion criteria, data sources, and analysis plan. The study sites included 9 inpatient rehabilitation facilities in the United States and 1 in Canada. Approval was obtained from the institutional review board at each center. Participants were 14 years or older, gave (or their parent/guardian gave) informed consent, and were admitted to the facility's adult brain injury inpatient rehabilitation unit for initial rehabilitation after TBI. Trained personnel recorded and collected data from patient and family interviews and abstraction of inpatient rehabilitation medical records using standardized procedures and >95% accuracy.

Variables

Premorbid variables studied for association with RTAC included sex, race, age, education level, employment status, drug and alcohol use, and cause of injury. It was noted whether the original (at the time of injury) acute medical care was provided at an in-system (associated with the rehabilitation center) or an out-of-system (not associated with the rehabilitation center) hospital. The Glasgow Coma Scale (GCS) after resuscitation in the emergency department, CT scan findings during the first 7 days after injury, duration of posttraumatic amnesia, and time from injury to rehabilitation admission were used to describe injury severity. Height and weight at the time of rehabilitation admission were collected to calculate body mass index (BMI), and the World Health Organization's BMI category classifications were used. The Comprehensive Severity Index, the study's principal medical severity measure, was used to score the extent of deviation from the normal physiological status for each diagnosis including each medical complication and comorbidity present during the first 3 days after rehabilitation admission.[26] Higher Comprehensive Severity Index scores denote increased medical severity. We also noted primary payer and several medical conditions or procedures