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ORIGINAL ARTICLE

Medical Comorbidities in Disorders of Consciousness Patients and Their Association With Functional Outcomes

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Abstract

Objective: To identify, for patients in states of seriously impaired consciousness, comorbid conditions present during inpatient rehabilitation and their association with function at 1 year.

Design: Abstracted data from a prospective cross-sectional observational study with data collection occurring January 1996 through December 2007.

Setting: Four inpatient rehabilitation facilities in metropolitan areas.

Participants: The study sample of 68 participants is abstracted from a database of 157 patients remaining in states of seriously impaired consciousness for at least 28 days.

Interventions: Not applicable.

Main Outcome Measure: One-year cognitive, motor, and total FIM score.

Results: The most common medical complications during inpatient rehabilitation for the study sample are active seizures (46%), spasticity (57%), urinary tract infections (47%), and hydrocephalus with and without shunt (38%). Presence of $\geq$3 medical complications during inpatient rehabilitation, controlling for injury severity, is significantly ($P<.05$) associated with poorer total FIM and FIM motor scores 1 year after injury. The presence of hydrocephalus with and without shunt ($r=-.20, -.21, -.18$; $P \leq .15$), active seizures ($r=-.31, -.22, -.42$), spasticity ($r=-.38, -.28, -.40$), and urinary tract infections ($r=-.25, -.24, -.26$) were significantly ($P<.10$) associated with total FIM, FIM cognitive, and FIM motor scores, respectively.

Conclusions: Reported findings indicate that persons in states of seriously impaired consciousness with higher numbers of medical complications during inpatient rehabilitation are more likely to have lower functional levels 1-year postinjury. The findings indicate that persons with $\geq$3 medical complications during inpatient rehabilitation are at a higher risk for poorer functional outcomes at 1 year. It is, therefore, prudent to evaluate these patients for indications of these complications during inpatient rehabilitation.

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After severe traumatic brain injury (TBI) and non-TBI, patients experience seriously impaired consciousness that can last days, months, or years. The goal of inpatient rehabilitation for persons who remain in states of seriously impaired consciousness is to facilitate functional recovery and minimize functional impact of residual impairments. Efforts to achieve this goal include restoration of optimal health and prevention of secondary complications, because such conditions are likely to have deleterious effects on recovery and impede therapeutic efforts.

A study of 224 severe TBI survivors[1] admitted to intensive care examined the relation between nonneurologic complications (cardiovascular, respiratory, septic, abdominal/digestive, endocrinometabolic, and bleeding complications) and death during intensive care. Findings indicate that most subjects incurred sepsis (75%), with the next most common being respiratory infections (68%), hypotension (44%), severe respiratory failure (41%), and acute kidney injury (8%). Among the complications examined, hypotension, severe

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respiratory failure, septic shock, acute kidney injury, bleeding complications, and nonneurologic surgery were factors significantly related to greater risk of death during intensive care.

A statewide population-based mortality study (N = 18,998) of residents discharged alive from acute hospitalization indicates that TBI survivors were 2.5 times more likely to die after acute hospitalization discharge when compared with the general population.[2] Comorbidities found to significantly increase risk of death include seizures (standard mortality ratio [SMR] = 15.0), mental/behavioral disorders (SMR = 4.7), sepsis, digestive system diseases, stroke (SMR = 2.5), as well as circulatory system diseases, respiratory diseases, malignant neoplasms, and external causes, such as suicide, with an SMR of 2.4.

Once transferred to inpatient rehabilitation, medical complications impede therapeutic efforts and are difficult to detect, because the patient in a state of seriously impaired consciousness is not able to report symptoms. During inpatient rehabilitation, hydrocephalus is a common complication that occurs within 30% to 86% of patients examined between 3 and 12 months after severe brain injury (BI).[3] This rate of occurrence is thought to include both hydrocephalus and hydrocephalus ex vacuo.[4] Spasticity, for severe TBI, occurs in about 75% of the patients.[5] Less common complications include seizure, which occurs in about 10% of severe TBI survivors.[6]

Hypertension can be symptomatic of conditions, such as episodic pain or discomfort, and more complex conditions, such as dysautonomia,[7-10] which is a condition that occurs in about 26% of severe BI patients and is more common with older persons and persons incurring traumatic BI (32%) than patients with nontraumatic etiologies (eg, hypoxia = 16%).[9] Dysautonomia is characterized by the presence of ≥5 clinical criteria over a period of at least 2 weeks. The clinical criteria include tachycardia, tachypnea, systolic blood pressure >160mmHg, hyperthermia or hypothermia, excessive sweating, decerebrate or decorticate posturing, increased muscle tone, horripilation, or flushing.[9]

Although treating comorbid conditions optimize the central nervous system by decreasing metabolic costs, the relation between the presence of secondary medical complications during inpatient rehabilitation and long-term functioning is not well understood for persons who remain in states of seriously impaired consciousness for protracted durations. The objective of this article is to report findings from an examination of the relation between 5 common secondary medical complications and functional outcomes, as measured with the FIM, 1 year after severe BI.

Methods

Participants: study sample and study sites

The study sample of 68 patients was abstracted from a larger study database of 157 participants enrolled in an observational study aiming to characterize neurobehavioral recovery trajectories during inpatient rehabilitation relative to functional outcomes. All 157 participants were followed for 1 year after injury to obtain time to full consciousness, and 95 of these participants were interviewed with the FIM at 1 year. Twenty-seven of these 95 participants had missing information regarding medical complications during inpatient rehabilitation. The final sample for this article is, therefore, the 68 patients with complete medical complications data.

Participants, for the larger study, were recruited from 2 freestanding inpatient rehabilitation facilities, one long-term acute care hospital providing inpatient rehabilitation, and 1 Veterans Administration medical center providing inpatient rehabilitation, subacute rehabilitation, and acute care. Subjects were enrolled from 1996 to 2007, and human subjects institutional review board approval was obtained from each participating site.

The larger study sample enrolled all individuals incurring a severe BI and who were (1) admitted to 1 of 4 inpatient rehabilitation sites within 180 days of injury, (2) ≥18 years of age at time of study enrollment, and (3) in a state of seriously impaired consciousness for ≥28 days consecutively at time of study enrollment. Participants were determined to be in a state of seriously impaired consciousness if they did not demonstrate consistent and functional communication of basic needs, use of at least 1 common object, or evidence of behavior indicative of external awareness of their immediate environment.

Persons with TBIs and non-TBIs were eligible for enrollment in the larger study. TBI includes coup-contrecoup, blast, blunt, and penetrating injuries to the brain. Non-TBIs include vascular injuries and anoxia. Subjects were excluded if their BI was the result of cancer, tumors, inflammatory, infectious, and/or toxic metabolic encephalopathies.

Data collection procedures

At the time of study enrollment, each subject's emergency department, intensive care, acute care, and rehabilitation records were reviewed for sociodemographic information, medical history, injury etiology, and injury-related medical conditions. After review of each subject's records, a family/surrogate interview was conducted to collect any information not obtainable from the records and/or to confirm information regarding cause of injury. Data collection procedures did not identify when medical conditions occurred, only whether or not they were present at some time during inpatient rehabilitation. Licensed allied health clinicians, nurses, or trained research assistants completed all medical record abstraction. Data elements were abstracted from history and physical reports, discharge summaries, consult reports, and daily physician documentation. Medical complications tracked as present or absent were urinary tract infections (UTIs), hydrocephalus with or without shunt placement, hypertension, seizures, pneumonia, renal failure, and hypertonicity.

Because there is strong evidence that duration of seriously impaired consciousness may serve as a proxy for injury severity and could confound examinations of the influence of medical complications on long-term functional outcome recovery,[11-16] we needed to measure duration of seriously impaired consciousness. By necessity, this meant defining behavioral criteria for emergence from seriously impaired consciousness into full consciousness that could be measured during inpatient rehabilitation and follow-up interviews after rehabilitation discharge.

Although there is little evidence about the reliability and validity of clinical indices of behavior indicative of full consciousness,[17-21] there is currently, and was at the time of the study, start-up clinical consensus that a patient has emerged from seriously impaired consciousness when he/she demonstrates a consistent ability to (1) communicate interactively and/or (2) appropriately use 2 separate

List of abbreviations:

BI	**brain injury**
PTE	**posttraumatic epilepsy**
SMR	**standard mortality ratio**
TBI	**traumatic brain injury**
UTI	**urinary tract infection**