ORIGINAL ARTICLE

Influence of Sex and Age on Inpatient Rehabilitation Outcomes Among Older Adults With Traumatic Brain Injury

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ABSTRACT. Graham JE, Radice-Neumann DM, Reistetter TA, Hammond FM, Dijkers M, Granger CV. Influence of sex and age on inpatient rehabilitation outcomes among older adults with traumatic brain injury. Arch Phys Med Rehabil 2010;91:43-50.

Objective: To assess the influence of sex and age on inpatient rehabilitation outcomes in a large national sample of older adults with traumatic brain injury (TBI).

Design: Prospective case series.

Setting: Eight hundred forty-eight inpatient rehabilitation facilities that subscribe to the Uniform Data System for Medical Rehabilitation.

Participants: Patients (n=18,413) age 65 years and older admitted for inpatient rehabilitation after TBI from 2005 through 2007.

Interventions: None.

Main Outcome Measures: Rehabilitation length of stay, discharge FIM motor and cognitive ratings, discharge setting, and scheduled home health services at discharge.

Results: Mean age ± SD of the sample was 79±7 years, and 47% were women. In multivariable models, higher age was associated with shorter lengths of stay ($P<.001$), lower discharge FIM motor and cognitive ratings ($P<.001$), and greater odds of home health services at discharge ($P<.001$). Women demonstrated shorter lengths of stay ($P=.006$) and greater odds of being scheduled for home health services at discharge ($P<.001$) than men. The sex-by-age interaction term was not significant in any outcome model. Sex differences and trends were consistent across the entire age range of the sample.

Conclusions: Sex and age patterns in rehabilitation outcomes among older adults with TBI varied by outcome. The current findings related to rehabilitation length of stay may be helpful for facility-level resource planning. Additional studies are warranted to identify the factors associated with returning to home and to assess the long-term benefits of combined inpatient rehabilitation and home health services for older adults with TBI.

Key Words: Aged; Brain injuries; Rehabilitation.

TRAUMATIC BRAIN INJURY among older adults is a significant public health concern in terms of both patient well being and health care system costs. Persons age 65 years or older are at greater risk of being hospitalized with a TBI than any other age group.[1] Falls are responsible for more than half of all TBI-related emergency department visits, hospitalizations, and deaths among adults age 65 years or older.[2] Moreover, the risk of fall-related TBI increases substantially for each 10-year age increase over the age of 65 years.[3] Epidemiologic studies show that both the total number and percentage of older adults with TBI have increased over the past few decades.[1,3,4]

TBI often leads to permanent impairments in physical, cognitive, behavioral, and/or emotional functioning.[5] Many older adults with enduring physical or cognitive impairments after acute hospitalization for a TBI are transferred to inpatient rehabilitation.[6] A previous study[7] concluded that age does not affect the degree of functional improvement obtained during inpatient rehabilitation. Other studies, however, have shown that older persons with TBI experience poorer rehabilitation outcomes than younger persons.[8,9]

Like age, sex is also an established risk factor for TBI. Men are consistently at higher risk of TBI than women, with ratios greater than 2:1 in many age groups. However, the incidence rates among older adults are about the same for men and women.[10,11] Prior studies have included sex as an independent predictor of TBI outcomes in acute hospitalization,[12,13] inpatient rehabilitation,[14,15] and longer-term community settings.[16] While the results of these studies are mixed, women achieved better outcomes than men on several short-term measures. However, no study focused exclusively on adults age 65 years and older.

TBI rehabilitation is a rapidly growing area of research.[17,18] Despite the potential importance of age and sex on TBI outcomes, little is known about the influence of sex specifically among older adults who have sustained a TBI. Thompson et al[19] claim that there "is a significant gap in the [aging/TBI] literature." Many factors that are associated with recovery of function after injury, including sex, remain "understudied" in

List of Abbreviations

OR	odds ratio
PPS	prospective payment system
TBI	traumatic brain injury

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older adults with TBI.[19] The purpose of the current study was to assess the independent and interactive effects of sex and age on inpatient rehabilitation outcomes in a large national sample of adults age 65 years and older with TBI. To our knowledge, this is the first study to examine the interactive effects of sex and age on rehabilitation outcomes in older adults with TBI.

There is no consensus on sex-based differences in TBI outcomes in studies with mostly younger persons, and there is no precedent in studies with older adults exclusively. However, given that women, in general, demonstrate greater resilience and longevity than men and that age is an equalizer for many health disparities, we hypothesized that (1) older women would experience better rehabilitation outcomes overall compared with older men, and (2) the magnitude of male-female differences would diminish with increasing age. Information from this study may be useful for estimating responses to rehabilitation and resource needs for older adults with TBI.

METHODS

Data Source

Data were obtained from the Uniform Data System for Medical Rehabilitation.[20] Admission and discharge information were collected from patient medical records contained within the inpatient rehabilitation facility–patient assessment instrument.[21]

Study Sample

The inclusion criteria for this study included patients who were (1) being admitted for initial inpatient rehabilitation services after TBI, (2) age 65 years or older at the time of admission, (3) living at home prior to injury, and (4) discharged from rehabilitation in 2005 through 2007. Qualifying etiology included traumatic brain dysfunction coded with Uniform Data System for Medical Rehabilitation Impairment Group Codes 02.21 (Traumatic, Open Injury) and 02.22 (Traumatic, Closed Injury).[21] There were 19,411 patients in the initial sample. Exclusion criteria were (1) duration from injury onset to admission greater than 365 days (n=300), (2) program interruption for readmission to acute care (n=236), and (3) length of stay less than 3 days or greater than 100 days (n=462). The final sample contained 18,413 patient records from 848 inpatient rehabilitation facilities across the United States. Compared with the final sample, excluded patients were less likely to be women, to have a closed head injury, and to be discharged home after rehabilitation. In addition, excluded patients showed a longer duration from injury onset to admission, shorter lengths of stay in rehabilitation, and lower functional status at both admission and discharge.

Variables

Demographic information. Age was recorded in years. The age variable was centered at 65 years (centered age=patient age–65) for entry in the multivariable models in order to facilitate interpretation and accuracy of the regression coefficients.[22] Sex and marital status (married vs not married) were coded dichotomously. Self-reported race/ethnicity was coded as black, Hispanic, white, and other categories. "Other" included Asian, Hawaiian/Pacific Islander, Native American/Alaskan, or unspecified. The race/ethnic groups were dummy coded (0, 1: reference=white) for entry in the regression models.

Living situation and home health. Self-reported living arrangement (alone vs not alone) and setting (home vs not home) were coded dichotomously and recorded for both prehospitalization and posthospitalization. As described, living at home prehospitalization was an inclusion criterion for this study. A dichotomous (yes vs no) variable was also coded to identify patients discharged home who were scheduled for continued services through a home health agency.

Admission delay and length of stay. Admission delay refers to the time between injury onset and admission to inpatient rehabilitation. Length of stay refers to the time from rehabilitation admission to discharge. Both were measured in days.

Comorbidities and injury type. A summary score was calculated for the total number of additional health conditions (range, 0–10) beyond the primary diagnosis: all ICD-9-CM codes (maximum of 10) recorded in each patient's medical record. Skull integrity was recorded dichotomously (open vs closed head injury).

Functional status. Functional status data were obtained using the FIM instrument at admission and discharge. The FIM instrument contains 18 items covering 6 domains of functioning: self-care (activities of daily living), sphincter control, transfers, locomotion, communication, and social cognition. Each item is scored on a scale from 1 (complete dependence) to 7 (complete independence); that is, higher scores represent better functioning/greater independence. The FIM motor subscale contains 13 items (range of possible scores, 13–91), and the FIM cognitive subscale contains 5 items (range of possible scores, 5–35). The reliability, validity, and responsiveness of the FIM instrument are well documented.[23]

Efficiency. Rehabilitation efficiency was defined as the average functional improvement a day. It is calculated by subtracting admission FIM total from discharge FIM total to obtain FIM total gain and then dividing this value by length of stay in days.

Data Analysis

Univariate differences between older women and men were tabulated for all variables. Independent *t* tests were used for numerical variables and chi-square tests for categorical data. Multiple linear regression models were used to assess the independent effects of sociodemographic, case complexity, and functional status factors on length of stay, discharge FIM motor ratings, and discharge FIM cognitive ratings. Logistic regression was performed to examine the effects of these factors on discharge setting (not home vs home) and being scheduled to receive home health services (no vs yes). An interaction variable linking sex with age was also included in all 5 outcome models. The interaction variable was created by dummy coding the sex variable (reference category=men) and then multiplying this by the value of the (numerical) age variable. All variables were entered as a single block. Last, we calculated and graphed expected values for each outcome by sex and age. For these calculations, the most likely sex-specific values (group means or modes) for all variables in the models were multiplied by the respective regression coefficients. Alpha was set to .05. SPSS version 14 software[a] was used for all statistical analyses.

RESULTS

Sample Characteristics

Women represented 47% of the 18,413 older adults (mean age ± SD, 79±7y) in our sample who received inpatient rehabilitation after TBI from 2005 through 2007. The sample was predominantly white, slightly more than half were married, and approximately one third was living alone at the time of the injury. More than 97% of patients experienced closed head