ORIGINAL ARTICLE

Pre-existing Health Conditions and Repeat Traumatic Brain Injury

Lee L. Saunders, PhD, Anbesaw W. Selassie, DrPH, Elizabeth G. Hill, PhD, Michael D. Horner, PhD, Joyce S. Nicholas, PhD, Daniel T. Lackland, PhD, John D. Corrigan, PhD

ABSTRACT. Saunders LL, Selassie AW, Hill EG, Horner MD, Nicholas JS, Lackland DT, Corrigan JD. Pre-existing health conditions and repeat traumatic brain injury. Arch Phys Med Rehabil 2009;90:1853-9.

Objective: To assess and compare the effect of Pre-existing epilepsy/seizure disorder and drug/alcohol problem on the hazard of repeat traumatic brain injury (TBI) in persons with TBI who participated in a follow-up study.

Design: Retrospective cohort.

Setting: Acute care hospitals in South Carolina.

Participants: Participants were from the South Carolina Traumatic Brain Injury Follow-up Registry cohort of persons (N=2118) who were discharged from an acute care hospital in South Carolina and who participated in a year-1 follow-up interview.

Interventions: Not applicable.

Main Outcome Measures: Repeat TBI was defined by 2 isolated events of TBI in the same person at least 72 hours apart and recorded in hospital discharge or emergency department records from 1999 through 2005.

Results: A Cox proportional hazards model was used to assess the associations of Pre-existing epilepsy/seizure disorder and drug/alcohol problem with time to repeat TBI, controlling for other confounding factors. There were 2099 persons with information on both Pre-existing conditions. There were 147 (7%) persons who sustained repeat TBI after recruitment to the follow-up study, and 82 (3.9%) had a previous TBI before recruitment for which they were seen in the hospital discharge or emergency department since 1996. The hazard of repeat TBI for persons with Pre-existing epilepsy/seizure disorder was 2.3 times the hazard for those without (hazard ratio, 2.3; 95% confidence interval, 1.2–4.4; $P=.011$). Pre-existing drug/alcohol problem was not associated with repeat TBI. Other variables significantly associated with repeat TBI were having a prior TBI, being insured under Medicaid, and having no insurance.

Conclusions: Pre-existing epilepsy/seizure disorder predisposes to repeat TBI. Appropriate management of seizure control may be an important strategy to allay the occurrence of repeat TBI.

Key Words: Brain injuries; Epilepsy; Rehabilitation; Seizures.

TRAUMATIC BRAIN INJURY is a significant public health problem in the United States, with 1.4 million Americans sustaining a TBI each year,[1] and 5.3 million living with a TBI-related disability.[2] More recently, Selassie et al[3] estimated that 43.3% of TBI hospitalizations would result in long-term disability; however, their definition of disability included not only physical limitation but also cognitive complaints, postinjury symptoms, and mental health problems that are limiting to perform an activity. Persons who have sustained one TBI have been shown to be at increased risk to sustain another.[4,5] Research on repetitive TBI has been focused primarily on athletes, with very little information available on repeat TBI in the general population. However, evidence suggests a cumulative effect of TBIs on health outcome. Studies have found associations between the number of concussions and mild cognitive impairment[6] and more permanent problems in memory and thinking among retired professional football players.[7] Also, in men, a relationship has been found between the number of TBIs with unconsciousness, and symptoms such as dizziness, concentration difficulty, depression, visual problems, and overall health problems.[8] Although these findings are informative of some athletes, they do not account for injuries occurring off the field, do not require the diagnosis of a physician for the classification of TBI, and do not include women. Further, the risk of repeat TBI as a function of Pre-existing conditions, such as epilepsy/seizure disorder or alcohol/drug problems, has not been explored.

Preinjury treatment for drug or alcohol problems has been associated with heavy drinking post-TBI.[9] Limited previous research has been conducted evaluating the association between alcohol/drug abuse and repeat TBI. Walker et al[10] re-

List of Abbreviations

AIS	Abbreviated Injury Scale
CI	confidence interval
CPH	Cox proportional hazard
ICD-9-CM	*International Classification of Diseases, Ninth Revision, Clinical Modification*
SCTBIFR	South Carolina Traumatic Brain Injury Follow-up Registry
TBI	traumatic brain injury

From the Departments of Health Sciences and Research (Saunders), Biostatistics, Bioinformatics, and Epidemiology (Selassie, Hill, Nicholas, Lackland), and Psychiatry and Behavioral Sciences (Horner), Medical University of South Carolina, Charleston, SC; the Mental Health Service, Ralph H. Johnson Department of Veterans Affairs Medical Center, Charleston, SC (Horner); and Department of Physical Medicine and Rehabilitation, Ohio State University, Columbus, OH (Corrigan).

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Reprint requests to Lee L. Saunders, PhD, Dept of Rehabilitation Sciences, Medical University of South Carolina, 77 President St, Ste 117, MSC 700, Charleston, SC 29425, e-mail: *saundel@musc.edu*.

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ported that prisoners with 2 or more TBIs had more alcohol problems than prisoners with 1 or no TBIs. However, this was a cross-sectional study and therefore could not establish temporal sequence. Drubach et al[11] found that of persons admitted to a brain injury rehabilitation unit, those with prior drug and alcohol abuse were the most likely to have had a prior TBI. Lastly, in a review by Salcido and Costich,[12] alcohol/drug use was found to be associated with repeat TBI. These studies were conducted in very specific populations and therefore have limited generalizability.

Epilepsy/seizure disorder is another condition which might contribute to repeat TBI. Not only can seizures occur as a result of a TBI, but seizures can also contribute to TBIs.[13] Wirrell[14] found that persons with epilepsy had more injuries than the general population, and that a quarter of those injuries were seizure related, with head injuries being one of the more common injuries. The extent to which Pre-existing epilepsy contributes to the recurrence of TBI has not been quantified and described in a population-based setting.

The aim of this article is to assess and compare the effect of Pre-existing health conditions, specifically epilepsy/seizure disorder and drug/alcohol problems, on the risk of repeat TBI in a cohort of 2118 persons with TBI who participated in a follow-up study. We hypothesized that persons with Pre-existing epilepsy/seizure disorder and/or Pre-existing alcohol/drug treatment would have a larger hazard of repeat TBI than those without these Pre-existing conditions.

METHODS

Study Population

This study followed a retrospective cohort design in which a cohort of TBI hospital discharges was assessed for prior epilepsy/seizure disorder and alcohol/drug problems and then followed up for repeat TBI. Data from the SCTBIFR were used.[15] In South Carolina, all nonfederal hospitals are required to provide Uniform Billing-92 abstracted data for all hospital discharges to the Office of Research and Statistics. Persons admitted to the hospital between January 1, 1999, and June 30, 2002, with a primary or secondary diagnosis of TBI made up the sampling frame. SCTBIFR excluded persons younger than 15 years at the time of injury, out-of-state residents, and persons who died in the hospital. Of 7613 persons in the sampling frame, 4519 persons were sampled using a 2-stage random sampling method.[15] Medical records were abstracted on the sample to obtain more complete information about the circumstances of their injury.

Of 4519 persons sampled, 773 (17.1%) were found ineligible for recruitment for the following reasons: 382 (8.4%) had died after discharge from acute care, 80 (1.8%) were medically unable to participate and had no proxy, 92 (2.0%) were prisoners, 195 (4.3%) had moved out of state, and 24 (0.5%) were unable to speak English. Of those eligible, 2118 completed an in-depth telephone survey conducted by trained interviewers 1 year after their TBI. Lead questions related to events, dates, places, and how consistent these were to the records on file were used to assess the participants' cognitive competencies. Proxy respondents were used (n=285) when a person was deemed cognitively impaired or not able to follow commands or not able to respond to the telephone survey. Proxies were not asked all questions, especially pertaining to quality of life, but questions about alcohol and epilepsy/seizure were asked of proxies. The interview included questions on Pre-existing health conditions, including epilepsy/seizure disorder and drug/alcohol treatment. The survey instrument can be found at http://www.musc.edu/sctbifr. Eligible persons who did not complete the year-1 interview were more likely to be nonwhite males, have less severe TBI, and be without health insurance (χ^2 test of homogeneity, $P<.001$).[15] However, persons who were interviewed were not significantly different from persons not interviewed with respect to their repeat TBI status ($P=.932$).

Definitions

TBI was defined using the ICD-9-CM nature of injury codes (800.0–801.9, 803.0–804.9, 850.0–854.1, and 959.01) obtained through hospital discharge and emergency department records.[16] Discharge diagnoses are 100% complete and have high accuracy. Both hospital discharge and emergency department records contain personal identifiers, patient demographics, admission and discharge dates, acute care charge, admission source, discharge disposition, external cause of injury codes, procedure codes, and 1 primary and up to 9 secondary diagnosis codes based on ICD-9-CM. The TBI that resulted in the selection of the person to the SCTBIFR study was defined as the index TBI.

The main outcome, repeat TBI, was defined by 2 isolated events of TBI in the same person at least 72 hours apart and recorded in hospital discharge or emergency department records from 1999 through 2005. Although 9.5% of the cohort had more than one repeated TBI, the response was made binary by lumping all repeats into one category. A person who was transferred to another hospital or readmitted for the same event because of complications, late effects, or worsening of symptoms was not identified as having repeat TBI. Hospital and emergency department records for persons included in the sample were linked across time using personal identifiers, enabling the identification of repeat TBI. Unique identifiers were available back through 1996, and therefore prior TBI for this period was assessed.

Epilepsy/seizure disorder was identified at the year-1 follow-up after the index TBI by the question, "Before your injury, did a doctor ever tell you that you had a seizure disorder or epilepsy?" In this analysis, the response reflected epilepsy/seizure disorder occurring before the TBI under reference. In addition, we identified persons with epilepsy or seizure diagnosis codes, ICD-9-CM 345 and 780.3, in their index TBI medical record. A 3-level categorical variable was created using these 2 sources: (1) persons with both self-reported epilepsy/seizure disorder and an epilepsy/seizure disorder diagnosis code; (2) persons with either, but not both; and (3) persons with neither. The purpose of this definition was to capture persons who have ever had epilepsy/seizure disorder (whether or not they have been told by a doctor they have epilepsy/seizure disorder) and to also identify persons who are having active seizures (through medical records).

Previous treatment for drug/alcohol problems was also identified at the year-1 interview (1 year after the index TBI) by the question, "Before your injury, had you ever been treated for a drug or alcohol problem?" In addition, drug and alcohol problems were assessed through medical record review. Trained abstractors extracted information on alcohol and drug use from the medical record using notes about drug or alcohol problems as well as previous referrals to drug or alcohol treatment.

Other explanatory variables were identified from hospital discharge records as noted at discharge from the index TBI. Because only 2.4% of persons in the sample were not white or black, race was categorized as white and nonwhite. Cause of injury was categorized as motor vehicle collision, fall, sports injury, violence injury, and all other using ICD-9-CM external cause of injury codes. Insurance was categorized as commercial, Medicaid, Medicare, and uninsured. Concomitant injury,