Factors Associated with Difficulty in Returning to School in Students After Traumatic Brain Injury

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Abstract: Traumatic brain injury (TBI) often causes behavioral problems and difficulties with school work, but the specific factors associated with difficulty in returning to school after TBI still remain unclear. The purpose of this study was to investigate factors associated with difficulty in returning to school within 1 year of injury in students with traumatic brain injury. This study is a secondary analysis of existing data sets. We recruited patients aged 16 years in the United States with a primary rehabilitation diagnosis of TBI registered in the Traumatic Brain Injury Model Systems National Database. We compared variables between the students who returned to school and those who did not return to school. In addition, subgroup analyses were performed focused on traumatic brain injury severity. We excluded those who were received <10 years of schooling, and 309 eligible students were identified for the analysis. Of these, 246 (80%) did not return to school within 1 year of injury. There were fewer cases of severe TBI in the group of students who returned to school than in the group who did not return to school (29% vs 44%; P = 0.03). The duration of rehabilitation was significantly longer in the group who returned to school than in the group who did not return to school (mean days 40 vs 29, P = 0.001), and a subgroup analysis showed in the severe traumatic brain injury group (mean days 46 vs 29; P = 0.02) and the non-severe traumatic brain injury group (mean days 37 vs 26; P = 0.02) similar results. Insufficient amount of rehabilitation was associated with difficulty in returning to school in students after TBI, regardless of the severity of the injury.

Keywords: brain injuries, trauma, return to school, rehabilitation.

Introduction

Traumatic brain injury (TBI) affects about 400 per 100,000 population, with an estimated 5.3 million disability cases resulting from TBI in the USA and an estimated 6.2 million in Europe [1]. Thus, TBI is a major individual and societal problem worldwide.

TBI often impairs mood and cognition, especially memory, attention, and executive function, and can cause behavioral problems [2]. There are about 70,000
people with neuropsychological disorders after TBI in Japan [3]. Two-thirds of children with TBI are reported to have difficulties with school work, and half have difficulties with attention, concentration, and memory [4]. Scores on several neuropsychological examinations have emerged as the most significant predictors of return to work or school following TBI [5]. A previous systematic review reported that several factors [symptom severity, symptoms (headache, visual disturbance, memory deficits, difficulty concentrating, executive dysfunction and vestibular abnormalities), duration of symptoms, age/grade or school level, rest following injury] should be considered for return to school following concussion [6]. However, the specific factors associated with difficulty in returning to school after TBI require further investigation [7] and need to be verified. This exploratory study investigated the factors associated with difficulty in returning to school in students with TBI.

**Methods**

This study was approved by the relevant institutional review board.

**Data Source**

We conducted a retrospective analysis of data in the Traumatic Brain Injury Model System (TBIMS) National Database (NDB), which contains data from a multicenter prospective longitudinal study of TBI outcomes that was funded by the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR, formerly NIDRR), a United States governmental agency [8]. The original sample consisted of 39,019 adults with TBI, from 19 medical centers (each providing emergency medical services, intensive and acute medical care, inpatient rehabilitation, and a spectrum of community rehabilitation services), who participated in the National Institute on Disability and Rehabilitation Research Traumatic Brain Injury Model Systems program between 1990 and 2014 [9]. As previously described [10], the database contains information on individuals with TBI who were aged ≥16 years at the time of injury, received medical care within 72 h of injury at a TBIMS-affiliated trauma center, were transferred to an affiliated inpatient TBI rehabilitation program, and provided informed consent to participate (or consent by legal proxy was obtained). TBI was defined as meeting at least 1 of the following criteria: Glasgow Coma Scale score <13 on emergency admission (not because of intubation, sedation, or intoxication); loss of consciousness for >30 min (not because of sedation or intoxication); posttraumatic amnesia for >24 h; and trauma-related intracranial abnormality on neuroimaging. All participants or their proxies completed a brief assessment protocol during inpatient rehabilitation and were followed up prospectively using a standardized follow-up assessment protocol. Follow-up data on return to school were collected 1, 2, 5, and 10 years post-injury and every fifth year thereafter. The follow-up survey was completed in-person or via telephone or mail with the participant or a proxy if the participant was unable to respond [11]. We sent an application for data use and details of the research plan to the manager of the TBIMS database. The application was accepted, and the data became available after they were validated.

For the present study, we extracted data for individuals (students) who were 16 years of age at the time of injury, and excluded those with <10 years of schooling. Students who are 17 years of age are likely to go to college the next year, but not all individuals in the United States continue on to college. We set a criterion for the number of years of schooling because we wanted to limit the study to those who had successfully followed the standard academic track and had remained in school at the time of injury.

**Variables and Outcomes**

We extracted the following data from the database for the above-mentioned sample: race (Caucasian or not), sex (male or female), traffic accident (or not), admission day from injury, severe TBI (brain injury resulting in a loss of consciousness > 6 h and Glasgow Coma Scale score 3-8) [12], computed tomography finding (frontal lobe contusion, subarachnoid hemorrhage, midline shift), craniotomy (with or without), duration of posttraumatic amnesia, duration of in-hospital rehabilitation, motor Functional Independence Measure (FIM) score on discharge, and cognitive FIM score on discharge. The higher the score on each of the 18 items in the FIM, the more independently the
patient can perform the tasks required by that item; the motor subscale score ranges from 13 to 91 [13].

**Statistical Analysis**

We compared variables between the students who returned to school and those who did not return to school within 1 year of injury, using the chi-square test for categorical variables and the unpaired t-test for continuous variables. We used only 1-year data about return to school because there would probably be many missing values after 2 and 5 years. Multiple logistic regression analysis with return to school as the dependent variable was performed to calculate the odds ratio with the following independent variables: race, sex, traffic accident, craniotomy, computed tomography findings, admission day from injury, duration of posttraumatic amnesia, duration of rehabilitation, and motor and cognitive FIM score on discharge. Subgroup analyses were performed after dividing the students by TBI severity: severe TBI and non-severe TBI.

Values are expressed as mean ± standard deviation. We conducted all statistical analyses using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY). Statistical significance was set at $P < 0.05$.

### Results

From 749 TBI patients aged 16 years old, 440 with less than 10 years of schooling were excluded, leaving 309 students for analysis (Fig. 1). Table 1 shows the demographics for all the students and for the group of students who returned to school within 1 year of injury and the group who did not. Of the total 309 students, 70% were white, traffic accidents accounted for 67% of the injuries, > 40% of the students had severe TBI, 20% of the students required craniotomy, average mo-

| Race (Caucasian) | Total n = 309 | Returned to school n = 63 | Did not return to school n = 246 | P-value |
|------------------|---------------|--------------------------|-------------------------------|---------|
| 217 (70)         | 51 (81)       | 166 (68)                 |                               | 0.53    |
| Sex (Male)       | 198 (64)      | 36 (57)                  | 162 (66)                      | 0.61    |
| Traffic accident | 206 (67)      | 48 (76)                  | 158 (64)                      | 0.06    |
| Severe traumatic brain injury | 126 (41) | 18 (29) | 108 (44) | 0.03 |
| Craniotomy       | 61 (20)       | 15 (24)                  | 46 (19)                       | 0.38    |
| Computed tomography finding | | | | |
| Frontal lobe contusion | 166 (54) | 39 (62) | 127 (52) | 0.16 |
| Subarachnoid hemorrhage | 139 (45) | 24 (38) | 115 (47) | 0.26 |
| Midline shift    | 88 (29)       | 21 (33)                  | 67 (27)                       | 0.35    |
| Admission day from injury (days) ± SD | 20 ± 14 | 20 ± 9 | 20 ± 16 | 0.99 |
| Posttraumatic amnesia (days) ± SD     | 24 ± 21 | 27 ± 28 | 23 ± 19 | 0.23 |
| Duration of rehabilitation (days) ± SD | 31 ± 26 | 40 ± 33 | 29 ± 23 | 0.001 |
| Motor FIM score on discharge ± SD     | 75 ± 62 | 65 ± 25 | 77 ± 68 | 0.16 |
| Cognitive FIM score on discharge ± SD | 25 ± 6 | 23 ± 8 | 25 ± 6 | 0.06 |

FIM: functional independence measure, SD: standard deviation, ( )：%
tor FIM score on discharge was 75, and 246 (80%) did not return to school. There were fewer cases of severe TBIs among students who returned to school within 1 year of TBI than among those who did not (29% vs 44%, respectively, \( P = 0.03 \)). Rehabilitation was significantly longer among students who returned to school (mean days 40 vs 29, respectively, \( P = 0.001 \)). Multiple logistic regression analysis showed that duration of rehabilitation was significantly associated with return to school (odds ratio, 1.02; 95% confidence interval, 1.00 to 1.04; \( P = 0.04 \)) (Table 2).

Table 2. Multiple regression analysis for return to school

| Sample                  | Odds Ratio | 95% CI       | \( P \)-value |
|-------------------------|------------|--------------|---------------|
| Race (Caucasian)        | 1.17       | 0.51 to 2.66 | 0.70          |
| Sex (Male)              | 0.71       | 0.32 to 1.60 | 0.42          |
| Traffic accident        | 1.19       | 0.53 to 2.70 | 0.66          |
| Severe traumatic brain injury | 0.51 | 0.23 to 1.13 | 0.09          |
| Craniotomy              | 0.90       | 0.32 to 2.48 | 0.84          |
| Frontal lobe contusion  | 1.93       | 0.93 to 4.00 | 0.07          |
| Subarachnoid hemorrhage | 0.52       | 0.23 to 1.15 | 0.10          |
| Midline shift           | 1.30       | 0.57 to 2.93 | 0.52          |
| Admission day from injury (days) | 1.02 | 0.98 to 1.07 | 0.24          |
| Posttraumatic amnesia (days) | 0.99 | 0.96 to 1.02 | 0.84          |
| Duration of rehabilitation (days) | 1.02 | 1.00 to 1.04 | 0.04          |
| Motor FIM score on discharge | 1.01 | 0.98 to 1.05 | 0.27          |
| Cognitive FIM score on discharge | 1.00 | 0.92 to 1.09 | 0.89          |

FIM: functional independence measure, CI: confidence interval

Table 3 shows the results of the subgroup analysis focused on severity of TBI. Rehabilitation was significantly longer among students who returned to school, irrespective of whether they had severe TBI or not.

**Discussion**

A previous study using the TBIMS NDB found that preinjury productivity, age, education, and duration of rehabilitation were all significantly associated with postinjury employment at year 1 after TBI [9]. However, no detailed analysis of the parameters affecting return to school has been made using the TBIMS NDB until the present study. Using this database to examine the predictive factors of return to school after TBI, we found that students who did not return to school within 1 year of TBI had received significantly shorter rehabilitation, irrespective of TBI severity, than those students who returned to school within 1 year of injury.

Regardless of the severity of TBI, students may have problems with retaining and retrieving newly learned information [14]. However, for those with severe TBI, cognitive impairment may worsen over time [15], and impairment of memory and concentration are particularly handicapping in the classroom [16].

Neuropsychological evaluation is important in rehabilitation to plan a strategy for return to school [17]. This evaluation would allow us to predict some of the problems that the student may face. Rehabilitation programs targeting return to school include training to participate in classes with attention, concentration, and learning. The appropriate provision of compensatory technologies for certain memory deficits through the use of digital or non-digital prostheses is also effective. A personal digital assistant is an example of equipment that has proven useful [18]. The ability to return to school may be increased if enough time is taken to evaluate cognitive and behavioral problems, teach different coping strategies, and educate teachers about the students’ needs [19].

**Study Limitations**

Our study had several limitations. First, the database that we used lacks detailed information about rehabilitation received and neuropsychological disorders. Second, the TBIMS NDB does not contain random
samples, which limits the ability to generalize these findings to all TBI students. Third, the database lacks information about mental problems that may hinder return to school. Students with short training periods may have had confounding factors such as apathy and depression. Fourth, classes for special needs students are not common in the United States, and students are forced to return to regular classes as much as possible, based on the Individuals with Disabilities Education Act. Japanese students tend to have lower return to school rates than students in the United States. This fact may preclude the generalizability of this study to Japan.

**Conclusions**

Our data suggests that, for students, a shorter period of rehabilitation was associated with difficulty in returning to school after TBI, regardless of its severity.

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**Conflicts of Interest**

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脳外傷後の復学困難に関連する因子

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要旨: 脳外傷はしばしば, 行動障害や復学困難を引き起こす。しかしながら, 脳外傷後の復学困難を誘起する因子についてはまだ明らかにされていない。本研究の目的は若年脳外傷患者における1年以内の復学困難に関連する因子について探索的に検討することである。本研究は既存データセットの二次解析である。米国のTraumatic Brain Injury Model Systems National Databaseに登録された脳外傷患者（受傷時16歳）のデータを用いた。1年以内に復学できた者とできなかった者とで2群間比較をし, 脳外傷重症度に着目したサブグループ解析を追加した。教育歴が10年未満の者を除外し, 合計309人の脳外傷患者が抽出された。そのうち246人（80%）の患者は1年以内の復学が困難であった。復学した患者群では復学できなかった患者群に比べ重症脳外傷例が少なかった（29% vs 44%, P = 0.03）。また, 復学した患者群では復学できなかった患者群に比べリハビリテーション期間が長く（平均日数: 40 vs 29; P = 0.001）, 脳外傷重症度によるサブグループ解析でも重症脳外傷者群（平均日数: 46 vs 29, P = 0.02）, 非重症脳外傷者群（平均日数: 37 vs 26, P = 0.02）ともに同様の結果であった。脳外傷重症度に関わらず, リハビリテーションの不足が脳外傷後の復学困難に関連していた。

キーワード: 脳損傷, 外傷, 復学, リハビリテーション,

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