Characteristics and Outcomes of Thai Patients Hospitalized with Severe Traumatic Brain Injury between 2009 and 2011

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Objective: *To describe the characteristics and outcomes of Thai patients who suffer from severe traumatic brain injury (TBI).*

Material and Method: *We examined the clinical characteristics and outcomes of a cohort of severe TBI patients receiving care at Songklanagarind Hospital, Thailand between January 1, 2009 and December 31, 2011. Using a modified version of the National Institutes of Neurological Diseases and Stroke Common Data Elements, we abstracted medical record data on demographics, hospital course, and outcomes (mortality and Glasgow Outcome Scale [GOS]). Inclusion criteria were history of trauma, traumatic head computed tomography finding, age 18 years and older, admission Glasgow Coma Scale score less than 9, head Abbreviated Injury Score of 3 or greater, and tracheal intubation in the intensive care unit. GOS 4 or 5 reflects favorable outcome.*

Results: *Data from 200 patients (27.4% of hospitalized TBI) were reviewed. Median age was 34±1.2 years and most (80.5%, n = 161) were male. The most common mechanism of injury was motorcycle collision (65.5%, n = 131). Most patients (110, 55%) were transported to hospital by a vehicle managed by a non-profit organization. Computerized head tomography showed subdural hematoma in 105 (52.5%), subarachnoid hemorrhage in 93 (46.5%), contusion in 47 (23.5%), and midline shift in four (23.5%) patients. Blood alcohol was positive in over 50% and 62.5% had polytrauma. Discharge mortality was 17% (n = 34) and discharge GOS was 4±1. Three, 6, and 12 months GOS among patients with follow-up were 4±0.1 (n = 71/200), 5±0.2, (n = 48/200), and 5±0.2 (n = 30/200), respectively.*

Conclusion: *The proportion of trauma patients hospitalized with severe TBI is high. Most patients with TBI have multiple trauma, and in-patient mortality is high. Blood alcohol level may contribute to the high TBI burden. Fewer than 50% of severe TBI patients received follow-up care at the trauma center.*

Keywords: *Adherence, Guideline, Traumatic brain injury*

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Deaths from injury increased worldwide by 10.7% from 4.3 to 4.8 million between 1990 and 2013[1]. The 2010 Global Burden of Disease Project reported that road traffic injuries were a leading cause of mortality worldwide[2], and that traumatic brain injury (TBI) was the leading cause of trauma-related death[3]. Thus, reducing the TBI burden is a global priority[4-12]. In Thailand, road traffic injuries are one of the leading causes of death, especially in younger people[4,13-15]. In 2012, the Thai mortality rate from road traffic injuries was reported to be 22 per 100,000, and more than half of the 65% of motorcycle crash-related deaths were the result of TBI[16]. Inadequate injury prevention strategies along with the increasing number of motorcycles (20 million in Thailand) have made TBI a leading national public health issue. However, there is a paucity of data on the characteristics and outcomes of Thai patients hospitalized with severe TBI.

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In a Thai study published in 2000, investigators reported on a total of 3,194 and 4,217 consecutive trauma patients who attended a single center emergency department during two time periods: 1986 and 1996, respectively[17]. Between this ten-year period, the authors reported that the proportion of trauma patients treated for TBI doubled from 504 (15.8%) to 1,224 (29%). Diagnoses of acute subdural hematoma (SDH) and diffuse brain injury increased from 12.2 to 32% and from 9 to 16.8%, respectively. This increase in diffuse brain injury was coincident with an increase in mortality of admitted patients from 14.4 to 21.8%, $p<0.01$[17].

Since publication of the above study, no additional data have been published regarding the epidemiology of TBI patients or the clinical characteristics and outcomes of patients with severe TBI in Thailand. Moreover, there are no data on functional outcomes of TBI patients. The objective of the present study was to examine the clinical characteristics and outcomes of severe TBI patients recently hospitalized in a tertiary trauma care center in Thailand.

Material and Method

Setting

This retrospective study was performed at Songklanagarind Hospital, a designated Thai level 1 trauma center affiliated with Prince of Songkla University. The facility is an 856-bed medical center in Hat Yai, Songkhla, Thailand with 45 intensive care unit (ICU) beds and separate ICUs for trauma/surgical, burn, neurosurgery, and medical patients. As a level 1 trauma center, all ICUs have 24-hour in-house physician coverage and are staffed by intensivist-led teams consisting of an attending physician, and senior and junior residents. The departments of surgery, anesthesiology, and internal medicine all provide physicians, attendings, and trainee coverage. The present study was approved by the University of Washington (Seattle, WA) and Prince of Songkla University (Songkhla, Thailand) Institutional Review Boards.

TBI and TBI severity

Inclusion criteria for TBI were patients ≥18 years of age with trauma who received hospital care between January 2009 and December 2011, and had TBI ICD-9 diagnosis codes of 800.xx to 804.xx, 850.xx to 854.xx. Patients with severe TBI had an admission Glasgow Coma Scale (GCS) score <9, head Abbreviated Injury Score (AIS) ≥3, traumatic head computed tomography finding, and tracheal intubation for TBI, as previously described[18].

Data sources

The National Institute of Neurological Disease and Strokes (NINDS) Common Data Elements (CDEs) variable definitions were used to abstract data[19] and to develop a local TBI registry. Data were abstracted from electronic and paper hospital medical records.

Outcome measures

Main patient outcomes were in-patient mortality and discharge Glasgow Outcome Scale (GOS) score, where GOS 1 = death, 2 = persistent vegetative state, 3 = severe disability (need help for daily life), 4 = moderate disability (no need for assistance in daily life, but may require special equipment), and 5 = low disability (light damage with minor neurological and psychological deficits)[20]. Hospital length of stay (LOS) data was abstracted. We also recorded outcomes of patients who returned to the hospital at 3, 6, and 12 months after discharge.

Statistical analysis

Statistical analyzes were performed using R3.0.1. Descriptive statistics were used to examine clinical characteristics, including frequency of computed tomography scan lesions (Marshall system[21]), LOS, discharge GOS, and in-patient mortality. Data are presented as mean and standard deviation (SD) for parametric data or median and standard error of the mean (SEM) for non-parametric data, or as n (%) for categorical variables.

Results

Patient characteristics

Severe TBI was diagnosed in 200 (27.4%) patients admitted with documented TBI. Among severe TBI patients, median age was 34±1.2 years and most were male (161, 80.5%) (Table 1). Blood alcohol was present in over 50% of patients. The median GCS score was 7±0.2. Most patients (110, 55%) were transported to the hospital by a vehicle managed by a non-profit organization. The most common mechanism of injury was motorcycle collision (131, 65.5%) and the majority of patients (133, 62.5%) had an extracranial injury (Fig. 1). Other organ injuries involved are orthopedics (80, 40%) followed by chest (55; 27.5%) and maxillofacial (50, 25%), as showed in Fig. 2. The

Table 1. Patient characteristics

Characteristics	
Age (years)	34.0±1.2 (18 to 87)
Male gender	161 (80.5)
Admission Glasgow Coma Scale score	7.0±0.2
3	43 (21.5)
4	12 (6.0)
5	9 (4.5)
6	20 (10.0)
7	76 (38.0)
8	40 (20.0)
Head Abbreviated Injury Score (AIS)	4.0±0.1
3	71 (35.5)
4	46 (23.0)
5	83 (41.5)
6	0
Injury Severity Score (ISS) [2-75]	25.00±0.79
Pupil size (mm)	
Right eye	3.00±0.08
Left eye	3.00±0.09
Alcohol use	109 (54.5)
Blood alcohol level (mg%)	207.6±96.1 (37.8 to 397.8)
Other drug abuse	10 (5.0)
Transportation to hospital	
Non-profit organization	110 (55.0)
Ambulance	82 (41.0)
Private vehicle	8 (4.0)
Marshall classification on initial CT	187 (93.5)
Grade I (no visible injury)	14 (7.0)
Grade II (midline shift 0 to 5 mm with present cisterns)	77 (38.5)
Grade III (Grade I-II + compressed or absent cisterns)	55 (27.5)
Grade IV (Grade I-III + midline shift >5 mm)	41 (20.5)

CT = computed tomography
Data as n (%), median ± SEM, or mean ± SD (range)

two most common intracranial injuries were subdural hematoma (105, 52.5%) and subarachnoid hemorrhage (93, 46.5%) (Fig. 3).

Outcome characteristics

The median hospital LOS was 12±2.2 days (range 3 to 260 days). Most patients (56, 28%) were discharged from the hospital with GOS 4 (Fig. 4). Follow-up rates at 3, 6, and 12 months were 35.5%, 24.0%, and 15.0%, respectively. Most patients (71, 42%) who returned to hospital for follow-up had improved GOS when they came for follow-up at 6 and 12 months (Fig. 4). There was no relationship between discharge GOS and follow-up rate.

Discussion

The present study examined the clinical characteristics and outcomes of patients recently hospitalized with severe TBI at a Thai tertiary care hospital, and provides new information on post-discharge

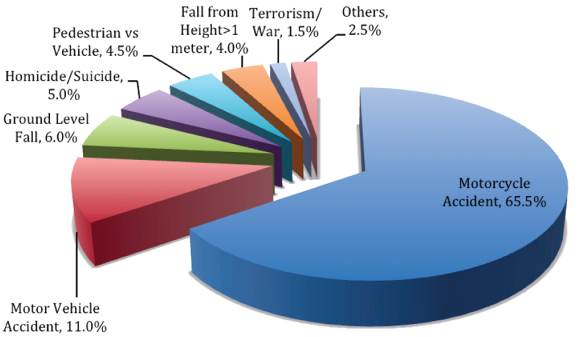

Fig. 1 Mechanism of injury of 200 patients with severe traumatic brain injury.

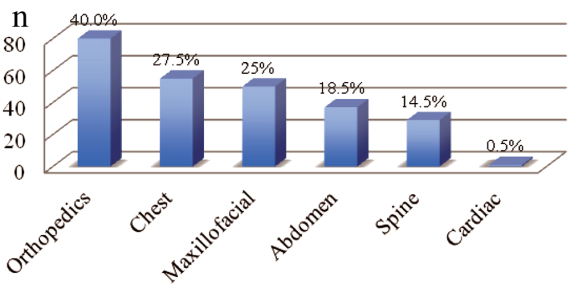

Fig. 2 Extracranial injuries present among 200 patients with severe traumatic brain injury.

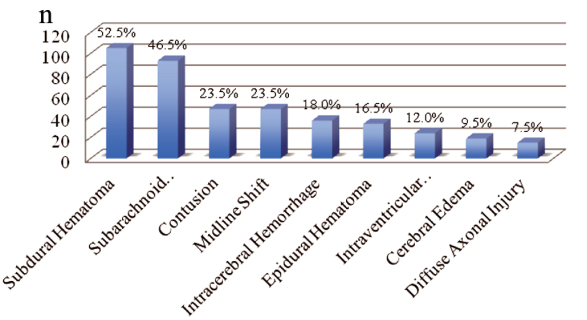

Fig. 3 Head computerized tomography scan findings present among 200 patients with severe traumatic brain injury.

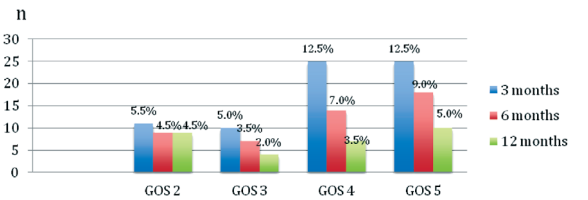

Fig. 4 Post-discharge, 3, 6, and 12 months Glasgow Outcome Scale (GOS) score among discharge survivors.

follow-up and outcomes among patients discharged alive. Main findings are 1) the proportion of TBI patients with severe TBI increased substantially since 1996, 2) the morbidity and mortality of patients with severe TBI has not decreased than the previously reported, 3) blood alcohol was detected in the majority of patients, and 4) the mode of transportation differed from the report in other developing nations. Finally, this is the first study to demonstrate the feasibility of using the NINDS-based common data elements to abstract data and to document post-discharge outcomes in severe TBI in Thailand.

In 2000, Phuenpathom presented the first epidemiological report of the severe TBI burden in Thailand[17]. Considering his findings and the present study, these cross-sectional data showed that the proportion of TBI patients admitted to this Thai trauma center has increased substantially over the past four decades from 15.8% (1986) to 29.6% (1996) to 40.2% (2011)[17]. Despite an initial decrease during the first decade of examination, severe TBI constituted a greater percentage of the admitted TBI population over time [12.4% (1986) vs. 7.9% (1996) vs. 27.4% (2011)]. This represented a doubling of the proportion of severe TBI patients between 1986 and 2011. While we cannot draw inferences regarding the exact reasons for this dramatic increase, we speculate that these statistics may represent an increase in the numbers of patients with TBI, an increase in occurrence of severe TBI, a higher admission rate of patients with TBI due to secular trends, and/or a combination of the three factors. Moreover, we know of no change in referral patterns to our tertiary care trauma center. Thus, the increase in severe TBI admissions may reflect an overall increase in the severe TBI burden in Thailand.

The in-hospital mortality rate in the present study of severe TBI patients was 17%. Compared with the previous study, which included all TBI patients, mortality rates have not reduced [21% (1996) and 14% (1985-1986)]. Given the difference in severity levels of patients in these two studies, we cannot determine if there has been any improvement in care or outcomes following severe TBI during the interval period. However, given general improvements in healthcare, these findings suggest that such benefits have not translated to patients with TBI.

Most patients with severe TBI in the present study were discharged from the hospital with moderate disability. Since there are no formal neuro-rehabilitation or skilled nursing facility programs in Thailand, patients were hospitalized until they were deemed ready to be discharged home. This may explain the longer hospital LOS in the present study than reported in developed nations such as the United States[22]. Although our primary aim was not to examine long-term GOS, our data provide useful information on hospital follow-up after severe TBI. Fewer than 50% of severe TBI patients received follow-up care at the trauma center, which may reflect loss to follow-up, death of patients following discharge, or logistical follow-up constraints faced by patients. Although there was no relationship between discharge GOS and follow-up rate, patients receiving follow-up may also represent those with better outcomes, who lived closer to the center, or those with the financial means to receive follow-up care at the tertiary care facility.

Blood alcohol level was elevated in the majority of our severe TBI patients and may be an additional risk factor for injury overall. This is relevant because previous studies have shown that brief interventions in hospitalized patients can reduce alcohol-related readmissions. The American College of Surgeons surveyed alcohol screening and brief intervention practices at level 1 trauma centers in the United States: 70% of responding centers routinely used laboratory tests (e.g., blood alcohol concentration) to screen patients for alcohol and 39% routinely used a screening questionnaire or standardized screening instrument[12].

Mode of transportation may play a role in patient outcomes after TBI. Private vehicle is the most common form of transportation of injured patients in low-middle income countries[2,23]. In Haiti, motorcycle taxi drivers function as the primary emergency transport mechanism to the hospital[24]. In Thailand[25], non-profit organizations and private vehicles are the most common modes of transporting patients. Ambulance service is not provided by the government and Thai patients or their families choose the mode of transportation to hospitals. Patterns of transportation in Thailand also vary from those in developed countries, which typically use ground emergency medical services (GEMS) or helicopter emergency medical services (HEMS)[25]. Although we did not study this aspect, educating personnel employed by transporting organizations regarding pre-hospital care of TBI patients could provide a means for improving both short and long-term outcomes after TBI.

The major mechanism of TBI in the present study was motorcycle accident, consistent with the report by the Thai Ministry of Public Health[16]. This is similar to the findings in other developing

countries[23,26] but different from developed countries where the most common mechanism is elderly falls[3,22]. Similarly, our severe TBI patients were younger than reported by developed nations[22]. Although our inclusion criteria relied on commonly used criteria for determining severe TBI, our study suggests that TBI severity may be lower than that encountered in both the United States and in certain developing nations. For example, despite a comparable mechanism of injury, the median GCS in the present study was 7, compared to the cohort enrolled by Chesnut et al[27] in Latin America (GCS 5). Similarly, the Marshall score in the study was Grade II compared to Chestnut's cohort, which had a Marshall score of Grade III[27]. Half of our patients had subdural hematoma. These differences may reflect differences in TBI exposure such as motor vehicle speed, or differences in admission criteria, as well as potential differences in hospital referral patterns and or pre-hospital mortality rate and survival bias.

There are some study limitations worth discussing. First, this was a retrospective study. Second, this was a convenient sample of consecutive patients at one trauma center, which may not represent the characteristics of severe TBI patients who received care throughout Thailand. Third, we did not have pre-hospital data for examination. Fourth, not all severe TBI patients received follow-up care at the trauma center. Despite these limitations, we provide new information on the characteristics and outcomes of patients with severe TBI in Thailand.

In summary, the proportion of trauma patients hospitalized with severe TBI is high, most patients with TBI have polytrauma, and in-patient mortality is high. This Thai trauma center has experienced an increase in the proportion of severe TBI admissions over time, with relatively no decrease in in-patient mortality. Blood alcohol level may contribute to the high TBI burden. Fewer than 50% of severe TBI patients received follow-up care at the trauma center, providing a future opportunity for assessing barriers to follow-up and improving outcomes.

What is already known on this topic?

Deaths from injury increased worldwide by 10.7% from 4.3 to 4.8 million between 1990 and 2013. The 2010 Global Burden of Disease project reported that road traffic injuries were a leading cause of mortality worldwide, and that traumatic brain injury (TBI) was the leading cause of trauma-related death. Thus, reducing the TBI burden is a global priority. In Thailand, road traffic injuries are one of the leading causes of death.

What is this study added?

No data have been added to the published regarding the epidemiology of TBI patients or the clinical characteristics and outcomes of patients with severe TBI in Thailand. Moreover, there are no data on functional outcomes of TBI patients. This study showed the clinical characteristics and outcomes of severe TBI patients recently hospitalized in a tertiary trauma care center in Thailand.

Funding disclosure

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Potential conflicts of interest

None.

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ลักษณะทางประชากรและผลลัพธ์ของผู้ป่วยไทยที่ได้รับบาดเจ็บทางศีรษะแบบรุนแรงที่เข้ารับการรักษาในโรงพยาบาลในประเทศไทยระหว่าง พ.ศ. 2552 ถึง พ.ศ. 2554

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วัตถุประสงค์: *เพื่ออธิบายลักษณะทางประชากรและผลลัพธ์ของผู้ป่วยไทยที่มีการบาดเจ็บทางศีรษะแบบรุนแรง*

วัสดุและวิธีการ: *ผู้ป่วยที่เข้ารับการรักษาในโรงพยาบาลสงขลานครินทร์จำนวน 200 ราย ใน พ.ศ. 2552 ถึง พ.ศ. 2554 ได้ถูกทำการเก็บข้อมูลโดยการใช้ Common Data Elements (CDEs) ของ National Institutes of Neurological Diseases and Stroke (NINDs) เก็บข้อมูลทางประชากร การรับการรักษาในโรงพยาบาลและผลลัพธ์ในแง่อัตราการตายและระดับการช่วยเหลือของผู้ป่วย (Glasgow Outcome Scale, GOS) โดยคัดเลือกผู้ป่วยที่มีอายุมากกว่า 18 ปี มี Glasgow Coma Scale score มากกว่า 9, head Abbreviated Injury Score ≥3 และใส่ท่อช่วยหายใจ*

ผลการศึกษา: *อายุเฉลี่ย 34±1.2 ปี เป็นเพศชาย 80.5% กลไกการบาดเจ็บที่พบมากที่สุด คือ อุบัติเหตุจากมอเตอร์ไซค์ 65.5% โดยผู้ป่วย 55% ถูกนำส่งโรงพยาบาลด้วยรถของหน่วยงานเอกชน ผลการตรวจศีรษะพบว่า มีเลือดออกใต้ชั้นดูรา 52.5%, มีเลือดออกในช่อง subarachnoid 46.5%, ได้รับการกระแทกทางศีรษะ 23.5% และมีการเคลื่อนของกึ่งกลางสมอง 23.5% ตรวจพบระดับแอลกอฮอล์ในกระแสเลือดสูงในผู้ป่วยมากกว่า 50% อัตราการตาย 17% และ GOS ขณะออกจากโรงพยาบาลเป็น 4±1 อัตราการติดตามอาการของผู้ป่วย GOS ที่ 3, 6 และ 12 เดือน เป็น 4±0.1 (n = 71), 5±0.2 (n = 48) และ 5±0.2 (n = 30) ตามลำดับ*

สรุป: *อัตราการได้รับบาดเจ็บทางศีรษะแบบรุนแรงของผู้ป่วยอุบัติเหตุเพิ่มขึ้น ผู้ป่วยส่วนใหญ่มีระดับแอลกอฮอล์ในเลือดสูงในระหว่างการเกิดอุบัติเหตุ ส่งผลให้เกิดผลเสียต่อประเทศชาติ*