

Characteristics of Traumatic Brain Injury in Sanglah Hospital, Bali, Indonesia: A Retrospective Study

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Traumatic head injury is the most common trauma found in the emergency department, and the most significant cause of morbidity as well. There are many traumatic head injuries in Sanglah Hospital which caused by traffic accidents. Epidemiological studies of traumatic head injuries are still limited. The purpose of this study is to describe the characteristics of traumatic head injury patients at Sanglah Hospital. This study is a retrospective study centered at Sanglah Hospital (single-centered). The data used are secondary data based on medical records from January to December 2017. Data were analyzed with SPSS version 21.0. Multivariate regression analysis was performed to determine the predictive variable for the first 24-hour mortality of traumatic head injury. From January to December 2017, a total of 525 samples were collected. Most of the samples are males (68.2%), with no significant differences in gender variable. The data also showed that mostly aged 19-40 years (47.6%), traffic accidents (86.3%), have a history of unconsciousness (74.1%), duration of unconsciousness <10 minutes (32.8%), time interval to hospital <1 hour (49.1%), GCS admission 13-15 (55.8%), blunt head injury (78.7%), 1 intracranial hemorrhage (43.2%). Multivariate regression analysis showed increased age, increased time to the hospital, decreased GCS scores, airway disturbance, decreased oxygen pressure in the blood, and increased types of intracranial hemorrhage significantly associated with first 24-hour mortality. Having data on head injury incidents in Bali is an important key to know the characteristics of head injury cases that can intervene in the future in the form of public health and prevention. Further research is needed to be able to represent the characteristics and to give appropriate management for traumatic head injury patient in order to decrease the mortality and morbidity especially for oxygen and airway management that are found to be significant risk of death in this study.

Keywords: Traumatic Brain Injury, Sanglah Hospital, Bali.

Traumatic head injury is the most common trauma found in the emergency department and is the most significant cause of morbidity and death in patients.¹ According to data from the CDC (Center of Disease Control and Prevention) in 2014, there were 2.87 million injuries traumatic head who came to the Emergency and Inpatient Unit.² Nearly 90%

of deaths due to prehospital trauma related to head trauma.² Based on the results of Riskesdas 2013 the prevalence of injury data in Indonesia nationally is (8.2%), the highest prevalence was found in South Sulawesi (12.8%) and the lowest in Jambi (4.5%).³

According to a study by the Global Status Report on Road Safety, in 2018 there were deaths

from traffic accidents of up to 7% of the world's population, with 1.35 million people die due to traffic accidents annually due to head injuries.⁴ The cause of head injuries can originate from various sources namely blunt and sharp violence; one of them is a traffic accident that is involved in blunt force. In addition to falling from height is also one of the causes of head injuries that fall into blunt force criteria.⁵

A study conducted at Haji Adam Malik General Hospital Medan, found that head injuries cause disability with the most incidents occurring at the age of 18-35 years with incidents of 150-200 people per one million population.¹ Traffic accidents that occur in developing countries, especially Indonesia, which had an inferior driving index rank third in pedestrians and cyclists with a mortality rate of 25-37%.¹ It is estimated that by 2025 head injuries are the most significant cause of death and disability in the world.

Based on previous studies, traumatic brain injury is mostly caused by traffic accident with 81.48% cases in Audina *et al.*, parallel with 79% cases in Sunarto *et al.*, and 84.21% cases in Rosyidi *et al.*, also 65.4% cases that specifically mentioned as motorcycle crashes in Faried *et al.* It becomes a critical public health and socioeconomic burden which basically crucial to understand the demographic and characteristics of traumatic head injury for better application of prevention and treatment efforts.⁶⁻¹¹

Epidemiological studies of traumatic head injuries are still limited. To date, there have been no epidemiological studies of head injuries in Bali Province. Having data on head injury incidents in Bali is an important key to know the characteristics of head injury cases that can intervene in the future in the form of public health and prevention. This study aims to describe the characteristics of head injury patients.

MATERIAL AND METHODS

This research is a retrospective study centered on Sanglah Hospital Denpasar (single-centered), where Sanglah Hospital serves referral patients from the Provinces of Bali, NTB, and NTT. Patient data were collected from hospital medical records from 1 January 2017 to 31 December 2017. The data in the medical records were confidential

that do not contain any identifying marks and are no accompanied by text that might identify the individual concerned. The inclusion criteria for this study were patients with a diagnosis of traumatic head injury based on the ICD-10 code (concussion S06.0). The incomplete patient medical record data will be excluded from the study. The research data was based on a review of medical records, which included data in the form of each patient's demographic information, mechanism of injury, history of previous injuries, prehospital status, type of head injury, number, and type of bleeding, 24-hour survival after injury. Prehospital status includes a history of unconsciousness before hospital admission, duration of unconsciousness, and time intervals to the hospital. The intended time interval starts from the time of the initial accident. The survey, which is evaluated upon entering the emergency department, includes the level of awareness, the condition of the presence of airway disturbance, as well as signs of impaired oxygen circulation.

Clinical / Radiological Evaluation

The level of awareness of patients suffering from traumatic head injuries was evaluated using the Glasgow Coma Scale (GCS). Traumatic head injury is defined as an injury to the head due to the traumatic process and/or the presence of one type of intracranial hemorrhage. The severity of head injuries is divided into minor head injuries (GCS 14-15), moderate (GCS 9-12), and severe (GCS 3-8). The number and type of intracranial hemorrhage are evaluated using Computed Tomography (CT) Head Scan, performed the first time the patient enters the emergency room. Oxygen circulation in the blood is evaluated by examining peripheral oxygen saturation and/or blood gas analysis if there are signs of respiratory failure (PaO₂ <60 mmHg or 8kPa). Patients assessed the condition of treatment outcomes in the form of mortality in the first 24 hours, whether the patient can still survive or die (Table 1).

Statistical analysis

A chi-square test was used to determine differences in categorical variables with patient care outcomes. P values <0.05 were categorized as statistically significant. Multivariate regression analysis was performed with SPSS 21.0 (SPSS Inc., Chicago, IL, USA) to identify variables related

Table 1. Variable Clinical Characteristics and Mortality Output of the First 24 Hour

Variable	Patient Outcome		Total	p
	Died	Not died		
Gender				0,303
Male	44 (12,3%)	314 (87,7%)	358 (68,2%)	
Female	26 (15,6%)	141 (84,4%)	167 (31,8%)	
Age				0,001*
0 – 5 years	1 (6,7%)	14 (93,3%)	15 (2,9%)	
6 – 13 years	2 (14,3%)	12 (85,7%)	14 (2,7%)	
14 – 18 years	7 (12,5%)	49 (87,5%)	56 (10,7%)	
19 – 40 years	19 (7,6%)	231 (92,4%)	250 (47,6%)	
41 – 59 years	24 (19,5%)	99 (90,5%)	123 (23,4%)	
≥ 60 year	17 (25,4%)	50 (74,6%)	67 (12,8%)	
History of Head Injury				0,064
Yes	5 (33,3%)	10 (66,7%)	15 (2,8%)	
No	65 (12,7%)	445 (87,3%)	510 (97,2%)	
Cause of Injury				0,03*
Traffic accident	59 (13%)	394 (87%)	453 (86,3%)	
Fell from height	4 (44,4%)	5 (55,6%)	9 (1,7%)	
Violence	6 (16,2%)	31 (83,8%)	37 (7%)	
Other	1 (4%)	25 (96%)	26 (5%)	
Unconscious History				0,007*
Yes	61 (15,7%)	328 (84,3%)	389 (74,1%)	
No	9 (66,7%)	127 (93,4%)	136 (25,9%)	
Duration of Unconscious				<0,001*
Conscious	6 (4,9%)	117 (95,1%)	123 (23,4%)	
< 10 minute	9 (5,2%)	163 (94,8%)	172 (32,8%)	
10 minute – 1 hour	24 (16,8%)	119 (83,2%)	143 (27,2%)	
> 1 hour	31 (35,6%)	56 (64,4%)	87 (16,6%)	
Time Interval to Hospital				0,012*
< 1 hour	23 (8,9%)	235 (91,1%)	258 (49,1%)	
1 – 4 hour	43 (17,8%)	198 (82,2%)	241 (45,9%)	
5 – 12 hour	2 (10%)	18 (90%)	20 (3,8%)	
> 12 hour	2 (33,3%)	4 (67,7%)	6 (1,2%)	
GCS entered				<0,001*
GCS 3 – 8	41 (52,6%)	37 (47,4%)	78 (14,9%)	
GCS 9 – 13	26 (16,9%)	144 (83,1%)	170 (32,4%)	
GCS 14 – 15	3 (1,1%)	274 (98,9%)	293 (52,8%)	
PaO ₂ < 60mmHg or O ₂ Sat < 90%				<0,001*
Yes	23 (69,7%)	10 (30,3%)	33 (6,3%)	
No	47 (15,3%)	445 (84,7%)	492 (93,7%)	
Airway Obstruction				<0,001*
Yes	29 (69%)	13 (31%)	42 (8%)	
No	41 (8,4%)	442 (91,6%)	483 (92%)	
Type of Head Injury				0,003*
Blunt	46 (11,1%)	367 (88,9%)	413 (78,7%)	
Open	7 (14,6%)	41 (85,4%)	48 (9,1%)	
Compression	17 (26,6%)	47 (73,4%)	64 (12,2%)	
Number of types of Bleeding				<0,001*
Not at all	4 (2,5%)	159 (97,5%)	163 (31%)	
1 Type	20 (8,8%)	207 (91,2%)	227 (43,2%)	
2 Type	28 (27,5%)	74 (72,5%)	102 (19,4%)	
3 Type	15 (50%)	15 (50%)	30 (5,7%)	
4 Type	3 (100%)	0 (0%)	3 (0,7%)	

*p < 0,05 show significant

Table 2. Multivariate Logistic Regression Analysis of Mortality in the first 24 Hours among Traumatic Head injury Patients

Variable	OR	95% CI	p
Age \geq 40 years old	2,23	1,13 – 4,37	0,02*
History of Injury	3,60	0,79 – 16,48	0,099
Unconscious history	1,03	0,42 – 2,54	0,953
Duration of unconsciousness >1 Hour	1,83	0,84 – 4,00	0,131
Time Interval to Hospital >1 Hour	2,26	1,11 – 4,57	0,024*
GCS < 9	4,69	2,06 – 10,64	<0,001*
Airway Obstruction	5,58	2,06 – 15,10	0,001*
PaO ₂ < 60mmHg or O ₂ Sat < 90%	3,22	1,01 – 10,23	0,048*
ICH \geq 2 type	5,65	2,82 – 11,34	<0,001*

to treatment outcomes of traumatic head injury patients. These variables include the duration of unconsciousness, time interval to the hospital, GCS admission, blood oxygenation status, and the number of types of bleeding.

Multivariate logistic regression for patient care outcomes showed that increased age, increased time to the hospital, decreased GCS score, impaired airway, reduced oxygen pressure in the blood, and increased types of intracranial hemorrhage were significantly associated with mortality in the first 24 hours (Table 2).

DISCUSSION

This study is the first study to examine the characteristics of traumatic head injuries in Bali. Head injury is the most significant cause of death and disability that can affect various sexes, circles, and age groups about traffic accidents that fall from heights, violence, and others. It is undeniable that head injuries are still a health burden in developing countries, especially in Indonesia, along with the increasing use of motor vehicles.

In this study, we used GCS scoring criteria according to classic GCS, which included a score of 15-14 as a category of minor head injuries. In the GCS scoring criteria, according to ATLS, a score of 15-13 is a category of minor head injuries. A study by Mena *et al.* found that GCS with a score of 15-14 included in the mild head injuries category had lower mortality than GCS scores, according to ATLS. In our study, using the GCS classic scoring with 14-15 as a criterion for a mild head injury,

13 - 9 as a criterion for moderate head injury and 8 - 3 as a criterion for a severe head injury.¹²

Head injuries are found to be highest in the 19-40 age group with the biggest causes of injuries in the form of traffic accidents. A study by Balestreri *et al.* found the age and outcome of a head injury were highly correlated. Found with ages 30-60 years have a higher mortality rate than younger age groups.¹³ The correlation between increasing age and worsening outcomes from head injuries was found to be significant. It is believed that with increasing age, the ability to repair damage decreases and is followed by an increased incidence of complications from head injuries. Moreover, older patients tend to have worse prognosis regardless other factors than younger patients might related of previous illness with higher risk of hemorrhage. Elderly patients were more prone to multiple bleed location but the younger patients were higher fracture incidence according Liaw *et al.* Elderly tend to be more coagulopathy and thrombocytopenic than the younger that might related with anticoagulant and antiplatelet consumption. Later on, it might also influence the surgical judgment along with complications in elderly cases.¹⁰

In this study, the incidence of head injuries occurred more in the male sex. Studies of gender differences in head injuries have been carried out. One of the studies conducted by Bayir *et al.*, said that men are more at risk of head injury.¹⁴ An increased risk of the male sex is associated with occupational risks that have a higher physical level than the female gender. This statement is

compatible with other studies that reported male predominance.^{6-11,15} A cohort study of Liaw *et al* represented that gender proportion of traumatic brain injury is dominated by male than female in both young (10:1) and elderly (4:3) groups but significantly distant ratio.¹⁰ Munivenketappa *et al* showed the quantity of head injuries and deaths was more among female than male in pediatric and elderly populations.¹⁶ Review article of gender differences in traumatic brain injury from Ma *et al* tried to understand the reasons of male predominance in head injuries event. They concluded that female has steroid hormones as neuroprotective effects through anti-inflammatory and antioxidant mechanism, along with microglia and dopamine system result in better prognosis than male populations.¹⁷ Unfortunately, the steroid hormones might decline in older age, it might be explained the distant ratio of this gender in young and older populations.

However, correlation of head injury outcomes to sex was found to be worse in female sex outcomes. Many reports on the correlation between sex with the outcome are said to be the role of the hormone in the form of protective effects of estrogens and progesterone.⁹ In this study, no significant differences were found in the correlation of outcomes with sex. The number of samples of this study, which is still relatively small in the genders, is still limited to prove the differences.

Studies conducted by Schofield *et al.*, found that patients with head injuries and had a history of minor head injuries and 80% were previously correlated with outcomes from these patients.¹⁸ It might be due to the presence of sequelae or episodes from a history of previous head injuries. In this study, there were no significant differences in the correlation of the history of head injury in previous patients with outcomes from patients. In our study, the number of samples from patients with a history of prior head injuries was small, so a larger sample was needed to prove the difference.

Impaired oxygen distribution to the brain and other vital organs is the fastest killer in injured patients. Airway (airway) is the first thing assessed in the initial evaluation of the patient.¹⁹ Brain cells are susceptible to a decrease in blood oxygen levels, if the amount of oxygen decreases, brain cells will start to die within 5 minutes.²⁰ Proven in the results

of this study, the existence of airway disorders and oxygen saturation <90% or PaO₂ <60mmHg are significantly associated with the risk of death. Therefore, the need for adequate airway handling in traumatic head injury patients to reduce the risk of death. In patients who have more than two types of head bleeding, 1 episode of head injury has a risk of 5.65 times associated with higher mortality than 1 type of bleeding in patients who can also significantly relate to the age factor e⁷ 40 years with mortality rates in patients Supported by studies conducted by Meirhaeghe *et al.*, in patients who are older and have more than 1 type of bleeding in patients tend to have high mortality rates.²¹ Pre-existing impairment of oxygen distribution such as hypoxia, intracranial hypertension, full stomach, and head/neck injuries might affecting difficult airway management, thus, preparation and pre-oxygenation is mandatory.¹¹ The role of adequate oxygenation is determining the result of head injuries, however, the high level of oxygen were associated with poor result in severe head injury cases because of alteration in cardiac output and metabolic activity of neurons that result in reduction of oxygen delivery to brain.²²

Road traffic accidents always remain as major issues of head injuries. The increasing number of vehicles on the road and the increasing mobility of the population with unstandardized level of security such as the low use of seat belts and helmets might increase cases of brain injury due to traffic accidents. Along with Faried *et al* study about characteristic of moderate and severe head injury, it reported 71,2% cases were not using the helmet and added information of 14% cases were under alcohol intoxication.⁹ Singapore Police Force in 2015 published a decline in number of road traffic accidents over the past four years but the number of road accidents still high. A developed country study has shown that application of motorcycle helmet law results in a lower incidence of TBI due to motorcycle accidents as compared with states in which such laws were not implemented.²³ Accordingly, tighter rules about seat belt use, alcohol consumption while driving, driving speed, and other proper educational of driving course is necessary.

Patients with head injuries required decently post-discharge care and rehabilitation that might influence the morbidity and mortality

rate if they lost in contact.²⁴ Unfortunately, some patients couldn't attend because of cost and transportation difficulties. Hence, a study suggested about nursing teleconsultation as electronically nursing services in remote areas, but this idea must supported by qualified nursing knowledge, supportive communication technology and system and information securities that not properly established.²⁵ Another similar innovative idea with computerized based that covered pre-hospital head injury cases were discussed by Sutiono *et al.*²⁶

Limitation

This study has several limitations. First, this study is a one-flashlight study in urban areas, unable to represent conditions elsewhere in Indonesia. The retrospective nature of this study is also limited by the amount of clinical information from the patient and the medical record. The patient care outcomes in this study were limited to whether the patient was alive or dead, not assessed using the Glasgow Outcome Scale (GOS) score. It mostly caused by medical record limitations that previously mentioned. The clinician perspective and institution policy might contribute of medical record limitations; hence, standard form and pathways with proactive and post-therapy measurement according to multidisciplinary studies are highly suggested for next researches. Besides that, "alive or dead" outcome is simply explained the prognosis in this study though less specific. Furthermore, based on author's knowledge, this article is the first study that described the characteristics of TBI in Bali populations; therefore, this study hopefully helps the next researches related traumatic brain injury especially in Bali.

CONCLUSION

This study is the first study to describe the characteristics of traumatic head injuries in Bali. The results of this study indicate that traffic accidents are mostly experienced by men and patients aged 19 - 40 years. Impaired oxygen distribution to the brain and other vital organs is the fastest killer in injured patients. Brain cells are susceptible to a decrease in blood oxygen levels. Proven in the results of this study, the existence of airway disorders and oxygen saturation <90% or PaO₂ <60mmHg are significantly associated with

the risk of death. Therefore, the need for adequate airway handling in traumatic head injury patients to reduce the risk of death. Further research is needed to be able to represent the characteristics of traumatic head injury patients and to give appropriate management for traumatic head injury patient in order to decrease the mortality and morbidity especially for oxygen and airway management that are found to be significant risk of death in this study. These results may provide new insights into the clinical and epidemiological characteristics of traumatic head injuries and help improve the clinical diagnosis and treatment of traumatic head injuries. Further research is needed with more than one research center, more sample sizes, longer time frames, and more variables to represent the characteristics of traumatic head injury patients in the province of Bali.

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