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Risk factors of mortality due to traumatic brain injury in Marsidi Judono general hospital, Belitung, Indonesia

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ABSTRACT

Introduction: Traumatic brain injury (TBI) is a global problem and the biggest cause of mortality and disability of all trauma cases. This study aimed to determine the characteristics and relationship between risk factors for TBI and its impact on mortality and also to provide epidemiological data related to TBI in Belitung regency.

Methods: A retrospective study was conducted using secondary data from the medical records of participants who met the inclusion and exclusion criteria at dr. H. Marsidi Judono General Hospital Belitung from January to December 2019. Data were analyzed as univariate, bivariate, and multivariate using binary logistic regression.

Results: Two hundred and seventy patients were included in this study. Men were more likely to have a TBI than women in all categories (65.9%). The adolescent age group (33.7%) followed by adults (31.5%) were the largest contributors to TBI. Road traffic accident cases (86.7%) dominated the incidence of TBI. The use of headgear was still lacking (36.7%) while cases of road traffic accidents were high. The use of ambulances was lacking (10.4%) compared to other vehicles. A total of 119 patients (44%) were hospitalized in either the general ward or ICU with an average length of hospitalization was 3 days. Of all TBI cases, the mortality rate was 11.9%. People with older age have a higher mortality rate compared to other age categories (OR 1.052; 95% CI: 1.001 – 1.106).

Conclusion: The mortality rate due to TBI reaches 11.9% in this region, with age as a statistically significant predictor of mortality due to TBI. Older patients tend to have a higher likelihood of death due to TBI. The data obtained can be used by general practitioners, disease preventative planners, and policymakers to reduce mortality due to TBI in Belitung regency.

Keywords: Belitung, risk factors of mortality, road traffic injury, traumatic brain injury.

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INTRODUCTION

Traumatic brain injury (TBI) is an injury that affects the structure of the skull that causes physiological changes in the brain which can be caused by mechanical or non-mechanical external forces.¹ TBI is a global problem and the biggest cause of mortality and disability of all trauma cases.² The global incidence of TBI reaches 939 cases per 100,000 people and it is estimated that almost 70 million people in the world sustain a TBI every year.³ In Asia, India has the second-largest population in the world and accounts for more than a quarter of deaths from trauma globally which can be estimated for more than one million deaths, or it can be said that around 50% of all their cases are caused by TBI.⁴ In addition to death, disability after

TBI is very high. It is estimated that 15 – 20 people out of every 100,000 population aged under forty sustain severe disabilities each year.⁵

In Indonesia, although the epidemiological data of TBI is still lacking, we can see in one of this data from dr. Soetomo General Hospital, Surabaya, in 2009 until 2013, where the incidence of TBI reached 1,178 cases every year, with mortality rates ranging from 6.2% to 11.2%.^{1,6} According to their data, the mortality rate is higher than the international standard, which is 3% to 8%.¹ Another data from Global Burden of Diseases, Injuries, and Risk Factors (GBD) 2016 stated that the incidence of TBI in Indonesia in that same year reached 670 thousand cases or around 264 cases per 100,000 population. This number

indicates an increase of incidences for about 25%, compared to the incidences in 1990.⁷ The increasing incidences of TBI worldwide, including Indonesia, is linked to the increasing use of motorized vehicles which is associated with traffic accidents as the main cause, followed by falls and violence.⁸ From Riskesdas 2018, the proportion of TBI in Indonesia was 11.9%. Our province itself, Bangka Belitung, was in 10th place of all provinces in Indonesia, where the proportion was greater than the national average, which was 14.2%.⁹

Especially in Belitung, there is no comprehensive epidemiological data on TBI even though the incidence is quite high. This research is expected to be sufficiently representative in providing an overview of TBI cases in Belitung as our hospital, dr. H. Marsidi Judono General

Hospital is the largest hospital and a regional referral center in the Belitung regency. We hope that this research may give a contribution to epidemiological data on brain injury at local, regional, and national levels, and also can be used as a basis for further research ideas and finally be useful in the making and implementing local and central government policies.

METHODS

This study was held at dr. H. Marsidi Judono General Hospital Belitung, which is the regional referral center in Belitung regency. This study was a retrospective cohort study with secondary data from the medical records of TBI patients who came to the emergency department from January to December 2019. Sampling was carried out using a non-probability sampling technique. The study population was all TBI patients at our hospital. The inclusion criterias were patients diagnosed with mild (GCS 13 – 15), moderate (GCS 9 – 12), and severe (GCS 3 – 8) TBI based on the Glasgow Coma Scale (GCS); TBI patients with multiple trauma; TBI patients older than five years. Patients with wounds that were in the head area but not diagnosed with TBI and patients with incomplete medical records were not included in this study.

The medical record is used to obtain information regarding gender, age, GCS value at the time of arrival, cause of TBI (traffic or non-traffic accident), wearing of head protection (wearing or not wearing), mode of transportation used to go to the hospital (ambulance or other vehicles), hospitalization (not hospitalized, inpatient in the general ward or inpatient in the ICU), length of stay, and the patient's outcome (improving or dying). For epidemiological data, variables of age and length of stay are divided into subgroups. Age was divided into children (5 – 11 years), adolescents (12 – 25 years), adults (26 – 45 years), elders (46 – 65 years), and seniors (> 65 years) categories. Length of stay was divided into no hospitalization (0 day), 1 – 2 days, 3 – 5 days, and more than 6 days. Motorcycle injuries, car injuries, and pedestrian injuries were within traffic accidents, whereas falls, assaults, and other injuries were included in non-traffic accidents.

Data obtained were analyzed using SPSS version 23. Bivariate logistic regression was used to determine the relationship between each variable with the patient's outcome and multivariate logistic regression was used to estimate the relationship between all variables and the patient's outcome. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 333 samples were obtained from the medical records unit. Sixty-three samples were excluded due to incomplete medical record data, leaving us with 270 samples.

Two hundred twenty-five of them are mild TBI (83.3%), followed by severe TBI in 26 cases (9.6%), and the remainder (7.1%) are moderate TBI. Men dominated the incidence of TBI in as many as 178 patients (65.9%). The mean age of the patients in this study is 33.4 years, with the youngest being 6 years to the oldest 98 years. Adolescents (12 – 25 years) and adults (26 – 45 years), which are respectively 91 patients and 85 patients, are the group who sustain the most brain injury.

Motorcycle accidents were the most common cause of TBI (222 cases, 94.9%) of all traffic accidents. Falls accidents (24 cases, 66.7%) were the most common cause of all non-traffic accident cases (Fig. 1A and Fig. 1B). Motorcyclists who wear head protectors/helmets were only 99 (36.7%) out of 222 cases, with the male motorcyclist, as many as 87 patients are the frequent ones who do not wear helmets (70.7%) (Fig. 1C). The most common mode of transportation to go to the hospital after sustaining TBI is other vehicles than ambulances, with as many as

242 cases (89.6%).

After the medical assessment of all TBI cases, 119 patients were hospitalized with 103 patients being treated in the general ward (38.1%) and 16 patients being admitted to the ICU (5.9%). Mild brain injury cases were the most frequently treated in the general ward (90 patients, 40%) while the ICU was the most frequent place of care for severe TBI cases (12 patients, 46.2%). The duration of hospitalization varied, from the shortest, which is one day, to the longest, which is twelve days, with the average duration of hospitalization for all cases being 3.1 days. The mean duration of hospitalization for cases that were admitted to the ICU alone is 2.3 days. After receiving the medical intervention, both hospitalized and non-hospitalized patients, as much as 238 patients (88.1%), showed some improvement in their condition. This number is dominated by mild TBI cases (98.2%). Meanwhile, the number of deaths due to TBI was 32 cases (11.9%) with 24 of them (92.3%) were severe TBI cases. (Table 1 and Table 2).

There were 16 cases of death due to TBI that occurred in the emergency department. This number included patients who had received medical intervention and patients who have already dead on arrival. Of the 119 patients treated, as many as 103 patients (87%) had improvement on their level of consciousness and the remaining (13%) had worsened on their level of consciousness until they were finally death. Table 1 provides information that the elderly group accounted for the most cases of death with 12 cases (37.5%) and followed by the adolescents group with 10 cases (31.3%).

Figure 1. A. Causes of TBI; B. Types of traffic accidents; C. Helmet use on motorcycle riders based on gender.

Bivariate test results with binary logistic regression showed that age ($p = 0.009$), head protection ($p = 0.005$), mode of transportation ($p = 0.028$), hospitalization ($p = 0.001$), and GCS value ($p = 0.001$) influenced the patient's outcome. Meanwhile, gender ($p = 0.058$), causes of TBI ($p = 0.224$), and duration of hospitalization ($p = 0.827$) did not

significantly influence the outcome (Table 3). Multivariate analysis with binary logistic regression showed that age was the only variable that significantly affected the risk of death from brain injury, where older age led to a higher risk of death from brain injury with OR 1.052 (95% CI: 1.001 – 1.106).

DISCUSSION

Belitung regency based on data from the Central Bureau of Statistics of Belitung in 2019, is inhabited by 173,717 people, and it is estimated that the incidence of TBI in Belitung reached 192 cases per 100,000 population.¹⁰ The number of cases found in this region is less than data from Global Burden of Diseases, Injuries, and Risk Factors (GBD) 2016, which provides an estimated incidence of TBI in Indonesia that is 264 cases per 100,000 population.⁷ In Indonesia, information about the incidence of TBI is still focused on local studies especially on teaching hospitals such as RSUP Sanglah Denpasar, which found more than 2,000 TBI cases.¹¹ With this very limited and centralized data, a better recording and reporting system is needed in the future so that the incidence of brain injury on a national scale can be described.

Men dominated the incidence of TBI in this study. In this study, men were 1.9 times more likely to sustain TBI than women. This is consistent with several demographic studies conducted abroad. Munivenkatappa *et al.* conducted a study that questioned whether gender will influence the outcome of patients with TBI. Their study showed the ratio of men to women patients is 4.5:1, with the most common causes of TBI were traffic accidents and fights.¹² In general, men were more likely to experience recurrent traffic accidents due to their higher mobility than women.¹³

Adolescents and adults are the largest contributors to TBI. It is associated with higher mobility such as working and schooling where the use of motorized vehicles in countries with lower middle income is still quite high so that the tendency for traffic accidents is also increased.¹⁴ In several studies, age variable

Table 1. Demographic characteristic of samples.

Variable	Improve		Death		Total	
	n	%	n	%	n	%
Gender						
Men	152	63.9	26	81.3	178	65.9
Women	86	36.1	6	18.8	92	34.1
Age group (years)						
Children (5 – 11)	12	5.0	2	6.3	14	5.2
Adolescents (12 – 25)	81	34.0	10	31.3	91	33.7
Adults (26 – 45)	82	34.5	3	9.4	85	31.5
Elders (46 – 65)	48	20.2	12	37.5	60	22.2
Seniors (> 65)	15	6.3	5	15.6	20	7.4
Causes of TBI						
Traffic accident	204	85.7	30	93.8	234	86.7
Non-traffic accident	34	14.3	2	6.2	36	13.3
Head protection						
No use	143	60.1	28	87.5	171	63.3
Use	95	39.9	4	12.5	99	36.7
Mode of transportation						
Other vehicle	217	91.2	25	78.1	242	89.6
Ambulance	21	8.2	7	21.9	28	10.4
Hospitalization						
No hospitalization	135	56.7	16	50.0	151	55.9
General ward	102	42.0	1	3.1	103	38.2
Intensive care unit	1	0.4	15	46.9	16	5.9
Length of stay						
0 day	135	56.7	16	50.0	151	55.9
1 – 2 days	45	18.9	10	31.3	55	20.4
3 – 5 days	49	20.5	4	12.5	53	19.6
> 6 days	9	3.8	2	6.3	11	4.1
GCS						
Mild TBI	221	92.9	4	12.5	225	83.3
Moderate TBI	15	6.3	4	12.5	19	7.1
Severe TBI	2	0.8	24	75	26	9.6

Table 2. Overview of hospitalization and mortality against the degree of TBI.

Variable	Mild TBI		Moderate TBI		Severe TBI		Total	
	n	%	n	%	n	%	n	%
Hospitalization								
No hospitalization	135	60	3	15.8	13	50	151	55.9
General ward	90	40	12	63.2	1	3.8	103	38.1
Intensive care unit	0	0.0	4	21.1	12	46.2	16	5.9
Mortality**	4	1.8	4	21.1	24	92.3	32	11.9

** : Death on arrival and after hospitalization

Table 3. Bivariate logistic regression and multivariate analysis.

Covariates	Bivariate association			Multivariate association		
	P	OR	95% CI	P	OR	95% CI
Gender						
Men	0.058	2.452	0.971 – 6.191	0.810	1.260	0.191 – 8.324
Women	0.058	0.480	0.162 – 1.030	0.810	0.794	0.120 – 5.243
Age	0.009	1.025	1.006 – 1.044	0.044	1.052	1.001 – 1.106
Causes						
Traffic accident	0.224	2.500	0.571 – 10.95	0.232	1018	0.003 – 3805
Non-traffic accident	0.224	0.400	0.091 – 1.751	0.232	0.000	0.000 – 366.5
Head protection						
Use	0.005	4.650	1.580 – 13.68	0.776	0.197	0.197 – 8.841
No use	0.005	0.215	0.073 – 0.633	0.776	0.113	0.113 – 5.083
Transportation						
Other vehicle	0.028	0.346	0.134 – 0.894	0.183	0.305	0.305 – 508.2
Ambulance	0.028	2.893	7.484 – 0.183	0.183	0.002	0.002 – 3.281
Hospitalization						
No	0.000	0.008	0.001 – 0.064	0.104	0.000	0.000 – 4.448
General ward	0.000	0.001	0.000 – 0.011	0.069	0.000	0.000 – 1.631
Intensive care unit	0.000	126.6	15.66 – 1022	0.104	0.225	0.225 – 9983
Length of stay	0.827	0.979	0.813 – 1.180	0.121	0.058	0.058 – 1.391
Severity of TBI						
Mild brain injury	0.000	0.002	0.000 – 0.009	0.110	0.000	0.000 – 16.18
Moderate brain injury	0.000	0.022	0.004 – 0.137	0.214	0.000	0.000 – 224.1
Severe brain injury	0.000	663.0	115.3 – 3811	0.110	0.062	0.062 – 9269

CI: Confidence interval; OR: Odds ratio

greatly influences the severity, progression, and prognosis of a TBI.^{15,16} Older age and early childhood (< 6 years old) have anatomical and physiological differences that are not negligible when compared to adult patients. It makes the impact of morbidity and mortality in this age group higher than in other groups.¹⁷

The use of helmets for motorcyclists in Bangka Belitung Province according to the data from Riskesdas 2018 is divided into three categories, 41.9% always wear a helmet, 42.4% sometimes wear a helmet and the remain do not wear a helmet. Especially in Belitung regency, there is no specific data, but from this study, it is found that only about 30% of motorcycle accident victims who wore helmets suffered a TBI. Research from Lahdimawan *et al.* illustrated the importance of using head protection both when working and driving a vehicle, especially motorbikes, where this study showed a significant relationship between head protection variables and the severity of TBI.¹⁸

In the case of TBI, an ambulance equipped with standardized health personnel and facilities is an important

factor to prevent secondary TBI (increased intracranial pressure, hypotension, hypoxia, hyperthermia, and seizures) when transferring a patient to the emergency department.¹⁹ In this study, the majority of patients with mild TBI arrived by vehicle other than an ambulance (92.4%) whereas only 28 patients (10.4%) of all TBI cases used ambulances. Several factors such as the location of the accidents, which is far from health facilities, panic from the patient's family/local residents, and the lack of public knowledge about the importance of good patient transfers, are thought to have caused the low use of ambulances in Belitung regency.

Duration of hospitalization can be influenced by failure in treatment, the severity of disease, limitations in medical facilities, and inadequate treatment of a disease.²⁰ Research at a public hospital in Sumba, East Nusa Tenggara, where the condition of the hospital was not much different from the hospital where this study was conducted, showed that the mean duration of hospitalization for mild TBI was 2 days, moderate TBI was 3 days, and severe TBI was 5 days.²¹ At the

hospital where this study was conducted, moderate and severe TBI or TBI with rapid progression, often treated with pharmacology alone. Limited facilities and the absence of a neurosurgeon in Belitung regency make the medical intervention of TBI cases not optimal so that the duration of treatment in the hospital will increase and the cost of treatment becomes even greater.

The mortality rate of TBI in this study was 11.9%. Most of the deaths were severe TBI cases, which was 88.9%, while its incidence of all cases was 8.9%. Compared with the existing literature in Indonesia, according to the research of Tjahjadi *et al.*, the incidence of severe TBI in Indonesia was between 6% and 12% with a mortality rate range between 25% and 37%.²² Another study conducted at dr. Soetomo General Hospital Surabaya, with the availability of facilities and neurosurgeons, showed the death rate due to TBI was 6.2% to 11.2%.¹ In the hospitals in remote areas such as Umbu Rara Meha General Hospital, Waingapu with conditions similar to the hospital where this study was conducted, the mortality rate due to

TBI was 2.2%.²¹ Compared with some existing literature, the death rate from TBI in Belitung regency was higher, especially when it is compared to the areas that have better treatment ability and other areas with similar health facilities.

Prabhakaran *et al.* demonstrated a significant association between secondary transfers (non-trauma hospitals without a specialist transferring a patient to the trauma center) and decreased survival rates.²³ Guidelines on the prehospital management of TBI from Brain Trauma Foundation 2018 recommend transferring the patients directly to a hospital with a neurosurgical facility for the efficiency of time in managing TBI. The neurosurgical facilities in question are the availability of computed tomography scans, intracranial pressure monitors, the availability of neurosurgeons, and the availability of ICU.²⁴

Increasing age makes patients more susceptible to death after TBI. Several studies have suggested an association between older age and increased mortality from TBI. The mortality rate for patients aged > 65 years in this study was 8.5%, higher than the mortality rate for patients aged under 65 years, which was 3.87%. This is in accordance with the research of Salottolo *et al.*, which showed an increase in mortality with increasing age.²⁵ Thus, increasing age independently increases mortality and older age can also be used to predict mortality from TBI by determining the level of consciousness.²⁶

CONCLUSION

The mortality rate from TBI cases in Belitung regency reached 11.9% with age variable as a predictor which had a significant effect on this. The older the patient gets, the higher the likelihood of death from TBI. The absence of neurosurgeons in our hospitals as the regional referral center for Belitung regency and the limited hospital facilities make the management of TBI cases are not optimal, resulting in increased mortality. The data obtained in this study can be used by clinical practitioners, disease preventative planners, and policymakers to reduce the mortality rate of TBI in Belitung regency.

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CONFLICT OF INTEREST

The author declares no conflict of interest.

AUTHOR CONTRIBUTION

The first author provided the idea of the research and study design, contributed to data collection, analyzing and interpreting the data, and participated in writing the manuscript. The second author gave corrected the manuscript and also provided input on the interpretation of the results.

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