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Profile of pediatric traumatic brain injury at the Dr. Soetomo General Hospital, Surabaya, Indonesia



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ABSTRACT

Background: Traumatic brain injury (TBI) is an emergency condition for children. TBI affects more than three million children worldwide each year. It is a common cause of death and disability in children. Knowing the profile of pediatric TBI is important because it can help provide more effective treatment management and increase public awareness of child safety. However, pediatric TBI has not been widely studied in Indonesia. This study aimed to ascertain the profile of pediatric TBI at Dr. Soetomo General Hospital.

Methods: A retrospective study was conducted using medical records of pediatric TBI patients aged < 18 years old who met the inclusion and exclusion criteria at Dr. Soetomo General Hospital from January 2016 to December 2020. Data were processed in the form of descriptive analysis and distributed into frequency tables.

Results: This study included 124 patients. The highest incidence occurred in the age range of 12 – 18 years old (33.87%). Males suffered from TBI more commonly (74.19%) than females with a ratio of 3:1. Accidents were the most common cause of pediatric TBI (66.94%). Most patients came with decreased consciousness (40.55%) and were diagnosed with intracranial injury (52.22%) with epidural hematoma (21.28%) as the most common type. The majority of patients were moderate TBI (41.93%) and received operative management (66.94%) with a percentage of 95.16% of cases being discharged after their condition improved.

Conclusion: Pediatric TBI predominantly occurred in males with an age range of 12 – 18 years old. Traffic accidents were the main cause of pediatric TBI, so it is important to pay attention to child safety, especially when driving.

Keywords: pediatric, profile, traffic accidents, traumatic brain injury.

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INTRODUCTION

Traumatic brain injury (TBI) is an emergency condition for children. TBI is an external mechanical trauma of the head that causes developmental, cognitive, physical, and psychosocial disturbance. This is a common cause of death and disability in both children and adults.¹ Trauma incidents in Indonesia that disrupted daily activities relatively increased from 2007 – 2018. These incidents occurred more frequently at the ages of 15 – 24 years (12.2%) and 5 – 14 years (12.1%).²

Children tend to experience traumatic events more frequently. The incidence of pediatric TBI worldwide ranges broadly from 12 to 486 per 100,000 people. Motor vehicle collisions and falls tend to be the majority of causes of TBI. Mortality rates ranged from 1% – 7% in most study samples or between 2.8

and 3.75 per 100,000 children annually.³ In Indonesia, it was reported that the number of pediatric TBI in Dr. Cipto Mangunkusumo National Central Public Hospital Jakarta from January 2004 – July 2005 was 503 cases. Most of them did not require special therapy (65.6%) and returned home without disabilities.⁴ In the Wongsonegoro Regional Public Hospital in Semarang from 2017 – 2019, 296 cases with falling from a motor vehicle being the most common cause.⁵ In Sanglah Central General Hospital, Denpasar, in 2020, there were 86 cases with the most common cause being traffic accidents without wearing a helmet.⁶ Children are in a growth and development phase so if there is a worsening of conditions it could affect their condition in the future.⁷

This study determines the profile of pediatric TBI at Dr. Soetomo General Hospital. Knowing the characteristics of

pediatric TBI is important because it can help provide more effective diagnosis and management. However, pediatric TBI has not been widely studied in Indonesia. This study was undertaken to address gaps in the literature on the profile of pediatric TBI in Indonesia. Therefore, research needs to be done on cases of TBI in children at Dr. Soetomo General Hospital as the type A hospital, academic hospital, and the highest referral hospital in Eastern Indonesia. The results of this study are expected to increase child safety awareness so that the incidence of pediatric TBI can be controlled.

METHODS

This was a descriptive study using medical records of pediatric TBI patients during 2016 – 2020. The population of this study was all pediatric TBI patients aged < 18 years old at Dr. Soetomo General Hospital

during 2016 – 2020. The research sample was taken by a non-random sampling method. The inclusion criteria for this study were pediatric TBI patients who had complete and accessible medical records, were hospitalized, and the data were followed up for up to three months after hospital discharge.

This study had been approved by the health research ethics committee of Dr. Soetomo General Hospital with a letter-number of 0851/LOE/301.4.2/III/2022. The statistical analysis of this study was in the form of a descriptive analysis. Profile patient includes age, gender, complaint, cause of injury based on ICD-10, severity degree of injury using Glasgow Coma Scale (GCS) score, diagnosis based on ICD-10, therapy management, and discharge condition. Data processing was carried out with Microsoft Office 2019 and distributed into a frequency table.

RESULTS

The total number of pediatric TBI patients hospitalized at Dr. Soetomo General Hospital during 2016 – 2020 based on existing medical record data was 124 cases.

Table 1 showed the patient demographic by age and gender. The incidence of pediatric TBI among males was 92 subjects (74.19%) and females had as many as 32 subjects (25.81%). There were nine subjects with TBI aged < 1 year (7.26%), eight subjects aged 1 – 2 years old (6.45%), 28 subjects aged 3 – 5 years old (22.58%), 37 subjects aged 6 – 11 years old (29.84%), and aged 12 – 18 years old amounted to 42 subjects (33.87%).

External causes of injury were classified by ICD-10 code range V00-Y99. The cause of injury were accidents in 83 subjects (66.94%), assault in one subject (0.81%), the event of undetermined intent in 30 subjects (24.19%), complications of medical and surgical care in two subjects (1.61%), and other cause in eight subjects (6.45%). There was no data about the subject of intentional self-harm, legal intervention, operations of war, military operations, and terrorism. Due to accidents, there were 21 subjects had mild TBI (25.3%), 41 subjects had moderate TBI (49.4%), and 21 subjects had severe TBI (25.3%) as can be seen in **Fig. 1**. About 22 subjects (8.66%) came

Table 1. Demographic of pediatric traumatic brain injury patients at Dr. Soetomo general hospital.

Variable	N	%
Gender		
Male	92	74.19
Female	32	25.81
Age (Years)		
< 1	9	7.26
1 – 2	8	6.45
3 – 5	28	20.16
6 – 11	37	30.65
12 – 18	42	35.48
Cause of injury		
Accidents	83	66.94
Intentional self-harm	-	-
Assault	1	0.81
Event of undetermined intent	30	24.19
Legal intervention	-	-
Operations of war, military operations, and terrorism	-	-
Complications of medical and surgical care	2	1.61
Others	8	6.45
Complaint		
Headache	22	8.66
Bleeding	22	8.66
Vomiting	66	25.99
Decrease of consciousness	103	40.55
Seizure	24	9.45
Others	17	6.69

with complaints of headaches, 22 subjects (8.66%) had bleeding, 66 subjects (25.99%) was vomiting, 103 subjects (40.55%) experienced decreased consciousness, seizures in 24 subjects (9.45%), and others in 17 subjects (6.69%).

Diagnosis of TBI was classified using ICD-10 codes range S00-S09. **Table 2** showed that there were eight subjects diagnosed with an open wound of the head (4.44%), 75 subjects with fracture of the skull and facial bone (41.67%), two subjects with injury of the eye and orbit (1.11%), 94 subjects with intracranial injury (52.22%), and one subject with crushing injury of the head (0.56%). There was no data about the subject with superficial injury of the head, dislocation, sprain, and strain of joints and ligaments of the head, injury of cranial nerves, traumatic amputation of part of the head, and others.

Table 3 showed the manifestations of intracranial injuries that are often found in pediatric TBI. There were 10 subjects had a concussion (7.09%), 25 subjects had cerebral edema (17.73%), 19 subjects

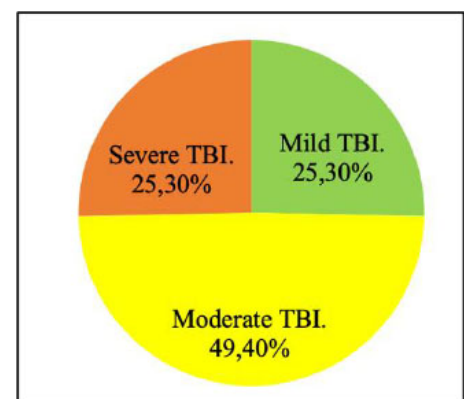


Figure 1. Distribution of traumatic brain injury caused by accidents.

had a diffuse brain injury (13.47%), 28 subjects had a focal brain injury (19.86%), 30 subjects had an epidural hematoma (21.28%), 26 subjects had a subdural hematoma (18.44%), and three subjects had subarachnoid hemorrhage (2.13%).

TBI characteristics in pediatric patients can be seen in **Table 4**. There were 43 subjects (34.68%) with mild TBI, 52 subjects (41.93%) with moderate TBI, and 29 subjects with severe TBI (23.39%). An overview of the TBI severity based on age

Table 2. Diagnosis of pediatric traumatic brain injury based on ICD-10 at dr. Soetomo general hospital.

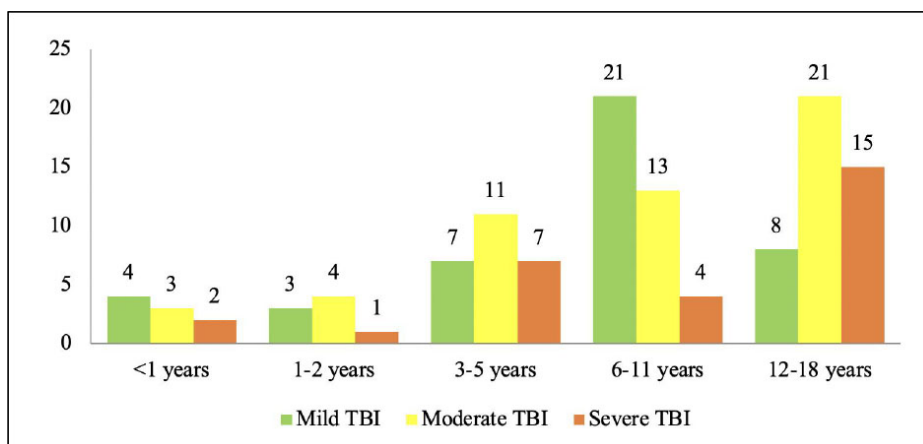
Diagnosis	N	%
Superficial injury of head	-	-
Open wound of head	8	4.44
Fracture of skull and facial bones	75	41.67
Dislocation, sprain and strain of joints and ligaments of head	-	-
Injury of cranial nerves	-	-
Injury of eye and orbit	2	1.11
Intracranial injury	94	52.22
Crushing injury of head	1	0.56
Traumatic amputation of part of head	-	-
Others	-	-

Table 3. Type of intracranial injury of pediatric traumatic brain injury.

Diagnosis	N	%
Concussion	10	7.09
Cerebral edema	25	17.73
Diffuse brain injury	19	13.47
Focal brain injury	28	19.86
Epidural hematoma	30	21.28
Subdural hematoma	26	18.44
Subarachnoid haemorrhage	3	2.13

Table 4. Characteristic of traumatic brain injury in the study.

Variable	N	%
Severity		
Mild	43	34.68
Moderate	52	41.93
Severe	29	23.39
Therapy management		
Conservative	41	33.06
Operative	83	66.94
Discharge condition		
Recovered	118	95.16
Death	6	4.84

**Figure 2.** Distribution of traumatic brain injury severity by age.

can be seen in Fig. 2. Of the 44 pediatric patients aged 12–18 years who experienced the most TBI, 21 of them had moderate

TBI. Meanwhile, in the age range of 6–11 years, 21 out of 38 children experienced mild TBI. Forty-one subjects received

conservative management (33.06%) and 83 subjects underwent surgery (66.94%). After therapy, 118 subjects (95.16%) were discharged and six subjects (4.84%) died.

DISCUSSION

In this study, pediatric TBI patients at Dr. Soetomo General Hospital was most commonly found in the age range of 12–18 year old then followed by the 6–11 year old age group. The group with an age range of > 11 years old was also the group of children who most often experience TBI according to previous studies in Indonesia.^{5,6} Another study showed that children in the age group 6–10 years were even the age with the highest incidence of TBI.⁴ At this age, children tend to be more active and have a high sense of exploration, so they may pay less attention to safety when driving. This is supported by research in Indonesia that children aged 5–14 years were the most who did not use helmets while driving with a percentage of 58.2%.² The sex ratio of male and female patients who experienced TBI in this study was 3:1. Males tended to experience more frequent TBI. The high incidence of TBI in males is also supported by other studies in Indonesia.^{4,5} This pattern indicates that males in adolescence and school age a more susceptible to TBI. This could be influenced by factors of their higher activity, lack of use of personal protective equipment, and lack of caution when driving.

In this study, accidents were the most common cause of pediatric TBI. Patients who came because of accidents can occur due to collisions between motorized vehicles, single accidents, falling from a bicycle, being hit while walking, or a child falling from the passenger seat. As a result of this accident, 49.4% of children experienced moderate TBI. Accidents as the most common cause of TBI in children were also found in previous studies in Indonesia. Falling from a motorized vehicle was the most common cause of TBI in children.⁵ Traffic accidents were the most common cause of trauma, especially for those who use motorized vehicles without helmets.⁶ In contrast to the data in Dr. Cipto Mangunkusumo National Central Public Hospital Jakarta, traffic accidents only caused 21.9% of TBI cases

in children. In that study, approximately 61.6% of parents did not know the mechanism of TBI in their children.⁴ Therefore, parental supervision needs to be a concern. Parents are responsible for ensuring the safety of their children both when playing and when carrying children in the passenger seat while driving.

Most pediatric TBI patients came with complaints of decreased consciousness (40.55%). This was followed by complaints of vomiting (25.99%) and seizures (9.45%). Other complaints that were reported less frequently by patients included limb weakness, decreased visual acuity, speech disturbances, bumps, and head injuries. The pattern of complaints experienced by patients in this study is different from other studies. In the previous study at Dr. Cipto Mangunkusumo National Central Public Hospital Jakarta, headache was the most frequently reported complaint by patients (25.6%). Nonetheless, vomiting (20.9%) and seizures (4.4%) were also common complaints in pediatric patients with TBI.⁴ Another study at Sanglah Central General Hospital in Denpasar also stated that headache was the most common complaint experienced by pediatric patients with TBI (79.1%), followed by a history of fainting (52.3%), vomiting (51.2%), and decreased consciousness (38.4%).⁶ The mechanism of altered consciousness in TBI is influenced by various factors. There are several possible hypotheses for altered TBI consciousness, including the reticular, pontine-cholinergic, centripetal, and convulsive system hypotheses. The reticular activating system (RAS) hypothesis states that disruption of the polysynaptic pathways in the RAS alters consciousness. The pontine cholinergic system hypothesis states that changes in consciousness in TBI occur because trauma induces activation of the dorsal tegmental inhibitory pontine cholinergic system. The centripetal hypothesis occurs when rotational forces cause stress, the nerve fibers experience functional decoupling. Whereas the convulsive hypothesis occurs when direct injury to the neurons results in neuronal exhaustion after a phase of hyperexcitability and widespread membrane depolarization.⁸

In this study, most patients came with a moderate TBI (41.93%). While mild TBI

occurred in 43 subjects (34.68%) and severe TBI occurred in 29 subjects (23.39%). Severe TBI caused death in around 17.24% of this study. Even though the incidence of mild TBI is less than moderate TBI, children with mild TBI have a high risk of experiencing disability. The incidence of disability in children 12 months after experiencing TBI at the age of 2 – 4 years old was 27.2%. This figure continued to increase with age until it reached 66.2% in children aged 15 – 17 years who experience mild TBI. Therefore, even mild TBI in children needs proper monitoring and management to prevent defects in children.⁹ The high incidence of moderate TBI in children who have experienced TBI is different from the data collected by other researchers. A previous study at Dr. Cipto Mangunkusumo National Central Public General Hospital Jakarta showed 91.8% of pediatric TBIs were mild.⁴ Other data at Wongsonegoro Regional Public Hospital Semarang, the majority of pediatric patients experienced mild TBI (38.18%).⁵ Research at Sanglah Central General Hospital in Denpasar also showed that the majority of pediatric patients experienced mild TBI (55.88%).⁶ Nonetheless, there are differences in the classification used at Wongsonegoro Regional Public Hospital Semarang and Sanglah Central General Hospital Denpasar. They defined TBI as mild if the GCS was 14 – 15, moderate if the GCS was 9 – 13, and severe if the GCS was ≤ 8 . In addition to the differences in the classification used, the number of referral cases at Dr. Soetomo General Hospital as the highest referral hospital in Eastern Indonesia can also be a factor in differences in patient severity patterns. Many cases of TBI referred to Dr. Soetomo General Hospital came with moderate to severe TBI.

Based on the results of the study, most pediatric TBI patients hospitalized at Dr. Soetomo General Hospital during 2016 – 2020 were diagnosed with intracranial injury (52.22%) followed by fracture of the skull and facial bones (41.67%). Some patients were diagnosed with both types of TBI, which is about 40% of the total patients. Diagnoses that were rarely given to pediatric patients with TBI were crushing injury of the head (0.56%), injury of the eye and orbit (1.11%), and

open wound of the head (4.44%). As for the diagnosis of superficial injury of the head, dislocations, sprains, and strain of joints and ligaments of the head, injury of cranial nerves, traumatic amputation of part of the head, and other head injuries were not found in this study. Research at the Wuhan Women and Children Medical Treatment Center (WMCCWC) showed that intracranial injury was the most common type of TBI in children (39.46%).¹⁰ Previous study in Indonesia also showed that the most common type of TBI in pediatric patients was epidural hematoma (49.57%) in the operative patient group and concussion (53.59%) in the non-operative patient groups.⁵ These results show the same pattern as this study. The epidural hematoma was the most common type of pediatric TBI. Epidural hematoma is often caused by bleeding from the middle meningeal artery between the outer layer of the dura mater and the inner layer of the skull.¹¹ However, the middle meningeal artery in children does not attach directly to the bone as it does in adults. This makes epidural bleeding less common. Even so, the epidural hematoma can still occur due to tears at the edges of the fracture.¹² In addition, epidural hematoma in infants is rarely reported because the structure of the dura mater tightly adheres to the skull.¹³ The incidence of epidural hematoma in pediatric TBI is less than in adults, which is around 36%. It is most commonly caused by falls. As age increases, it often causes by accidents.¹⁴

Operative management was often given to pediatric TBI patients at Dr. Soetomo (66.94%). Around 93.98% gave good results in the patient outcome. The results of these data are also in line with studies showing that surgery is often performed on pediatric TBI patients. At Dr. Cipto Mangunkusumo National Central Public Hospital Jakarta, the most common therapy given to pediatric TBI patients was surgery (65.6%).⁴ This management is generally to monitor intracranial pressure, circulation, evacuation of bleeding, and reconstruction after the patient has been resuscitated and established initial treatment. In TBI patients, circulatory disorders and the presence of mass lesions in the headspace can increase intracranial pressure (ICP). Therefore, ICP monitoring

and management of increased ICP are one of the most important components in the management of TBI. ICP monitoring can use some invasive technologies such as external ventricular drain (EVD) or parenchymal ICP monitoring devices.¹⁵

Many pediatric TBI patients at Dr. Soetomo Hospital were sent home after receiving therapy (95.16%). While there were six subjects (4.84%) who died. Study at Wongsonegoro Regional Public Hospital Semarang, over 90% of subjects could be discharged after therapy.⁵ The condition is influenced by various factors, both before admission and after receiving treatment. Several factors can affect the outcome of TBI patients, including the presence of comorbidities, clinical features of seizures and decreased consciousness, increased ICP, the severity of TBI, the presence of hypotension, hyperglycemia, and special findings on head CT scans. Patients with contusions, diffuse axonal injury (DAI), or intracranial hemorrhage on a head CT scan were at significant risk of morbidity and mortality.¹⁶ At Dr. Cipto Mangunkusumo National Central Public Hospital Jakarta, 1% of subjects died after being hospitalized.⁴ Case findings in China also showed that mortality due to TBI in children was around 0.3%.¹⁰ This relatively small percentage may reflect the success rate of treatment in the management of pediatric TBI. Accurate and precise diagnosis, treatment according to indications and caution, as well as patient transfer factors to the hospital, can have implications for reducing deaths from TBI in children.

CONCLUSION

Pediatric TBI at Dr. Soetomo General Hospital predominantly occurred in males with an age range of 12 – 18 years old. Accidents were the main cause of pediatric TBI, so it is important to pay attention to child safety, especially when driving. Most of the patients came with moderate TBI and were diagnosed with intracranial injury, especially epidural hematoma. Operative management was often given and most patients could be discharged after the post-therapy conditions improved. This study has a limitation where we did not evaluate the post-therapy condition

with the GOSE variable because there was no data in medical records. The results of this study will help medical personnel handling pediatric TBI cases in the future, provide an overview for further research, and increase awareness and supervision of road safety from parents to reduce morbidity and mortality in pediatric patients.

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CONFLICT OF INTEREST

There is no conflict of interest related to the materials or methods used in this study.

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ETHICAL APPROVAL

This study has been approved by the health research ethics committee of Dr. Soetomo General Hospital with a letter-number 0851/LOE/301.4.2/III/2022.

AUTHOR CONTRIBUTION

JNF provided the research study design, contributed to data collection, analyzed and interpreted the data, and participated in writing the manuscript. MAP provided the research idea. Both MAP and WS made corrections and revisions to the manuscript and provided input on the interpretation of the results.

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