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RISK FACTORS FOR MORTALITY IN PEDIATRIC TRAUMATIC BRAIN INJURY IN THE PEDIATRIC INTENSIVE CARE UNIT (PICU) OF RSUD DR. MOEWARDI

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ABSTRAK

Trauma kepala adalah jenis cedera yang paling umum terjadi di seluruh dunia dan dapat menyebabkan kematian atau kecacatan permanen pada anak. Sebagian besar penelitian di Indonesia lebih banyak membahas trauma kepala pada usia dewasa. Penelitian ini bertujuan untuk mengidentifikasi faktor risiko mortalitas pada pasien trauma kepala anak. Penelitian ini merupakan studi observasional analitik dengan desain cross sectional. Sumber data berasal dari rekam medis pasien trauma kepala anak usia 1–18 tahun yang dirawat di PICU RSUD Dr. Moewardi selama periode Januari–Desember 2023. Jumlah sampel dalam penelitian ini sebanyak 40 pasien. Analisis data dilakukan dengan uji Chi-square/Fisher's Exact, dilanjutkan dengan Regresi Logistik menggunakan SPSS. Mortalitas pasien trauma kepala anak pada penelitian ini sebesar 25% (10 pasien). Berdasarkan analisis bivariat, dua variabel berpengaruh signifikan terhadap mortalitas, yaitu skor GCS ≤8 (OR = 36; CI 95% = 3,79–342,02; p<0,001) dan respons pupil abnormal (OR = 15,17; CI 95% = 2,73–84,18; p = 0,002). Analisis multivariat menunjukkan bahwa skor GCS ≤8 merupakan faktor risiko paling signifikan (OR = 22.87; 95% CI 2.15–243.20; p = 0,009), diikuti oleh respons pupil abnormal (95% CI 2,73–84,18). Faktor risiko mortalitas pada pasien trauma kepala anak di PICU RSUD Dr. Moewardi adalah skor GCS ≤8 dan respons pupil abnormal.

ABSTRACT

Risk Factors for Mortality in Pediatric Traumatic Brain Injury in the Pediatric Intensive Care Unit (PICU) of RSUD Dr. Moewardi. Traumatic brain injury (TBI) represents the most common type of injury globally and can lead to death or permanent disability in children. In Indonesia, most existing studies have concentrated on adult TBI cases. This study aimed to identify the risk factors associated with mortality in pediatric patients with traumatic brain injury. This research employed an analytical observational approach with a cross-sectional design. Data were obtained from the medical records of pediatric patients aged 1–18 years diagnosed with TBI and admitted to the PICU of RSUD Dr. Moewardi between January and December 2023. A total of 40 patients were included. Statistical analyses were conducted using the Chi-square or Fisher's Exact test and logistic regression via SPSS. Mortality occurred in 25% of the patients (10 out of 40). Bivariate analysis indicated that a Glasgow Coma Scale (GCS) score ≤8 (OR = 36; 95% CI = 3.79–342.02; p < 0.001) and abnormal pupillary response (OR = 7.99; 95% CI = 2.73–84.18; p = 0.047) were significantly associated with mortality. Multivariate analysis identified a GCS score ≤8 as the most significant risk factor (OR = 22.87; 95% CI = 2.15–243.20; p = 0.009), followed by abnormal pupillary response (OR = 7.99; 95% CI = 2.73–84.18; p = 0.047). In conclusion, a GCS score ≤8 and abnormal pupillary response are significant risk factors for mortality in pediatric TBI patients admitted to the PICU of RSUD Dr. Moewardi.

INTRODUCTION

Traumatic brain injury is the most common type of injury worldwide that can cause death or permanent disability in children.[1] Worldwide, the prevalence of pediatric traumatic brain injury in most reports varies between 47 and 280 per 100,000 people with a mortality rate between 2.8 to 3.75 per 100,000 children annually.[2] In Indonesia, based on data from the medical records department of Wongsonegoro General Hospital, there were 296 cases of pediatric traumatic brain injury at Wongsonegoro General Hospital in Semarang between January 2017 and December 2019.[3] Although traumatic brain injury can affect people of all ages, children are more susceptible to hospitalization, impairment and death from traumatic brain injury due to their physiological and anatomical vulnerability and propensity to suffer severe injuries. Children's weaker necks, flexible brains, softer skulls, and rudimentary myelination of the developing brain make them more vulnerable to serious injury, which can impact the severity and long-term consequences.[4]

With the high mortality rate in pediatric traumatic brain injury patients, it is necessary to identify the risk factors that affect these deaths. A study conducted by Garg et al. demonstrated that factors associated with mortality in pediatric traumatic brain injury patients are young age, low GCS, hypotension, and the presence of coagulopathy.[5] Another study by El Sebaie et al. found that low initial GCS scores, hypotension, hypoxia, unequal pupils, hemiplegia, and the presence of midline shift or subdural hemorrhage on initial CT are factors of poor prognosis in pediatric traumatic brain injury patients.[6] Meanwhile, research by Özcan et al. states factors affecting mortality in pediatric traumatic brain injury patients are abnormal pupillary response and low GCS on admission.[7]

Most of the existing research in Indonesia focused on traumatic brain injury in adults. Adults and children experience traumatic brain injury in very different ways. Therefore, the researchers wanted to dig deeper into the risk factors that influence the mortality of pediatric traumatic brain injury patients in the Pediatric Intensive Care Unit (PICU) of RSUD Dr. Moewardi. The risk factors that will be the variables of this study are age, GCS score, systolic blood pressure, and pupillary response.

METHODS

This study was an analytic observational study with a cross-sectional design to identify the risk factors for mortality in pediatric traumatic brain injury patients. The study was conducted in the PICU of RSUD Dr. Moewardi from August - December 2024. The sampling method used was purposive sampling, where patients were chosen based on predefined inclusion and exclusion criteria. The inclusion criteria included patients aged 1-18 years with complete medical record data. The exclusion criteria were patients who had previous central nervous system disorders. Determination of the sample size in this study using the rule of thumb formula, namely, the sample size is 10 times more than the number of independent variables, so that the sample size is at least 40 pediatric traumatic brain injury patients admitted to the PICU of RSUD Dr. Moewardi from January to December 2023.

The dependent variable in this study was mortality in pediatric traumatic brain injury patients. The independent variables were age, Glasgow Coma Scale (GCS) score, systolic blood pressure, and pupillary response. Age was categorized as $<$5 years and ≥5 years. Hypotension was defined as systolic blood pressure below the 5th percentile for age, according to Pediatric Advanced

Life Support (PALS) guidelines. GCS score was categorized as ≤8 or >8. Pupillary response was classified as normal if both pupils were reactive to light, and abnormal if one or both pupils were unresponsive.

Variable measurement tools used medical records and categorical measurement scales. The data were then analyzed using the SPSS 27 software using the Chi-square or Fisher's Exact test and logistic regression. This study was approved by the Ethics Committee of RSUD Dr. Moewardi on July 30, 2024, with Ethical Clearance number 1782/VII/HREC/2024.

RESULTS

Table 1. Characteristics of Research Subjects

Variables	Mortality Rate				Total	
	Died		Survived			
	N	%	N	%	N	%
Age						
<5 years	3	50	3	50	6	15
≥5 years	7	20,6	27	79,4	34	85
GCS Score						
≤8	9	60	6	40	15	37,5
>8	1	4	24	96	25	62,5
Systolic Blood Pressure						
Hypotension	2	66,7	1	33,3	3	7,5
No Hypotension	8	21,6	29	78,4	37	92,5
Pupillary Response						
Normal	3	10,3	26	89,7	29	72,5
Abnormal	7	63,6	4	36,4	11	27,5

Based on the table of characteristics of the study subjects, patients aged <5 years were 6 patients (15%) with 3 of them died, patients with GCS score ≤8 were 15 patients (37.5%) with 9 of them died (60%), patients with hypotension were 3 patients (7.5%) with 2 of them died, and patients with abnormal pupillary response were 11 patients (27.5%) with 7 of them died (63.6%). Mortality of pediatric traumatic brain injury patients in this study was found to be 10 patients (25%).

Table 2. Bivariate Analysis of the Relationship between Risk Factors and Mortality

Variables	Mortality Rate				OR	95% CI	p-value
	Died		Survived				
	N	%	N	%			
Age							
<5 years	3	50	7	20,6	3,857	0,635-23,412	0,307
≥5 years	3	50	27	79,4			
GCS Score							
≤8	9	60	1	4	36	3,789-342,021	**<0,001**
>8	6	30	24	96			
Systolic Blood Pressure							

Hypotension	2	66,7	8	21,6	7,250	0,581-90,545	0,149
No Hypotension	1	33,3	29	78,4			
Pupillary Response							
Abnormal	7	63,6	3	10,3	15,167	2,733-84,182	**0,002**
Normal	4	36,4	26	89,7			

Based on bivariate analysis, two variables were found to affect mortality of pediatric traumatic brain injury patients, which were GCS score ≤8 and abnormal pupillary response, with OR values of 36 (95% CI 3.79- 342.02) and 15.17 (95% CI 2.73-84.18), respectively, with a p-value of < 0.05. It is significant that a GCS score ≤8 increases the risk of mortality of pediatric traumatic brain injury patients by 36 times and abnormal pupillary response by 15.2 times.

Meanwhile, age <5 years and hypotension had no significant effect on mortality of pediatric traumatic brain injury patients, with OR values of 3.86 and 7.25, respectively, 95% CI values exceeding one, and p values are> 0.05. This suggests that GCS score ≤8 and abnormal pupillary response are risk factors for mortality in pediatric traumatic brain injury patients, while age <5 years and hypotension are not.

Table 3. Multivariate Analysis of GCS Score, Systolic Blood Pressure, and Pupillary Response

Variables	B	OR	95% CI		p-value
			Lower	Upper	
GCS Score	3,130	22,868	2,150	243,202	**0,009**
Systolic Blood Pressure	0,693	2	0,051	78,270	0,711
Pupillary Response	2,078	7,989	1,028	62,088	**0,047**

Based on the multivariate analysis table, both GCS score and pupillary response were identified as significant risk factors for mortality in pediatric traumatic brain injury patients, with a p value < 0.05. GCS score ≤8 is the most significant risk factor with an OR value of 22.87 (95% CI 2.15–243.20), followed by abnormal pupillary response with an OR value of 7.99 (95% CI 2.73-84.18). Meanwhile, systolic blood pressure was not a risk factor for mortality in pediatric trauma patients, with an OR value of 2, 95% CI values exceeding one, and p values> 0.05.

DISCUSSION

This study found that pediatric traumatic brain injury patients in the PICU of RSUD Dr. Moewardi in 2023 were predominantly aged ≥5 years (85%), with only 6 out of 40 children aged <5 years. These findings are consistent with a study by Fauziyah et al., which reported that 63.7% of cases occurred in children aged ≥5 years.[3] Mortality was higher in younger children, with 50% of those aged <5 years dying, compared to 20.6% in those aged ≥5 years. Similarly, Garg et al. reported a higher mortality rate in patients aged <5 years (23%) versus ≥5 years (12%).[5] Although the present study showed a 3.9-fold increased risk of death in children <5 years (OR = 3.86; 95% CI = 0.63–23.41), the association was not statistically significant (p = 0.307). In contrast, a study by Tang et al. demonstrated that younger age was an independent risk factor for mortality (p = 0.036), attributed to the vulnerability of the developing brain, which is more susceptible to secondary hypoxic-ischemic injury following trauma, leading to cerebral edema and worsening levels of consciousness.

In addition, immature cerebral autoregulation in young children can further exacerbate brain injury.[11] The lack of significance might be due to the small number of patients aged <5 years, which could limit statistical power.

In this study, it was found that the majority of pediatric traumatic brain injury patients had GCS scores >8 (62.5%), while the remainder had GCS scores ≤8. These findings are consistent with research by Diyo et al., which reported that 97.9% of patients had GCS >8.[8] Mortality was notably higher among those with GCS ≤8 (60%) compared to those with GCS >8 (4%), in line with Garg et al., who found the highest mortality in patients with GCS ≤8 (91,7%).[5] Bivariate analysis in this study showed a statistically significant association between GCS and mortality (OR = 36; 95% CI = 3.79–342.02; p < 0.001), indicating that patients with GCS ≤8 had a 36-fold greater risk of death. Multivariate analysis further confirmed GCS ≤8 as an independent risk factor for mortality (p = 0.009). This is supported by Garg et al., who reported GCS ≤8 strongly associated with increased mortality risk (p < 0.0001).[5] Lower GCS scores are associated with complications such as hypoxia and hypotension, also reflect extensive brain damage, impaired autoregulation, and increased intracranial pressure, all of which contribute to secondary brain injury and early mortality.[10,12,13]

This study found that 92.5% of pediatric traumatic brain injury patients did not experience hypotension, with only 3 out of 40 pediatric traumatic brain injury patients experiencing hypotension. These findings are consistent with a study by Garg et al., who reported normotension in 75.7% of pediatric trauma cases.[5] Mortality was higher in hypotensive patients (2 out of 3), compared to those without hypotension (8 out of 37). In contrast, Yao et al. reported a mortality rate was 50% in hypotensive patients versus only 0.7% in normotensive patients.[9] Although the present study showed a 7.25-fold increased risk of death in children <5 years (OR = 7.25; 95% CI: 0.58–90.54), the association was not statistically significant (p = 0.149). These findings contrast with a study by Suttipongkaset et al., which demonstrated a significant association between hypotension and increased mortality (p=0.036). Hypotension may reflect inadequate cerebral perfusion and exacerbate secondary brain injury through ischemia and oxygen deprivation.[14] The lack of significance in this study may be due to the small number of hypotensive patients, limiting statistical power, as similarly reported by Tang et al.[11] Additionally, most patients in this study were ≥5 years old, generally more stable hemodynamically. At the same time, younger children are more susceptible to hypotension due to lower baseline blood pressure and immature autoregulation, which may influence outcomes.[16]

The majority of pediatric traumatic brain injury patients in this study had normal pupillary response (72.5%), while the remainder had abnormal pupillary response. It is consistent with Kennedy et al., who reported 84.2% with normal pupils.[10] Mortality was substantially higher in patients with abnormal pupillary response (63.6%) compared to those with normal response (10.3%), supporting Özcan et al., who found higher mortality in patients with abnormal pupillary response (73.3%).[7] Bivariate analysis revealed a significant association between pupillary response and mortality (OR = 15.17; 95% CI = 2.73–84.18; p = 0.002), indicating that children with abnormal pupils had a 15.2-fold higher risk of death. Multivariate analysis further confirmed abnormal pupillary response as an independent risk factor for mortality (p = 0.047). Abnormal pupillary findings, such as anisocoria and bilaterally dilated non-reactive pupils, may reflect increased intracranial pressure and brain herniation risk, which are known to worsen prognosis.[16] This is supported by a study by Balakrishnan et al., who found mortality increased from 4.7% in patients with bilateral reactive pupils to 80% in those with bilateral non-reactive pupils (p < 0.0001).[17]

CONCLUSION

The results of this study indicate that GCS score ≤8 and abnormal pupillary response were identified as significant risk factors for mortality in pediatric traumatic brain injury patients with GCS score ≤8, as the most significant risk factors, followed by abnormal pupillary response. Age and systolic blood pressure are not risk factors for mortality in pediatric traumatic brain injury patients.

This study cannot be separated from the limitations that cause some hypotheses not to be proven. First, the Confidence Interval value obtained in this study is wide, which can reduce the study results' precision, so it cannot generalize the results to the population in other hospitals. Second, this study used a cross-sectional method, so it could not explain the cause-and-effect relationship between each risk factor and mortality. In addition, the researchers did not include confounding factors such as the overall severity of the trauma, the time since the trauma occurred, and the influence of medication that could bias the study.

Therefore, there are several suggestions. First, the study can be developed with multicenter locations to obtain more representative and precise results. Second, the research method uses a retrospective cohort to provide more accurate information about the relationship of each risk factor to mortality. In addition, for future similar studies, the overall severity of the trauma, the time since the trauma occurred, and the influence of drugs as confounding factors that can affect the mortality of pediatric traumatic brain injury patients can be investigated.

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