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The Predictive Impact of The PECARN Score in Pediatric Patients with Minor Head Trauma

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Abstract

Aim: Head trauma is a leading cause of emergency department visits in children, with an annual incidence of 1.850 per 100.000. Computed tomography (CT) scans are the standard for diagnosing head trauma but involve risks like sedation, radiation exposure, and high costs. This raises the question of CT necessity for children with a Glasgow Coma Scale (GCS) score of 14 or above. The Pediatric Emergency Care Applied Research Network (PECARN) rules, introduced in 2009, aim to identify low-risk patients to reduce unnecessary CT scans and associated risks.

Materials and Methods: This retrospective observational study reviewed patients under 18 with minor head trauma from January 1 to December 31, 2022. Inclusion criteria were a GCS score of 14 or higher and presentation within 24 hours of injury. Patients were evaluated using PECARN criteria and divided into two groups: Group A (age >2 years) and Group B (age ≤2 years). These groups were further categorized into low, medium, and high-risk levels. Clinically important traumatic brain injury was defined by criteria including death, surgery requirement, intubation, or hospitalization for two or more days. Data collected included patient age, gender, symptoms, and CT scan results. Statistical analyses were conducted using SPSS software.

Results: The study found that 95.8% of low-risk patients under 2 years and all low-risk patients over 2 years had normal CT scans, supporting the PECARN criteria's effectiveness in identifying patients unlikely to benefit from CT imaging.

Conclusion: Implementing PECARN guidelines can enhance patient safety, reduce radiation exposure, and optimize resource use in emergency settings.

Keywords: Trauma, score, pediatric

Introduction

Head trauma is one of the most common reasons for children to visit the emergency department, with an estimated annual incidence of 1850 per 100.000 (1). Approximately 90% of these cases are minor head trauma. Minor head trauma can be defined as caused by an external force in which the patient shows few or no symptoms. The question of whether there is a serious traumatic brain injury (TBI) resulting from minor head trauma is of great importance (1,2). Computed tomography (CT) scanning is the gold standard for the evaluation and management of patients with head trauma (3). However, CT scans involve certain clinical challenges such as risks associated with sedation, exposure to carcinogenic ionizing radiation, and cost. It is estimated that brain tomography results in a fatal malignancy in 1 in 1000 to 1 in 5000 cases, with the risk increasing as the child gets (4). Therefore, weighing the potential benefits of tomography when a child experiences head trauma is crucial. Guidelines agree that CT is recommended for children with moderate or severe head trauma or a Glasgow Coma Scale (GCS) score of ≤13. The question arises about the necessity of CT imaging for children with a GCS of 14 and above.

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The Pediatric Emergency Care Applied Research Network (PECARN) published an age-based rule in 2009. These rules aim to identify low-risk patients, thereby reducing unnecessary CT scans and associated radiation exposure. It was developed for patients under 18 years old with a GCS score of 14-15 who presented within 24 hours of head trauma. Six criteria exist for children under 2 years old: (altered mental status, palpable skull fracture, loss of consciousness ≥5 seconds, scalp hematoma excluding frontal area, severe mechanism of injury, and abnormal behavior according to parents). For children over 2 years old, there are six criteria (altered mental status, vomiting, amnesia, severe mechanism of injury, clinical signs of basilar skull fracture, and severe headache) (5).

We aim to investigate compliance with PECARN rules in CT scanning decisions for pediatric patients with minor head trauma who present to the emergency department.

Materials and Methods

Study Design and Patients

Patients under the age of 18 who presented to the emergency department with minor head trauma between January 1, 2022, and December 31, 2022, were included. The study was conducted retrospectively and observationally, adhering to the principles of the Declaration of Helsinki. Since it is a retrospective study, Ethical Committee Approval from Bezmialem Foundation University Rectorate Technology Transfer Office was obtained, but patient consent was not obtained (decision number: 2022/113, date: 26.04.2022). Patients with a GCS score of 14 or above who presented within the first 24 hours after head trauma were included. Only falls and falls from heights were included in the study. There was no specific internal protocol applied during the study period. Clinicians independently utilized various guidelines reported in the literature. Patients with a GCS score of 13 or below, those with severe head trauma, those presenting to the emergency department more than 24 hours after trauma, and those who had neuroimaging at another hospital were excluded from the study. Additionally, patients who did not wait for the evaluation or refused clinical observation, those over 18 years of age, and those with incomplete data were also excluded. The patient flow chart is shown in Figure 1.

Clinical Protocol

We applied PECARN criteria to patients under two years old and over two years old included in the study. Patients were divided into two groups: Group A (age >2 years) and Group B (age ≤2 years). In our study, we applied the PECARN criteria separately to patients younger than two years old and those older than two years old, as these age groups have distinct evaluation protocols under the PECARN guidelines. All patients in the groups under and over two years old were further subdivided into three groups: low, medium, and high risk. We defined clinically important traumatic brain injury (ciTBI) by the presence of any of the following criteria (5): death following TBI, requiring brain surgery, intubation, or hospitalization for two days or more. We defined a lesion found on CT scan but not fitting the definition of "ciTBI" as an "abnormal CT finding."

Data Collection

The records of the patients included in the study were reviewed using the hospital automation system, including age, gender, loss of consciousness, headache, vomiting, abnormal behavior according to parents, amnesia, seizure, concern for non-accidental trauma, mechanism of trauma, abnormal mental status, signs of skull fracture, GCS, neurological deficit, follow-up, and CT scan results. Data were collected by emergency medicine physicians through a form specifically developed for the study.

Statistical Analysis

The quantitative variables were described using measures of central tendency and variance: mean ± SD. Fisher's exact test and chi-squared test were used to determine differences in proportions or relationships between categorical variables. To demonstrate behavioral differences in group means, the Kruskal-Wallis H-test was used when assumptions of normality and homoscedasticity were not met. The Bonferroni post hoc correction method was used for multiple comparisons between groups. Statistical significance for all cases was set at p=0.05. Statistical analyses were performed using IBM SPSS (Statistical Package for the Social Sciences for Windows, Version 21.0, Armonk, NY, IBM Corp.).

Results

Out of a total of 243 patients included in the study, 136 (56%) were classified as PECARN low risk, 78 (32.1%) as medium risk,

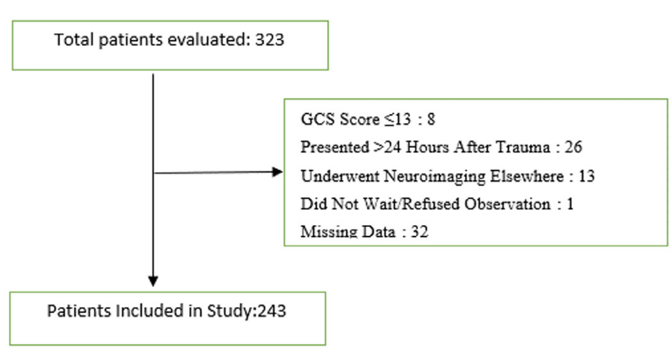

Figure 1. The patient flow chart

GCS: Glasgow coma scale

and 29 (11.9%) as high risk. The gender and age averages for Group A (>2 years) and Group B (≤2 years) are shown in Tables 1, 2. In Group A, all low-risk patients had normal CT scans. Among the medium-risk patients, 98.2% had normal CT scans, and among the high-risk patients, 60% had normal CT scans (p<0.05). In Group B, 95.8% (23 patients) of low-risk patients, 95.2% (20 patients) of medium-risk patients, and 66.7% (6 patients) of high-risk patients had normal CT scans (33.3% of high-risk patients had CT abnormalities) (p<0.05).

In Group A, 59.8% (67 patients) of the low-risk patients experienced simple falls, and 20.5% (23 patients) fell from a height greater than 1.5 meters. In Group B, 83.3% (20 patients) of the low-risk patients experienced simple falls. Among the medium-risk patients, 57.1% (12 patients) experienced simple falls, and 19% (4 patients) fell from a height greater than 90 cm. Among the high-risk patients, 66.7% (6 patients) fell from a height, and 22% (2 patients) rolled down stairs (at least 5 steps) (Tables 1, 2). The mechanisms of trauma for both groups are detailed in Tables 1,2.

Table 1. Group A

PECARN		Low	Medium	High	p	p^1	p^2	p^3
Age (year)		6.23±3.96	6.02±3.95	6.62±4.90	0.793(k)	1	1	1
CT result	Normal	112 (100.0%)	56 (98.2%)	12 (60.0%)	<0.001**	1	<0.001	<0.001
	Abnormal	0 (0.0%)	1 (1.8%)	8 (40.0%)				
Gender	Male	91 (81.2%)	16 (28.1%)	3 (15.0%)	<0.001*	<0.001	<0.001	1
	Female	21 (18.8%)	41 (71.9%)†	17 (85.0%)				
Mechanism of trauma	Simple falls	67 (59.8%)	25 (43.9%)	2 (10.0%)	<0.001**	0.012	<0.001	0.051
	Traffic accident	11 (9.8%)	2 (3.5%)	1 (5.0%)				
	Falling from high	23 (20.5%)	22 (38.6%)	12 (60.0%)				
	Falling off the stairs	1 (0.9%)	5 (8.8%)	5 (25.0%)				
	Head impact	10 (8.9%)	3 (5.3%)	0 (0.0%)				
Scalp hematoma	Nope	78 (69.6%)	12 (21.1%)	2 (10.0%)	<0.001**	<0.001	<0.001	0.018
	Frontal	19 (17.0%)	14 (24.6%)	3 (15.0%)				
	Temporal	0 (0.0%)	5 (8.8%)	10 (50.0%)				
	Parietal	9 (8.0%)	13 (22.8%)	3 (15.0%)				
	Occipital	6 (5.4%)	13 (22.8%)	2 (10.0%)				
Palpable fracture	Nope	112 (100.0%)	57 (100.0%)	16 (80.0%)	<0.001**	1	0.001	0.011
	Yes	0 (0.0%)	0 (0.0%)	4 (20.0%)				
Amnesia	Nope	109 (97.3%)	50 (87.7%)	18 (90.0%)	0.056**	0.096	0.495	1
	Yes	3 (2.7%)	7 (12.3%)	2 (10.0%)				
Loss of consciousness	Nope	112 (100.0%)	54 (94.7%)	13 (65.0%)	<0.001**	0,111	<0.001	0.007
	Yes	0 (0.0%)	3 (5.3%)	7 (35.0%)				
Abnormal behavior	Nope	112 (100.0%)	48 (84.2%)	20 (100.0%)	<0.001**	<0.001	1	0.306
	Yes	0 (0.0%)	9 (15.8%)	0 (0.0%)				
Vomiting	Nope	94 (83.9%)	15 (26.3%)	4 (20.0%)	<0.001*	<0.001	<0.001	1
	Yes	18 (16.1%)	42 (73.7%)	16 (80.0%)				
Seizure	Nope	112 (100.0%)	51 (89.5%)	14 (70.0%)	<0.001**	0.004	<0.001	0.203
	Yes	0 (0.0%)	6 (10.5%)	6 (30.0%)				
Headache	Nope	97 (86.6%)	22 (38.6%)	10 (50.0%)	<0.001*	<0.001	0.001	1
	Yes	15 (13.4%)	35 (61.4%)	10 (50.0%)				
Skin laceration	Nope	76 (67.9%)	52 (91.2%)	19 (95.0%)	<0.001**	0.002	0.040	1
	Yes	36 (32.1%)	5 (8.8%)	1 (5.0%)				
Treatment	Discharge	2 (1.8%)	8 (14.0%)	3 (15.0%)	0.007**	0.012	0.098	1
	Observation	103 (92.0%)	48 (84.2%)	17 (85.0%)				
	Leave without permission	7 (6.2%)	1 (1.8%)	0 (0.0%)				
Severe brain injury	Nope	112 (100%)	57 (100%)	20 (100%)	1*	1	1	1

Stats: n (%), *Pearson chi-squared test, **Fisher's exact test, Mean ± SD/Median (min-max), (k) Kruskal-Wallis H-test, p^1: Low vs. medium, p^2: Low vs. high, p^3: Medium vs. high, CT: Computed tomography, PECARN: Pediatric emergency care applied research network

Table 2. Group B								
PECARN		**Low**	**Medium**	**High**	**p**	**p1**	**p2**	**p3**
Age (year)		10.58±5.7	9.1±5.73	10.56±5.	0.647(k)	1	1	1
CT result	Normal	23 (95.8%)	20 (95.2%)	6 (66.7%)	0.051**	1	0.157	0.207
	Abnormal	1 (4.2%)	1 (4.8%)	3 (33.3%)				
Gender	Male	13 (54.2%)	11 (52.4%)	6 (66.7%)	0.872**	1	1	1
	Female	11 (45.8%)	10 (47.6%)	3 (33.3%)				
Mechanism of trauma	Simple falls	20 (83.3%)	12 (57.1%)	0 (0.0%)	**<0.001****	0.909	**<0.001**	**0.009**
	Traffic accident	0 (0.0%)	0 (0.0%)	1 (11.1%)				
	Falling from high	2 (8.3%)	4 (19.0%)	6 (66.7%)				
	Falling off the stairs	1 (4.2%)	3 (14.3%)	2 (22.2%)				
	Head impact	1 (4.2%)	2 (9.5%)	0 (0.0%)				
Scalp hematoma	Nope	19 (79.2%)	6 (28.6%)	2 (22.2%)	**<0.001****	**0.011**	**0.003**	0.065
	Frontal	3 (12.5%)	9 (42.9%)	0 (0.0%)				
	Temporal	0 (0.0%)	2 (9.5%)	1 (11.1%)				
	Parietal	1 (4.2%)	3 (14.3%)	2 (22.2%)				
	Occipital	1 (4.2%)	1 (4.8%)	4 (44.4%)				
Palpable fracture	Nope	24 (100.0%)	20 (95.2%)	8 (88.9%)	0.159**	1	0.819	1.000
	Yes	0 (0.0%)	1 (4.8%)	1 (11.1%)				
Loss of consciousness	Nope	24 (100.0%)	19 (90.5%)	3 (33.3%)	**<0.001****	0.636	**<0.001**	**0.009**
	Yes	0 (0.0%)	2 (9.5%)	6 (66.7%)				
Abnormal behavior	Nope	19 (79.2%)	17 (81.0%)	3 (33.3%)	**0.023****	1	**0.033**	**0.030**
	Yes	5 (20.8%)	4 (19.0%)	6 (66.7%)				
Vomiting	Nope	20 (83.3%)	7 (33.3%)	0 (0.0%)	**<0.00****	0.003	**<0.001**	0.213
	Yes	4 (16.7%)	14 (66.7%)	9 (100.0%)				
Seizure	Nope	24 (100.0%)	20 (95.2%)	4 (44.4%)	**<0.001****	1	**0.002**	0.014
	Yes	0 (0.0%)	1 (4.8%)	5 (55.6%)				
Headache	Nope	24 (100%)	21 (100%)	9 (100%)	1	1	1	1
	Yes	23 (95.8%)	16 (76.2%)	8 (88.9%)	0.127**	0.249	1	1
Skin laceration	Nope	1 (4.2%)	5 (23.8%)	1 (11.1%)				
	Yes	3 (12.5%)	3 (14.3%)	0 (0.0%)	0.051**	1	0.136	0.267
Treatment	Discharge	19 (79.2%)	17 (81.0%)	6 (66.7%)				
	Observation	0 (0.0%)	1 (4.8%)	3 (33.3%)				
	Leave without permission	2 (8.3%)	0 (0.0%)	0 (0.0%)				
Severe brain injury	Nope	24 (100.0%)	20 (95.2%)	7 (77.8%)	1	1	1	1

Stats: n (%), *Pearson chi-squared test, ** Fisher exact test, Stats: Mean ± SD/Median (Min-Max), (k) Kruskal-Wallis H-test, p1: Low vs. medium, p2: Low vs. high, p3: Medium vs. high, CT: Computed tomography, PECARN: Pediatric emergency care applied research network

Discussion

Minor head traumas constitute a significant portion of childhood injuries. Over 80% of patients presenting to the emergency department with head trauma have minor head injuries (6). Studies indicate that male children are more frequently subjected to head trauma, with incidences reported to be four times higher in males than females (7). In our study, 85% of high-risk patients over 2 years old were male, while this proportion was 66.7% in those under 2 years old. It is essential to recognize the higher risk of head trauma in male children and implement preventive health measures targeting this group (8,9). High-risk head trauma in both age groups primarily resulted from falls from heights, consistent with findings from similar studies.

The clinical decision-making process for children with minor head trauma is challenging. Although CT is the gold standard for diagnosing TBI, its use in minor head trauma remains controversial due to associated risks (10). PECARN criteria provide a safe evaluation method for pediatric patients without the need for CT. In our study, only 11.9% of patients undergoing CT were classified as high-risk by PECARN criteria, while 88.1% were low to moderate risk, yet still underwent CT. Previous research has shown that a high percentage (94.8%) of CT scans performed for minor head trauma are normal (11,12). Osmond et al. (13) found pathology in only 4.9% of CT scans for minor head trauma in children. In our study, 95.8% of patients under 2-year-old classified as low-risk by PECARN had normal CT results. All CT scans were normal for low-risk patients over 2 years old. For high-risk patients, CT showed TBI in 33% and 40% of those under and over 2 years old, respectively (14). Non-frontal scalp hematomas are considered a risk factor for TBI (15). Burns et al. (15) associated the highest rates of TBI with temporal/parietal and occipital scalp hematomas. In our study, the presence of a scalp hematoma was indicative of high-risk status. When scalp hematomas were absent, PECARN criteria classified 69.6% and 79.2% of patients in the low-risk group for younger than 2 years old and older, respectively. Among high-risk patients, 50% over the age of 2 had temporal scalp hematomas, while 44% under the age of 2, had occipital hematomas as the most common finding. The incidence of skull fractures following head trauma in children ranges from 2% to 20%, with a higher prevalence in those under 2 years old. Bressan et al. (17) reported a 13.3% incidence of skull fractures on CT in the high-risk group. Similarly, in our study, all patients over 2 years old with palpable fractures were high-risk, while this was true for only 50% of those under 2 years old. Despite nearly half of the infants under 2 years old with palpable fractures not being classified as high-risk, the presence of a palpable fracture suggests a potential for significant injury (18). Infants with intracranial injuries can often be asymptomatic. In our study, the presence or absence of amnesia did not show a statistically significant difference in risk classification in the over-2-year-old group. Amnesia may not be adequately assessed in acute settings, highlighting the importance of thorough evaluation in emergency management. Seizures are a recognized complication of TBI and often indicate more severe injuries. Approximately 5-7% of hospitalized TBI patients experience at least one Seizure (19). Post-traumatic seizures occur in about 18% of children aged 2 years and under (20). In our study, the presence of seizures correlated with higher PECARN risk levels, suggesting the necessity of CT in such cases. Even if CT results are normal, this information is valuable for safely discharging patients from the emergency department. Vomiting is a common side effect of head trauma, with a general incidence of 7% in adults and 15% in children Dayan et al. (21) reported TBI in only two out of 815 patients with isolated post-traumatic vomiting (22,23). In our study, all patients under 2 years old with vomiting were classified as high-risk. Applying PECARN rules in children presenting to the emergency department with head trauma can reduce the rate of CT scans. Many studies have demonstrated that PECARN rules have high sensitivity and specificity for identifying serious brain injuries (24). These guidelines provide a systematic and reliable approach for evaluating pediatric head trauma, enhancing patient safety, and optimizing resource use in emergency settings.

Study Limitations

The retrospective nature and the small number of patients are the limitations of the study

Conclusion

PECARN criteria provide a reliable framework for the evaluation and management of pediatric head trauma in emergency settings. Implementing these guidelines can enhance patient safety, optimize the use of medical resources, and reduce unnecessary radiation exposure. Future studies should continue to refine these criteria and explore additional factors that may influence risk stratification and clinical decision-making.

Ethics

Ethics Committee Approval: Since it is a retrospective study, Ethical Committee Approval from Bezmialem Foundation University Rectorate Technology Transfer Office was obtained, but patient consent was not obtained (decision number: 2022/113, date: 26.04.2022).

Informed consent: Retrospective study.

Footnotes

Authorship Contributions

Concept: A.D.D., Design: A.D.D., A.N.D., B.T., Data Collection or Processing: A.D.D., U.E., Analysis or Interpretation: A.D.D., U.E., B.T., Literature Search: A.D.D., A.N.D., U.E., Writing: A.D.D.

Conflict of Interest: One author of this article, Bahadır Taşlıdere, is a member of the Editorial Board of the Eurasian Journal of Emergency Medicine. However, he did not involved in any stage of the editorial decision of the manuscript. The editors who evaluated this manuscript are from different institutions. The other author declared no conflict of interest.

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