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Comparative Study on Different Clinical Decision-Making Tools in Pediatric Head Injury Cases

Mohsin Shahzad, Ammar Yasir*, Saqib Islam, Khurram Hussain, Raja Nand, Hafiz Asghar Ali*****

Department of Surgery, 5 Mountain Medical Battalion, Forward Kahuta Pakistan, *Department of Surgery, 136 Medical Battalion, Bagh Azad Jammu and Kashmir, Pakistan, **Department of Surgery, Combined Military Hospital Thal /National University of Medical Sciences (NUMS) Pakistan, ***Department of Surgery, Combined Military Hospital, Rahim Yar Khan/National University of Medical Sciences (NUMS) Pakistan

ABSTRACT

Objective: To carry out a comparative study on effective clinical decision-making tools between Canadian Assessment of Tomography for Childhood Head injury, Pediatric Emergency Care Applied Research Network (PECARN) and Children's Head injury Algorithm for the prediction of Important Clinical Events in pediatrics head trauma cases.

Study Design: Validation study.

Place and Duration of Study: Department of Surgery, Saif Shaheed Hospital, Haveli Kahota, Azad Kashmir, Pakistan, from Oct 2021 to Nov 2022.

Methodology: One hundred and fifty paediatric patients suffering from minor head injury were evaluated on clinical intervention decisions as per emergency procedures during the period of study. Sensitivity, Specificity, Positive Predictive Value and Negative Predictive Value of the selected diagnostic tests was checked.

Results: Based on the head CT positivity, PECARN was found to be 81.8% sensitive and 61.9% specific. Canadian Assessment of Tomography for Childhood show sensitivity of 90.9 % and specificity of 65.5%. CHALICE had sensitivity and specificity of 63.6% and 61.5% respectively. CHALICE was unable to identify a pathological CT result with statistical significance (p=0.17) however PECARN and CATCH rule proved significant (p<0.05). CATCH rule show highest positive predictive score of 17.2% and negative predictive score of 98.8%.

Conclusion: PECARN, CATCH, and CHALICE criteria are effective in deciding whether or not to perform Computerized Brain Tomography (CBT) scans on children with MHT, leading us to believe that employing these criteria could prevent unnecessary CBT scans.

Keywords: CATCH, CHALICE, Head Injuries, PECARN, Pediatrics.

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INTRODUCTION

A significant portion of childhood injuries are caused by minor head traumas (MHTs). MHTs in children are a common occurrence, with millions of children experiencing some form of head injury each year. While many of these injuries are mild and resolve on their own, some may require medical attention to prevent more serious complications.[1] Even though trauma mechanisms can vary, children under the age of two are particularly susceptible to falling from heights. In children with MHT, the incidence of intracranial pathologies ranges from 3-5%, with younger infants experiencing a higher rate. However, appropriate treatment for these patients is still up for debate, and these pathologies rarely necessitate surgical intervention.[2]

In patients admitted with MHT, computerized brain tomography (CBT) has emerged as the gold standard for detecting intracranial injuries.[2] however, its widespread and unnecessary use not only raises medical costs but also increase exposure to radiations risk.[3,4] The most widely accepted clinical decision-making criteria for selective computed tomography (CT) requests are those of the Pediatric Emergency Care Applied Research Network (PECARN), the Canadian Assessment of Tomography for Childhood Head Injury (CATCH) and the Children's Head Injury Algorithm for the Prediction of Important Clinical Events (CHALICE).[5,6]

Due to a dearth of similar studies in the region, we aimed to study clinical decision-making for children with MHT to avoid unnecessary radiation exposure, to determine how well the PECARN, CATCH, and CHALICE criteria worked as diagnostic tools in our setup, evaluate their veracity and select the best algorithm for cranial imaging of MHT children, thereby considerably containing the chances of excessive radiation exposure in patients.

METHODOLOGY

The validation study was conducted at Department of Surgery, Saif Shaheed Hospital Haveli

Correspondence: Dr Mohsin Shahzad, Department of Surgery, 5 Mountain Medical Battalion, Forward Kahuta Pakistan

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Kahota, Azad Kashmir, Pakistan, from Oct 2021 to Nov 2022, after approval from the Institutional Ethical review Board (letter no. IRB-9157).

Inclusion Criteria: Minor head trauma (MHT) patients under the age of 16, who had suffered head trauma with GCS≥13 and were presented at the hospital emergency were included.

Exclusion Criteria: Patients with hemorrhagic diathesis, patients taking anticoagulants, patients with penetrant trauma, patients with previously known brain tumors, and patients with neurological diseases were excluded.

A total of 215 patients were subjected to a retrospective screening, and 65 of them were excluded on account of age group beyond 16 years. On hundred and fifty patients fulfilling our inclusion criteria were selected based on non-probability convenience sampling, after obtaining written informed consent.

The patient's files were used to gather data on age, gender, loss of consciousness, headache, vomiting, abnormal behaviors toward parents, amnesia, episodes, concerns of non-accident trauma, trauma mechanism, abnormal mental state, cranial fracture findings, GCS≥13, neurological deficit, monitoring, and CBT results in the patients. The "abnormal CBT" group included abnormal CBT findings like epidural bleeding, subdural bleeding, and all types of skull fractures. The PECARN, CATCH, and CHALICE criteria were used to group the patients. Patients, who were subjected to CBT imaging, were the subjects of this retrospective study.

The automation system at the hospital and the patient's files provided the data regarding patient's personal data, demographic and medical history. Current work includes a comparative analysis on three basic algorithmic clinical decision-making tools with specific focus on reducing unnecessary computerized brain tomography (CBT) and thus minimizing excessive radiation exposure of pediatric patients.

All statistical analysis was performed using Statistics Package for Social Sciences (SPSS) version 24. Quantitative values were used as Mean±SD. However, qualitative values were used as either percentages or frequencies. Two-by-Two (2x2) contigency table was used for the estimation of diagnostic parameters.

RESULTS

Out of 150 patients included in our study, 118(78.7%) were boys and 32(21.3%) were girls. Male to female ratio was 3.7:1. The mean age of patient was 6.6±3.8 years. Twenty-one (14.0%) patients were <2 years and 129 (86.0%) were >2 years. Total of 9(6.0%) patients had a GCS of 14, whereas 141 (94.0%) had a GCS of 15. 11(7.8%) patients had aberrant findings in the CBT outcomes. One (50%) patient with GCS =14% and 9(6%) of patients with GCS =15 had abnormal CBT findings as shown in Table-I.

Table-I: Demographic Characteristics of Pediatric Patients Presenting with Minor Head Trauma (n=150)

Variables		n (%)
Age Groups	<2 years	21(14.0%)
	>2 years	129(86.0%)
Gender	Male	118(78.7%)
	Female	32(21.3%)
GCS	15/15	141(94.0%)
	14/15	9(6.0%)
CBT2	Positive	11(7.3%)
	Negative	139(92.7%)
CHALICE	Positive	61(40.7%)
	Negative	89(59.3%)
CATCH	Positive	58(38.7%)
	Negative	92(61.3%)
PECARN	Positive	62(41.3%)
	Negative	88(58.7%)

Distribution of different groups of clinical decision rules shown in Table-II. A statistically significant difference observed PECARN AND CATCH group when we compared it head CT (p<0.05) whereas CHALICE group did not shown significant difference (p=0.107).

Table-II: Summary of Pecarn, Catch and Chelice Decision Rules and Significance based on Head CT Findings (n=150)

Diagnostic Outcomes	CT head positive n(%)	CT head negative n(%)	*p*-value
PECARN Positive	9(6%)	53(35.3%)	0.005
PECARN Negative	2(1.3%)	86(57.3%)	
CATCH Positive	10(6.7%)	48(32%)	0.001
CATCH Negative	1(0.7%)	91(60.7%)	
CHELICE Positive	7(4.7%)	54(36%)	0.107
CHELICE Negative	4(2.7%)	85(56%)	

Out of these PECARN had sensitivity of 81.8% and specificity of 61.9%. positive predictive value of 14.5% and 97.7% predictive negative. in CHELICE group had 63.3% sensitivity and 61.6% specificity with 11.5% positive predictive value and 95% negative predictive value. Catch group showed 90.9% sensitivity, 65.5% specificity and had 17.2% positive predictive value and 98.8% negative predictive value as shown in Table-III.

Table-III Diagnostic validity of Pecarn, Catch and Chalice Clinical Decision Rule in Comparison of Head CT

Diagnostic Tool	Sensitivity	Specificity	PPV	NPV
PECARN	81.8%	61.9%	14.5%	97.7%
CATCH	90.9%	65.5%	17.2%	98.9%
CHELICE	63.6%	61.5%	11.5%	95%

DISCUSSION

As in the rest of the globe, head injuries are a frequent cause of hospital visits in Pakistan, particularly for children who seek pediatric emergency services.[7] MHT makes up a significant portion of these visits. Male kids are more likely to sustain brain injuries. A higher male to female ratio in our study (3.7:1) was in favor of boys and was consistent with the literature.[8] Boys being pre-dominant contributors to the injured patients have certain aggressive and adventurous behavior which results into frequent head injuries. The most common reason for head injury in studied cases were falling from heights and crashing into objects.

MHT is present in more than 80% of head trauma patients who visit emergency rooms. As CBT became more common, a number of debates about how to treat these patients arose. Since the number of patients is high, intracranial pathologies are only detected in a small percentage of cases, it is costly for the country's economy, and patients are exposed to radiation, it is not appropriate to perform CBT scans on all patients. CBT scans were ordered for 14,969 (35.3 percent) of 42,414 children with head trauma in a multi-center study because of their clinical findings. Of these, 14,189 (94.8 percent) had no pathological findings. All 235 of the cases in our study had CBT scans, but pathological findings were only found in 44(8.3%) of those cases.[9,10] The discussions in the literature regarding CBT scans are supported by our study's finding that a high percentage, 91.7 percent, had normal CBT results.

Clinical decision-making guidelines have been created to enable doctors to diagnose all pertinent injuries while minimizing CBT scans in children who are at high risk of brain injury. The PECARN, the CATCH, and the CHALICE are three sets of clinical decision-making criteria that have been created with excellent methodological quality in multi-center studies with sizable samples. Studies have examined the PECARN criteria and clinician judgments in terms of the prediction of traumatic brain injury in children with MHTs in research that was carried out to investigate the sensitivity and specificity of the PECARN criterion.[11,12]

Our study result show PECARN rule with sensitivity and specificity of 81.8% and 61.9% respectively. These results are comparable with Bozan *et al*. who studied 256 kids and evaluated MHTs using the PECARN and CATCH criteria. PECARN had a sensitivity of 100% and a specificity of 53.6% for kids under 2 years old, and 96.8% and a specificity of 58.2% for kids who were 2 years old or older. Additionally, it had a positive predictive value of 2.4% and a negative predictive value of 100% for children under the age of two, compared to 2.2% and 99.95% for those who were two years old or older.[12] Local studies show sensitivity of 82% and specificity of 33%.[8,11]

Easter et al. in their study show that PECARN had sensitivity of 95% and specificity of 63%, whereas CATCH had sensitivity and specificity of 91% and 44% respectively. CATCH had 86% and 78%.[13] It was discovered that there were very few studies in the literature that looked into the CHALICE criteria's sensitivity and specificity. Crowe *et al*. found that CHALICE is one of the strongest clinical decision-making tools for management of head trauma in children. A comparison of the sensitivity values of the PECARN, CATCH, and CHALICE criteria in our research, we discovered that CHALICE had the highest sensitivity value and same is endorsed by past research. Similar research in the New Zealand by also concludes that usual clinical strategies without the use of PECRAN, CHALICE or CATCH present more effective and economical option than using these tools in MHT cases.[14,15] Another study on the subject found PECARN to be most effective tool for children under the age of 2. It was followed by CATCH and the CHALICE in predicting the optimum clinical strategy in MHT cases.[16-18]

Conflict of Interest: None.

Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

MS & AY: Data acquisition, critical review, approval of the final version to be published.

SI & KH: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

RN & HAA: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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