Research Article

Validity of Pediatric Emergency Care Applied Research Network (PECARN) in Pediatric Trauma Patients - A Cross Sectional Study from a Tertiary Care Hospital in Pakistan

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Abstract:

Introduction: Head trauma in the pediatric age group is a common presentation in the Emergency Room (ER). The Pediatric Emergency Care Applied Research Network (PECARN) tool can help an ER clinician to identify pediatric head trauma patients at very low risk of clinically important traumatic brain injuries (ciTBIs) and avoid unnecessary CT scans.

Objective: To determine the validity of PECARN rule as compared to the head CT (gold standard) in identifying low risk traumatic brain injury pediatric patients.

Methods: A cross-sectional study was done at Aga Khan University Hospital (AKUH) Emergency Department ED. All pediatric head trauma patients were included in this study between 2017-2019. A total of 218 head trauma cases were reviewed which were evaluated for the PECARN criteria. Data were extracted on a prepared data collection form. Data were entered and analyzed using SPSS. Chi-square test was used.

Results: Among the total 218, 190 cases (87%) had CT scans ordered. Out of these 190 patients 156 (82%) met PECARN criteria, while 34 (18%) were PECARN negative. The sensitivity and specificity of PECARN was calculated as 82% and 33% respectively, with a fair level of agreement with CT scan based on Kappa statistics.

Conclusion: PECARN has a higher sensitivity but lower specificity in comparison to CT scan.

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Introduction:

Children can frequently present to the emergency department (ED) with head trauma[1]. Identifying clinically important traumatic brain injuries (ciTBIs) occurring in pediatric trauma cases be challenging for the emergency physician[2]. Reasons can be uncooperative pediatric patients, inconsistent history by the child or unreliable parental observations. The clinician must decide whether to order a computed tomography (CT) scan or not; in order to evaluate for ciTBI[3,4]. There are two widely recognized rules that the clinician can use here: the Canadian Assessment of Tomography for Childhood Head Injury (CATCH) [5] and the Children's Head Injury Algorithm for Prediction of Important Clinical Events (CHALICE)[6]. These two assessments can be useful however, they do not help with the infant population.

A third assessment criteria which can be of use among children is called Pediatric Emergency Care Applied Research Network (PECARN). PECANRN can help the clinician to identify infants at very low risk of ciTBIs who do not typically require CT scans[7,8].One example is that of infants with mild blunt head trauma presenting to the emergency department with isolated loss of consciousness (LOC). These infants rarely have ciTBI and do not routinely require computed tomographic evaluation[9]. The minor head trauma patient upon presentation to the ED are usually consciousness and lack any neuro-

logical abnormalities[10]. A study from Japan has identified the use of PECARN useful in such patients where the clinician can safely opt out of CT scan and continue observation at home[11]. Exposing children to radiations in a CT scan is another problem that can be avoided through the use of a criteria like PECARN. It has been estimated that the use of computed tomography (CT) in children has doubled over the last two decades, from 10.6 CTs per 1000 children to 21.5 CTs per 1000 children[12]. 0.1% to 0.5% of these exposed children can develop lethal cancers[13] which is worrisome. Keeping these figures in mind and identifying the need for reliable tools it is estimated that the use of CT for pediatric head trauma/ TBI would decrease by 20–25% while rarely missing a positive finding in a child[14].

Keeping the above rationale in mind the aim of this study was to determine the validity of PECARN-rule in pediatric head trauma patients in a tertiary care hospital in Pakistan. This study can be useful in determining the clinical significance of PECARN in the context of a low income setting like Pakistan where the aim is to avoid ordering unnecessary imaging.

Methods:

The Aga Khan University Hospital AKUH pediatric emergency room ER is a 10-bedded area with a well-equipped resuscitation room. It is well-suited to manage a variety of pediatric emergencies along with pediatric head injury which are received often to the ER.

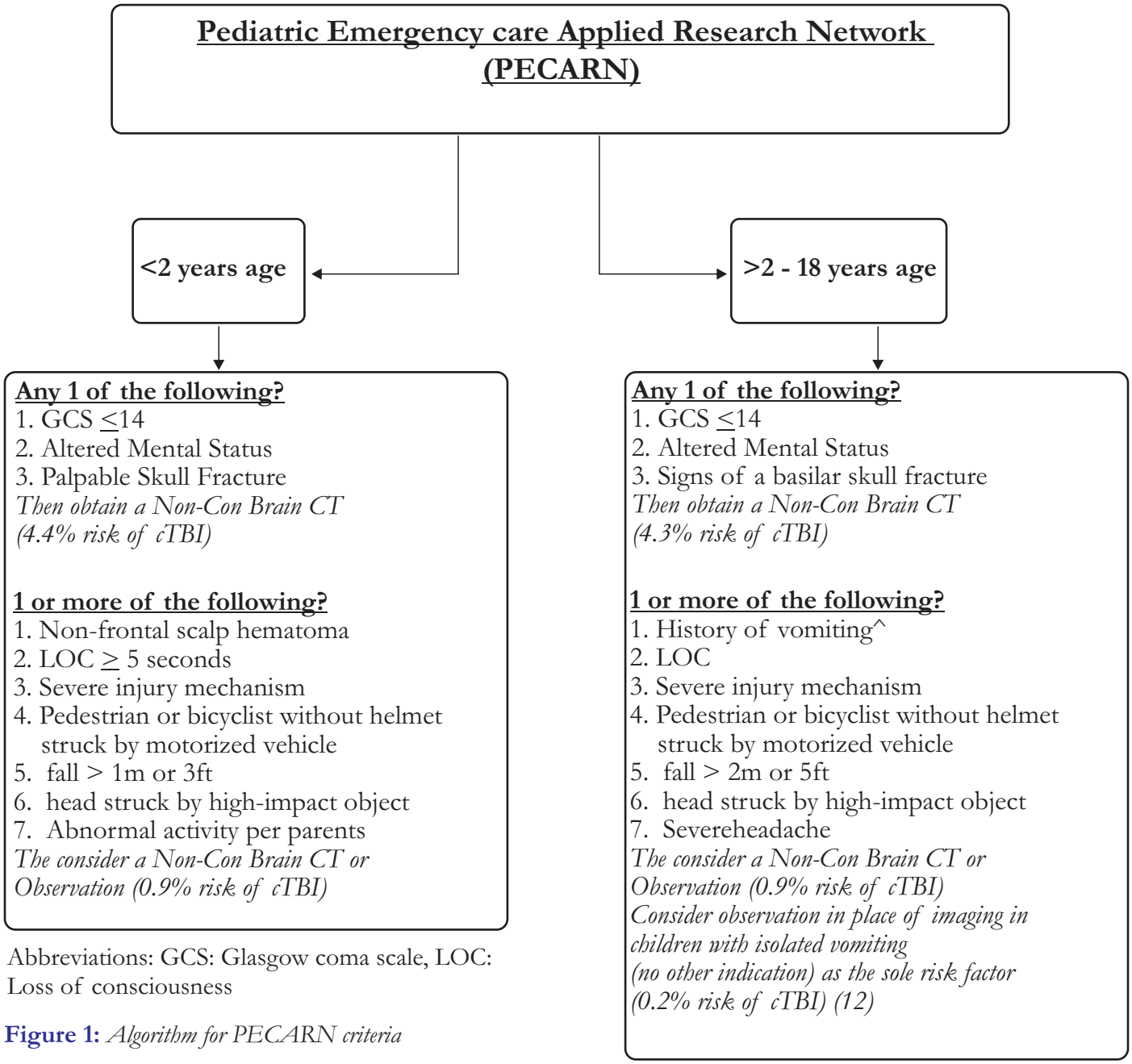
The was a single-center retrospective chart review done at the AKUH pediatric ER. Ethical approval was obtained from Ethical Review Board at AKU prior to data collection which was granted on 03/04/2021 (4511-EM-ERC-16). A non-probability convenient sampling strategy was used. All the pediatric patients (0-18 years of age) received at the emergency room with head trauma from Jan 2017 to Dec 2019 were included in this study. Based on a previous sensitivity of PECARN close to 95%, and a margin of error of 5% with a 95% confidence level, a sample of 213 was calculated as suggested by HajianTilaki[11]. A total of 129 medical records were reviewed based on the inclusion criteria of age between 0-18 years and a visit to the ER with a head trauma. There were 11 patients which had missing data and were excluded based on that. The medical record numbers MRN were revealed as per the coded diagnosis of head injury due to road traffic injury, fall or gun shot. AKUH has a HIMS (Health Information Management System) which was used to obtain the records. Data were extracted on a pre-designed proforma. The study variables were designed based on PECARN rule. Data were obtained for demographics, mechanism of injury, Glasgow coma scale, disposition, CT scan finding for TBI, and the presence of CT head. Since data was obtained from retrospective chart review details regarding CT scan findings and indications could not be gathered. PECARN was calculated based on the available data from charts. Outcome variables were PECARN criteria and presence of CT scans. Data confidentiality was maintained through replacing MRN with codes. Patient identifiers like names were not reported to ensure confidentiality of patients.

Data were entered and analyzed with SPSS version 20. Hypothesis testing was done, and two tailed p value was used at a significance level of 0.05. Categorical variables were reported as frequencies and percentages. Age was continuous which was further categorized into two categories of > 2 years and < 2 years. Chi-square test was used for analyzing the association of PECARN (outcome variable) and other independent variables.

Variables PECARN criteria and presence of CT scans were made into a 2x2 table. Validity of PECARN was manually calculated and given as sensitivity, specificity, positive and negative predictive values. The level of agreement was manually calculated using Kappa statistics. False positive rate was the probability of having a positive PECARN criteria given that the CT scan was performed. False negative rate was the probability of having a negative PECARN criteria given that the CT scan was performed.

PECARN Rule algorithm:

This rule was derived from the multicenter PECARN study to detect ciTBI in children 0 to 18yrs old after head trauma[15]. The rule initially stratifies patients into two groups based on ages, < 2 years old and ≥ 2 years old, figure 1. It further stratifies based on the mental status which can be determined with the Glasgow Coma Scale which is a standard score having a range of 3 to 15. With 3 being the worst and 15 being best[14] and the severity of the head trauma.



Abbreviations: GCS: Glasgow coma scale, LOC: Loss of consciousness

Figure 1: *Algorithm for PECARN criteria*

Results:

Medical records of 218 pediatric patients presenting with head injury were reviewed. Stratification of the patients based on PECARN criteria has been presented in table 1. The cross tabulation of the PECARN criteria and its association with the demographics has been presented in table 2. 84% of the patients visiting the emergency room were ages 2 - 18 years. Most of the patients were boys (67.4%), while girls were fewer (32.6%). Falls (47.7%) and road traffic injuries (45.4%) were among the most common injuries among pediatric patients presenting to the ER.

Table 1: *Stratification of pediatric head trauma patients based on PECARN criteria*

PECARN criteria	Frequency	Percentage
Yes	184	84.4%
No	33	15.6%

Our results show that almost half of the patients 49.5% (n=108) had a Glasgow coma scale (GCS) < 14. Loss of consciousness of more than five seconds was reported in 49.1% (n=107) of patients. Abnormal activity/ behavior was reported among two children. 58.7% (n=128) children had a history of vomiting upon admission, while 17.3% (n=16) had had severe headache.

Table 2: Demographic characteristics of pediatric patients presenting with head injury and their association with PECARN criteria

Variables	Frequency N=218	Percentage (%)	p-value
Age			0.91
0- 2 years	39	(18)	
> 2 years	179	(82.11)	
Sex			0.63
Male	147	(67.4)	
Female	71	(32.6)	
Mechanism of injury			< 0.05
Road Traffic Injury	99	(45.4)	
Fall injury	104	(47.7)	
Assault	1	(0.5)	
Gunshot	4	(1.8)	
Blast injury	2	(0.9)	
Fall of object on head	6	(2.8)	
Collision with another child while playing	2	(0.9)	
			< 0.01
Pediatric ward	51	(23.4)	
Special care unit	90	(41.3)	
Intensive care unit	50	(22.9)	
Discharge	16	(7.3)	
Leave against medical advice	7	(3.2)	
Operation Theatre	1	(0.5)	
Transfer out	2	(0.9)	
Discharge on requests	1	(0.5)	

Table 3: *Clinical characteristics of head injury patients and its association with PECARN criteria*

Variables	Frequency N=218	Percentage (%)	P-value
GCS <14			< 0.01
Yes	108	49.5%	
No	110	50.5%	
Altered Mental Status			< 0.01
Yes	107	49.1%	
No	111	50.9%	
Skull Fracture			0.60
Yes	1	0.5%	
No	217	99.5%	
Scalp Hematoma			0.60
Yes	1	0.5%	
No	217	99.5%	
LOC ≥ 5 seconds			< 0.01
Yes	107	49.1%	
No	111	50.9%	
Abnormal activity reported by parents			0.24
Yes	2	0.9%	
No	216	99.1%	
History of Vomiting			< 0.01
Yes	128	58.7%	
No	90	41.3%	
Severe Headache			< 0.05
Yes	16	7.3%	
No	202	92.7%	
CT head performed			< 0.01
Yes	190	87.2%	
No	18	8.3%	
Outside	10	4.6%	

Table 4: *Validity of PECARN-rule and comparison with head CT*

	CT Head Done	CT Head Not done	Total
PECARN Positive	156	28	184 (84%)
PECARN Negative	20	14	34 (15.5%)
Total	176 (81%)	42 (19.2%)	218

Sensitivity= 82%
Specificity=33%
Positive Predictive Value= 85%
Negative Predictive Value= 58.8%
False Positive rate= 67%
False Negative rate= 11%
Kappa Statistics=24% (Level of agreement= Fair)

Out of the 218 records reviewed, 190 patients had head CT scans done. Among the 190 with CTs, 34 patient's PECARN rule was not justified. Among these 34 PECARN negative patients, 20 CT scans were negative for any traumatic brain injury (TBI) as shown in table 2 and 3.

Calculation of validity for PECARN are shown in table 4. PECARN has a high sensitivity when compared with CT scan of the head. However, it has lower specificity compared to CT scan. 85% of the patients who were

PECARN positive had a head CT for brain injury, while 59% of those who had not had a head CT scan done for brain injury were PECARN negative. When kappa statistics are calculated it shows a fair level of agreement between head CT scan and PECARN criteria.

Discussion:

Validity of the PECARN rule has been done in other Asian and Western countries. This is among the first studies conducted in Pakistan to determine the applicability of PECARN rule in a Pakistani setting. We have compared the PECARN rule with head CT scan in pediatric head trauma patients. Emergency physicians usually have a low threshold for ordering CT head for pediatric head trauma patients to avoid missing on ctbi[16]. CT scans are expensive procedures and can be a problem especially in a low-income country like Pakistan. Due to limited resources, there are many ERs across Pakistan where the facility of head CT is not even available. Another important issue is the increasing the risk of exposure to radiations in children[10]. Due to all of these reasons we explored PECARN as an alternative to CT scans in a pediatric head trauma patient. We compared the results from these results to previous literature from Asian region. The overall sensitivity of 82% for PECARN was close to that of 85% reported from Japan[2]. The sensitivity from this study was lower when compared to a recent multicenter study conducted in Iran. They reported a sensitivity (92.3%) and specificity (40.6%) which is higher compared to 82% and 33% from this study[16]. Our findings show that the ability of PECARN to correctly identify those with cTBI is 82%, also in ruling out those who should not have a head CT it is of lesser advantage.

Comparing the results of our study to a similar study done by Nishijima et al from USA[2]. Their model assumed a 100% sensitivity and specificity for PECARN to detect TBI among children. They also report cost effectiveness of PECARN model as compared to conventional CT scans for all patients[2]. Our sensitivity and specificity are substantially low which could be due to a number of reasons. One reason being that 84% of our patients were older (> 2 years), almost half of the patients had a GCS < 14 and had altered mental status pointing towards a higher severity of injuries. PECARN has shown a higher sensitivity among patients < 2 years and those with minor injuries with good GCS scores.

Our study showed a sensitivity of 82% for PECARN when compared to head CT scan in identifying ctbi. However, we found a fair agreement between PECARN, and head CT scan based on Kappa statistics. We have explored the use of PECARN for pediatric head trauma patients, however we cannot fully recommend that head CT scan be avoided. The review of the international data provides promising results regarding application of PECARN rule in deferring head CT scans ultimately decreasing the cost and preventing radiations in children[2]. However, we cannot fully recommend PECARN because of a low specificity and a fair level of agreement.

This study had limitations because it was a retrospective chart review which limits the quality of data retrieved. The risk stratification based on PECARN criteria requires prospective studies where outcome can be assessed. Stratification of patients could not be achieved because it was a retrospective review. Another limitation of our study was lack of available CT scan findings which limits the results. There is a need to further explore the effectiveness of PECARN in Pakistani pediatric population through prospective studies.

Conclusion: Pediatric Emergency Care Applied Research Network (PECARN) has a higher sensitivity but lower specificity in comparison to CT scan.

Ethical Approval: Given

Conflict of Interest: The authors declare no conflict of interest.

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