Pediatric Emergency Care Applied Research Network (PECARN)

see PECARN traumatic brain injury algorithm.

The overuse of CT leads to inefficient care. Therefore, to maximize precision and minimize the overuse of CT, the Pediatric Emergency Care Applied Research Network (PECARN) previously derived clinical prediction rules for identifying children at high risk and very low risk for intra-abdominal trauma undergoing acute intervention and clinically important traumatic brain injury after blunt trauma in large cohorts of children who are injured.

A study aimed to validate the IAI and age-based TBI clinical prediction rules for identifying children at high risk and very low risk for IAIs undergoing acute intervention and clinically important TBIs after blunt trauma.

This was a prospective 6-center observational study of children aged <18 years with the blunt torso or head trauma. Consistent with the original derivation studies, enrolled children underwent a routine history and physical examinations, and the treating clinicians completed case report forms prior to knowledge of CT results (if performed). Medical records were reviewed to determine clinical courses and outcomes for all patients, and for those who were discharged from the emergency department, a follow-up survey via a telephone call or SMS text message was performed to identify any patients with missed IAIs or TBIs. The primary outcomes were IAI undergoing acute intervention (therapeutic laparotomy, angiographic embolization, blood transfusion, or intravenous fluid for ≥2 days for pancreatic or gastrointestinal injuries) and clinically important TBI (death from TBI, neurosurgical procedure, intubation for >24 hours for TBI, or hospital admission of ≥2 nights due to a TBI on CT). Prediction rule accuracy was assessed by measuring rule classification performance, using a standard point and 95% CI estimates of the operational characteristics of each prediction rule (sensitivity, specificity, positive and negative predictive values, and diagnostic likelihood ratios).

The project was funded in 2016, and enrollment was completed on September 1, 2021. Data analyses are expected to be completed by December 2022, and the primary study results are expected to be submitted for publication in 2023.

This study will attempt to validate previously derived clinical prediction rules to accurately identify children at high and very low risk for clinically important intra-abdominal trauma and traumatic brain injury. Assuming successful validation, widespread implementation is then indicated, which will optimize the care of children who are injured by better aligning CT use with need.

International registered report identifier (irrid): RR1-10.2196/43027 [1].

Background

Blunt head trauma is common in children and a common reason for presentation to an emergency department. Head CT involves radiation exposure and the risk of fatal radiation-related malignancy increases with younger age at CT [2]. The PECARN flow diagram flags assessment features that increase the risk of ci-TBI and weigh them against the risk of radiation exposure. Therefore, it is useful in avoiding unnecessary radiation exposure in younger patients, where it is safe to do so, and identifying those at risk that require further investigation.

In PECARN, altered mental status was defined as GCS 14 or agitation, somnolence, repetitive questioning, or slow response to verbal communication.

Severe mechanisms of injuries including:

motor vehicle crash with patient ejection

death of another passenger, or rollover

pedestrian or bicyclist without helmet struck by a motorized vehicle falls

more than 1.5 m (5 feet) for patients aged 2 years and older

more than 0.9 m (3 feet) for those younger than 2 years

head struck by a high-impact object

The algorithm was created from patients presenting to an emergency department within 24 hours of the trauma and with blunt trauma only.

Excluded criteria included:

penetrating trauma

known brain tumors

pre-existing neurological disorders complicating assessment

neuroimaging at a hospital outside before transfer

and therefore may not apply to patients with these features.

TBI on CT was defined as any of:

intracranial hemorrhage or contusion

cerebral edema

traumatic infarction

diffuse axonal injury

shearing injury

sigmoid sinus thrombosis

midline shift of intracranial contents or signs of brain herniation

diastasis of the skull

pneumocephalus

skull fracture depressed by at least the width of the table of the skull

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Kuppermann et al. analyzed 42 412 children (derivation and validation populations: 8502 and 2216 younger than 2 years, and 25 283 and 6411 aged 2 years and older). We obtained CT scans on 14 969 (35.3%); ciTBIs occurred in 376 (0.9%), and 60 (0.1%) underwent neurosurgery. In the validation population, the prediction rule for children younger than 2 years (normal mental status, no scalp hematoma except frontal, no loss of consciousness or loss of consciousness for less than 5 s, non-severe injury mechanism, no palpable skull fracture, and acting normally according to the parents) had a negative predictive value for ciTBI of 1176/1176 (100.0%, 95% CI 99.7-100 0) and sensitivity of 25/25 (100%, 86.3-100.0). 167 (24.1%) of 694 CT-imaged patients younger than 2 years were in this low-risk group. The prediction rule for children aged 2 years and older (normal mental status, no loss of consciousness, no vomiting, non-severe injury mechanism, no signs of basilar skull fracture, and no severe headache) had a negative predictive value of 3798/3800 (99.95%, 99.81-99.99) and sensitivity of 61/63 (96.8%, 89.0-99.6). 446 (20.1%) of 2223 CT-imaged patients aged 2 years and older were in this low-risk group. Neither rule missed neurosurgery in validation populations.

These validated prediction rules identified children at very low risk of ciTBIs for whom CT can routinely be obviated [3].

A study applied two different machine learning (ML) models to diagnose mTBI in a paediatric population collected as part of the paediatric emergency care applied research network (PECARN) study between 2004 and 2006. The models were conducted using 15,271 patients under the age of 18 years with mTBI and had a head CT report. In the conventional model, random forest (RF) ranked the features to reduce data dimensionality and the top ranked features were used to train a shallow artificial neural network (ANN) model. In the second model, a deep ANN applied to classify positive and negative mTBI patients using the entirety of the features available. The dataset was divided into two subsets: 80% for training and 20% for testing using five-fold cross-validation. Accuracy, sensitivity, precision, and specificity were calculated by comparing the model's prediction outcome to the actual diagnosis for each patient. RF ranked ten clinical demographic features and twelve CT-findings; the hybrid RF-ANN model achieved an average specificity of 99.96%, sensitivity of 95.98%, precision of 99.25%, and accuracy of 99.74% in identifying positive mTBI from negative mTBI subjects. The deep ANN proved its ability to carry out the task efficiently with an average specificity of 99.9%, sensitivity of 99.2%, precision of 99.9%, and accuracy of 99.9%. The performance of the two proposed models demonstrated the feasibility of using ANN to diagnose mTBI in a paediatric population. This is the first study to investigate deep ANN in a paediatric cohort with mTBI using clinical and non-imaging data and diagnose mTBI with balanced sensitivity and specificity using shallow and deep ML models. This method, if validated, would have the potential to reduce the burden of TBI evaluation in EDs and aide clinicians in the decision-making process [4].

1)

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2)

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3)

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