PECARN Update on Head Injury: Translating Research into Usable Care Strategies

The Pediatric Emergency Care Applied Research Network (PECARN) has performed substantial research and published much literature surrounding the identification of patients at low risk for traumatic brain injury. This work is expansive in informing the diagnosis and management of special subpopulations of children with head trauma or isolated risk factors associated with clinically significant head injuries. This expert lecturer will describe the PECARN clinical decision rule, provide updates on its application, and describe new translational studies to assist us in putting the rule into practice in our EDs.

OBJECTIVES

- Discuss a decision rule for identifying children at low risk for traumatic brain injury
- Describe subpopulations of children at risk after head trauma, e.g. children with bleeding disorders, isolated severe injury mechanisms, isolated loss of consciousness, young children with isolated scalp hematomas after blunt head trauma
- Discuss the role of clinical observation before the decision to CT in select populations
- Describe methods to integrate the decision rule into clinical practice using computerized decision support
- Discuss when and how to use shared decision making with the patient's guardian to decide on CT use

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DISCLOSURES:
(*) Ownership Interest (stocks, stock options, or other ownership interest excluding diversified mutual funds): InsuCalc
PECARN Update on Head Injury: Translating Research into Usable Care Strategies

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Disclosure

◆ No financial relationships or conflict of interests related to this talk
Background of a Story

- Change of research focus based on clinical events
- New environment: trauma, trauma, trauma
- I knew about clinical efficiencies, risk-stratification and radiation risk, but I wanted to know:
  - Who really needs a CT
  - Once you figure it out, how do you change practice
  - How do you involve patients when the decision is unclear

Objectives

- To review the PECARN Traumatic Brain Injury Prediction Rule derivation / validation
- To describe how PECARN is translating the Traumatic Brain Injury Prediction Rules into practice
- To describe the principles of shared decision-making and patient-centered outcomes in research and its application to the PECARN TBI rules
Case

◆ 8 month-old falls 2 feet from a carrier
◆ No LOC
◆ On exam, acting normally
◆ Small forehead hematoma, tender at site

What are you going to do?

Epidemiology of Pediatric Head Trauma

◆ Trauma the leading cause of death among children > 1 year
◆ Traumatic brain injury (TBI) the leading cause of death and disability due to trauma (> 70% of deaths)
◆ On an annual basis in the U.S., BHT in children results in:
  • 6,000 deaths
  • 60,000 hospitalizations
  • 620,000 ED visits (~50% evaluated with CT scans, use of CT increasing over the past decade, much variability in care)

NHAMCS 2006; Blackwell 2007; Centers for Disease Control 2010
Controversy over CT for Minor BHT

Arguments for liberal use of CT:

- Preventable morbidity/mortality due to unrecognized TBIs
- Preverbal children difficult to eval.
- When indicated, benefit of CT greatly outweighs risk, however…

Arguments against liberal use of CT:

- Of the large number of children evaluated with CT after BHT, fewer than 10% have TBI
- Drawbacks of CT include transport outside the ED, pharmacological sedation, costs
- Most important (theoretical) risk: lethal malignancy risk from a single CT may be as high as 1:2500

*Pediatric BHT high priority for AAP, IOM, EMSC…*
CT Radiation Risks

- Estimates (theoretical, not observed) of risks of lethal malignancies extrapolated from survivors of WWII atomic explosions:
  - 1 per 2500 head CT scans for 5 year-olds
  - 1 per 5000 for 10 year-olds
- Age and size-based radiation-reduction efforts ongoing ("ALARA" principle)
- CT radiation risks important from a public-health view
  - ~300,000 CTs for BHT, ~6 million pediatric CTs annually in U.S.
Ongoing PECARN Research Development

- Patient safety and error reduction
- Quality of PEM care
- Evaluation of head trauma
- C-Spine immobilization
- Steroids in acute bronchiolitis
- The burden of mental illness and psychiatric emergencies in PED
- RCT of fluids for DKA
- Magnesium for sickle cell pain
- Therapeutic hypothermia in pediatric cardiopulmonary arrest
- Diagnostic categorization of illnesses and injuries in the PED
- Management of status epilepticus
- Evaluation of abdominal trauma
- Screening for alcohol abuse
- Probiotics for AGE
- Knowledge translation of TBI rules
- RNA transcription biosignatures to diagnose febrile infants

The PECARN Head Injury Study

Goal: to derive a clinical decision rule to accurately identify children at near zero risk of clinically important traumatic brain injury after blunt trauma with high accuracy and wide generalizability
Outcome Definition

Clinically-important TBI (ciTBI)
- Death from TBI
- Neurosurgical procedure
- Intubation for $\geq 24$ hours for head injury
- Positive CT in association with hospitalization $\geq 2$ nights

Results

- 57,030 eligible
- 2,568 GCS $<14$ or other exclusion
- 54,161 GCS 14-15
- 11,749 (21.7%)
- 42,412 (78.3%)
- Enrolled
- 54,161
  - 42,412
  - 11,749
  - Not enrolled
- Validation
  - 8,627
- Derivation
  - 33,785
  - 288 ciTBI (0.9%)
- 88 ciTBI (1.0%)
The PECARN TBI Rules (derived and validated)

Children are at very low risk of clinically-important traumatic brain injury (TBI) if they meet all criteria in age-specific rule:

**Children < 2 years**
1. Severe mechanism of injury
2. History of LOC ≥ 5 sec
3. GCS = 14 or other signs of altered mental status
4. Not acting normally per parent
5. Palpable skull fracture
6. Occipital/parietal/temporal scalp hematoma

**Children 2-18 years**
1. Severe mechanism of injury
2. History of LOC
3. GCS = 14 or other signs of altered mental status
4. History of vomiting
5. Severe headache in the ED
6. Signs of basilar skull fracture
Recommendations for children younger than 2

GCS=14 or other signs of altered mental status†, or palpable skull fracture

Yes

CT recommended

13.9% of population
4.4% risk of cTBI

No

Occipital or parietal or temporal scalp hematoma, or history of LOC ≥ 5 s, or severe mechanism of injury†, or not acting normally per parent

Yes

Observation versus CT on the basis of other clinical factors including:
- Physician experience
- Multiple versus isolated findings
- Worsening symptoms or signs after emergency department observation
- Age < 3 months
- Parental preference

32.9% of population
0.9% risk of cTBI

No

53.2% of population
< 0.02% risk of cTBI

CT not recommended

The Rule

Suggestions
Recommendations for children 2 years and older

The Rule

Suggestions
Negative CT Scans

Do Children With Blunt Head Trauma and Normal Cranial Computed Tomography Scan Results Require Hospitalization for Neurologic Observation?


From the Department of Emergency Medicine, University of California, Davis School of Medicine, Sacramento, CA (Holmes); the Department of Emergency Medicine, University of Michigan School of Medicine and Hurley Medical Center, Flint, MI (Bogdalski); the Department of Pediatrics, University of Pennsylvania School of Medicine, Philadelphia, PA (Nadel); the Department of Pediatrics, Washington University School of Medicine, St. Louis, MO (Quylo); the Departments of Emergency Medicine and Pediatrics, Newark Beth Israel Medical Center, Newark, NJ (Schirian); the Department of Surgery, Columbia University Medical Center at Harlem Hospital, New York, NY (Cooper); the Department of Pediatrics, University of Utah, Salt Lake City, UT (Schurik) and PCORI Central Data Management and Coordinating Center, University of Utah, Salt Lake City, UT (Makin); the Departments of Pediatrics and Emergency Medicine, The George Washington University School of Medicine, Washington, DC (Makin); the Department of Emergency Medicine, Michigan State University School of Medicine/Children’s Hospital of Michigan, East Lansing, MI (Kuppermann); and the Departments of Emergency Medicine and Pediatrics, University of California, Davis School of Medicine, Sacramento, CA (Kuppermann).

Observation Before CT Decisions

The Effect of Observation on Cranial Computed Tomography Utilization for Children After Blunt Head Trauma

AUTHORS: Lisa E. Mignano, MD, MPH; Jeff T. Shurik, MD; Anna Fein, MD; Arthur Cooper, MD; Michelle Misklin, MS; Sheneen M. Atabaki, MD, MPH; John Hoy, MD; Peter S. Dayon, MD, MSc; Nathan Kuppermann, MD, MPH; and the Traumatic Brain Injury Group of the Pediatric Emergency Care Applied Research Network

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Objective emergency department observation of children with minor blunt head trauma for asymptomatic progression before making a decision regarding the use of cranial computed tomography may decrease cranial computed tomography use. The actual impact of this strategy on computed tomography use and clinical outcomes, however, is unknown.

What’s Known on This Subject: Emergency department observation of children with minor blunt head trauma for asymptomatic progression before making a decision regarding the use of cranial computed tomography may decrease cranial computed tomography use. The actual impact of this strategy on computed tomography use and clinical outcomes, however, is unknown.

What This Study Adds: Clinicians currently observe some children with head trauma before deciding whether to obtain a cranial computed tomography scan. Patients who were observed had a significantly lower rate of cranial computed tomography use after adjusting for markers of head injury severity.

Abstract

Objective: Children with minor blunt head trauma often are observed in the emergency department before a decision is made regarding cranial computed tomography use. We studied the impact of this clinical strategy on computed tomography use and outcomes.

Key Words: cranial computed tomography, clinical decision making.
Isolated Clinical Findings

outcomes

How to get clinicians to use the prediction rules?
Knowledge Translation

“Knowledge translation (KT) is the effective and timely incorporation of evidence-based information into the practices of health professionals in such a way as to effect optimal health care outcomes and maximize the potential of the health system.”

(Modified from the Canadian Institutes for Health Research definition)

Need definitive, validated evidence that is ripe for translation
- Not all data should be translated

Knowledge Translation Pipeline

Glasziou and Haynes, 2005
Translating Research into Practice

What works

Clinical decision support more successful when:

◆ Automatic provision of support in workflow
◆ Recommendations given rather than risks
◆ Support given at the time and location of decision-making
◆ Support is computer based

Kawamoto, BMJ, 2005
Translating Research into Practice

*What PECARN is doing…*

Implementation of the PECARN Traumatic Brain Injury Prediction Rules Using Electronic Health Record-Based Clinical Decision Support: *An Interrupted Time Series Trial*

Funded by the American Recovery and Reinvestment Act – Office of the Secretary: Grant #S02MC19289-01-00

PI – Peter Dayan, MD, MSc
Specific Aims

1. To develop and pilot test computer-based data collection and recommendation system to implement the PECARN TBI prediction rules for children with minor head trauma.

2. To assess whether this system decreases the number of (unnecessary) head CTs obtained by clinicians in the ED in children with minor blunt head trauma at very low risk of important brain injuries.

Methods

Computer-Based Decision Support Development and Pilot

♦ Perform focus groups
♦ Perform ED work flow assessments
♦ Develop EHR blunt head injury template
♦ Develop CDS
♦ Pilot testing
**Blunt Head Trauma Assessment**

**Methods – design**

**Interrupted Time Series Trial with Concurrent Controls**

- **Month of Trial**
  - Pre-intervention phase
  - Intervention implemented
  - Intervention maintained (post-intervention phase)
  - Main Comparisons: Pre to post int.

- **Intervention Group Measurement** (receives CDS)
  - Baseline rate of CT use
  - Post-intervention rate of CT use

- **Control Group Measurement** (standard of care)
  - Rate of CT use measured throughout the study period
Case

- 8 month-old falls 2 feet from a carrier
- No LOC
- On exam, acting normally
- Small forehead hematoma, tender at site

What are you going to do?
What about sharing decision-making with patients/parents/guardians?

The Head CT Choice Trial

Funded by a grant from the Patient Centered Outcomes Research Initiative (PCORI)

PI – Erik Hess, MD, MSc
Overview

◆ What is shared decision making?
◆ Why shared decision making?
◆ Why in pediatric minor head injury?

What is Shared Decision Making?

◆ Educating patients (parents) such that they are empowered to apply their values and preferences to management decisions

◆ Inviting patients (parents) to participate in decision making to the extent that they desire

◆ Coming to a consensus on the best management approach, such that risk-informed parental preferences are taken into consideration
What Shared Decision Making is Not

- Handing over the decision to the patient (parent) regardless of your professional opinion
- Primarily an effort to manage legal risk: it’s not about us, it’s about the patient

Why Shared Decision Making?

- Respect for autonomy
- Opportunity to rapidly develop rapport and meaningfully connect
Paternalistic

Shared Decision Making

Why Pediatric Head Injury?
Recommendations for children younger than 2

A

GCS=14 or other signs of altered mental status,  
or palpable skull fracture

Yes

CT recommended

13.9% of population
4.4% risk of cTBI

No

Occipital or parietal or temporal scalp haematoma,  
or history of LOC ≥ 5 s, or severe mechanism of injury; or not acting normally per parent

Yes

Observation versus CT on the basis of other clinical factors including:
- Physician experience
- Multiple versus isolated findings
- Worsening symptoms or signs after emergency department observation
- Age < 3 months
- Parental preference

32.9% of population
0.9% risk of cTBI

No

53.2% of population
<0.02% risk of cTBI

CT not recommended

Recommendations for children 2 years and older

B

GCS=14 or other signs of altered mental status,  
or signs of basilar skull fracture

Yes

CT recommended

14.0% of population
4.3% risk of cTBI

No

History of LOC, or history of vomiting, or severe  
mechanism of injury; or severe headache

Yes

Observation versus CT on the basis of other clinical factors including:
- Physician experience
- Multiple versus isolated findings
- Worsening symptoms or signs after emergency department observation
- Parental preference

28.8% of population
0.8% risk of cTBI

No

57.2% of population
<0.05% risk of cTBI

CT not recommended
Let’s talk about concussion and your child’s risk for more serious injury such as bleeding in or around the brain.

**Concussion**
- Traumatic movement within the skull
- Symptoms may include headache, nausea, dizziness, or difficulty concentrating
- Symptoms should resolve in several days to a few months
- Recovery is almost always complete
- Cannot be seen on a CT scan

**Brain Injury**
- In 100 children with minor head injury similar to your child: 1 will have brain injury and 99 will not
- Occurs when the head injury is severe enough to cause bleeding in or around the brain
- May require medical intervention such as a stay in the hospital or surgical procedure

**Head CT Choice Trial**

**Hypothesis:** Use of Head CT Choice will

- Significantly increase parents’ knowledge, engagement, and satisfaction
- Safely decrease the rate of head CT and 7-day healthcare utilization