Disclosure

- No financial relationships or conflict of interests related to this talk

Objectives

- Review the PECARN Traumatic Brain Injury (TBI) Prediction Rules derivation / validation
- Describe how PECARN is translating the TBI Prediction Rules into practice
- Describe the principles of shared decision-making and patient-centered outcomes in research and its application to the PECARN TBI Prediction Rules
Case

- 8 month-old falls 2 feet from a carrier
- No LOC, one episode of emesis
- 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., blunt head trauma 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)

Controversy over CT for Minor Blunt Head Trauma

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...
Controversy over CT for Minor Blunt Head Trauma

Arguments against liberal use of CT:

- Of the large number of children evaluated with CT after blunt head trauma, 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

- Imaging in pediatric head trauma high priority for AAP, NAM, 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
- CT radiation risks important from a public-health view
  - ~300,000 CTs for BHT, ~6 million pediatric CTs annually in U.S.

Reducing CT Radiation Exposure

- Age and size-based radiation-reduction efforts ongoing ("ALARA" principle)
- Creation/validation of large CT imaging rules
- Slowing of new indications of CT, improved awareness of guidelines, increased use of ultrasound (Arasu 2015)
- Feedback to physicians on test ordering, shared decision-making (Kanzaria 2015)
Pediatric Emergency Care Applied Research Network (PECARN)

Supported in full by Project #U03 MC00001-01 from the Maternal and Child Health Bureau, Health Resources and Services Administration, Department of Health and Human Services

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 ≥ 24 hours for head injury
- Positive CT in association with hospitalization ≥ 2 nights

Results

57,030 eligible
42,412 (78.3%)
11,749 (21.7%)

88 ciTBI (1.0%)

Enrolled
54,161 GCS 14-15
2,869 GCS <14 or other exclusion

Not enrolled

Validation
8,627

Derivation
33,785

86 ciTBI (1.2%)
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

![Diagram]

**Suggestions**
- Observation versus CT on the basis of other clinical factors including:
  - Physical examination
  - Multiple versus isolated findings
  - Worrisome symptoms or signs after emergency department observation
  - Age < 2 months
  - Parental preference

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6
Recommendations for children 2 years and older

What to do with Negative CT Scans

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

FINANCIAL/COMMERICAL RELEVANCE

John P. Hooten, MD, MPH; Elizabeth J. McGovern, DO, MPH; Stephen H. Kolber, MD, PhD; Lenora M. Quinonez, MD; Madeleine J. Delaney, MD; Shannon E. Jones, MD; Michelle B. Glickman, MD; Michael B. Roberts, MD; John A. Hooten, MD; Peter C. Jones, MD; John D. Reynolds, MD; and the NIH Study Group for the Provider: Emergency Care Against Head Injuries Network®
Observation Before CT Decisions

Isolated Clinical Findings

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

Challenges to Knowledge Translation using Computerized Algorithms  
*The human brain*

Shankar Vedantam (author of “The Hidden Brain” and NPR social science correspondent) and Berkeley Dietvorst (Wharton doctoral student)
- Even though algorithms typically outperform humans, we are distrustful of algorithms
- People fail to use algorithms even when they see it outperform humans
- Humans fear machines ("algorithmic aversion")

NPR Radio, February 3, 2015

Translating Research into Practice  
*What PECARN is doing...*
Specific Aims

1. To develop and pilot test a computer-based data collection and recommendation system to implement the PECARN TBI prediction rules.

2. To assess whether this system decreases the number of (unnecessary) head CTs in the ED in children 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

Case

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

What are you going to do?
# Methods – design

**Interrupted Time Series Trial with Concurrent Controls**

<table>
<thead>
<tr>
<th>Month of Trial</th>
<th>Pre-intervention phase</th>
<th>Intervention implemented</th>
<th>Intervention maintained (post-intervention phase)</th>
<th>Main Comparisons: Pre to post int.</th>
</tr>
</thead>
</table>

**Intervention Group Measurement (includes 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

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### What about sharing decision-making with patients/parents/guardians when the decision is not clear?

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### The Head CT Choice Trial

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

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

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 the clinician, it's about the patient
Why Do Shared Decision Making?

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

Paternalistic

Shared Decision Making

Why Pediatric Head Trauma?
Recommendations for children younger than 2

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

  - CT recommended

  - Observation versus CT on the basis of other clinical factors including:
    - Physical examination
    - History of LOC, history of vomiting, or severe mechanism of injury
    - Age ≤ 1 year
    - Parental preference

- Occipital or parietal or temporal scalp hematoma or history of LOC ≤ 14, or severe mechanism of injury, or radiological abnormality

  - No: 53.2% of population
  - Yes: 0.8% risk of CBI

  - CT not recommended

Recommendations for children 2 years and older

- History of LOC, history of vomiting, or severe mechanism of injury

  - No: 4.9% of population
  - Yes: 0.1% risk of CBI

  - Observation versus CT on the basis of other clinical factors including:
    - Physician's examination
    - History of vomiting
    - Worsening symptoms or signs after emergency department observation
    - Parental preference

- CT recommended
Head CT Choice Trial

- Hypothesis: Use of Head CT Choice will
  - Significantly increase parents’ knowledge, engagement, and satisfaction
  - Safely decrease the rate of CT and 7-day healthcare utilization

Conclusion

- Limiting inappropriate imaging a priority in EM
- Requires generating/validating definitive evidence
- Requires dissemination and implementation at the point of patient care, with minimal interruption
- Shared decision-making appropriate when the decision is not clear