Incorporating PECARN for mTBI

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• NO FINANCIAL COI
Objectives

• 1-Understanding PECARN
• 2-How to use PECARN in mTBI
• 3-Why PECARN, not CATCH or CHALICE
• 4-CDC incorporates PECARN into evaluation and treatment of minor TBI(JAMA Peds, 2018)
• 5-Be able to define a mTBI
• 6-Define the scope of this illness.
mild TBI

• CDC has adopted this name
• Maybe not the best way to discuss with parents??
• OK to stick with concussion!
context/classification

• TBI a leading cause of Morbidity & Mortality
HI context

- 600,000 HI’s USA/yr in kids
- 10%/60,000 $\rightarrow$ hospitalized
- 1%/6,000 $\rightarrow$ death
- 90%/540,000 will do fine

All ages $\rightarrow$ 4 million sports/rec related concussions/yr USA
HI Peds GCS

• Eyes: spont-4; speech-3; pain-2; none-1
• Verbal: coos-5; cries/consolable-4; cries/pain-3; moans pain2; none-1
• Motor: spontan-6; WD touch-5; WD pain-4; abnl flex-3; abnl ext-2; none-1
Dealing with the 540,000
mTBI

• Risk stratification use of CDIs
• CATCH who needs CT
• CHALICE who needs CT
• PECARN who doesn’t need a CT
CDI’s

• CATCH-Canadian Assessment for Tomography in Childhood Head injury
• CHALICE-Childhood Head injury ALgorithm for the prediction of Important Clinical Events
• PECARN-Pediatric Emergency Care Applied Research Network
CATCH-Osmond et al

- Designed to determine need for Head CT
- 3866 pts, age <16; 2010
- Secondarily evaluated scalp hematomas
- All but frontal, > 3 cm, boggy \(\rightarrow\) assoc with ci HI
<table>
<thead>
<tr>
<th>High &amp; Mod risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CATCH Predictors for Clinically Significant TBI</strong></td>
</tr>
<tr>
<td>GCS Less than 15 at 2 hours post trauma</td>
</tr>
<tr>
<td>Suspected open or depressed skull fracture</td>
</tr>
<tr>
<td>History of worsening headache</td>
</tr>
<tr>
<td>Irritability on exam</td>
</tr>
<tr>
<td>Any Sign of Basal Skull Fracture</td>
</tr>
<tr>
<td>Large, boggy scalp hematoma</td>
</tr>
<tr>
<td>Dangerous mechanism of injury defined as MVC, fall from &gt; 3 ft or 5 stairs, fall from bicycle with no helmet</td>
</tr>
</tbody>
</table>
CATCH

• For any high risk factor-100% predictive for neurosurgical intervention

• For any moderate risk factor-98.1% Sensitive for predicting ci TBI on CT
CHALICE-Dunning et al

- Also designed to see who needs Head CT
- Less sensitivity than PECARN
- Age inclusive to <16, all HIs, 2006
- Prospective multicentre cohort study-2006
- 22,772 kiddos
| History | Witnessed LOC > 5min  
History of Amnesia > 5 min duration  
Abnormal drowsiness  
≥ 3 vomits after head injury  
Suspicion of non-accidental injury  
Seizure after head injury in a patient with no history of epilepsy |
|---|---|
| Exam | GCS < 14 or GCS < 15 in a patient under 1 year of age  
Suspicion for penetrating or depressed skull injury or tense fontanelle  
Signs of Basal skull fracture  
Presence of a bruise, swelling, or laceration > 5 cm if < 1 year old |
| Mechanism | High speed accident (> 40 mph) as either a pedestrian, cyclist, or occupant  
Fall > 3 m  
High speed injury from projectile or object |
CHALICE

• Any one of predictors present $\rightarrow$ CT
• Sens-98% for detection of ci TBI
• Spec-87%
PECARN

- 42,000 pts (derivation and validation cohorts)
- Isolated LOC $\rightarrow$ low rate ci TBI (0.5%)
- Isolated emesis $\rightarrow$ ci TBI less common with V
- Isolated HA $\rightarrow$ ci TBI did not occur in any
- Isolated severe MOI $\rightarrow$ ci TBI 0.8%
- Divided into two age groups; <2 and 2-18
PECARN ci TBI

- Death
- Neurosurgery intervention
- Intubated > 24 hours
- Admission >2 nights
PECARN severe MOI

- Rollover MVC
- Pt ejection
- Death of another in MV
- Pedestrian struck by MV
- Nonhelmeted bicyclist struck by MV
- Fall >3 ft $\rightarrow$ <2 yrs
- Fall >5 ft $\rightarrow$ 2-18 yrs
- Head struck by high impact object
What is PECARN?

• Country divided into 7 regional research nodes, based out of 7 academic medical centers

• Collection of data from multiple institutions in prospective cohort trials

• Began in 2001; low risk head injury one of the studies from PECARN

• 2004-2006-data for low risk HI collected

• 2009-Nathan Kuppermann publishes his derivation and validation studies in Lancet 2009
CDC adopts 2018
Lumba-Brown, A et al.


JAMA Pediatr. 2018 Nov 1;172(11):e182853. PMID: 30193284
PECARN
Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study.

PECARN

- 42,412 pts, multicentre prospective cohort
- 33,785 derivation cohort (8,502 <2 yrs and 25,283 2-18 yrs old)
- 8,627 validation cohort (2,216 < 2 yrs and 6411 2-18 yrs)
PECARN Exclusions

- Trivial mechanism of injury
- Penetrating trauma
- Known brain tumor
- Pre-existing neuro disorder
- Any neuro-imaging from an outside hospital
PECARN low risk HI rule

• <2 years...8,502 pts
  • 1-AMS
  • 2-scalp hematoma
  • 3-LOC> 5 seconds
  • 4-Severe mechanism
  • 5-Palpable skull fx
  • 6-Abnormal behavior per parent(s)

• 2 - 18 years...25,283 pts
  • 1-AMS
  • 2-LOC
  • 3-Hx emesis
  • 4-Clin signs basilar skull fx
  • 5-severe mechanism
  • 6-severe HA
PECARN

• <2 yrs
  • No risk factor
  • Risk of ci TBI - <0.02%

• 2-18 yrs
  • No risk factor
  • Risk of ci TBI < 0.05%
  • Missed 2/3698 with no risk factor
• What was the clinically important TBI??

• 1-death
• 2-NSG intervention
• 3-intubation due to TBI
• 4-admission for >2 nights due to TBI on CT
<table>
<thead>
<tr>
<th>Predictor</th>
<th>Risk of Clinically Significant TBI</th>
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<tbody>
<tr>
<td>GCS ≤ 14</td>
<td>4.4%</td>
</tr>
<tr>
<td>Altered Mental Status</td>
<td></td>
</tr>
<tr>
<td>Palpable skull fracture</td>
<td></td>
</tr>
<tr>
<td>Scalp hematoma</td>
<td>0.9%</td>
</tr>
<tr>
<td>Severe Mechanism</td>
<td></td>
</tr>
<tr>
<td>LOC for more than 5 seconds</td>
<td></td>
</tr>
<tr>
<td>Abnormal behavior per parent</td>
<td></td>
</tr>
<tr>
<td>No predictors present</td>
<td>&lt;0.02%</td>
</tr>
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<tr>
<td>-----------------------------------</td>
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<tr>
<td>GCS ≤ 14</td>
<td>4.3%</td>
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<tr>
<td>Altered Mental Status</td>
<td></td>
</tr>
<tr>
<td>Signs of basilar skull fracture</td>
<td></td>
</tr>
<tr>
<td>LOC</td>
<td>0.8%</td>
</tr>
<tr>
<td>History of Vomiting</td>
<td></td>
</tr>
<tr>
<td>Severe headache</td>
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<td>Severe Mechanism</td>
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<td>No predictors present</td>
<td>&lt;0.05%</td>
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PECARN
PECARN

- <2 yrs
  - High risk
    GCS<14, AMS, palpable skull fx
  - Moderate risk
    Scalp hematoma, severe MOI, LOC>5 seconds, abnormal behavior
  - Low risk
    No predictors

- Risk ci TBI
  - 4.4% → CT

- 0.9% → +/- CT vs obs

- <0.02%
PECARN

- 2-18 yrs
- High risk
  GCS<14, AMS, Signs basilar skull fx
- Moderate Risk
  LOC, Hx vomiting, severe HA, severe MOI
- Low Risk
  No predictors

- Risk ci TBI
  4.3% → CT

- 0.8% → +/- CT vs obs

- <0.05% → no CT
PECARN

• Whether original or subsequent validation studies PECARN consistently approaches 100% sensitivity
Pediatric Emergency Care Applied Research Network head injury clinical prediction rules are reliable in practice.

Schonfeld D1, Bressan S, Da Dalt L, Henien MN, Winnett JA, Nigrovic LE.
Schonfeld et al

• External validation of PECARN
• 2 PEM Depts, 1 USA and 1 Italy
• 2439 pts, applied PECARN
• Sensitivity 100%...Spec 55%, NPV 100%
Validation of the PECARN clinical decision rule for children with minor head trauma: a French multicenter prospective study.

Lorton et al, 2016

• External validation, multicentre, prospective cohort study
• 1499 kids <16
• GCS 14-15
• 3 EDs
• S-100%, Sp-69.9%, NPV 100%

Babl et al, 2017

• Prospective cohort
• 20,137 kids, <18
• HI of any severity
Babl, et al 2017

• PECARN $\rightarrow$ 100% Sensitivity(<2); 99%(2-18)

• CATCH $\rightarrow$ 95% Sensitivity

• CHALICE $\rightarrow$ 92.3% Sensitivity

Easter JS1, Bakes K2, Dhaliwal J3, Miller M3, Caruso E2, Haukoos JS4
Easter et al

- Single center study, out of Denver
- 1009 pts
<table>
<thead>
<tr>
<th>Decision Rule</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
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<tbody>
<tr>
<td>PECARN</td>
<td>100%</td>
<td>62%</td>
</tr>
<tr>
<td>CHALICE</td>
<td>84%</td>
<td>85%</td>
</tr>
<tr>
<td>CATCH</td>
<td>91%</td>
<td>44%</td>
</tr>
<tr>
<td>Physician Judgement</td>
<td>95%</td>
<td>68%</td>
</tr>
<tr>
<td>Physician CT Practices</td>
<td>100%</td>
<td>50%</td>
</tr>
</tbody>
</table>
Conclusion

• Several CDIs available for us to use
• PECARN, CATCH, CHALICE-most studied
• PECARN-who doesn’t need a head CT
• PECARN-only CDI to approach 100%
• PECARN adopted by CDC
• These ‘rules’, instruments should not supersede physician judgement
The End