Head Injury CT Scan Quality and Safety

Shireen M. Atabaki, MD, MPH
ED Faculty
THIS IS WHERE THE VIDEO GOES
Local Problem
National Pediatric Concussion and CT Data

• Most frequent diagnosis for injured child is: HEAD INJURY
• Each year in the US:
  – 5 million children
  – Over 1 million ED visits
• 4 million pediatric CTs
  – 20 fold increase 1995-2003

Faul M, Centers for Disease Control, 2010
National Pediatric Concussion and CT Radiation

• Risks of lethal malignancies
  – Cranial CT = 100 x radiation of CXR
  – CT in 1st 22 yrs of life = 300% increase in lifetime cancer
  – 1/1100 infants w/ lethal malignancies

• NCI and FDA issued warnings in 2001

Pearce et al., Lancet, 2012
Evidence Based Medicine: Maternal Child Health Bureau Funded Study at CNHS

By Steve Stemberg, USA TODAY

Each year, about 1.6 million children in the USA get CT scans abdomen — and about 1,500 of those will die later in life of rad cancer, according to research out today.
Evidence Based Medicine CDS for Concussion and CT

- 2009 PECARN CT Decision Rules
- 44,000 children
- CDS to detect clinically important injury in the brain
  - 99.9% Negative Predictive Value

Kuppermann et al., Lancet, 2009
CNMC Concussion CT Scan
Pre-Implementation Data

• CT rates 30%
• 1954 head CTs between 2008 & 2009
• 939 with concussion
• Over 92% of CT scans were normal
• Percentage did not improve 2009-11
• Traditional KT is slow – 10-13 years
• 10 fold variation btw Providers in CT
How Health IT was Utilized
Health IT Optimization for Concussion Care

- Effective Use of Clinical Data
- Agile Research
- Evidence Based Medicine
- Health IT
- Patient Care
- Improved Outcomes
- Cost Reduction
- Radiation Reduction
Clinical Decision Rule for Head CT

**Age**
- [ ] < 2 years
- [ ] 2 years or older

**Risk Criteria**

**GCS**
- [ ] 15
- [ ] 14 or below

**Mental Status**
- [ ] Normal
- [ ] Altered

**Basilar Skull Fracture**
- [ ] Yes
- [ ] No

**Palpable Skull Fracture**
- [ ] Yes
- [ ] No

**Severe Headache**
- [ ] Yes
- [ ] No

**Examples of Severe Mechanism of Injury:**
1. Motor vehicle crash with patient ejection
2. Death of another passenger
3. Rollover
4. Pedestrian or bicyclist without helmet struck by a motorized vehicle
5. Falls more than 0.9 m (3 feet) for children < 2 years
6. Falls more than 1.5 m (5 feet) for children 2 years or older
7. Head struck by a high impact object

**Loss of Consciousness (LOC)**
- [ ] Yes
- [ ] No

**Loss of Consciousness (LOC) 5 sec. or more**
- [ ] Yes
- [ ] No

**Vomiting**
- [ ] Yes
- [ ] No

**Occipital or Parietal or Temporal Scalp Hematoma**
- [ ] Yes
- [ ] No

**Acting Abnormal per Parent**
- [ ] Yes
- [ ] No

**Severe Mechanism of Injury**
- [ ] Yes
- [ ] No

**CT Recommendations:**
- [ ] Low Risk - CT not recommended
- [ ] Intermediate risk: Consider observation or CT based on clinical judgment
- [ ] High Risk - CT recommended
CT Algorithm for children with GCS Scores of 14-15 after head trauma

For patients < 2 years old

A

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS=14 or other signs of altered mental status or palpable skull fracture</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>CT recommended</td>
</tr>
<tr>
<td></td>
<td>13.9% of population 4.4% risk of dTBI</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Occipital or parietal or temporal scalp haematoma, or history of LOC &gt; 5 s, or severe mechanism of injury; or not acting normally per parent</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Observation versus CT on the basis of other clinical factors including:</td>
</tr>
<tr>
<td></td>
<td>• Physician experience</td>
</tr>
<tr>
<td></td>
<td>• Multiple versus isolated findings</td>
</tr>
<tr>
<td></td>
<td>• Worsening symptoms or signs after emergency department observation</td>
</tr>
<tr>
<td></td>
<td>• Age &lt; 3 months</td>
</tr>
<tr>
<td></td>
<td>• Parental preference</td>
</tr>
<tr>
<td></td>
<td>32.6% of population 0.9% risk of dTBI</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>53.5% of population 0.0% risk of dTBI</td>
</tr>
<tr>
<td></td>
<td>CT not recommended</td>
</tr>
</tbody>
</table>

For patients ≥ 2 years old

B

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS=14 or other signs of altered mental status or signs of basilar skull fracture</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>CT recommended</td>
</tr>
<tr>
<td></td>
<td>14.0% of population 4.3% risk of dTBI</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>History of LOC, or history of vomiting, or severe mechanism of injury; or severe headache</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Observation versus CT on the basis of other clinical factors including:</td>
</tr>
<tr>
<td></td>
<td>• Physician experience</td>
</tr>
<tr>
<td></td>
<td>• Multiple versus isolated findings</td>
</tr>
<tr>
<td></td>
<td>• Worsening symptoms or signs after emergency department observation</td>
</tr>
<tr>
<td></td>
<td>• Parental preference</td>
</tr>
<tr>
<td></td>
<td>27.7% of population 0.9% risk of dTBI</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>52.3% of population &lt; 0.05% risk of dTBI</td>
</tr>
<tr>
<td></td>
<td>CT not recommended</td>
</tr>
</tbody>
</table>
Governance Design Implementation
Governance

• Goal

  Patient Safety  
  Quality Improvement  
  Evidence Based Medicine

  Health IT

  Best Concussion Care

• **Goal**: Decrease % of children with concussion who had a head CT ordered in our Emergency Departments.

• **Team**
  – SMEs in ED/Trauma/ Nursing/ IT/ Education
  – Project Manager
  – Analyst
  – Project Architect
Pre-implementation Data

• Head CTs Performed (7/1/08 – 6/30/09) = 1,954
• Concussion = 939
• Normal head CT rate: 92.4%
• 10-fold difference PPV of CT order: 4% to 48%

Bar graph showing the proportion of head injury patients with head CTs, with a note of large variation between providers.
Implementation Approach

• Multidisciplinary team worked on design, testing & implementing the CDS rules into the EHR workflow

• Wide spread education
  – Web based training
  – Classroom
  – At the elbow support
Previous Process

Provider assesses patient

Uses clinical judgment to determine if CT needed

NO

This process resulted an approximately 10 fold difference of head CTs in the Emergency Department

YES

Provider enters CT scan order

CT scan performed

Provider reviews results in EHR

Stop
Value Derived
Outcomes: Radiation & Cost Reduction

- **Radiation Reduction:**
  - 44% relative reduction in CT scan rate
    Pre: 1000 (27%) to Post: 444 (11.9%)

- **Cost Reduction:**
  - 556 avoided head CT scans
  - $875,144 cost reduction per year
  - No untoward outcomes

Atabaki, Jacobs et al., Ped Quality & Safety, 2017
Proportion of Concussion Patients with CT

Intervention

\[ y = -0.0138x + 0.258 \]
\[ R^2 = 0.7621 \]

\[ y = 0.0002x + 0.2394 \]
\[ R^2 = 0.0002 \]

November 10, 2010 to December 11, 2011
Outcomes Data

October 4, 2017
Benchmarking Feedback to Physicians

EHR data mined for rates of head CT pre and post intervention

Used CPOE decision rule to identify children at very low risk of clinically important concussion who do not require head CT

Feedback to Providers on overall head CT reduction

![Graph showing proportion of TBI patients with CT performed over time with an intervention point]

\[ y = 0.0002x + 0.2394 \]
\[ R^2 = 0.0002 \]

\[ y = -0.0136x + 0.268 \]
\[ R^2 = 0.7621 \]
Future Advancement
Goal #1: Harness Health IT for Knowledge Translation for Other Diseases

Abdominal CT
• Abdominal trauma
• Appendicitis

Head CT
• Headache
• Seizure
• VP shunt

Holmes et al., Annals Emerg Med, 2013
Goal #2: Harnessing Health IT for Knowledge Translation to Improve Quality and Reduce Costs

- EBM models can be transferred across EHRs
- City wide collaboration
- National and International EBM dissemination
- Provider education strategies

Meaningful Use in Oklahoma & the District of Columbia, AHRQ 2015
Ongoing CNMC Concussion Research

• CDC Funded Project
  – Created effective diagnostic tools for ED
  – Created education for outpatient
  – Communication to school and PCP
  – Improve Outcomes

CDC Grant 1U49CE001385-01

Zuckerbraun, Atabaki, Collins, Gioia et al, Pediatrics, 2015
Mobile App for Patients and Families

• Developed a mobile health solution that communicates via the EHR to the concussion screening information
  – Allows for patients to beRxed mobile App and go home with a concussion check list and daily reminders
  – Provides secure communication with the patient’s school nurse and primary care physician