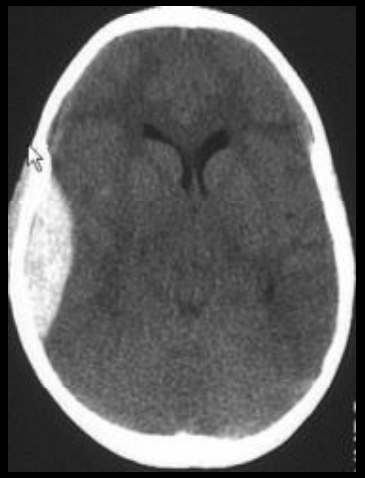
The PECARN Traumatic Brain Injury Prediction Rule Study

What have we learned?



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Sociedad Española de Urgencias de Pediatría
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Disclosure

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

Objectives

In 15 minutes…

- To describe the risks of serious brain injuries after minor blunt head trauma in children
- To describe the indications, risks, and benefits of computed tomography (CT) scanning
- To review the PECARN Traumatic Brain Injury study, and key sub-studies resulting from this work

Case

- 6 year-old falls 1 meter from a ladder
- 10 second loss of consciousness
- On exam, awake and alert
- 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…*

Controversy over CT for Minor BHT

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.

Pediatric Emergency Care Applied Research Network (PECARN)

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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

PECARN
Pediatric Emergency Care Applied Research Network

The PECARN Head Injury Study

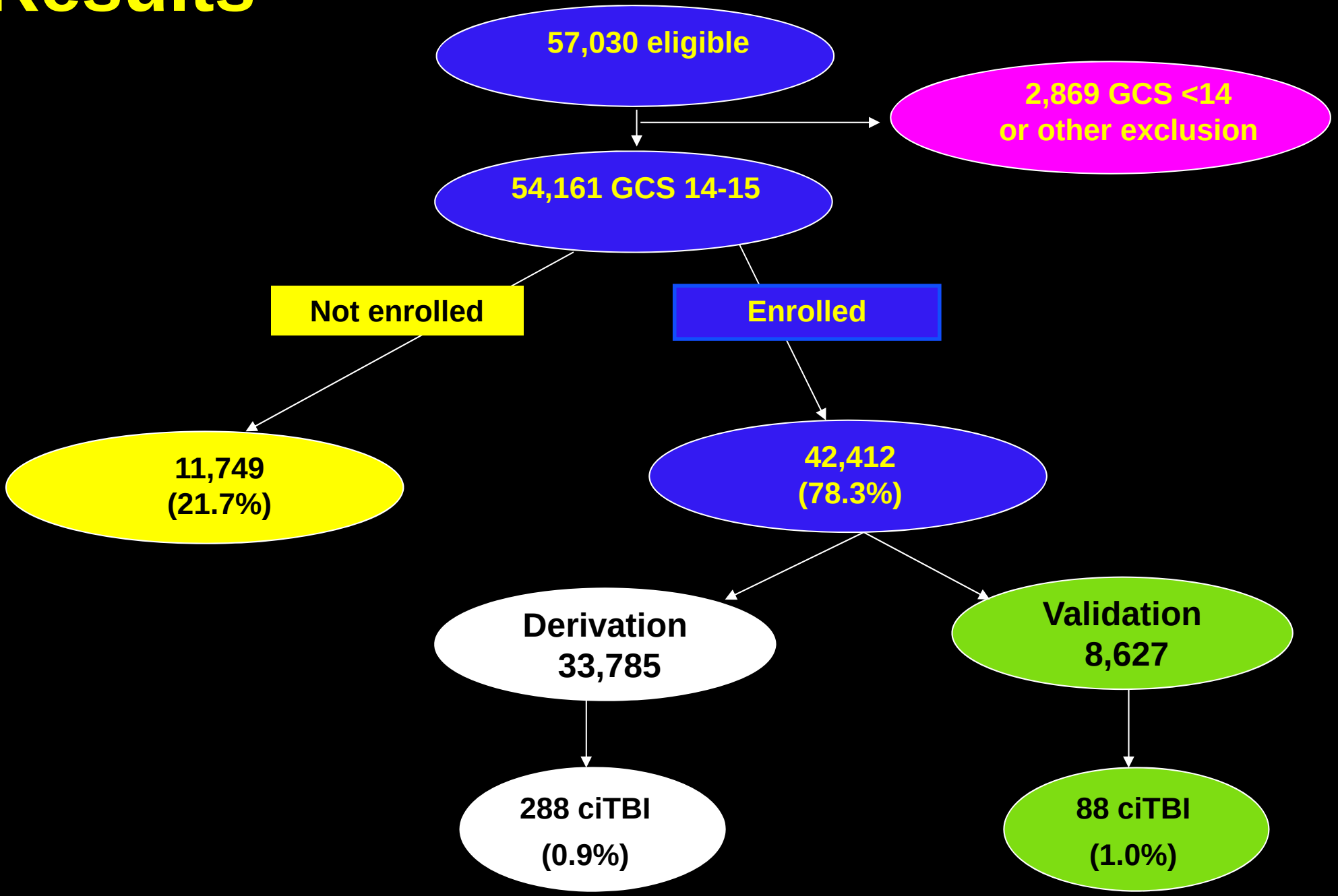
Goal: to derive a clinical decision rule to accurately identify children at near zero risk of clinically important traumatic brain injury after blunt trauma with high accuracy and wide generalizability

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
2,869 GCS <14
or other exclusion
54,161 GCS 14-15
Not enrolled
Enrolled
11,749
(21.7%)
42,412
(78.3%)
Derivation
33,785
Validation
8,627
288 ciTBI
(0.9%)
88 ciTBI
(1.0%)

Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study

*Nathan Kuppermann, James F Holmes, Peter S Dayan, John D Hoyle, Jr, Shireen M Atabaki, Richard Holubkov, Frances M Nadel, David Monroe, Rachel M Stanley, Dominic A Borgialli, Mohamed K Badawy, Jeff E Schunk, Kimberly S Quayle, Prashant Mahajan, Richard Lichenstein, Kathleen A Lillis, Michael G Tunik, Elizabeth S Jacobs, James M Callahan, Marc H Gorelick, Todd F Glass, Lois K Lee, Michael C Bachman, Arthur Cooper, Elizabeth C Powell, Michael J Gerardi, Kraig A Melville, J Paul Muizelaar, David H Wisner, Sally Jo Zuspan, J Michael Dean, Sandra L Wootton-Gorges, for the Pediatric Emergency Care Applied Research Network (PECARN)**

Lancet 2009; 374: 1160–70
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See Comment page 1127
*Members listed at end of paper

Summary

Background CT imaging of head-injured children has risks of radiation-induced malignancy. Our aim was to identify children at very low risk of clinically-important traumatic brain injuries (ciTBI) for whom CT might be unnecessary.

Methods We enrolled patients younger than 18 years presenting within 24 h of head trauma with Glasgow Coma Scale scores of 14–15 in 25 North American emergency departments. We derived and validated age-specific prediction rules for ciTBI (death from traumatic brain injury, neurosurgery, intubation >24 h, or hospital admission ≥2 nights).

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:

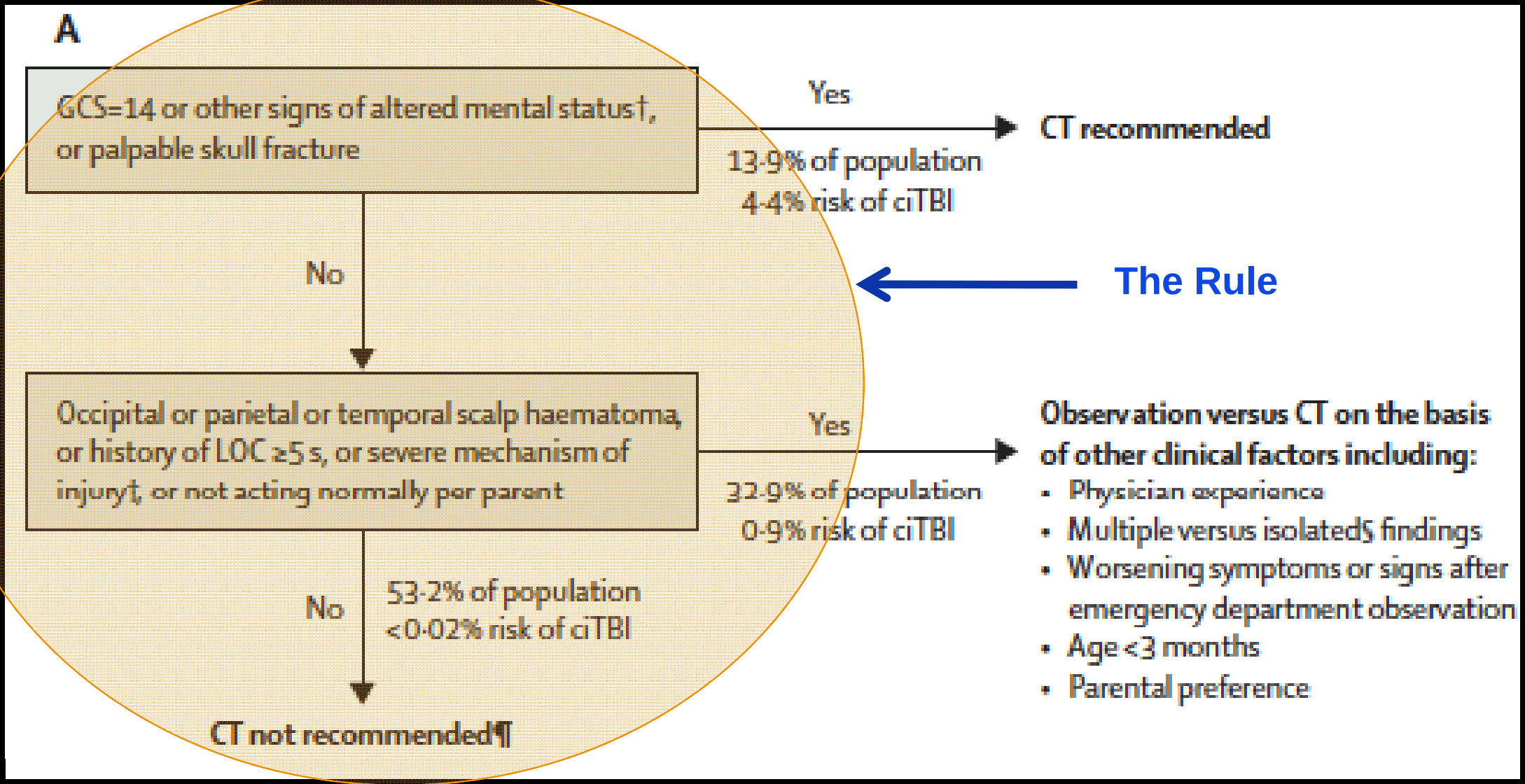
Children < 2 years

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

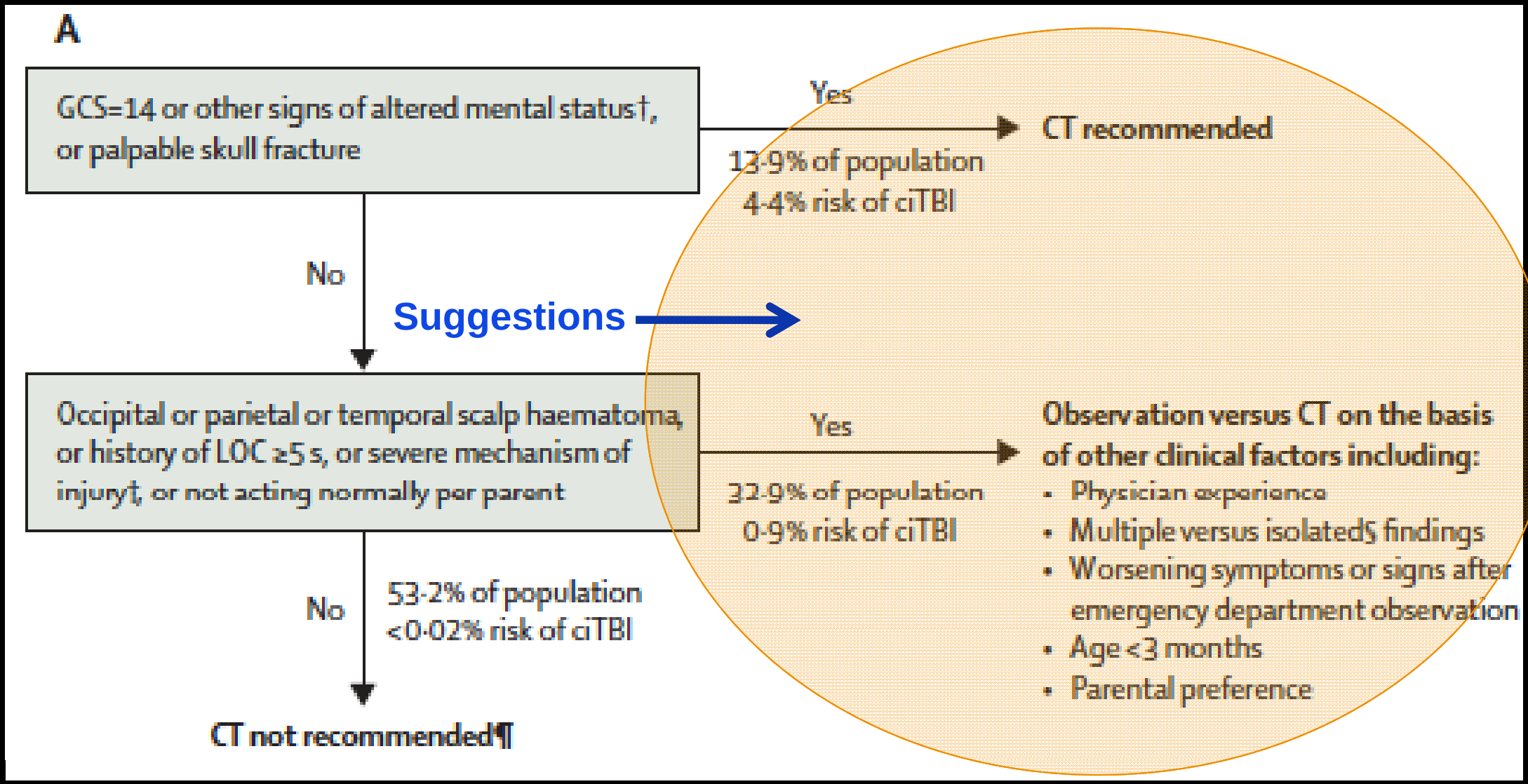
Children 2-18 years

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

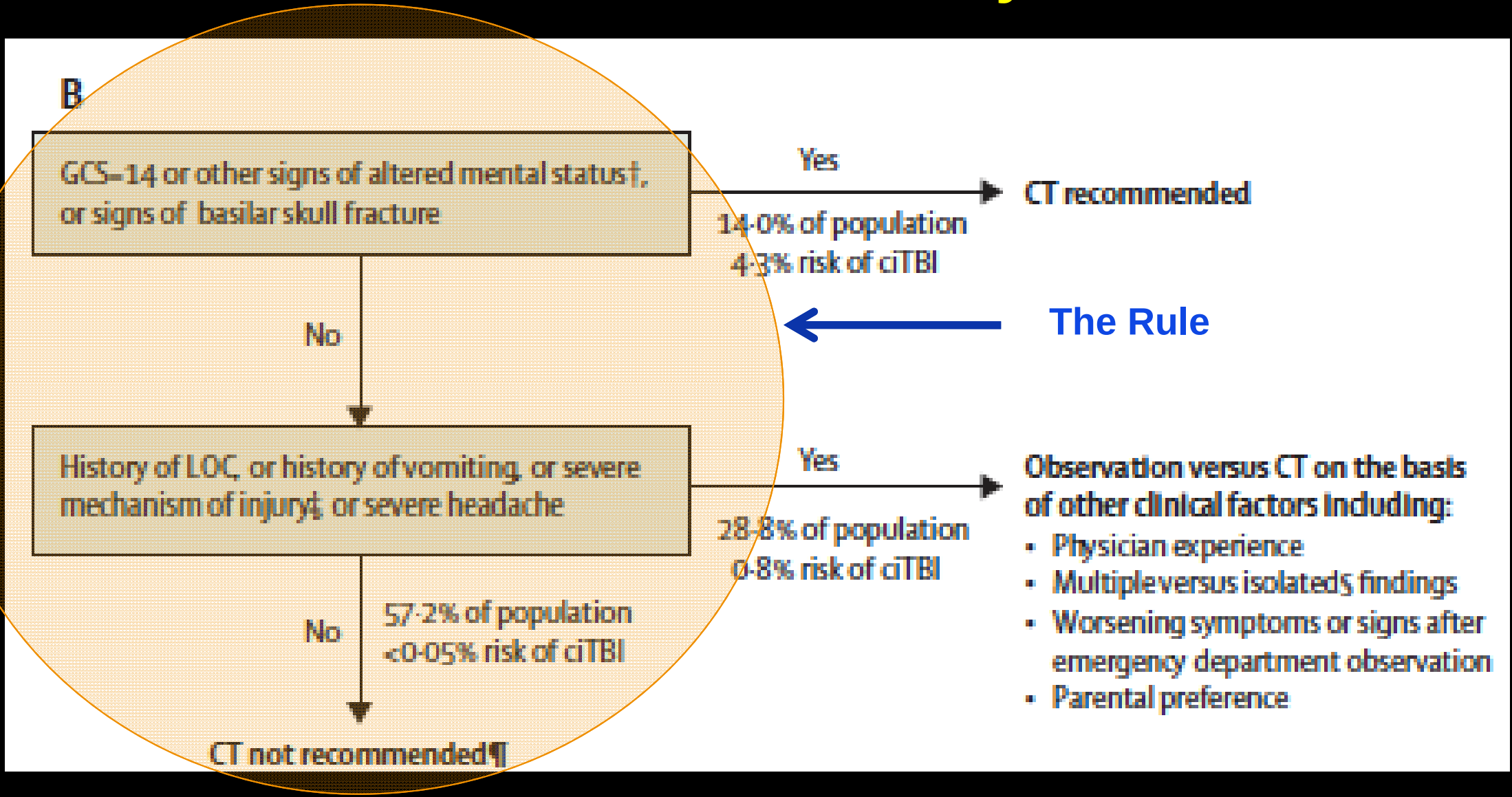
Recommendations for children younger than 2



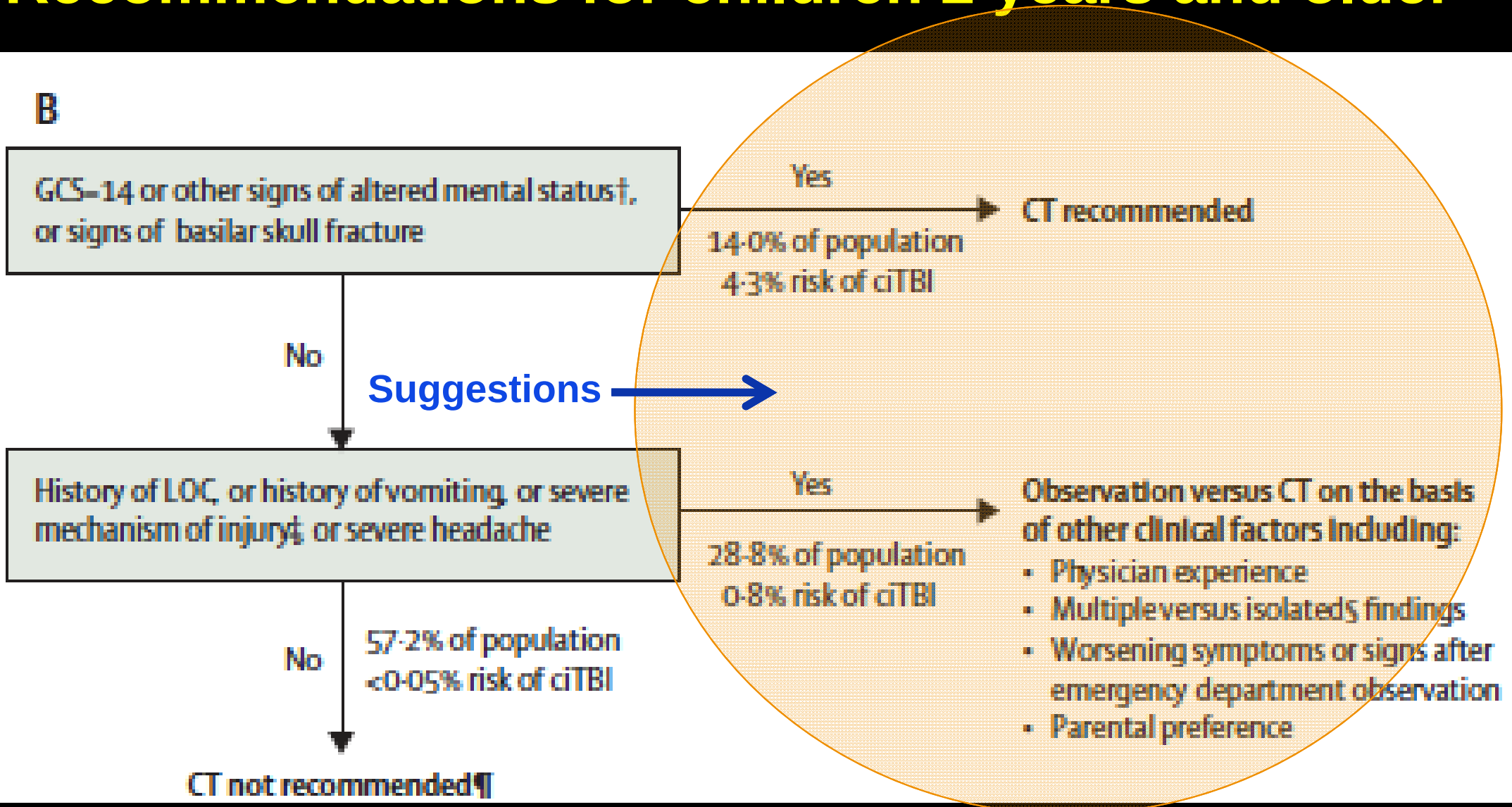
Recommendations for children younger than 2



Recommendations for children 2 years and older



Recommendations for children 2 years and older



Negative CT Scans

PEDIATRICS/ORIGINAL RESEARCH

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

James F. Holmes, MD, MPH, Dominic A. Borgialli, DO, MPH, Frances M. Nadel, MD, MSCE, Kimberly S. Quayle, MD, Neil Schambam, MD, Art Cooper, MD, Jeff E. Schunk, MD, Michelle L. Miskin, MS, Shireen M. Atabaki, MD, MPH, John D. Hoyle, MD, Peter S. Dayan, MD, MSc, Nathan Kuppermann, MD, MPH, and the TBI Study Group for the Pediatric Emergency Care Applied Research Network*

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 (Borgialli); 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 (Quayle); the Departments of Emergency Medicine and Pediatrics, Newark Beth Israel Medical Center, Newark, NJ (Schambam); 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 (Schunk) and PECARN Central Data Management and Coordinating Center, University of Utah, Salt Lake City, UT (Miskin); the Departments of Pediatrics and Emergency Medicine, The George Washington University School of Medicine, Washington, DC (Atabaki); the Department of Emergency Medicine, Michigan State University School of Medicine/Helen DeVos Children's Hospital, Grand Rapids, MI (Hoyle); the Department of Pediatrics, Columbia University College of Physicians and Surgeons, New York, NY (Dayan); 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

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KEY WORDS

traumatic brain injury, computed tomography, clinical observation

WHAT'S KNOWN ON THIS SUBJECT: Emergency-department observation of children with minor blunt head trauma for symptom progression before making a decision regarding computed tomography may decrease 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 overall cranial computed tomography use after adjusting for markers of head injury severity.

abstract

FREE

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

Isolated Clinical Findings

outcomes

ARTICLE

ONLINE FIRST

Prevalence of Clinically Important Traumatic Brain Injuries in Children With Minor Blunt Head Trauma and Isolated Severe Injury Mechanisms

Lise E. Nigrovic, MD, MPH; Lois K. Lee, MD, MPH; John Hoyle, MD; Rachel M. Stanley, MD; Marc H. Gorelick, MD; Michelle Miskin, MS; Shireen M. Atabaki, MD; Peter S. Dayan, MD, MSc; James F. Holmes, MD, MPH; Nathan Kuppermann, MD, MPH; for the Traumatic Brain Injury (TBI) Working Group of the Pediatric Emergency Care Applied Research Network (PECARN)

PEDIATRICS/ORIGINAL RESEARCH

Risk of Traumatic Brain Injuries in Children Younger than 24 Months With Isolated Scalp Hematomas

Peter S. Dayan, MD, MSc; James F. Holmes, MD, MPH; Sara Schutzman, MD; Jeffrey Schunk, MD; Richard Lichenstein, MD; Lillian A. Foerster, MD; John Hoyle Jr, MD; Shireen Atabaki, MD, MPH; Michelle Miskin, MS; David Wisner, MD; SallyJo Zuspan, RN, MSN; Nathan Kuppermann, MD, MPH; for the Traumatic Brain Injury Study Group of the Pediatric Emergency Care Applied Research Network (PECARN)*

PEDIATRICS/ORIGINAL RESEARCH

Association of Traumatic Brain Injuries With Vomiting in Children With Blunt Head Trauma

Peter S. Dayan, MD, MSc; James F. Holmes, MD, MPH; Shireen Atabaki, MD, MPH; John Hoyle Jr, MD; Michael G. Tunik, MD; Richard Lichenstein, MD; Elizabeth Alpern, MD, MSCE; Michelle Miskin, MS; Nathan Kuppermann, MD, MPH; for the Traumatic Brain Injury Study Group of the Pediatric Emergency Care Applied Research Network (PECARN)*

Research

Original Investigation

Isolated Loss of Consciousness in Children With Minor Blunt Head Trauma

Lois K. Lee, MD, MPH; David Monroe, MD; Michael C. Bachman, MD; Todd F. Glass, MD; Prashant V. Mahajan, MD, MPH, MBA; Arthur Cooper, MD; Rachel M. Stanley, MD, MHSA; Michelle Miskin, MS; Peter S. Dayan, MD, MSc; James F. Holmes, MD, MPH; Nathan Kuppermann, MD, MPH; for the Traumatic Brain Injury (TBI) Working Group of the Pediatric Emergency Care Applied Research Network (PECARN)

Headache in Traumatic Brain Injuries From Blunt Head Trauma

Peter S. Dayan, MD, MSc[a], James F. Holmes, MD, MPH[b], John Hoyle Jr, MD[c,d,e,f], Shireen Atabaki, MD, MPH[g,h], Michael G. Tunik, MD[i,j], Richard Lichenstein, MD[k], Michelle Miskin, MS[l], Nathan Kuppermann, MD, MPH[b,m], for the Pediatric Emergency Care Applied Research Network (PECARN)

Racial and Ethnic Disparities

ARTICLE

Cranial Computed Tomography Use Among Children With Minor Blunt Head Trauma

Association With Race/Ethnicity

JoAnne E. Natale, MD, PhD; Jill G. Joseph, MD, PhD; Alexander J. Rogers, MD; Prashant Mahajan, MD, MPH, MBA; Arthur Cooper, MD; David H. Wisner, MD; Michelle L. Miskin, MS; John D. Hoyle Jr, MD; Shireen M. Atabaki, MD, MPH; Peter S. Dayan, MD, MSc; James F. Holmes, MD, MPH; Nathan Kuppermann, MD, MPH; for PECARN (Pediatric Emergency Care Applied Research Network)

Incidental CT findings

Incidental Findings in Children With Blunt Head Trauma Evaluated With Cranial CT Scans

WHAT'S KNOWN ON THIS SUBJECT: The evaluation of blunt head trauma in children who undergo cranial computed tomography will occasionally reveal incidental findings. These findings may require further evaluation or intervention. The prevalence of incidental findings has previously been described using small cohorts, limiting generalizability.

WHAT THIS STUDY ADDS: This study is the largest pediatric multicenter description of the prevalence of incidental findings on cranial computed tomography. Incidental findings are categorized by urgency to describe the spectrum of abnormalities, providing a context for clinicians faced with these unexpected results.

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abstract

Case

- 6 year-old falls 1 meter from a ladder
- 10 second loss of consciousness
- On exam, alert and awake
- Small forehead hematoma, tender at site

What are you going to do?