Evidence Generation to Knowledge Translation: The PECARN Head Injury Story

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Disclosures

- **No Conflicts of Interest**

  Peter Dayan denies any conflicts of interest in relation to this continuing education activity.

- **No Commercial Support**

  Peter Dayan declares that there is no commercial support related to this continuing educational activity.

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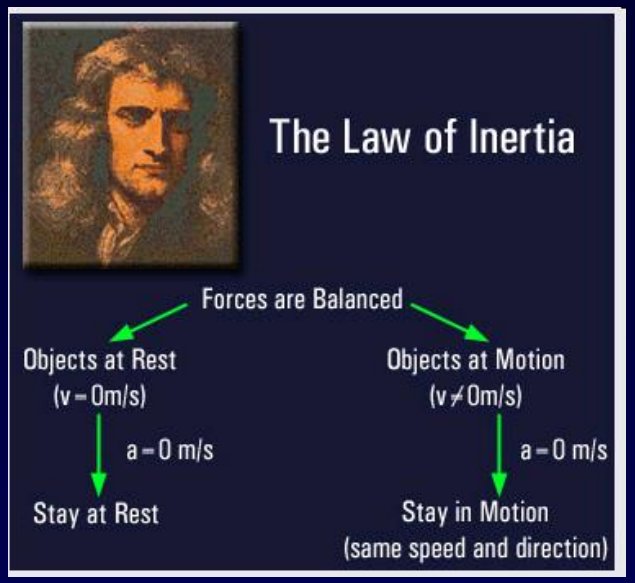
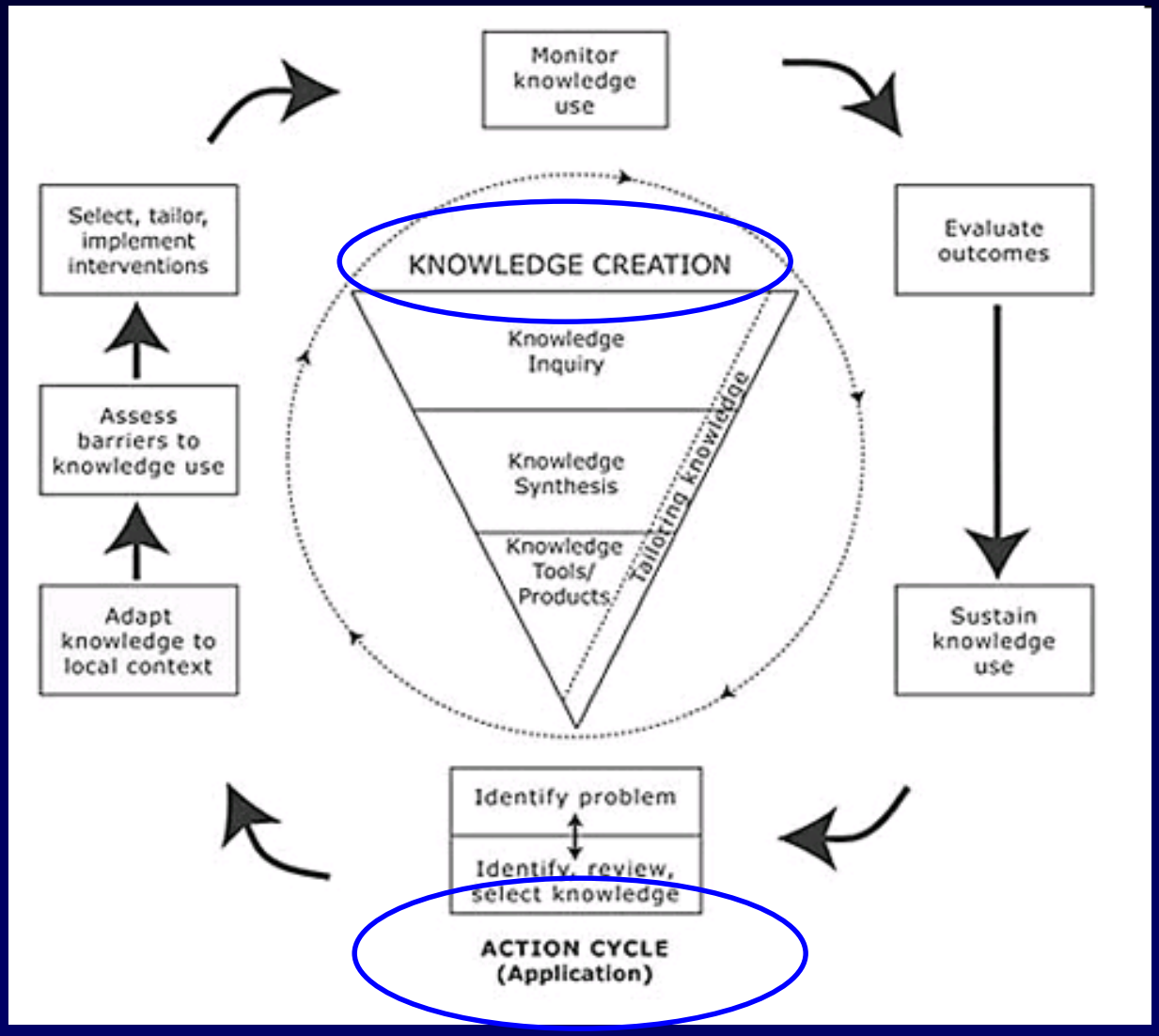
A body at rests stays at rest and a body in motion stays in a straight line…



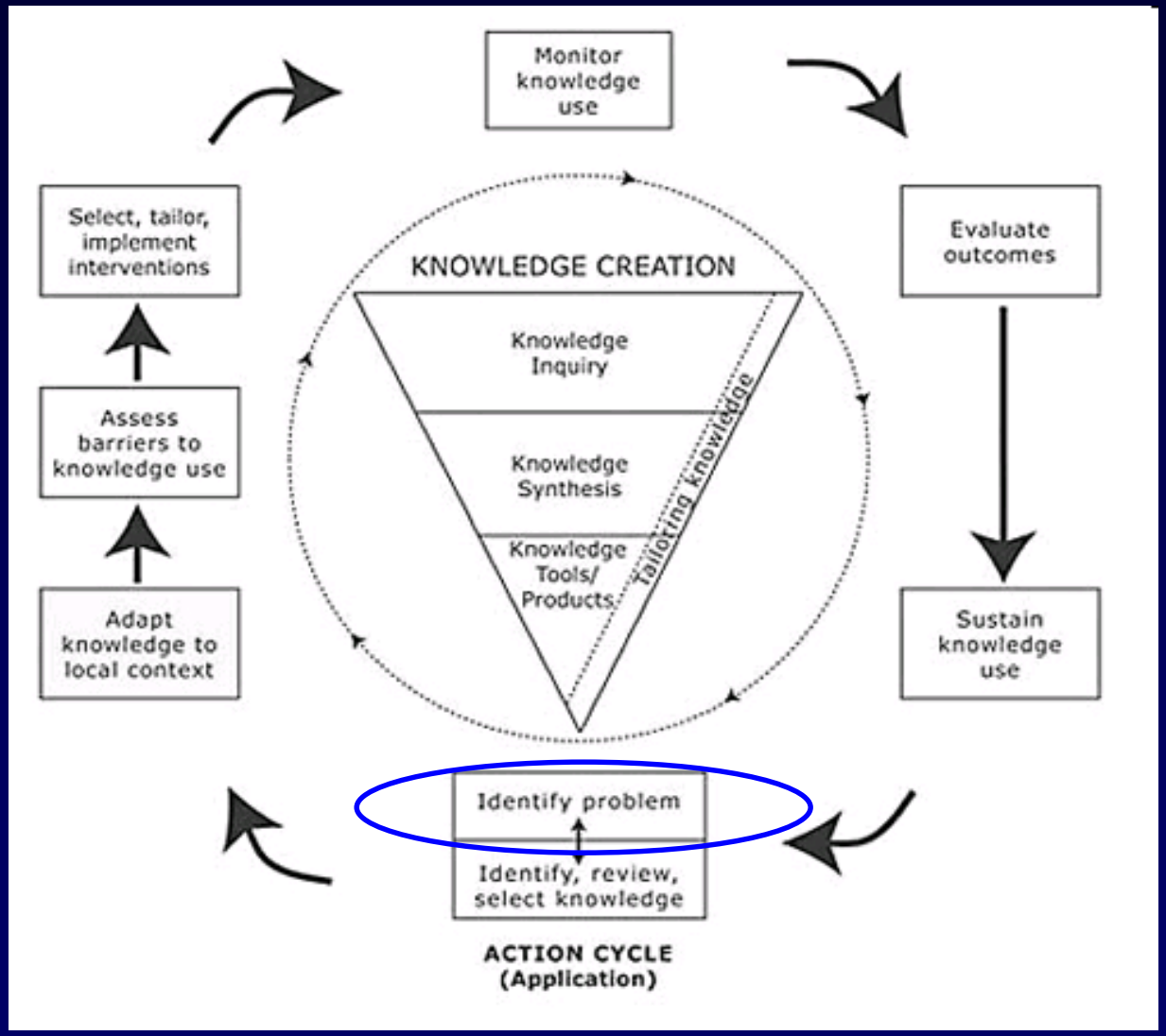
Unless acted on by an outside force

Knowledge to Action Cycle



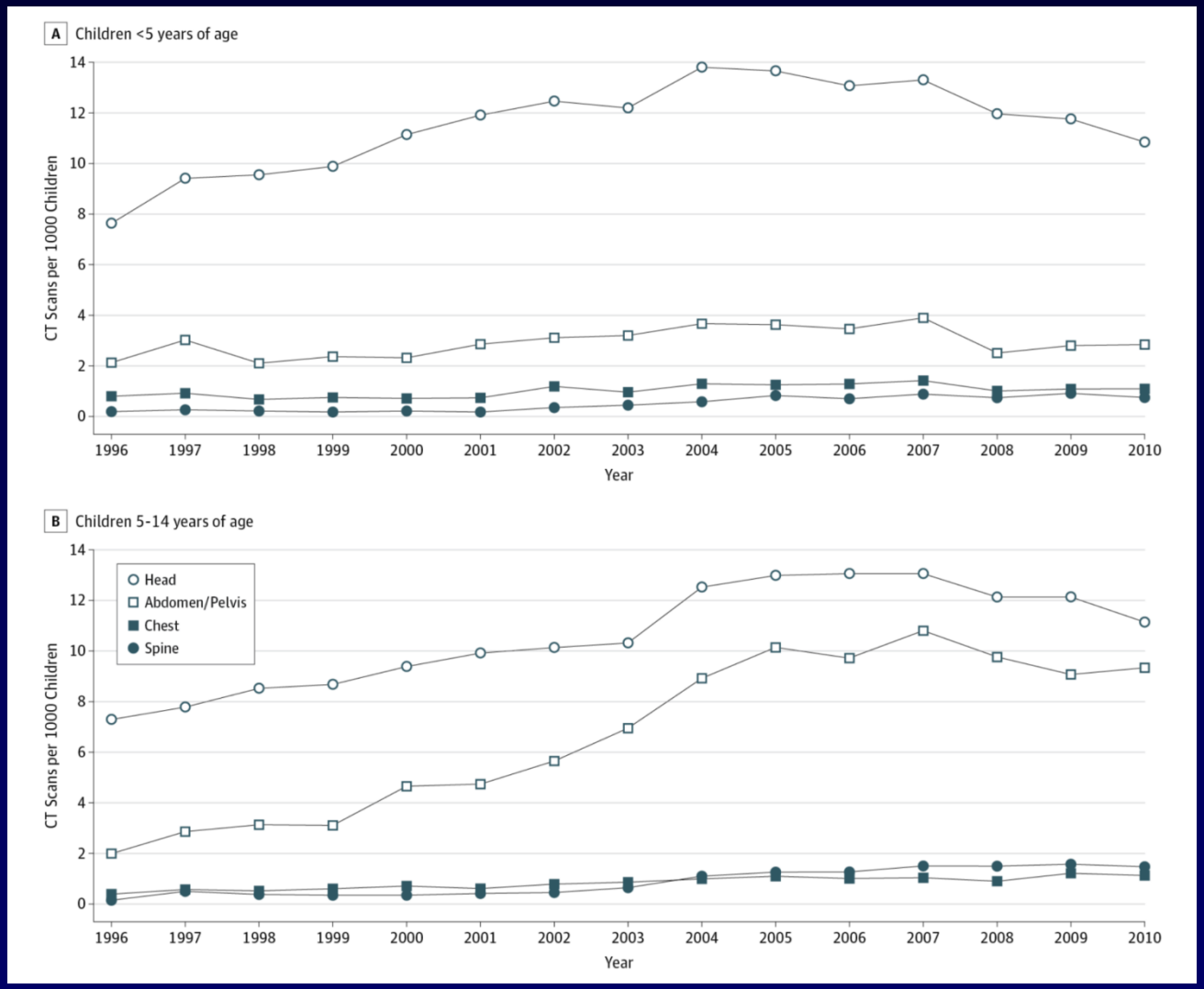
Graham ID et al. *J Continuing Education in Health Professions*, 2006

Knowledge to Action Cycle



Graham ID et al. *J Continuing Education in Health Professions*, 2006

Minor head trauma: Was there a problem?



Miglioritti. JAMA Pediatr. 2013

CT Radiation Risks

	Head Scan			Abdomen/Pelvis Scan		
	Solid Cancer			Solid Cancer		
Age, y	Girls	Boys	Leukemia	Girls	Boys	Leukemia
Lifetime Attributable Risk of Cancer per 10 000 CT Scans						
<5	17.5	7.4	1.9	33.9	14.8	0.8
5-9	1.6	2.4	0.9	25.8	13.7	0.7
10-14	1.1	2.1	0.5	27.2	13.1	1.0
No. of CT Scans Leading to 1 Case of Cancer (Rounded to the Nearest 10)						
<5	570	1350	5250	300	670	12 170
5-9	6130	4150	11 660	390	730	14 470
10-14	9020	4660	21 160	370	760	10 380

Miglioritti. JAMA Pediatr. 2013

Reducing CT Radiation Risks

- From a public-health view
  - ~300,000 CTs annually for pediatric head trauma
  - Millions for all reasons
- Age and size-based radiation-reduction efforts ongoing ("*ALARA*" principle)
- How to motivate individual practitioners to change?

Goals

- Evidence Generation (knowledge creation)
  - PECARN blunt head trauma prediction rules… and much more (*Dissection of the Hx and PE*)
- Knowledge Translation (application)
  - The Action Cycle
    - Qualitative assessments – led to trial
    - Head trauma ‘pragmatic’ trial – electronic health record-based clinical decision support

The PECARN TBI Rules
(derived and validated)

Children are at very low risk of clinically-important traumatic brain injury (TBI) if they meet none of the following criteria:

Children < 2 years	**Children 2-18 years**
Severe mechanism of injury History of LOC ≥ 5 sec GCS = 14 or other signs of altered mental status Not acting normally per parent Palpable skull fracture Occipital/parietal/temporal scalp hematoma	Severe mechanism of injury History of LOC GCS = 14 or other signs of altered mental status History of vomiting Severe headache in the ED Signs of basilar skull fracture

Lancet - Figure 3

What To Do for Under 2 Years?

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

Yes → CT recommended

No ↓

Occipital or parietal or temporal scalp hematoma, or history of LOC ≥5 sec, or severe mech. of injury, or not acting normally per parent

Yes → 32.6% of population

Observation vs. CT based on other clinical factors including:

- Physician experience
- Multiple vs. isolated findings
- Worsening symptoms or signs after ED observation
- Age <3 months
- Parental preference

No ↓

CT not recommended

53.5% of population

Lancet - Figure 3

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Really interesting group

No ↓

CT not recommended

53.5% of population

What's the risk with one finding?

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)*

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)

Original Investigation

Association of a Guardian's Report of a Child Acting Abnormally With Traumatic Brain Injury After Minor Blunt Head Trauma

Daniel K. Nishijima, MD, MAS; James F. Holmes, MD, MPH; Peter S. Dayan, MD, MSc; Nathan Kuppermann, MD, MPH

Observation Before CT Decision

Does observation change decision making?

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

AUTHORS: Lise E. Nigrovic, MD, MPH,[a] Jeff E. Schunk, MD,[b,c] Adele Foerster, MSN,[d] Arthur Cooper, MD,[e] Michelle Miskin, MS,[c] Shireen M. Atabaki, MD, MPH,[f] John Hoyle, MD,[g] Peter S. Dayan, MD, MSc,[h] James F. Holmes, MD, MPH,[i] Nathan Kuppermann, MD, MPH,[j] and the Traumatic Brain Injury Group for the Pediatric Emergency Care Applied Research Network

[a]Division of Emergency Medicine, Children's Hospital Boston, Harvard Medical School, Boston, Massachusetts; [b]Department of Pediatrics, Primary Children's Medical Center, Salt Lake City, Utah; [c]University of Utah School of Medicine, Salt Lake, Utah; [d]Silver Spring Emergency Physicians, Holy Cross Hospital, Silver Spring, Maryland; [e]Department of Surgery, Harlem Hospital Medical Center and [h]Department of Pediatrics, Morgan Stanley Children's Hospital of New York–Presbyterian, Columbia University College of Physicians and Surgeons, New York, New York; Departments of [f]Pediatrics and Emergency Medicine, Children's National Medical Center, George Washington University School of Medicine, Washington, DC; [g]Division of Emergency Medicine, Helen DeVos Children's Hospital, Michigan State University School of Medicine, Grand Rapids, Michigan; and [i]Department of Emergency Medicine and Departments of [j]Emergency Medicine and Pediatrics, Davis Medical Center, University of California, Davis School of Medicine, Davis, California

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

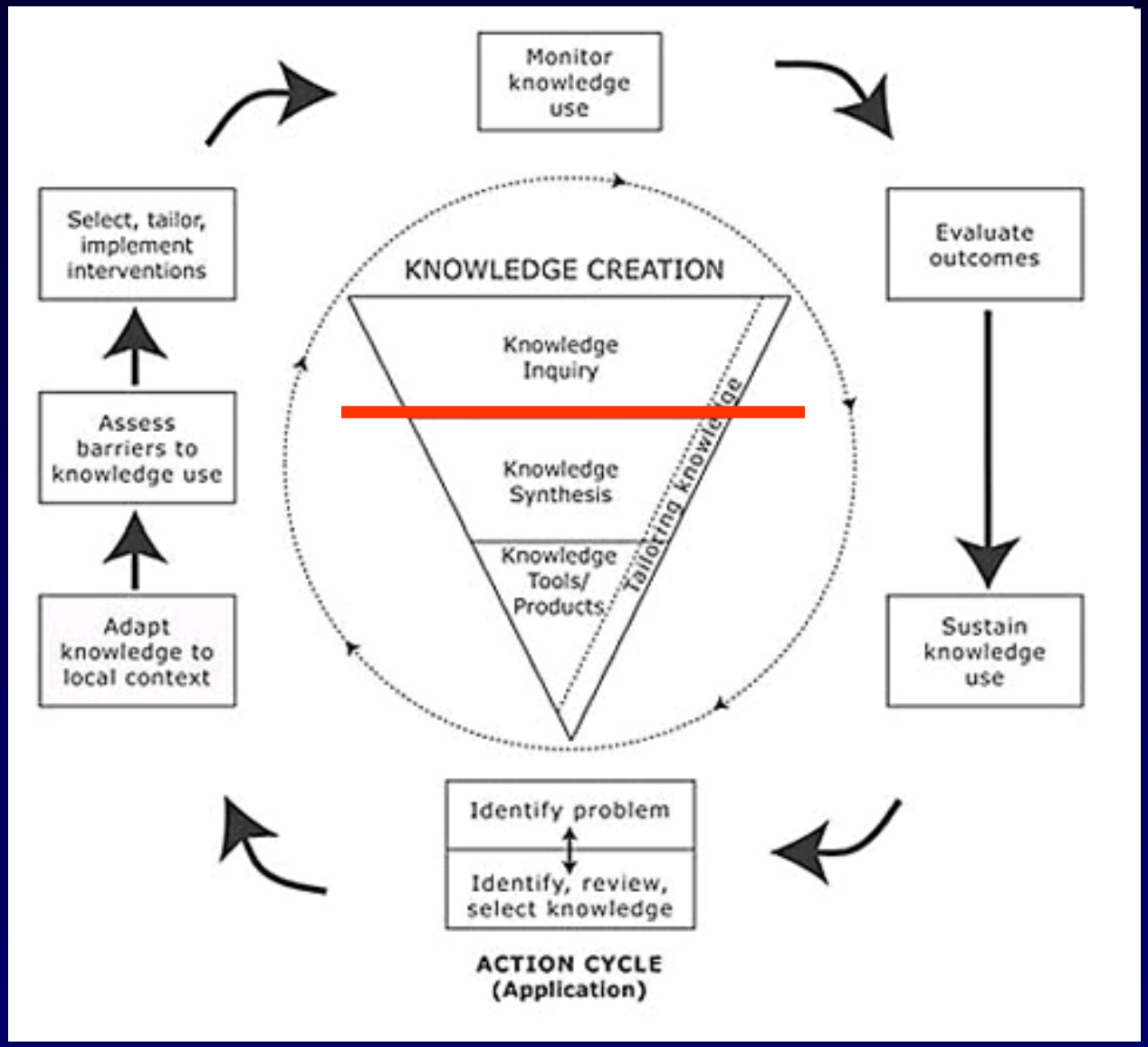
FREE

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.

The Evidence

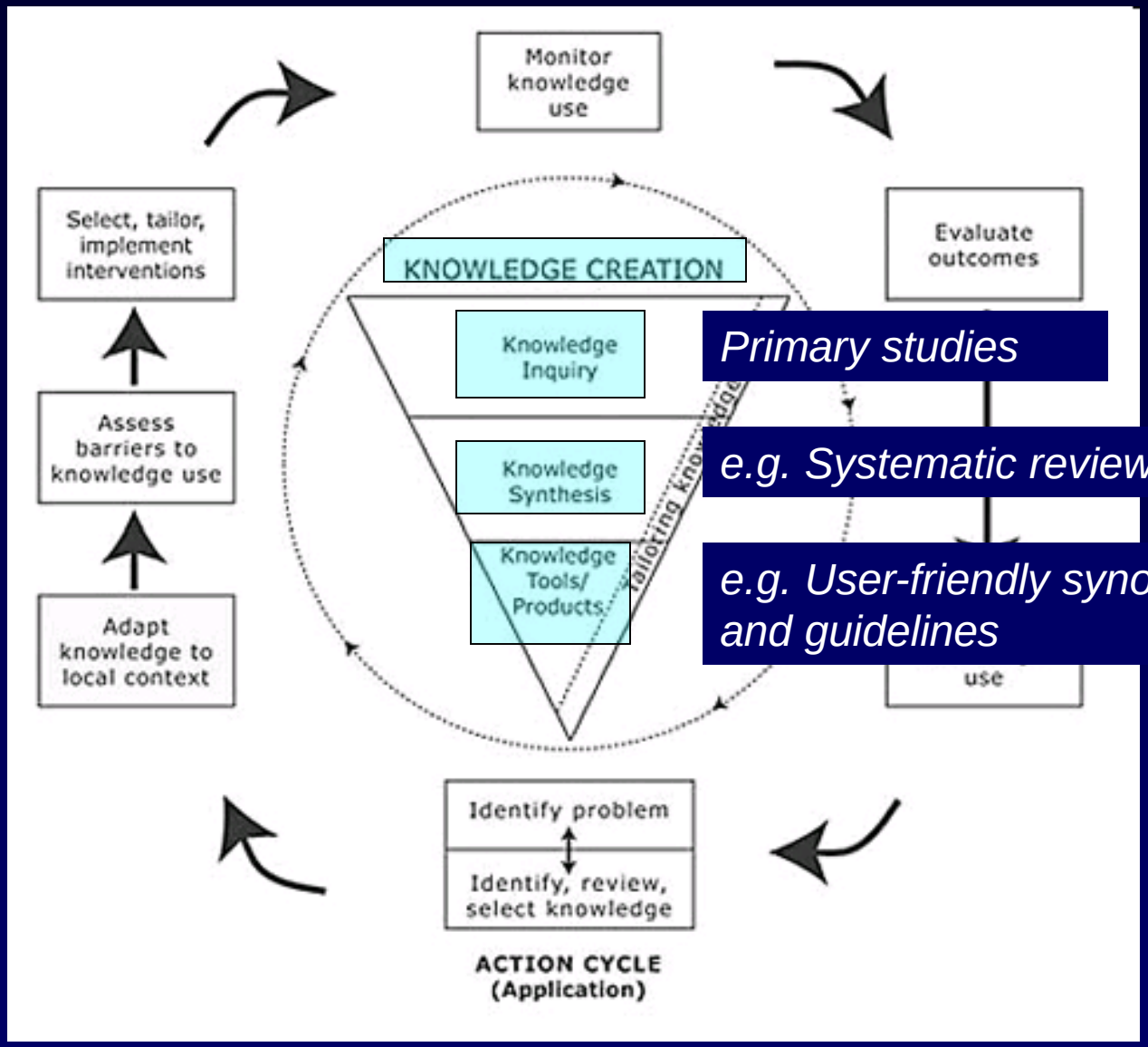
- Dissection of the clinical exam
  - Sensible very low risk prediction rules
  - Risks for individual and combinations of variables when do not meet rule
- Observation influences CT decision

Knowledge to Action Cycle



Where on this cycle was all this evidence

Knowledge to Action Cycle



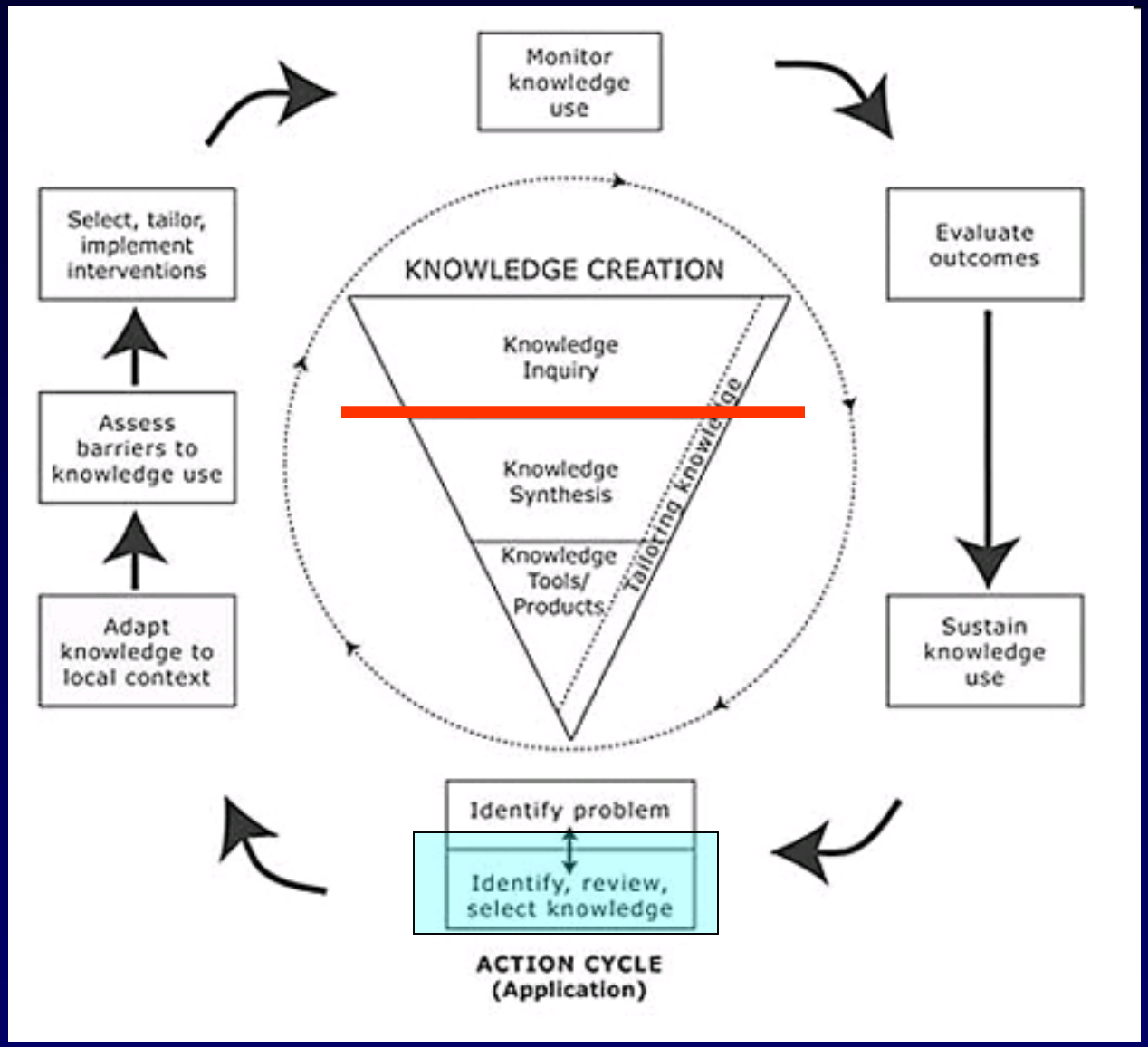
Primary studies

e.g. Systematic reviews

e.g. User-friendly synopses and guidelines

Graham ID et al. *J Continuing Education in Health Professions*, 2006

Knowledge to Action Cycle



Where on this cycle was all this evidence

Knowledge Translation Defined:
Canadian Institutes of Health Research (CIHR)

KT is a dynamic and iterative process that includes synthesis, dissemination, exchange and ethically sound application of knowledge to improve the health of Canadians, provide more effective health services and products and strengthen the health care system.

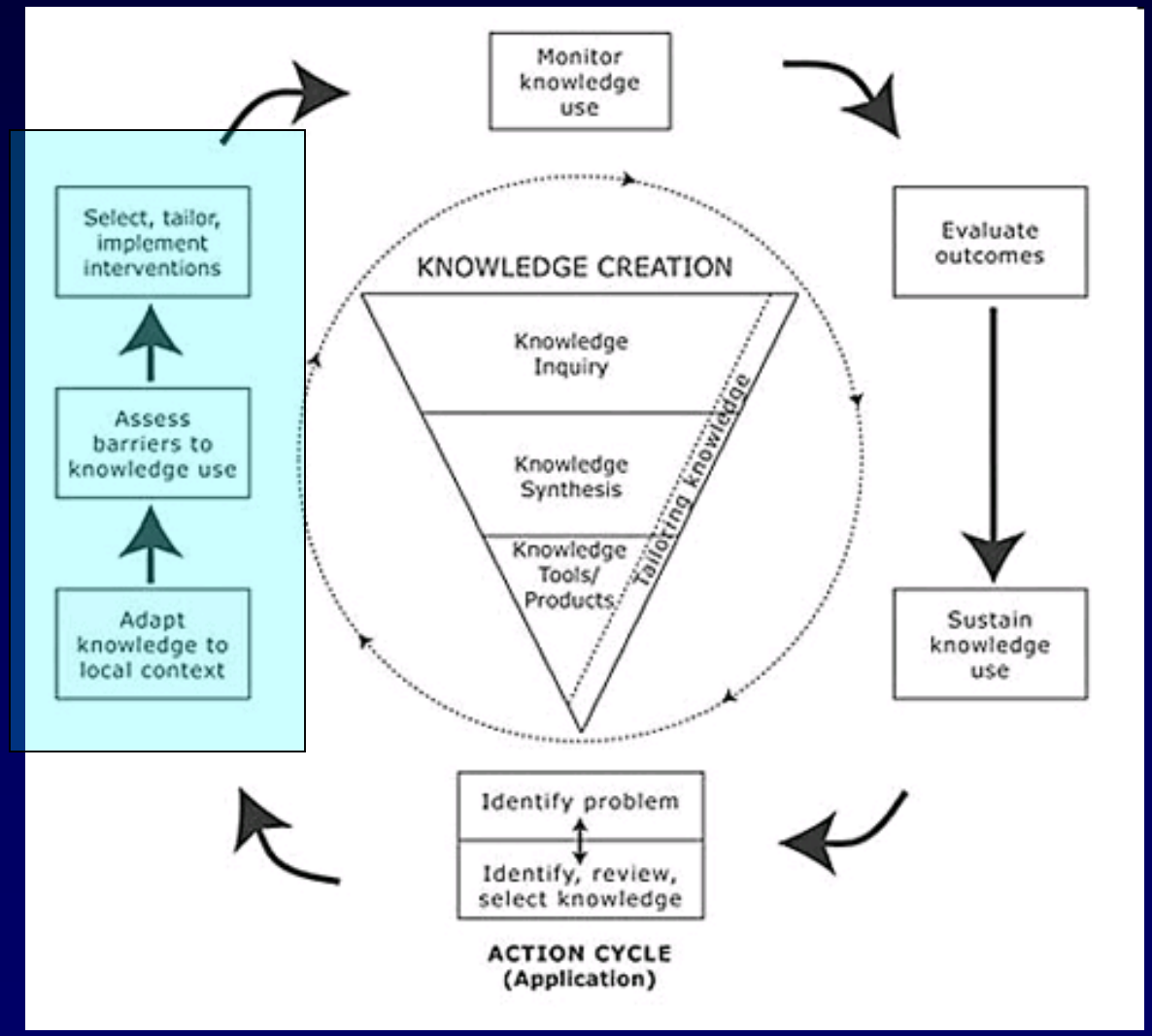
This process takes place within a complex system of interactions between **researchers and knowledge users**, …

The KT Players (Stakeholders)

- Patients
- Clinicians/practitioners
- Health care teams (e.g. ED QI team)
- Healthcare organizations and systems
- Policy makers
- …and investigators

Rule Implementation: Tasks to Consider

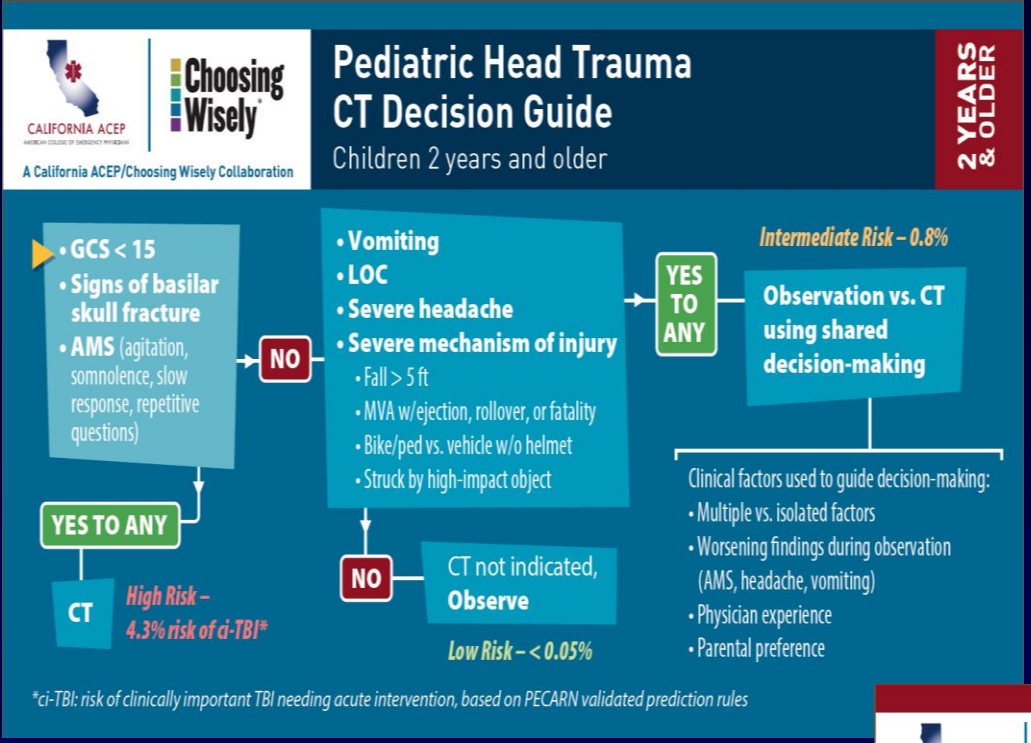
What to do first?

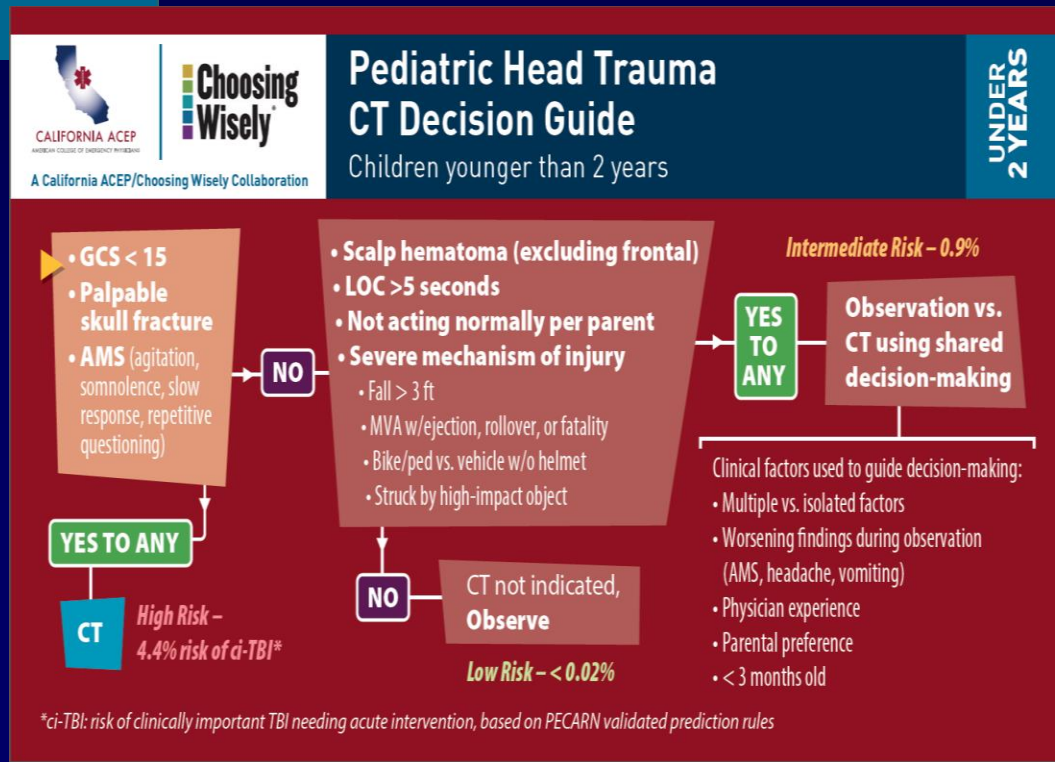


Rule Implementation

Potential solutions (among many):

- Clinical decision support (CDS)
  - **Includes:** alerts, reminders, order sets, documentation templates
- Educational strategies
  - Opinion leaders
  - Audit with feedback
  - *Not:* CME and unsolicited mailings
- Multiple interventions *(combined)*


CALIFORNIA ACEP
Choosing Wisely
A California ACEP/Choosing Wisely Collaboration
Pediatric Head Trauma
CT Decision Guide
Children 2 years and older
2 YEARS & OLDER
• GCS < 15
• Signs of basilar skull fracture
• AMS (agitation, somnolence, slow response, repetitive questions)
NO
YES TO ANY
CT
High Risk – 4.3% risk of ci-TBI*
• Vomiting
• LOC
• Severe headache
• Severe mechanism of injury
• Fall > 5 ft
• MVA w/ejection, rollover, or fatality
• Bike/ped vs. vehicle w/o helmet
• Struck by high-impact object
NO
CT not indicated, Observe
Low Risk – < 0.05%
YES TO ANY
Intermediate Risk – 0.8%
Observation vs. CT using shared decision-making
Clinical factors used to guide decision-making:
• Multiple vs. isolated factors
• Worsening findings during observation (AMS, headache, vomiting)
• Physician experience
• Parental preference
*ci-TBI: risk of clinically important TBI needing acute intervention, based on PECARN validated prediction rules


CALIFORNIA ACEP
Choosing Wisely
A California ACEP/Choosing Wisely Collaboration
Pediatric Head Trauma
CT Decision Guide
Children younger than 2 years
UNDER 2 YEARS
• GCS < 15
• Palpable skull fracture
• AMS (agitation, somnolence, slow response, repetitive questioning)
NO
YES TO ANY
CT
High Risk – 4.4% risk of ci-TBI*
• Scalp hematoma (excluding frontal)
• LOC >5 seconds
• Not acting normally per parent
• Severe mechanism of injury
• Fall > 3 ft
• MVA w/ejection, rollover, or fatality
• Bike/ped vs. vehicle w/o helmet
• Struck by high-impact object
NO
CT not indicated, Observe
Low Risk – < 0.02%
YES TO ANY
Intermediate Risk – 0.9%
Observation vs. CT using shared decision-making
Clinical factors used to guide decision-making:
• Multiple vs. isolated factors
• Worsening findings during observation (AMS, headache, vomiting)
• Physician experience
• Parental preference
• < 3 months old
*ci-TBI: risk of clinically important TBI needing acute intervention, based on PECARN validated prediction rules

Implementation of the PECARN Traumatic Brain Injury Prediction Rules Using Electronic Health Record-Based Clinical Decision Support

Children < 2 years	Children 2-18 years
Severe mechanism of injury History of LOC ≥ 5 sec GCS = 14 or other signs of altered mental status Not acting normally per parent Palpable skull fracture Occipital/parietal/temporal scalp hematoma	Severe mechanism of injury History of LOC History of vomiting GCS = 14 or other signs of altered mental status Severe headache in the ED Signs of basilar skull fracture

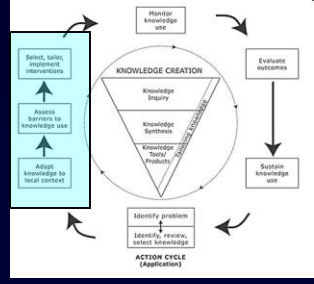
Funded by the American Recovery and Reinvestment Act – Office of the Secretary: Grant #S02MC19289-01-00

PECARN
Pediatric Emergency Care Applied Research Network

Specific Aims

1. To develop and pilot test the computer-based clinical decision support (CDS) system

2. To assess whether implementing the two age-specific PECARN TBI clinical prediction rules (one for preverbal and the other for verbal children) via CDS integrated with the EHR, decreases the number of (unnecessary) cranial CTs obtained by clinicians



Implementation Strategy

- Develop the theoretical basis for an intervention
- Define components of the intervention
  - using modeling, simulation, or qualitative methods
- Conduct exploratory studies to further develop the intervention
- Perform definitive evaluative study
  - predominantly randomized designs

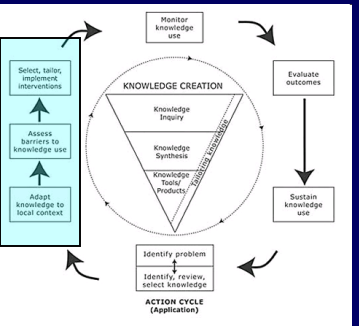
Eccles, Grimshaw, Qual Saf Health Care 2003

Theoretical Basis

Implementation via Decision Support

More successful when:

- Automatic provision of support in workflow
  - *Must evaluate and account for workflow*
- Recommendations given rather than risks
  - *Directive vs. assistive*



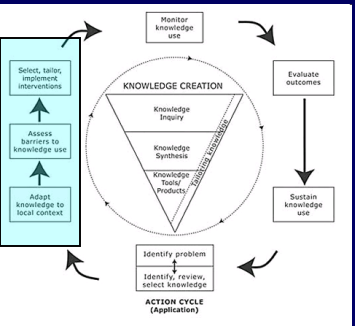
Kawomoto, BMJ, 2005

Theoretical Basis

Implementation via Decision Support

More successful when:

- Support given at the time and location of decision-making
  - *If just at time of order entry, perhaps (likely) too late*
- Support is computer based
  - *But I love my paper and laminated cards*



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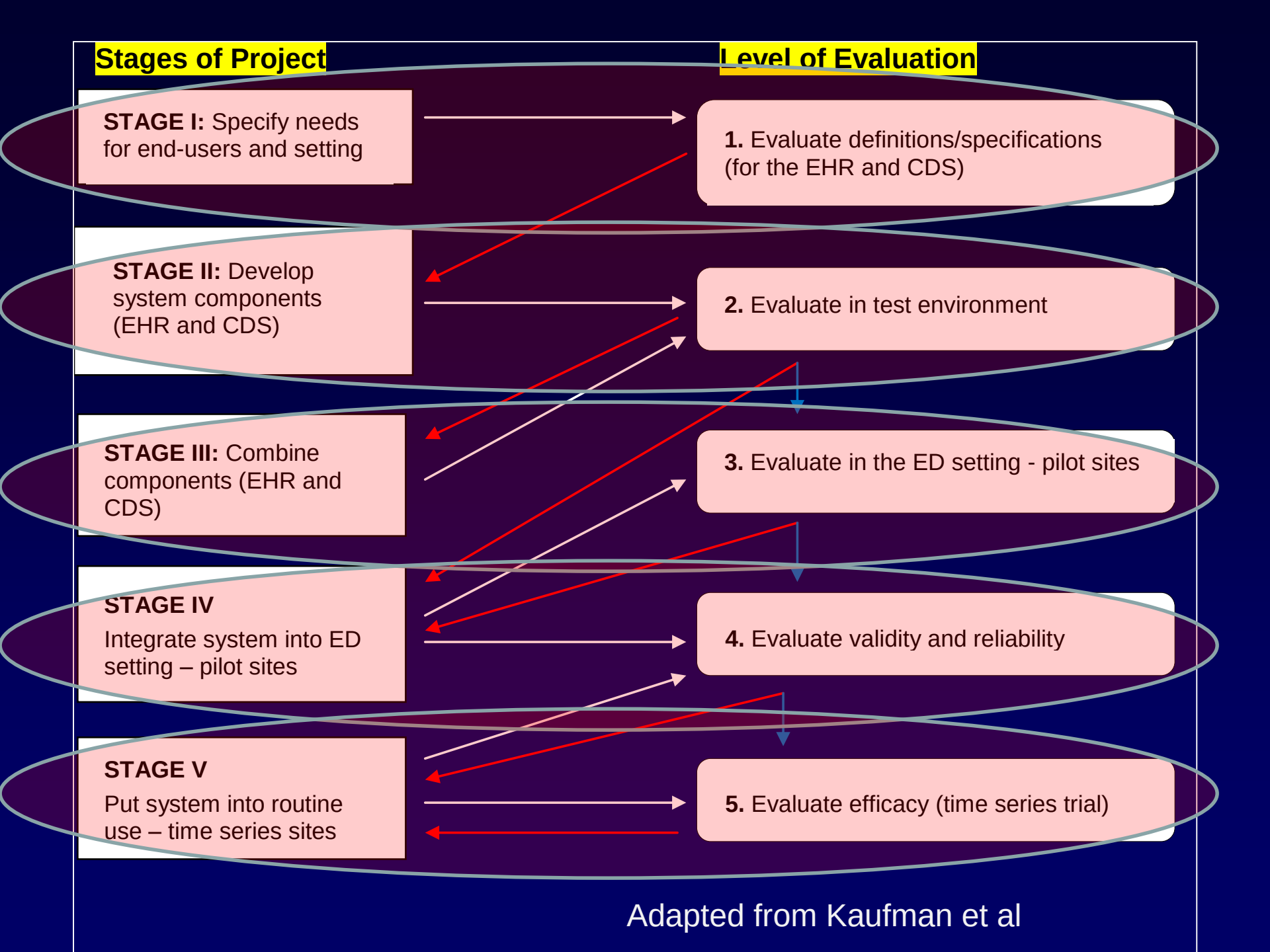
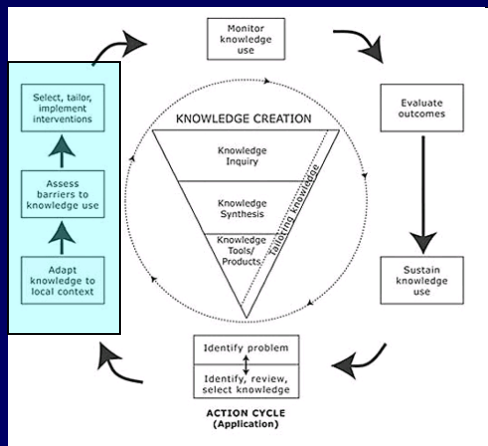


Adapted from Kaufman et al

Methods (Specific Aim 1: Stages I-IV)

EHR-Based Decision Support: Development and Pilot Testing

- Perform focus groups and key informant interviews
- Perform ED work flow assessments at all sites
- Develop EHR blunt head trauma data capture
- Develop CDS
- Conduct usability testing
- Pilot test at two sites



TBI-KT – Development Phase

- 11 focus groups
- 36 key stakeholder interviews
- 11 ED workflow evaluations
- …in 4 months

Assessing Barriers and Enablers to Successful ED Computerized Decision Support

		Themes		
		Interdisciplinary assessment process	*Clinical practice related to prediction rules*	*EHR as a decision support tool*
		Related Categories		CDSS Design Implications
Sociotechnical Dimensions	*Workflow and communication*	Routine task sequence Clinician variation Process [illegible]		Obtain minimal documentation up front Support inter-disciplinary data sharing Support shared decision-making Utilize current summary screens, support new views [illegible] documentation and CDSS to [illegible]/caregiver needs
	Organizational factors	Physical layout Technical layout Larger organizational goals	Inter-professional relationships External rules/regulations	Available IT resources Vendor relationships	Use flowsheets to facilitate data entry and capture Use mobile tools Develop replicable design approaches
	Human factors	ED culture Data entry preferences Tailoring to patient needs	Clinician attitudes/beliefs about TBI rules Clinician attitudes about guidelines Clinician attitudes about CT use in children	Clinician attitudes/beliefs about the EHR as a decision support tool	Provide for data validation process Provide TBI risk information Avoid over use of pop-up alerts

Started with a model

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		Related Categories			**CDSS Design Implications**
Sociotechnical Dimensions	***Workflow and communication***	Routine task sequence Clinician variation Process efficiency	Caregiver/patient preference	Future process changes	Obtain minimal documentation up front Support inter-disciplinary data sharing Support shared decision-making Utilize current summary screens, support new views Tailor documentation and CDSS to patient/caregiver needs
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What we learned

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		Interdisciplinary assessment process	*Clinical practice related to prediction rules*	*EHR as a decision support tool*
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CDSS Design Implications

Obtain minimal documentation up front

Support inter-disciplinary data sharing

Support shared decision-making

Utilize current summary screens, support new views

Tailor documentation and CDSS to patient/caregiver needs

Use flowsheets to facilitate data entry and capture

Use mobile tools

Develop replicable design approaches

Provide for data validation process

Provide TBI risk information

Avoid over use of pop-up alerts

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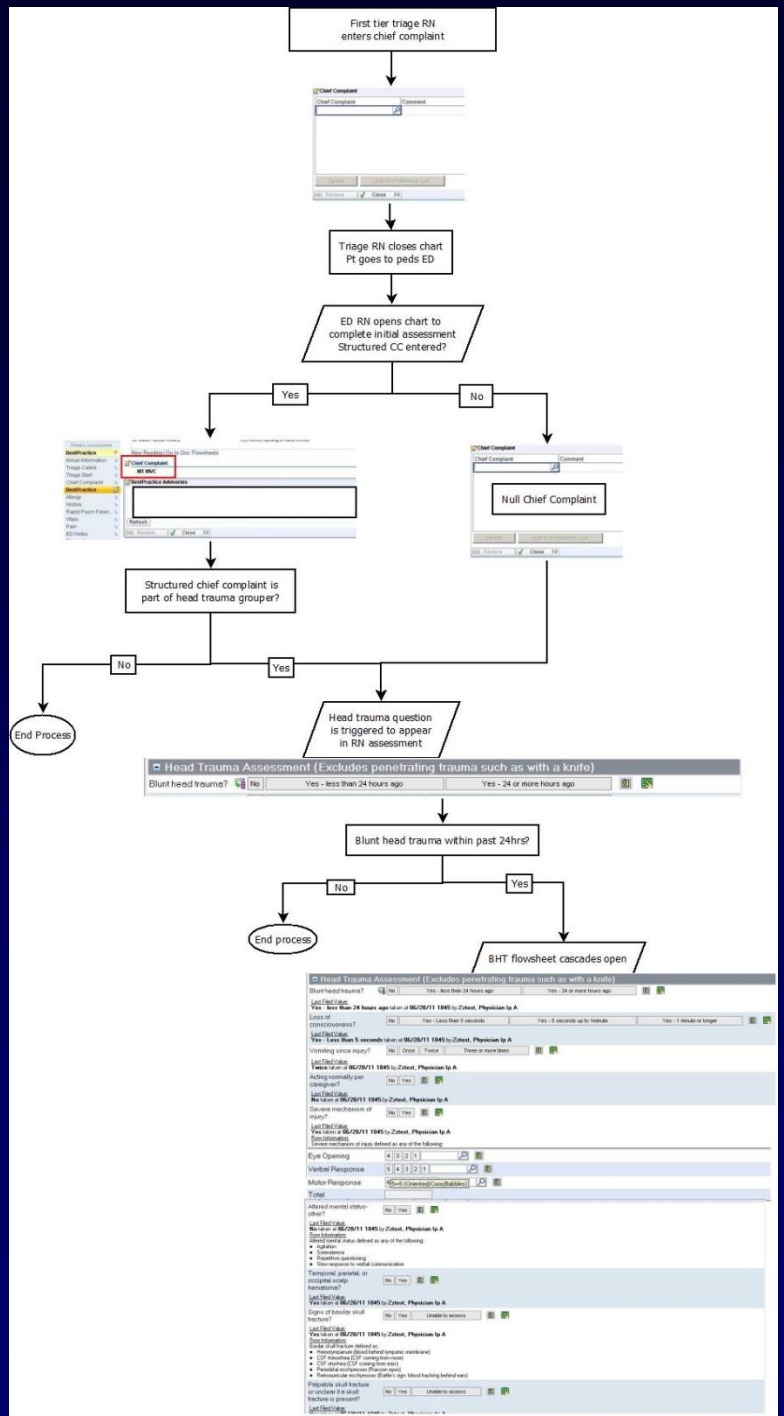
TBI-KT Development Phase

What we created



- Chief Complaint
  - Categorized complaint
  - Entered by Front-End Staff

Lessons learned

Triggering data collection by chief complaints – balancing sensitivity and specificity:

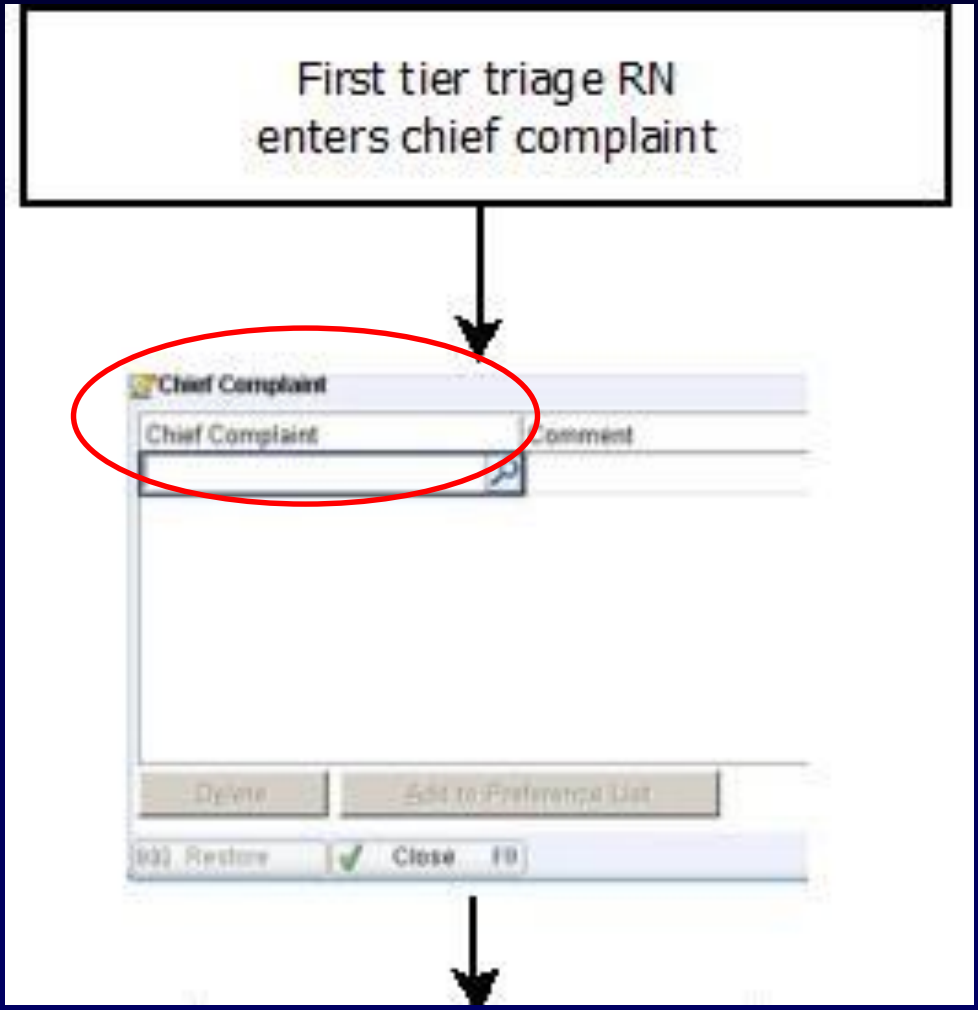
ALLEGED PHYSICAL ABUSE
ASSAULT
ATHLETIC INJURY
ATV ACCIDENT
AUTOMOBILE VERSUS PEDESTRIAN
BICYCLE CRASH
BICYCLE VS MOTOR VEHICLE
BIKE INJURY
CONCUSSION
EAR INJURY
FACIAL LACERATION
FALL
FALL FROM PLAYGROUND EQUIPMENT
FRACTURE OF SKULL
HEAD INJURY
HEAD LACERATION
HEAD LUMP

	No Head Injury	Head Injury	
No	11763	71	11834
Yes	3664	731	4395
	15427	802	16229

sensitivity	91.1%
specificity	76.2%
NPV	99.4%
PPV	16.6%

- Chief Complaint
  - Categorized complaint
  - Entered by Front-End Staff

- If blunt head trauma complaint entered, …



Data Completion by Nursing

Allergies
Vitals
Pain
Detailed Exam
ED Notes
Order Sets
Orders
Screening/Learning
Destination
Miscellaneous Notes
Redirect Screen
Called No Answer
Disposition
Care Everywhere

Neurologic

LOC: Alert | Responds to voice | Responds to pain | Unresponsive | Sleeping/no distress | Alert/decreased activity | Appropriate for developmental level | Oriented x 3 | Combative | Sleeping with distress

Appropriate for developmental level

Pupils Equal and Reactive, Anterior Fontanelle Flat: Yes

Neurological Assessment: Findings as Noted | Not Applicable to Complaint/Encounter

Blunt Head Trauma Assessment (skip any question if unable to determine answer)

Blunt head trauma?: No | Yes - less than 24 hours ago | Yes - more than 24 hours ago

Gastrointestinal

Abdomen Soft and Without Tenderness: Yes

If Triage RN enters *"Yes-less than 24 hours ago"* items for risk assessment will be enacted

Blunt Head Trauma Assessment

Blunt Head Trauma Assessment (skip any question if unable to determine answer)

Blunt head trauma?	No / Yes - less than 24 hours ago / Yes - more than 24 hours ago
Loss of consciousness?	No / Yes - less than 5 seconds / Yes - 5 seconds up to one minute / Yes - 1 minute or longer / Yes - duration unclear
Vomiting since injury?	No / Once / Twice / Three or more times
Acting normally per caregiver?	Yes / No
Severe mechanism of injury?	No / Yes
Current headache?	No / Mild / Moderate
Other signs of altered mental status?	No / Yes
Temporal, parietal, or occipital scalp hematoma?	No / Yes

GCS

Eye Opening	4 / 3 / 2 / 1
Verbal Response	5 / 4 / 3 / 2 / 1
Motor Response	6 / 5 / 4 / 3 / 2 / 1
Total GCS	

Other signs of altered mental status? No Yes

Row Information:

Other signs of altered mental status defined as any of the following:

- Agitation
- Somnolence
- Repetitive questioning
- Slow response to verbal communication

Temporal, parietal, or

Courtesy: Peter S. Dayan, MD, PECARN

Showing Clinicians the Information

Test, Two MRN2012137 (CSN: 600601032) (20 mos F) PCP: KANG, D (614-722-6547)

Chief Complaint

Laceration

Current Vitals/Pain

Date and Time	Temp	Source	Pulse	Resp	BP
10/28/11 1258	**36.9 (98.4)**	--	**120**	**30**	**80/50**

Nursing Notes

ED Notes signed by Zzuser, Rn, RN at 10/28/11 1300

Author:	Zzuser, Rn, RN	Service:	(none)
Filed:	10/28/11 1300	Note Time:	10/28/11 1300

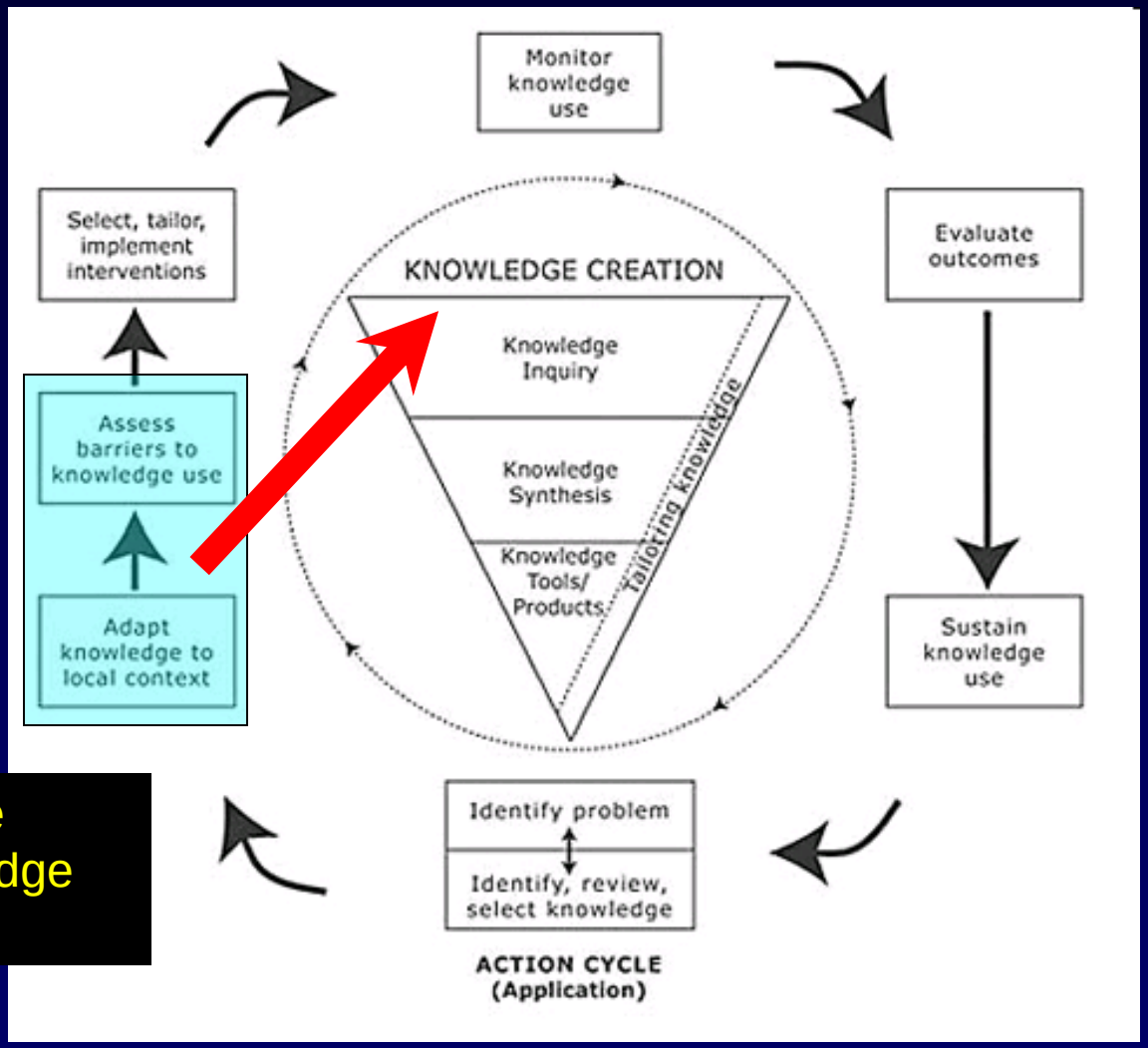
Fell and hit head on pavement. 2 cm lac to forehead

Blunt Head Trauma Assessment

	Most Recent Value
Blunt head trauma?	**Yes - less than 24 hours ago**
Loss of consciousness?	**Yes - less than 5 seconds**
Vomiting since injury?	**Twice**
Acting normally per caregiver?	**Yes**
Severe mechanism of injury?	**No**
Current headache?	**Mild**
Other signs of altered mental status?	**No**
Temporal, parietal, or occipital scalp hematoma?	**No**
Signs of basilar skull fracture?	--
Palpable skull fracture or unclear on the basis of swelling or distortion of the scalp?	--
Total GCS	**15**

Click here to Update/Complete Blunt Head Trauma Assessment

Lesson Learned: Use Knowledge to Action Cycle *Early*



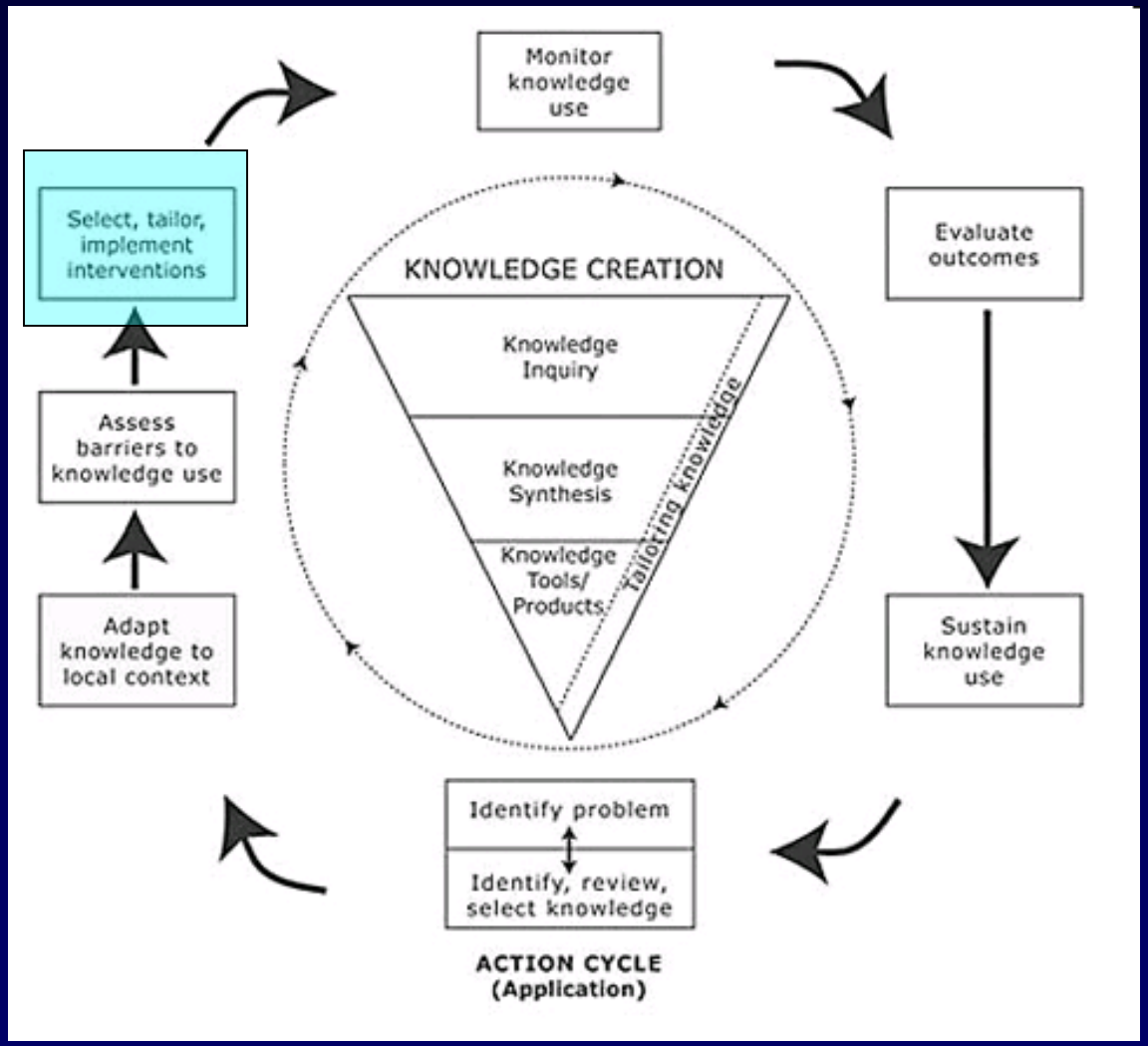
Think of KT side when in Knowledge Creation loop

How do you use the EHR to assess these exclusion criteria?

Exclusion Criteria		
Does the patient have a brain tumor?	Yes	No
Does the patient have a known bleeding disorder (coagulopathy)?	Yes	No
Does the patient have a ventricular shunt (e.g. VP shunt)?	Yes	No
Does patient have a pre-existing neurological disorder that complicates clinical assessment?	Yes	No
Was the patient transferred to ED with skull film, head CT, or MRI already obtained?	Yes	No

- Ask them in the EHR?
  - Clinicians and administrators rejected
  - Would not generalize outside of the study
- Retrospective – limitations and feasibility concerns

Development of the Intervention (Clinical Decision Support)



Methods

Multifaceted Intervention

- EHR-based clinical decision support that includes:
  - TBI prediction rule reminders
  - ***Management recommendations*** if the child meets very low risk criteria for clinically-important TBI
- Focused education
- Use of local opinion leaders

Based on conceptual models and prior implementation trials

Clinical Decision Support

- Clinician receives a statement no matter what is entered
- Formatted similarly across statements
  - Recommendation
  - Risk estimate of clinically-important TBI
    - What data were provided by clinician to make this estimation
  - Management options (if relevant)

Decision support: Patient < 2 years who meets rule

PECARN
Pediatric Emergency Care Applied Research Network

Traumatic Brain Injury Risk: Child less than 2 years

RECOMMENDATION: A head CT is not recommended for this patient based on the absence of any of the PECARN prediction rule variables.

Risk Estimate: The risk of clinically-important traumatic brain injury for patients less than 2 years is < 1/5000

Importantly, the PECARN rules were based on attending initial evaluations (not based on subsequent evaluations over time).

The age-specific PECARN rule findings documented are:

Loss of consciousness?:	No	10/05/12 1521 : THAM, ERIC
Acting normally per caregiver?:	Yes	10/05/12 1521 : THAM, ERIC
Mechanism of injury?:	Mild	10/05/12 1521 : THAM, ERIC
Total Glasgow Coma Scale score:	15	10/05/12 1521 : THAM, ERIC
Other signs of altered mental status?:	No	10/05/12 1521 : THAM, ERIC
Scalp hematoma?:	None	10/05/12 1521 : THAM, ERIC
Palpable skull fracture or unclear on the basis of swelling or distortion of the scalp?:	No	10/05/12 1521 : THAM, ERIC

If the above clinical findings are incorrect, please revise.

Note: The PECARN prediction rules do not apply to patients with: bleeding diatheses, ventricular (e.g. "VP") shunts, known brain tumors, or pre-existing neurological disorders complicating your clinical assessment.

Click here to view the PECARN prediction rule manuscript (Lancet)

Click to provide a revised risk assessment

PECARN
Pediatric Emergency Care
Applied Research Network

RECOMMENDATION: A head CT is not recommended for this patient

Decision support: Patient < 2 years who meets rule

Risk Estimate: The risk of **clinically-important traumatic brain injury** for patients less than 2 years is < 1/5000

PECARN
Pediatric Emergency Care
Applied Research Network

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PECARN
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Palpable skull fracture or unclear on the basis of swelling or distortion of the scalp?:	No	10/05/12 1521 : THAM, ERIC

PECARN
Pediatric Emergency Care
Applied Research Network

Click to provide a revised risk assessment

Patients who do not meet rule but for whom we gave specific information

Patients with only one of the following PECARN rule predictors:

1. Severe mechanism of injury (both age groups)
2. Temporal/parietal/occipital scalp hematoma (< 2 yr group)
3. Not acting normally per caregiver (< 2 yr group)
4. Loss of consciousness (2 years up to 18th birthday group)
5. Vomiting (2 years up to 18th birthday group)

A Generalizable Model for CDS?

Epic

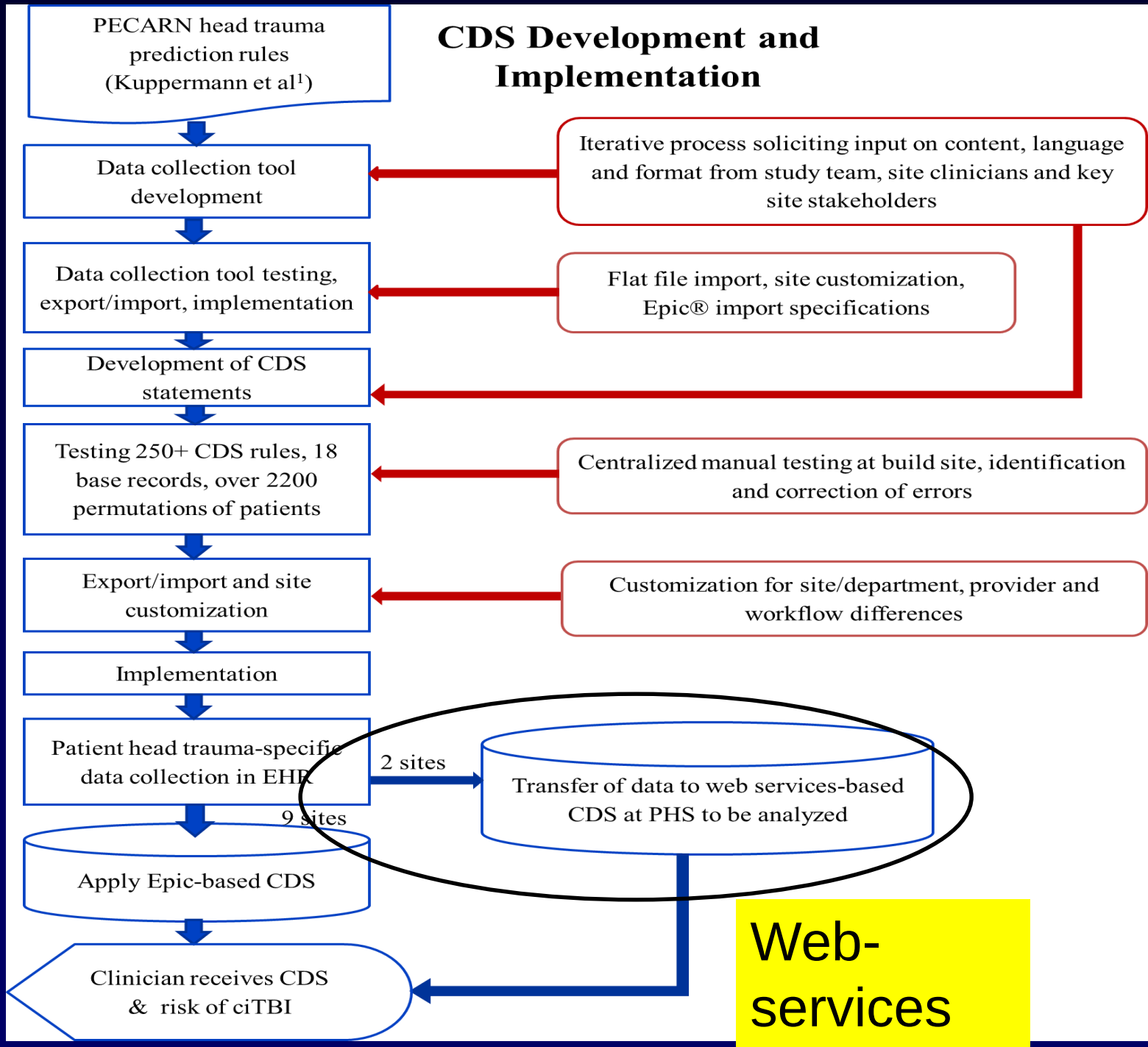
Cerner

Allscripts

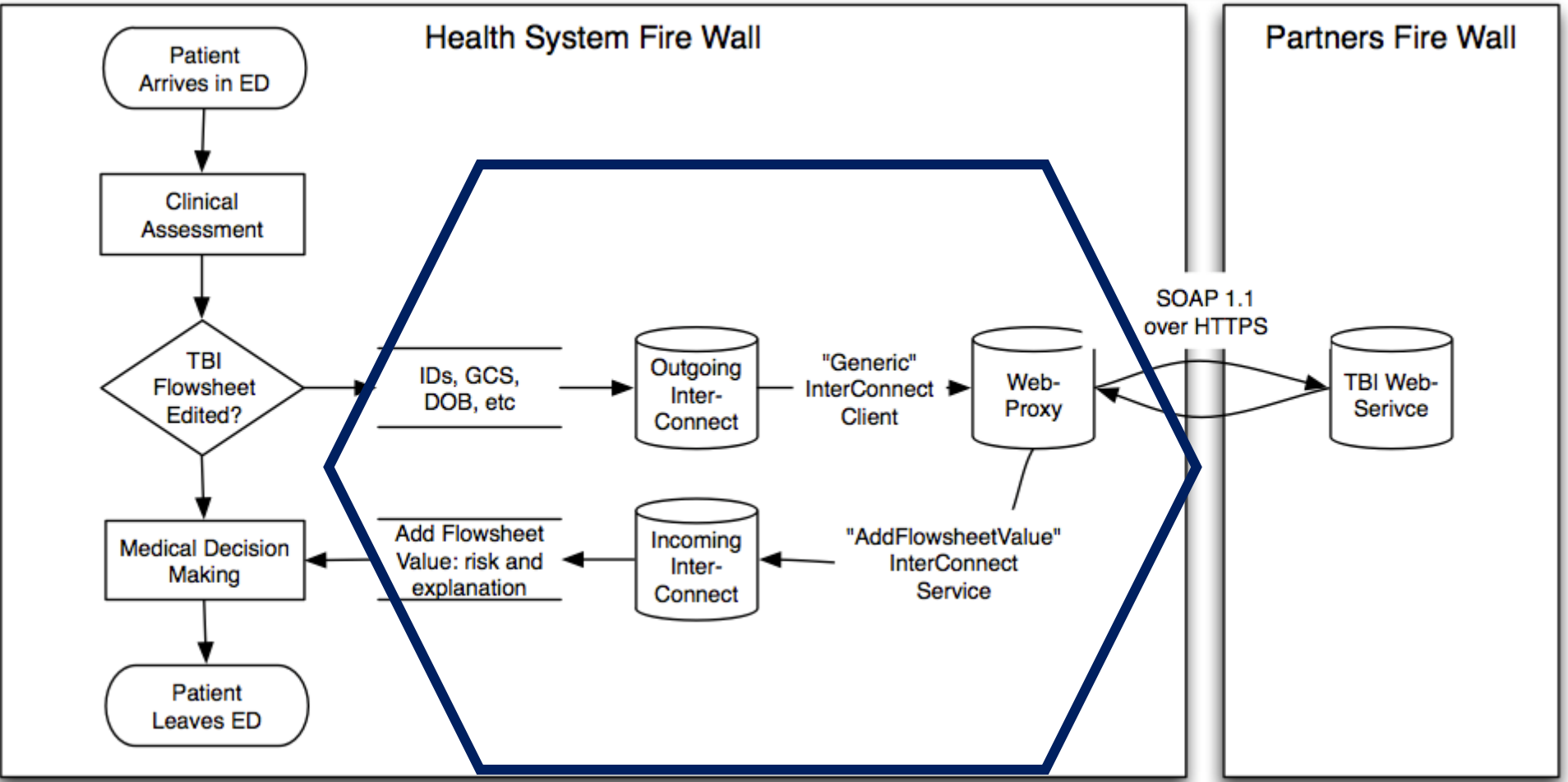
Multi-center CDS:

Resource intense at multiple steps

Thanks:
Eric Tham
Maggie S.
Jeff Hoffman
Allen Cole
Vickie Schum

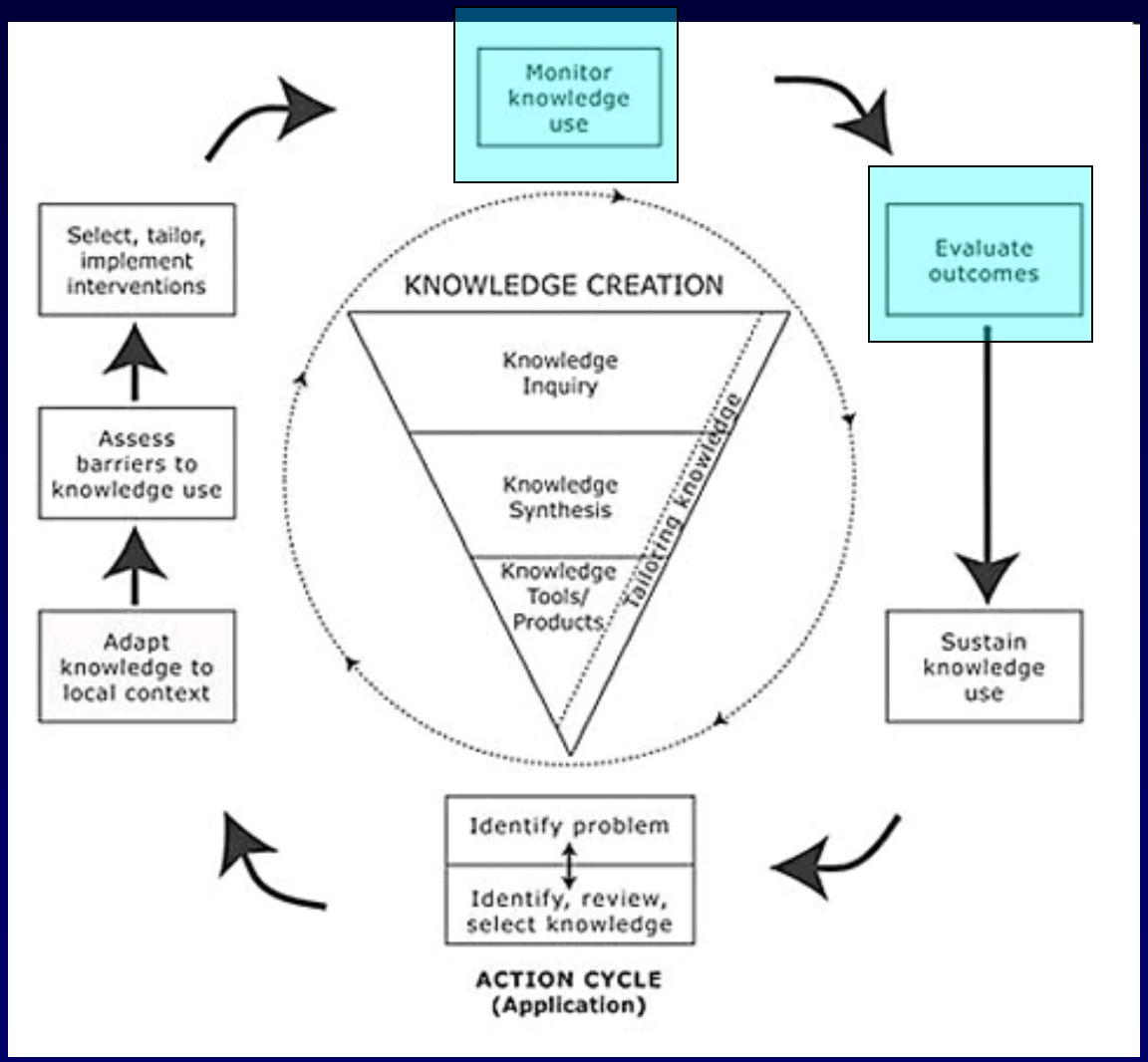


Web-services: Infrastructure Overview



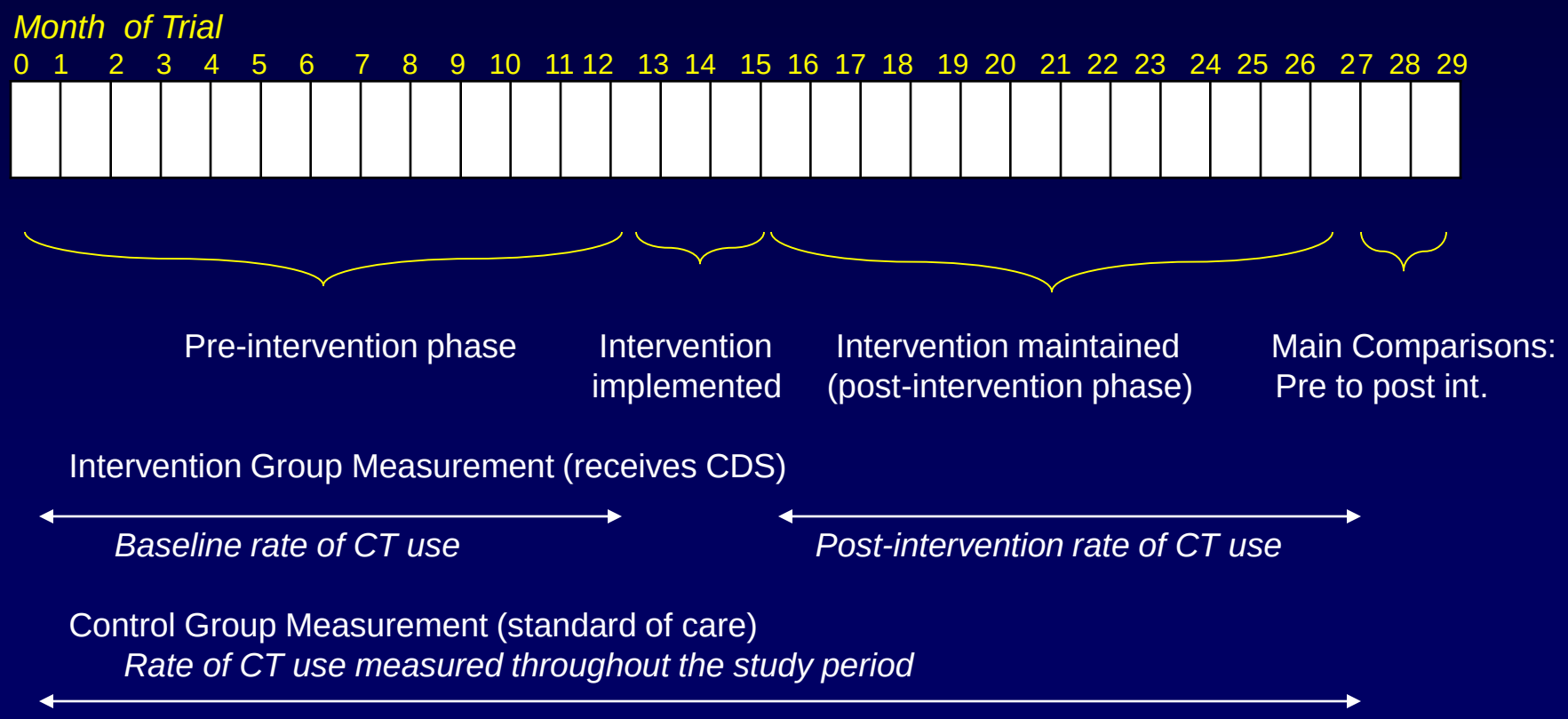
It’s Built: Now will they change

The Trial


Monitor knowledge use
Evaluate outcomes
Sustain knowledge use
Identify problem
Identify, review, select knowledge
ACTION CYCLE (Application)
Adapt knowledge to local context
Assess barriers to knowledge use
Select, tailor, implement interventions
KNOWLEDGE CREATION
Knowledge Inquiry
Knowledge Synthesis
Knowledge Tools/ Products
Tailoring knowledge

Methods – design

Interrupted Time Series Trial with Concurrent Controls

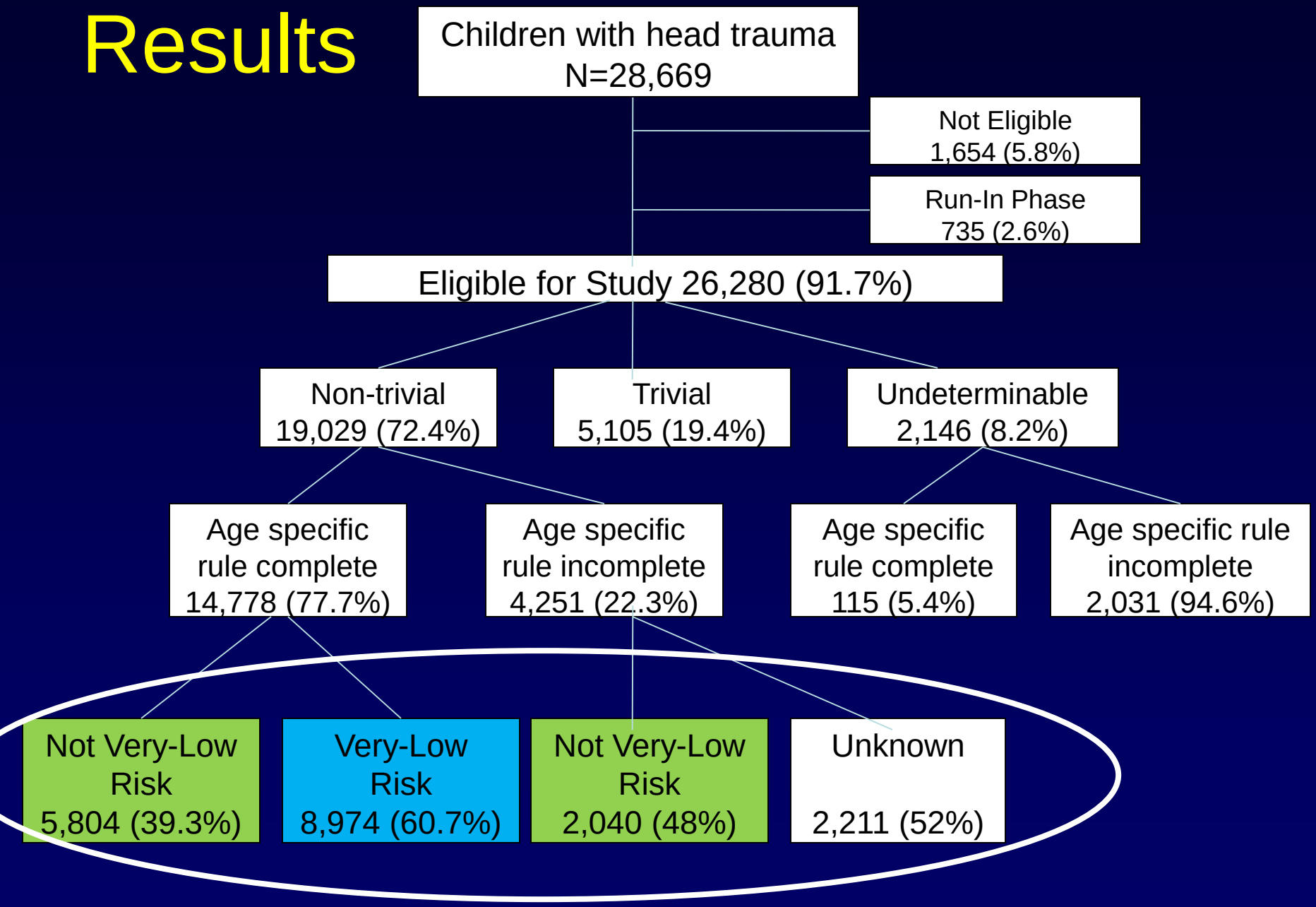


Methods

Trial sites

- 5 sites in PECARN
  - 4 pediatric EDs (1 control)
  - 1 pediatric ED within general ED
- 8 community, general EDs in Kaiser Permanente ED research network (CREST)
  - 3 paired EDs (1 control), 2 individual EDs
- All intervention sites used Epic
- Not randomized - informatics complexities

Results


Children with head trauma
N=28,669
Not Eligible
1,654 (5.8%)
Run-In Phase
735 (2.6%)
Eligible for Study 26,280 (91.7%)
Non-trivial
19,029 (72.4%)
Trivial
5,105 (19.4%)
Undeterminable
2,146 (8.2%)
Age specific rule complete
14,778 (77.7%)
Age specific rule incomplete
4,251 (22.3%)
Age specific rule complete
115 (5.4%)
Age specific rule incomplete
2,031 (94.6%)
Not Very-Low Risk
5,804 (39.3%)
Very-Low Risk
8,974 (60.7%)
Not Very-Low Risk
2,040 (48%)
Unknown
2,211 (52%)

Results

Very-low risk of ciTBI

EDs	CT Rate Before CDS	CT Rate After CDS	Adjusted OR
Intervention PED 1	5.4%	3.1%	0.56
Intervention PED 2	4.1%	2.7%	0.60
Intervention PED 3	8.0%	4.3%	0.49
Intervention PED 4	13.9%	13.2%	0.66

Results

Very-low risk of ciTBI

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Intervention PED 3	8.0%	4.3%	0.49
Intervention PED 4	13.9%	13.2%	0.66
Intervention GED 1	2.1%	2.6%	1.25
Intervention GED 2	2.7%	4.4%	1.78
Intervention GED 3	3.4%	1.8%	0.52
Intervention GED 4	4.0%	2.8%	3.30

Results

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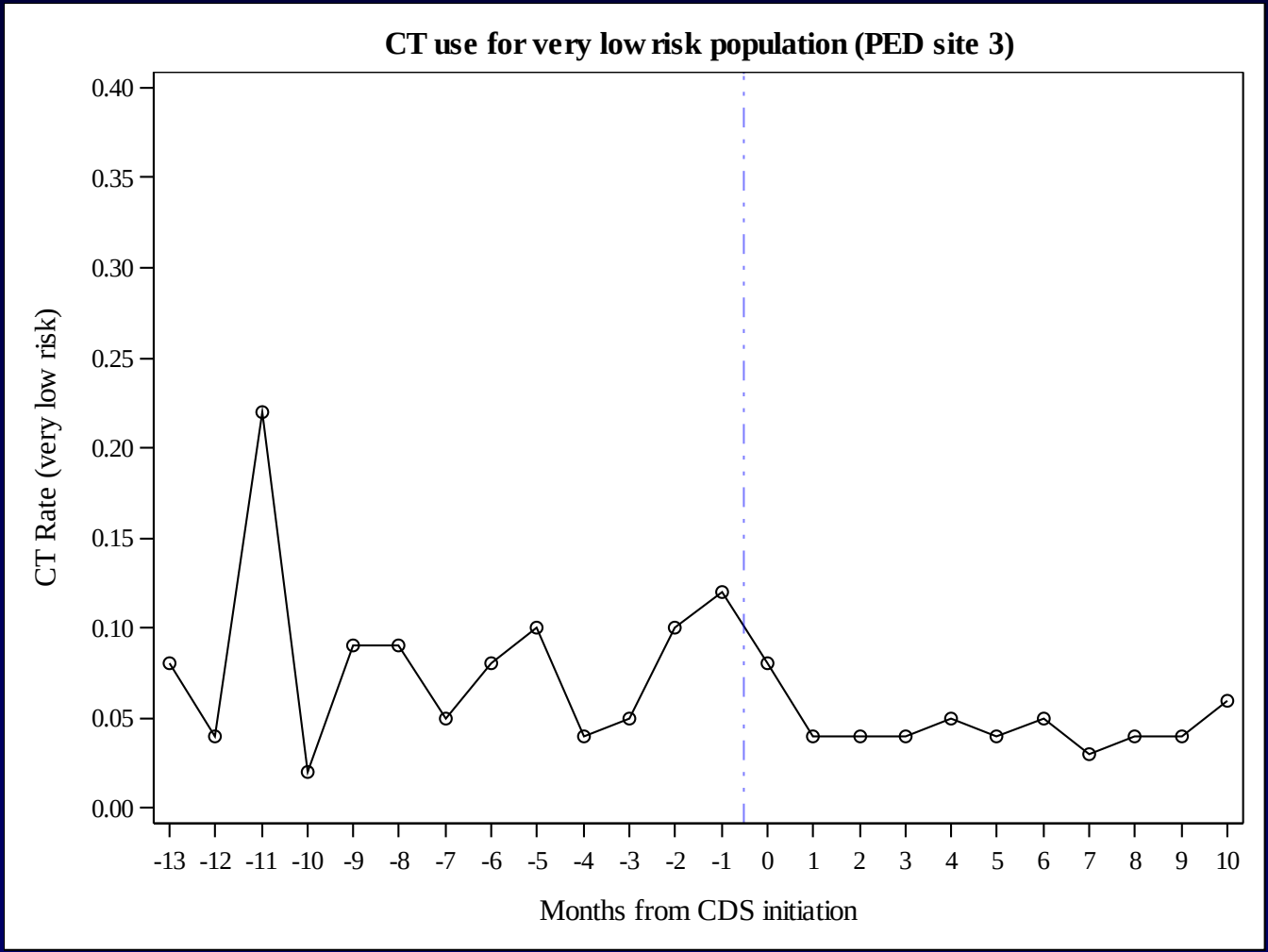
Intervention GED 2	2.7%	4.4%	1.78
Intervention GED 3	3.4%	1.8%	0.52
Intervention GED 4	4.0%	2.8%	3.30
Control PED	1.6%	2.9%	1.85
Control GED	7.1%	2.6%	0.35

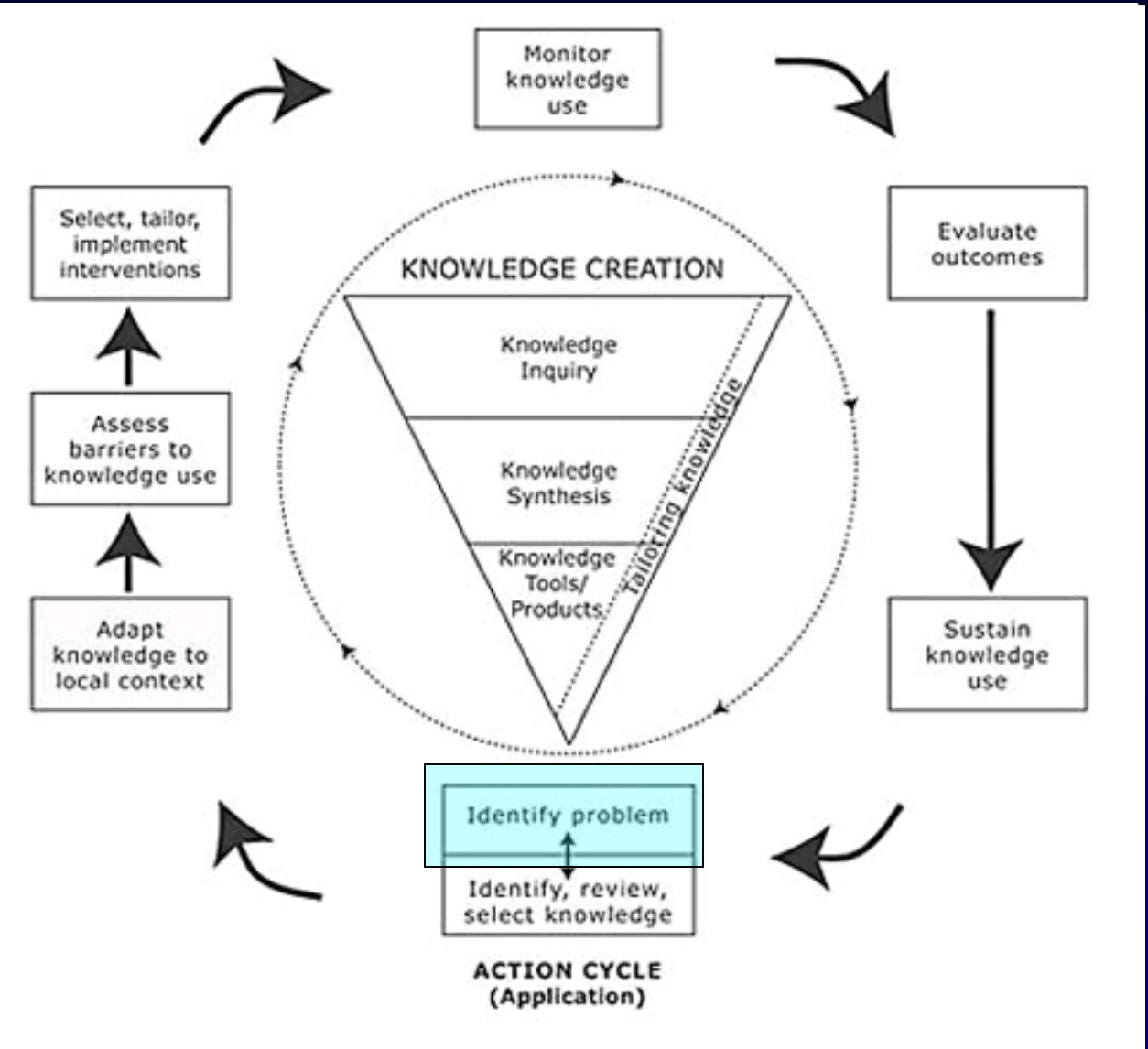
When stratified by age, the small decreases in CT rates at PEDs were noted mainly in children <2 years rather than in patients 2-18 years.

Results: very low-risk population

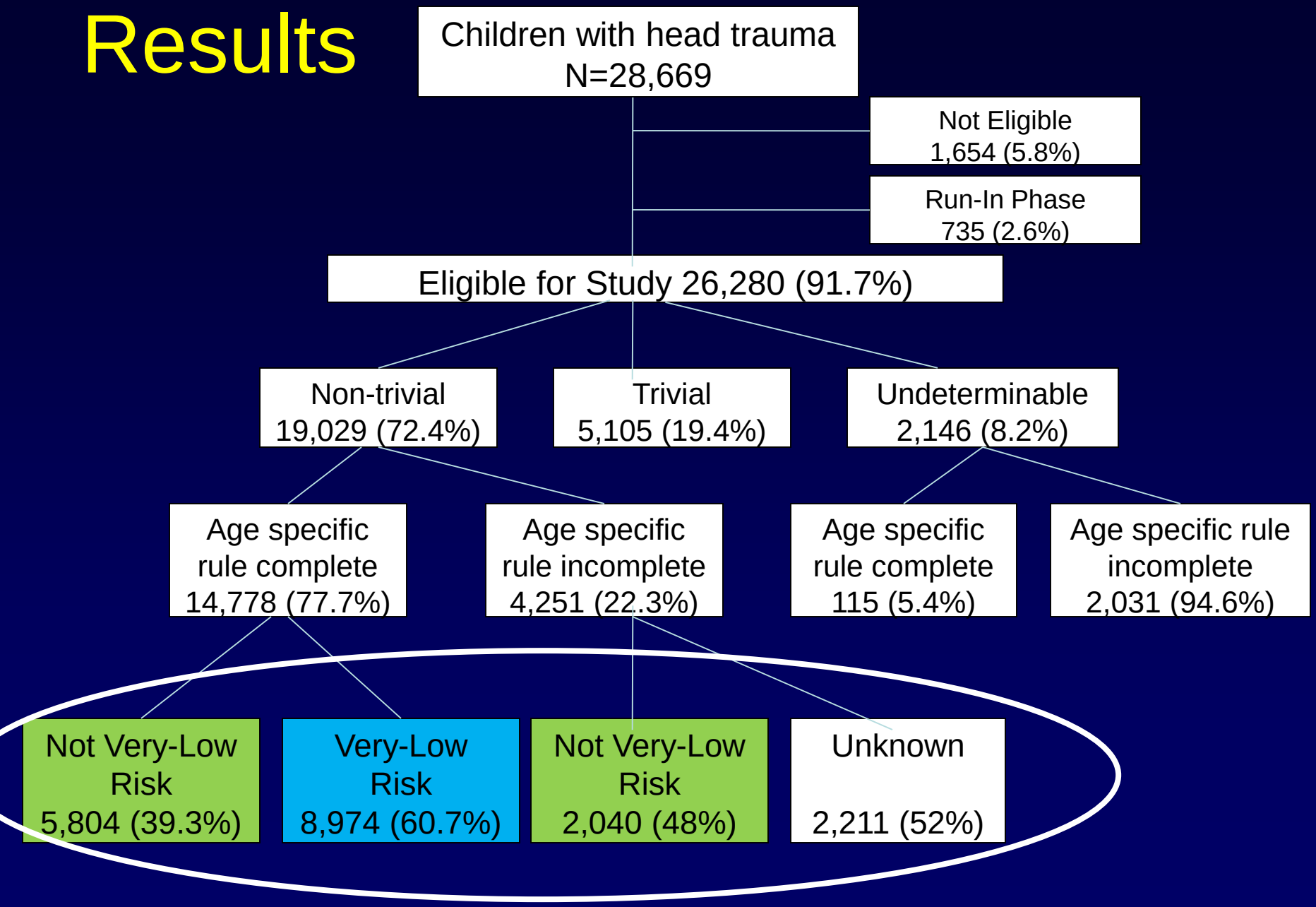
Example of CT use change over time



Knowledge to Action Cycle



Results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Unknown
2,211 (52%)

Results: Patients not meeting very-low risk criteria

EDs	CT Rate Before CDS	CT Rate After CDS
Intervention PED 1	33.6%	30.5%
Intervention PED 2	23.4%	21.2%
Intervention PED 3	33.1%	27.3%
Intervention PED 4	68.8%	64.8%
Intervention GED 1	38.3%	31.3%
Intervention GED 2	41.4%	32.2%
Intervention GED 3	31.8%	35.7%
Intervention GED 4	47.5%	35.7%

Results: Patients not meeting very-low risk criteria

EDs	CT Rate Before CDS	CT Rate After CDS
Intervention PED 1	33.6%	30.5%
Intervention PED 2	23.4%	21.2%
Intervention PED 3	33.1%	27.3%
Intervention PED 4	68.8%	64.8%
Intervention GED 1	38.3%	31.3%
Intervention GED 2	41.4%	32.2%
Intervention GED 3	31.8%	35.7%
Intervention GED 4	47.5%	35.7%
Control PED	36.5%	35.2%
Control GED	36.9%	44.4%

Study Conclusions

- EHR-based CDS led to small, variable decreases in CT use at PED sites in those at very low risk of ciTBI

- EHR-based CDS led to small decreases in CT use in all sites for patients with minor blunt head trauma

- CDS did not increase CT use in those patients who were not at very low risk of ciTBI

Summary

PECARN Implementation Study

Judicious, deliberate approach

- Develop the theoretical basis for an intervention
- Define components of the intervention
  - using modeling, simulation, or qualitative methods
- Conduct exploratory studies to further develop the intervention
- Perform evaluative study

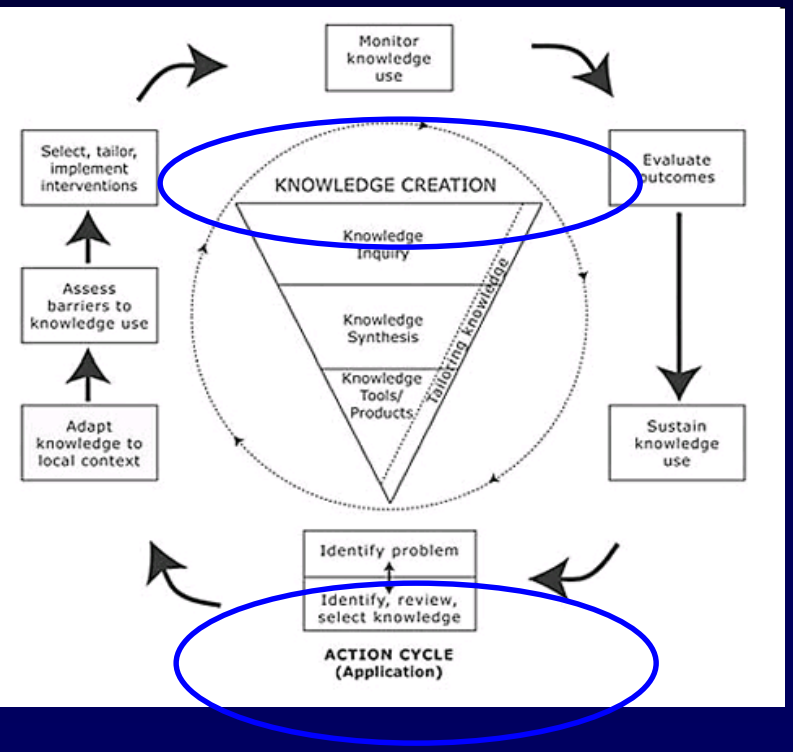
Eccles, Grimshaw, Qual Saf Health Care 2003

Recap

KT:

- Is the evidence ready?
  - If not, can still be transparent about use
- Prediction rules – validated? Made with KT in mind?
- What's the appropriate next step?
  - Use knowledge-to-action cycle

Recap



<u>'Definitive' Knowledge Creation</u>

- Multicenter collaboration – such as detailed for head trauma
- Think through how it will be implemented

<u>Thoughtful Progression to Successful Implementation (</u>*behavior change)*