History and Infrastructure of the Pediatric Emergency Care Applied Research Network (PECARN)

Rakesh D. Mistry, MD, MS
CHCO Section of Emergency Medicine
ACCORDS Learning Health Seminar
November 15, 2021

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care
Applied Research Network

Disclosures

- Funding

  Emergency Medical Services for Children Network for the sustainability of a Pediatric Emergency Care Applied Research Network. U03MC0007-11, Maternal Child Health Bureau

- No conflicts of interest

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

Objectives

1. Describe the infrastructure used to support the PECARN network and research studies

2. Identify challenges to conduct or large scale, multicenter prospective research in pediatric emergency medicine (PEM)

3. Describe the power and complexities of the PECARN Registry for large data research

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

What is PECARN?

- First federally-funded pediatric emergency medicine (PEM) research network in the US

- Goal: *Conduct meaningful and rigorous multi-institutional research into the prevention and management of acute illnesses and injuries in children and youth across the continuum of EM health care*

- Particularly useful to conduct studies in need of large sample sizes to analyze relatively rare outcomes

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

Why did we form PECARN?

- Prior multicenter network: Pediatric Emergency Medicine Collaborative Research Committee (1994)
  - Largely retrospective studies
  - No funding required
  - Open to many institutions

- Limitations
  - Fully dependent on volunteerism
  - Onerous regulatory management
  - No organized method for data management and analysis
  - Data issues: inadequate sample, case ascertainment, missingness

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

PECARN

- Federally-funded since 2001
  - HRSA/Maternal Child Health Bureau
  - Emergency Medical Services for Children (EMSC) program
  - Funds support infrastructure, **NOT** projects

- Infrastructure Composition (2001)
  - 6 Research Nodes: Pediatric and general EDs
  - Data Coordinating Center
  - Competitive renewal every 4 years

Children's Hospital Colorado
Section of Emergency Medicine

The Pediatric Emergency Care Applied Research Network (PECARN): rationale, development, and first steps. Acad Emerg Med. 2003 Jun;10(6):661-8. PMID: 12782530.

PECARN
Pediatric Emergency Care Applied Research Network

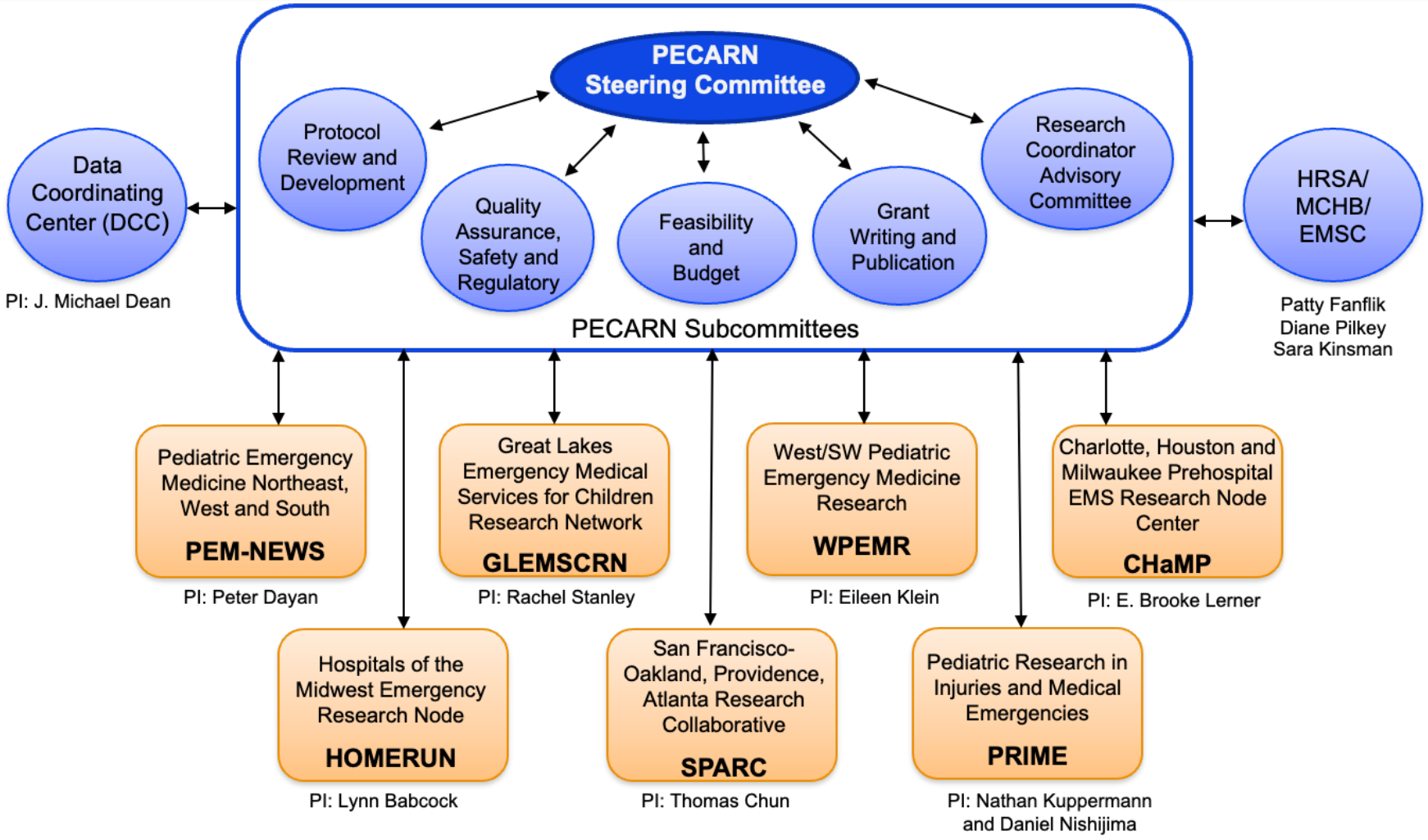
Current PECARN Organization

- 6 Research Node Centers
  - 18 hospital EDs
  - 6 Emergency Medical Service Affiliate agencies (1/node)
- 1 Prehospital node (3 EMS agencies)
- Data Coordinating Center (DCC, Univ of Utah)

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

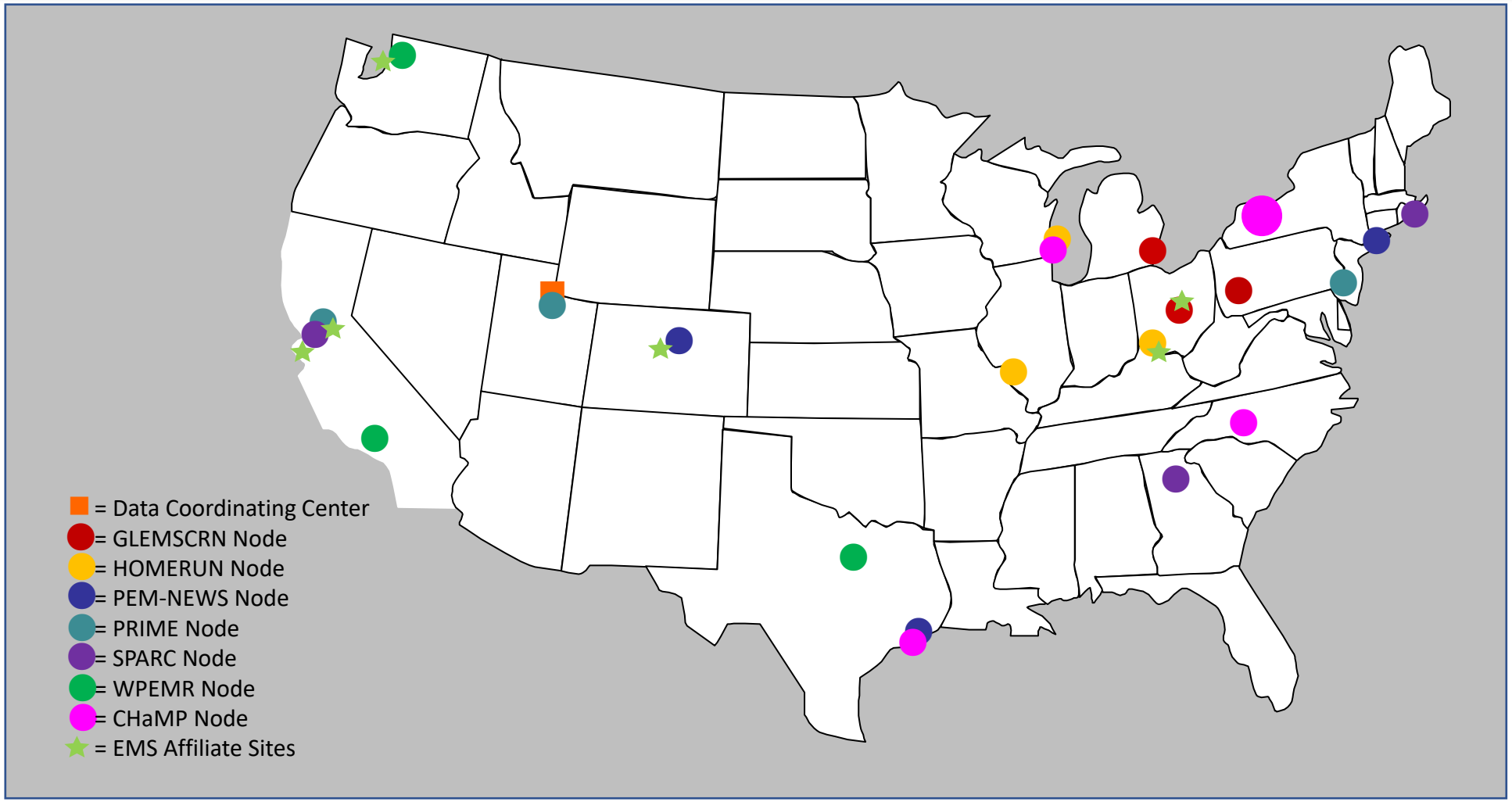
PECARN Governance



Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

PECARN: 2021



Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

PECARN Node Example

- Pediatric EM Northeast, West, and South (PEM-NEWS)
  - Columbia/Morgan Stanley: Maria Kwok (Site PI)
  - Texas Children's Hospital: Andrea Cruz (Site PI)
  - Children's Hospital Colorado: Rakesh Mistry (Site PI)
  - Aurora Fire EMS Affiliate: Katheen Adelgais (EMSA PI)

- PEM-NEWS Nodal Administration
  - Peter Dayan (Primary Investigator)
  - Raquel Shrager (Nodal administrator)

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

PECARN Enrollment

- Prospective enrollment at each ED
  - Research Coordinator (1.0 FTE funded)
  - Additional RC or PRAs (Funded by each study)

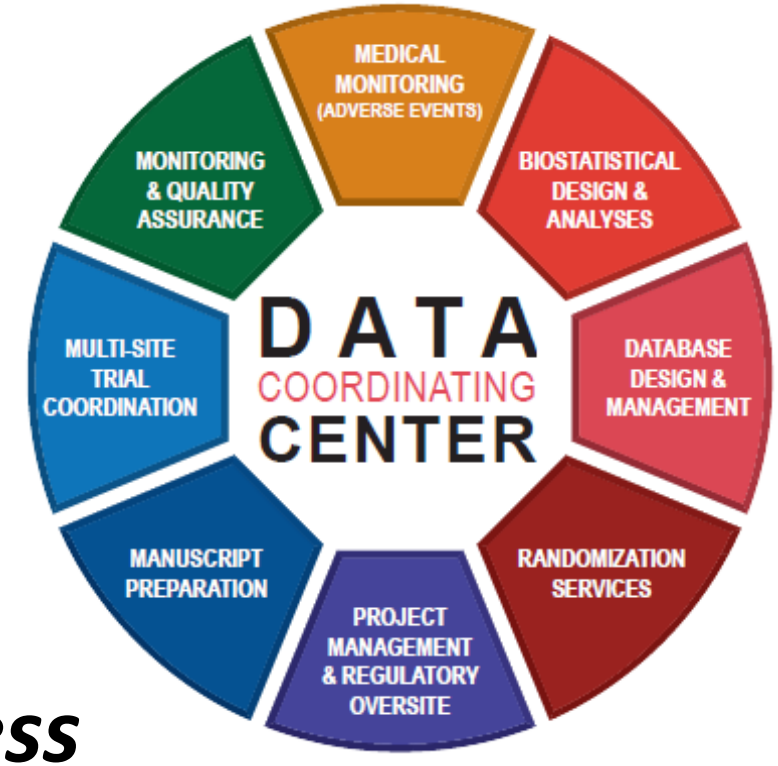
- Data Coordinating Center
  - Centrally created IRB, consent, and data collection forms
  - Data management (OpenClinica and QueryManager)
  - Statistical analysis

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care
Applied Research Network

DCC Faculty and Staff

- DCC PI: PECARN leadership and governance
- Project management (20)
- Data management/informatics (13)
- Biostatistics support (6 PhD/15 MS)
- IT systems (12)
- Manuscript development
- ***Concept-to-grant development process***



Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

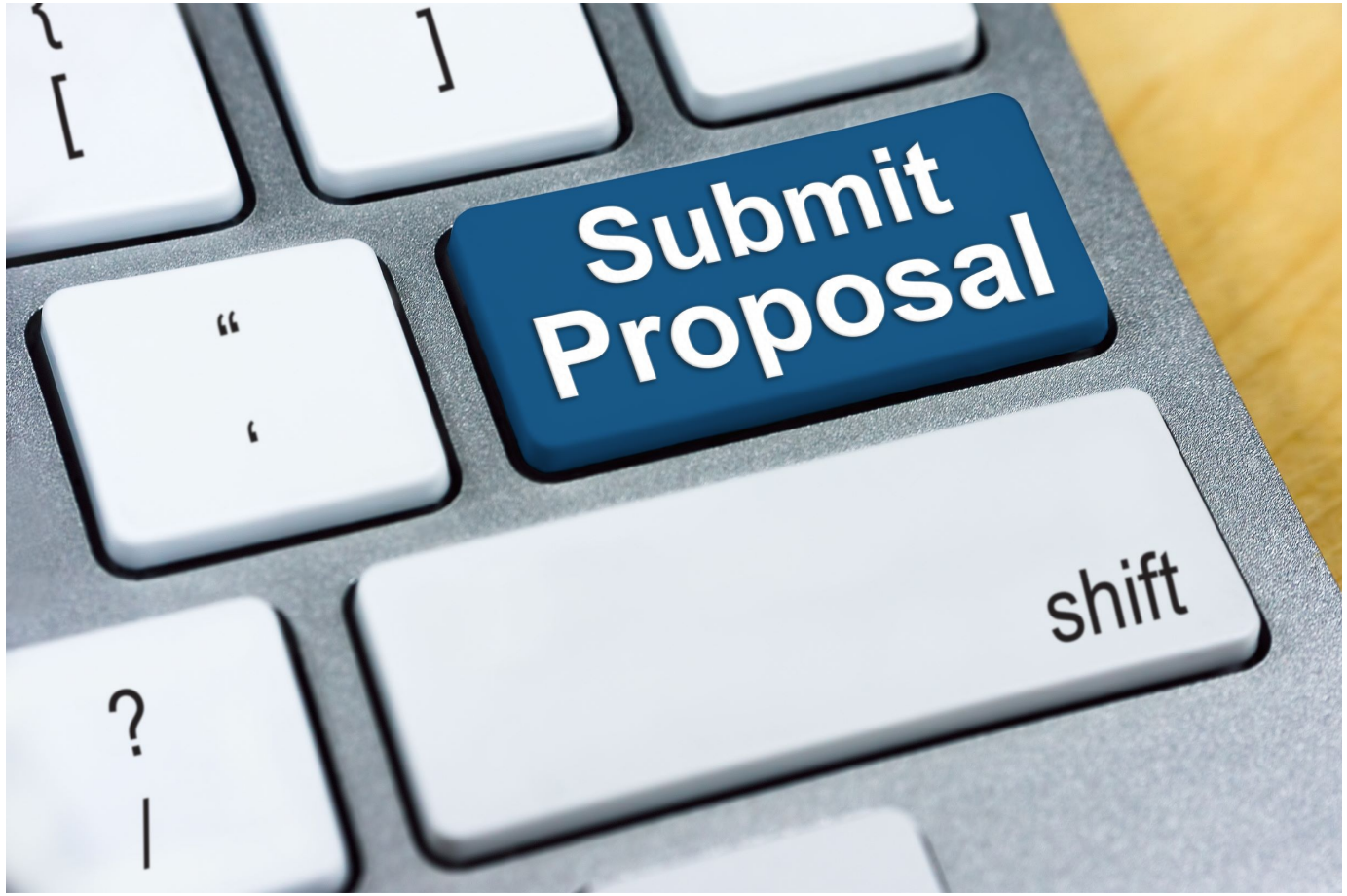
Submission of PECARN Studies

- Most originate within the existing EDs and EMSAs
- Non-PECARN investigators can submit with sponsorship from existing PECARN node
- Benefits
  - Access to over 1,000,000 ED visits per year
  - Scientific expertise
  - Data management and analysis via DCC
  - High extramural funding rate

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

Submission Process/Timelines



Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

Submission Process/Timelines

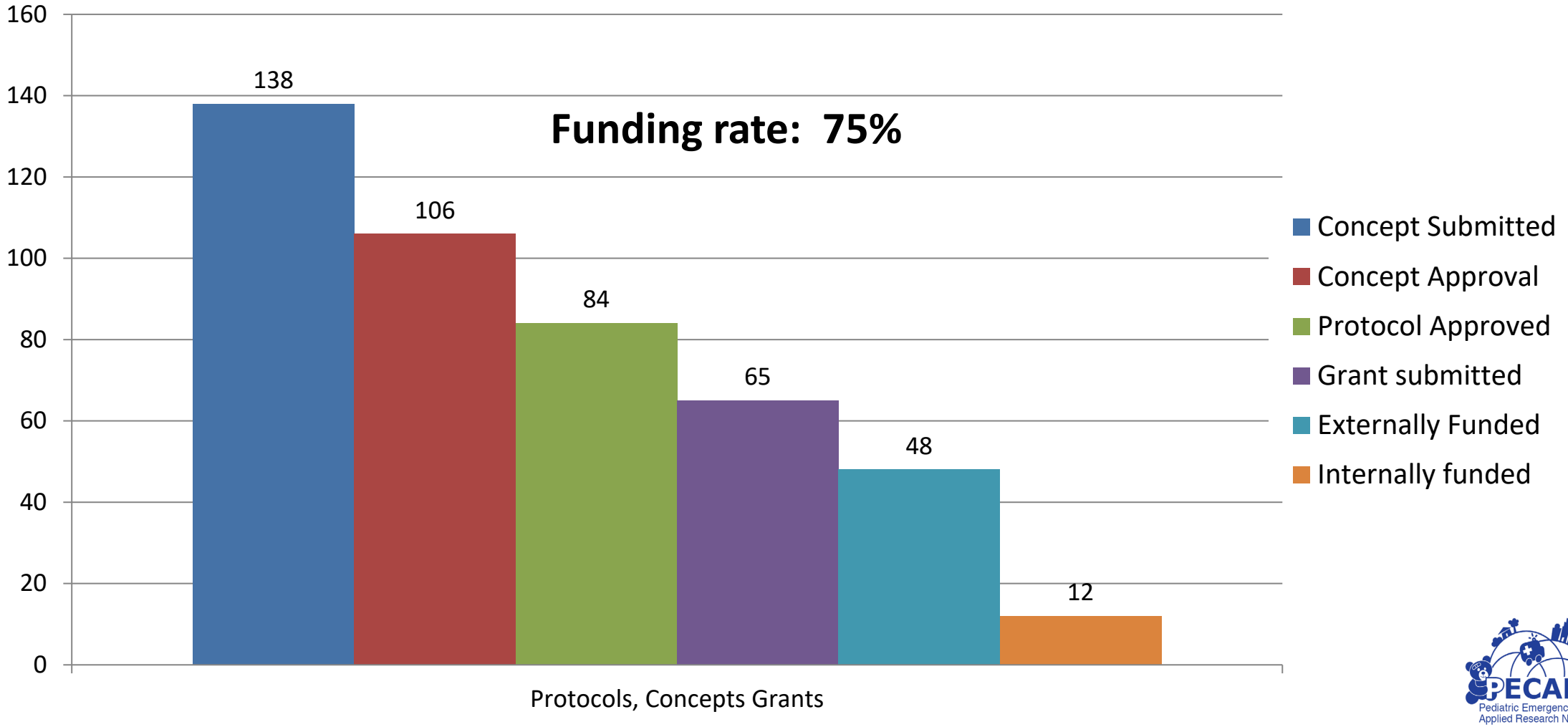
Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care
Applied Research Network

Submission Process/Timelines

- Development within Node and Nodal Approval
- Concept submission/presentation to PECARN SC
  - Vote for acceptance
  - Feedback provided
- Protocol/Grant Submission
  - Subcommittee feedback
  - No vote
- Protocol/Grant Submission (for vote)
- PECARN Approval…*then* submit to funding agency

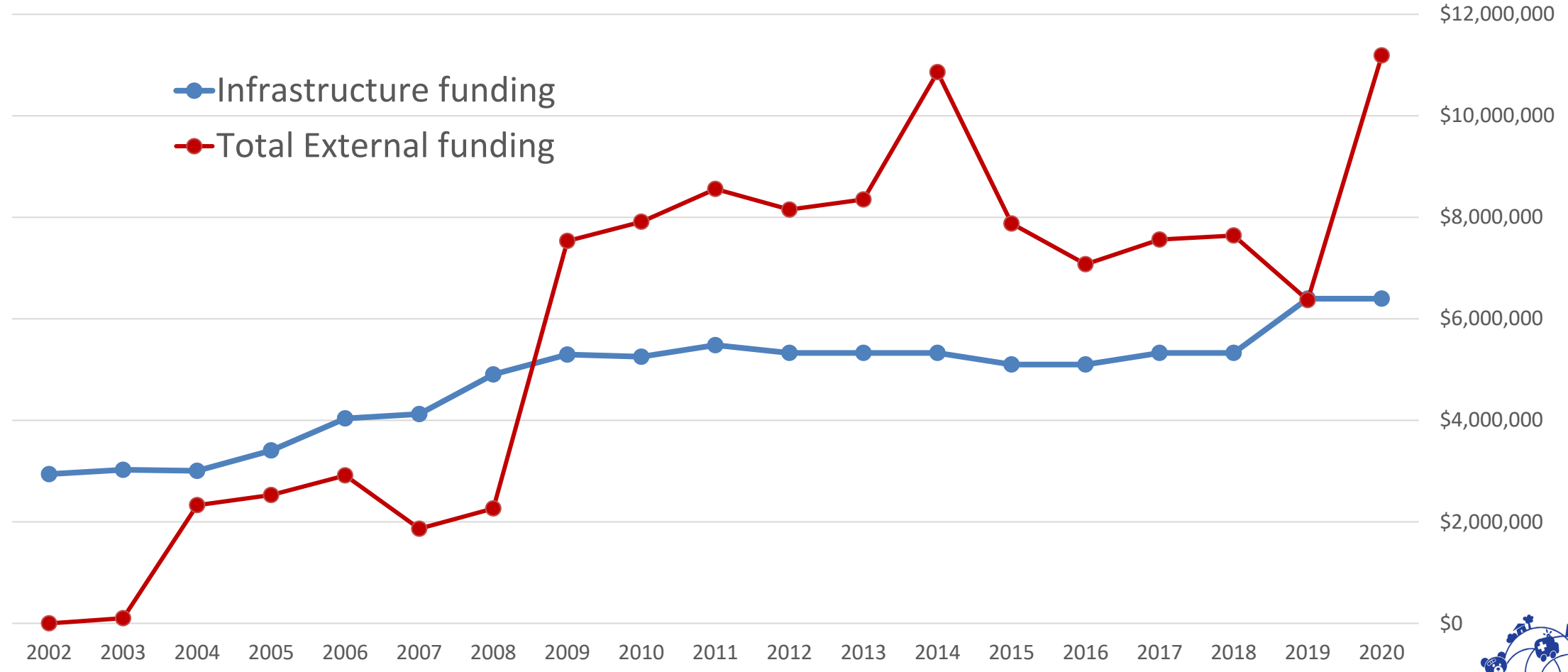
2001-Pres: Concepts, Protocols, Grants



Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

PECARN Annual Funding



Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care
Applied Research Network

Foci of PECARN Research

Disease Processes

- Traumatic injuries
- Respiratory illnesses
- Infectious diseases
- Sickle cell anemia
- Adolescent & mental health
- Critical illnesses: sepsis, seizure, DKA
- Prehospital/EMS care

Methodologies

- Complex RCTs
- Prediction modeling
- Risk stratification
- ***Clinical decision support***
- ***Novel approaches to use of large data***

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care
Applied Research Network

Foci of PECARN Research

Current Studies
Normal Saline vs. Lactated Ringers for Pediatric Sepsis
Azithromycin for Young Children with Wheezing
Dosing Regimen for Pediatric Seizures in the Prehospital Setting
Arginine for Sickle Cell Disease Vaso-Occlusive Crisis in Children
Procalcitonin to Determine Antibiotic Need in Children with Community-Acquired Pneumonia
Risk Stratification for Emergent Intracranial Abnormalities in Children with Headaches
Prediction Model for Pulmonary Embolus in Children
Risk Stratification for Pediatric Cervical Spine Injury
Pain Control in Children with Long Bone Fractures
Pediatric Sepsis Screening: Identification of Those at Risk

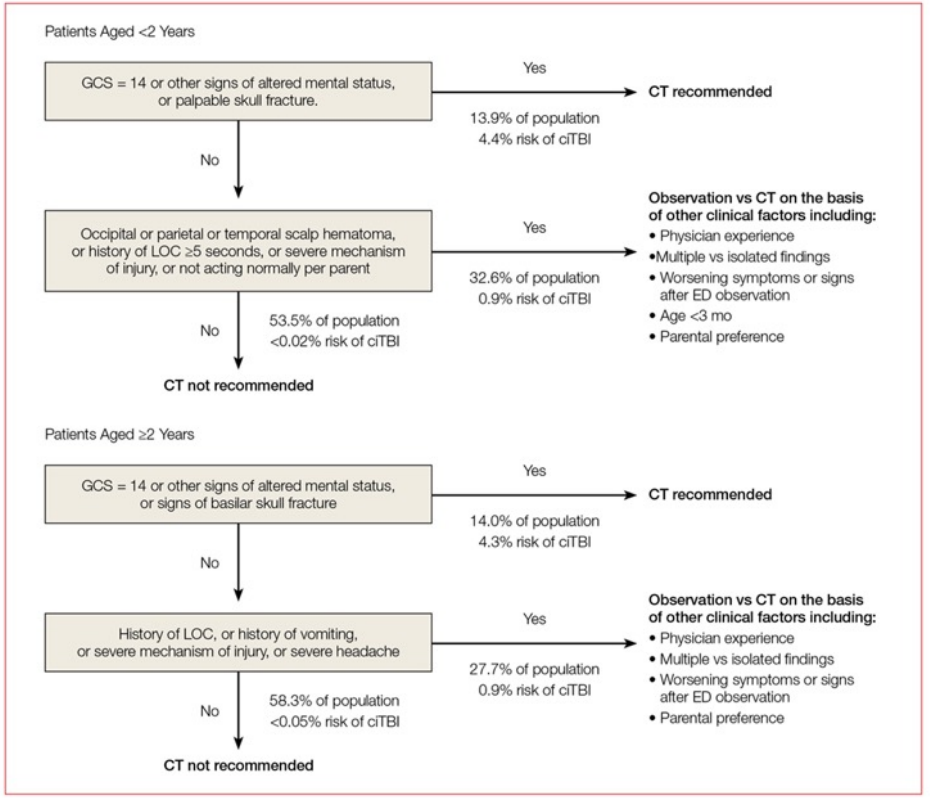
What about our patients?????

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care
Applied Research Network

Pediatric Head Trauma

- 42,412 children enrolled
  - CT Scans: 14,969 (35.3%)
  - Clinically important TBI: 376 (0.9%)
- Rules derived for <2 and ≥2 yrs of age
- Negative Predictive Values
  - <2 yrs: 1176/1176 (100.0%; 99.7-100.0)
  - ≥2 yrs: 3798/3800 (99.95%; 99.81-99.99)



Children's Hospital Colorado
Section of Emergency Medicine

Kuppermann et al,; Pediatric Emergency Care Applied Research Network (PECARN). Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study. Lancet. 2009 Oct 3;374(9696):1160-70.

PECARN
Pediatric Emergency Care Applied Research Network

PECARN and Implementation Science

Use of Traumatic Brain Injury Prediction Rules With Clinical Decision Support

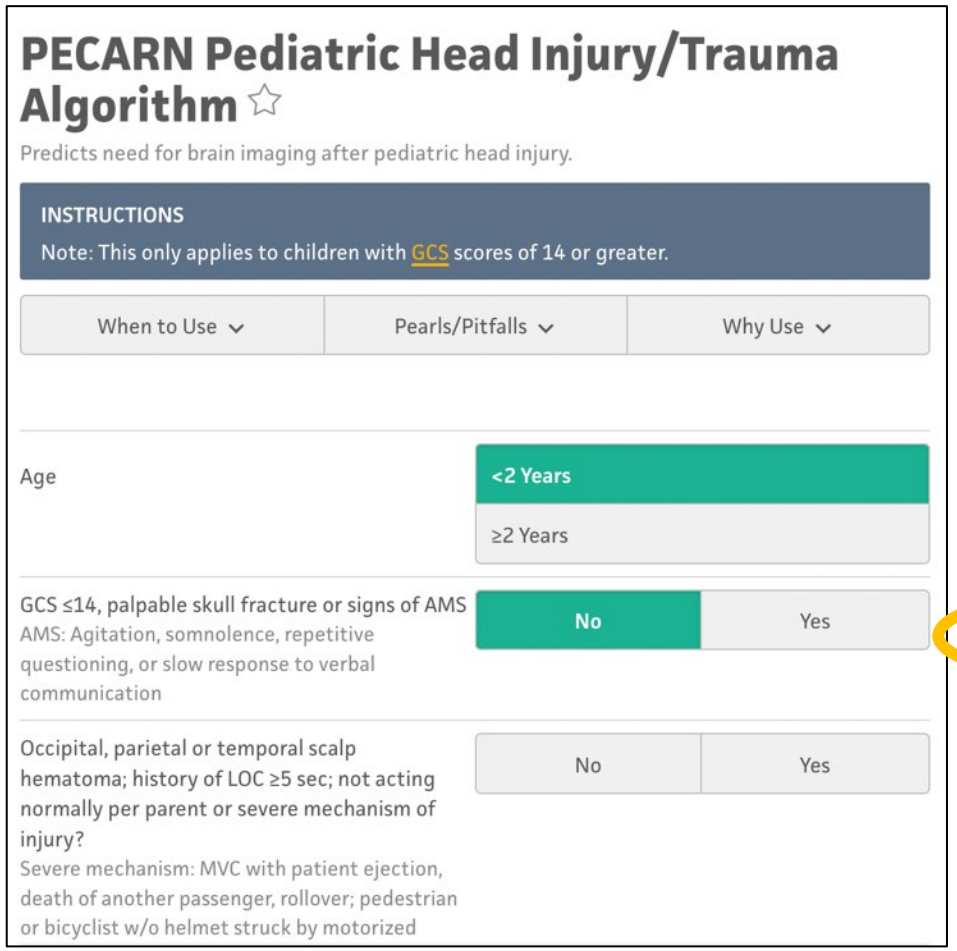
Peter S. Dayan, MD, MSc,[a] Dustin W. Ballard, MD, MBE,[b,c] Eric Tham, MD,[d] Jeff M. Hoffman, MD,[e] Marguerite Swietlik, MSN, RN,[f] Sara J. Deakyne, MPH,[f] Evaline A. Alessandrini, MD, MSCE,[g] Leah Tzimenatos, MD,[h,i] Lalit Bajaj, MD, MPH,[d] David R. Vinson, MD,[c,j] Dustin G. Mark, MD,[k] Steve R. Offerman, MD,[l] Uli K. Chettipally, MD, MPH,[m] Marilyn D. Paterno, MSBI,[n] Molly H. Schaeffer, MSc,[o] Jun Wang, MS,[p] T. Charles Casper, PhD,[p] Howard S. Goldberg, MD,[n,o] Robert W. Grundmeier, MD,[q] Nathan Kuppermann, MD, MPH,[h,i] for the Pediatric Emergency Care Applied Research Network (PECARN), Clinical Research on Emergency Services and Treatment (CREST) Network, and Partners Healthcare; Traumatic Brain Injury-Knowledge Translation Study Group

Children's Hospital Colorado
Section of Emergency Medicine

Dayan PS et al; Pediatric Emergency Care Applied Research Network (PECARN); Clinical Research on Emergency Services and Treatment (CREST) Network; and Partners Healthcare; Traumatic Brain Injury-Knowledge Translation Study Group. Pediatrics. 2017 Apr;139(4):e20162709

PECARN
Pediatric Emergency Care Applied Research Network

PECARN Head Trauma: Bedside



PECARN Pediatric Head Injury/Trauma Algorithm ☆

Predicts need for brain imaging after pediatric head injury.

INSTRUCTIONS

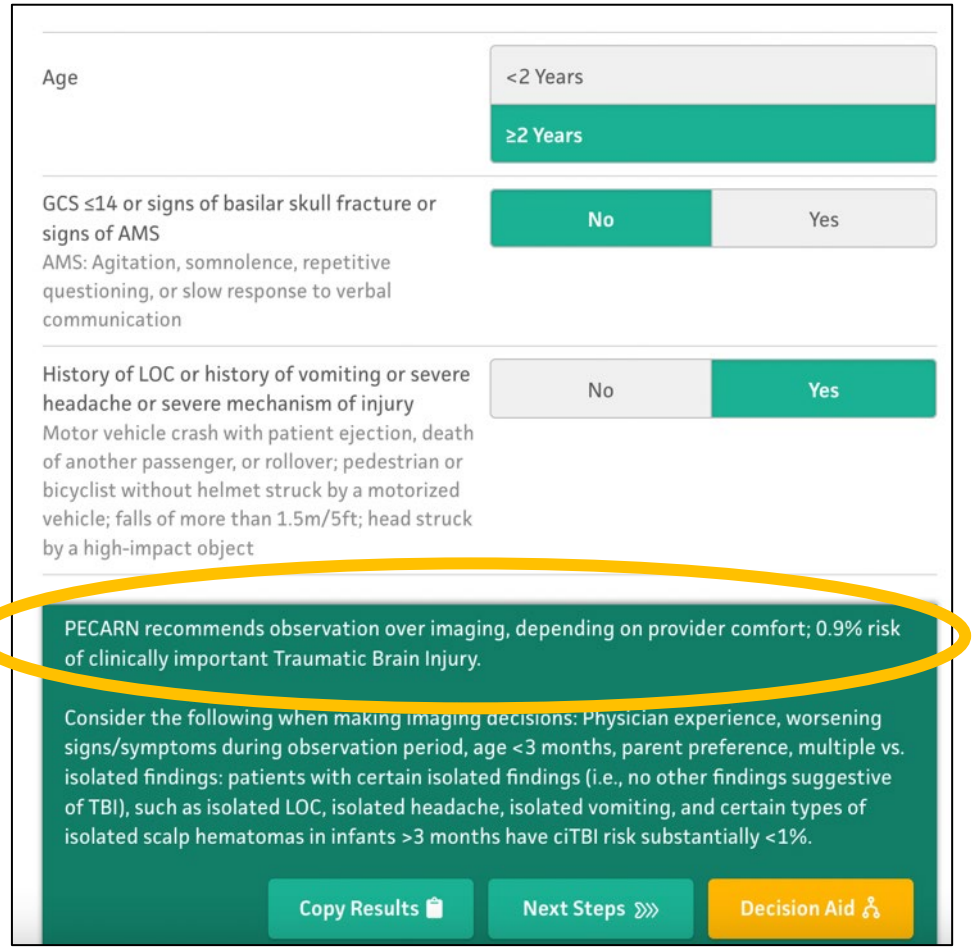
Note: This only applies to children with GCS scores of 14 or greater.

When to Use ⌄ | Pearls/Pitfalls ⌄ | Why Use ⌄

Age: **<2 Years** / ≥2 Years

GCS ≤14, palpable skull fracture or signs of AMS: **No** / Yes
AMS: Agitation, somnolence, repetitive questioning, or slow response to verbal communication

Occipital, parietal or temporal scalp hematoma; history of LOC ≥5 sec; not acting normally per parent or severe mechanism of injury?: No / Yes
Severe mechanism: MVC with patient ejection, death of another passenger, rollover; pedestrian or bicyclist w/o helmet struck by motorized



Age: <2 Years / **≥2 Years**

GCS ≤14 or signs of basilar skull fracture or signs of AMS: **No** / Yes
AMS: Agitation, somnolence, repetitive questioning, or slow response to verbal communication

History of LOC or history of vomiting or severe headache or severe mechanism of injury: No / **Yes**
Motor vehicle crash with patient ejection, death of another passenger, or rollover; pedestrian or bicyclist without helmet struck by a motorized vehicle; falls of more than 1.5m/5ft; head struck by a high-impact object

PECARN recommends observation over imaging, depending on provider comfort; 0.9% risk of clinically important Traumatic Brain Injury.

Consider the following when making imaging decisions: Physician experience, worsening signs/symptoms during observation period, age <3 months, parent preference, multiple vs. isolated findings: patients with certain isolated findings (i.e., no other findings suggestive of TBI), such as isolated LOC, isolated headache, isolated vomiting, and certain types of isolated scalp hematomas in infants >3 months have ciTBI risk substantially <1%.

Copy Results | Next Steps ⋙ | Decision Aid

Children's Hospital Colorado
Section of Emergency Medicine

https://www.mdcalc.com/pecarn-pediatric-head-injury-trauma-algorithm

PECARN
Pediatric Emergency Care Applied Research Network

CALIFORNIA ACEP
AMERICAN COLLEGE OF EMERGENCY PHYSICIANS

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

- **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

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

YES TO ANY

CT

*High Risk – 4.3% risk of ci-TBI**

NO

CT not indicated, **Observe**

Low Risk – < 0.05%

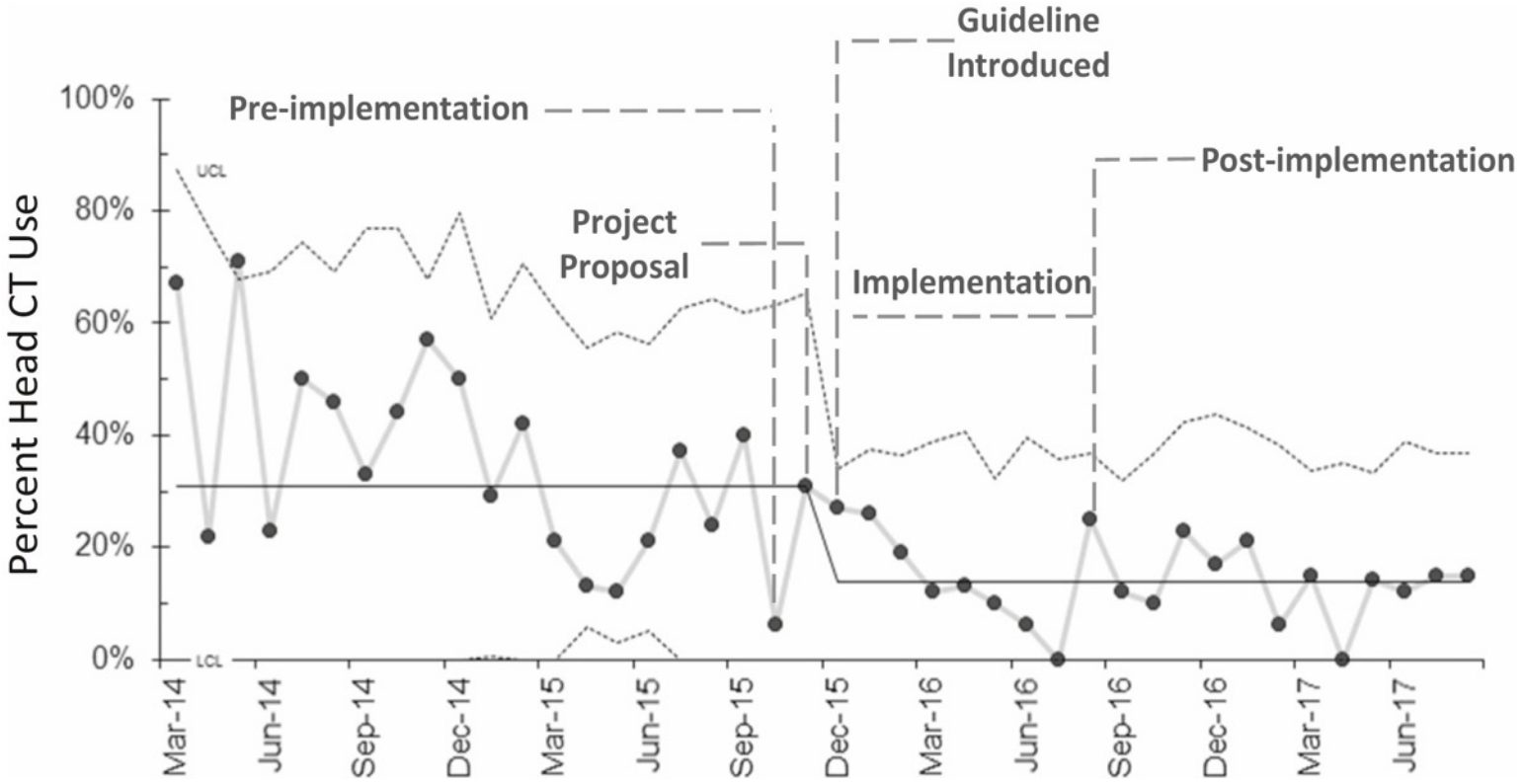
**ci-TBI: risk of clinically important TBI needing acute intervention, based on PECARN validated prediction rules*

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

Application in Practice

Reduction of Computed Tomography Use for Pediatric Closed Head Injury Evaluation at a Non-pediatric Community Emergency Department



Children's Hospital Colorado
Section of Emergency Medicine

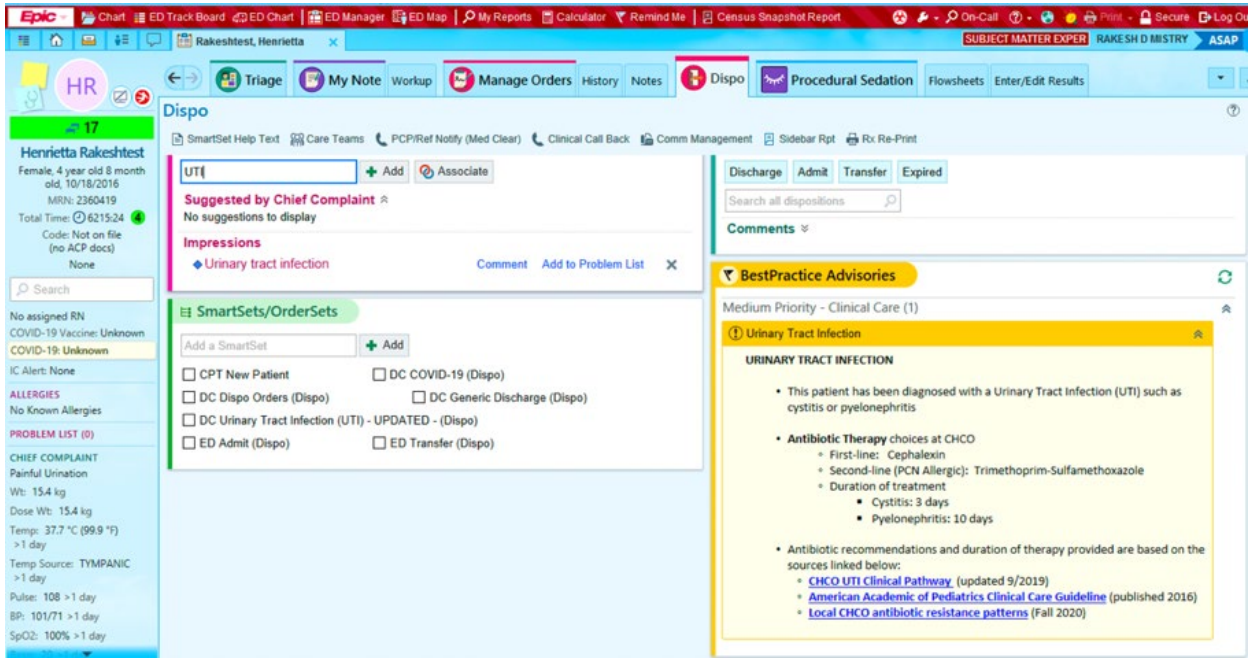
Ballard DW, Pediatric Emergency Care Applied Research Network (PECARN);. Ann Emerg Med. 2019 May;73(5):440-451.

PECARN
Pediatric Emergency Care Applied Research Network

Upcoming Development of CDS

- Implementation of ED-based Antimicrobial Stewardship (PI: Mistry)

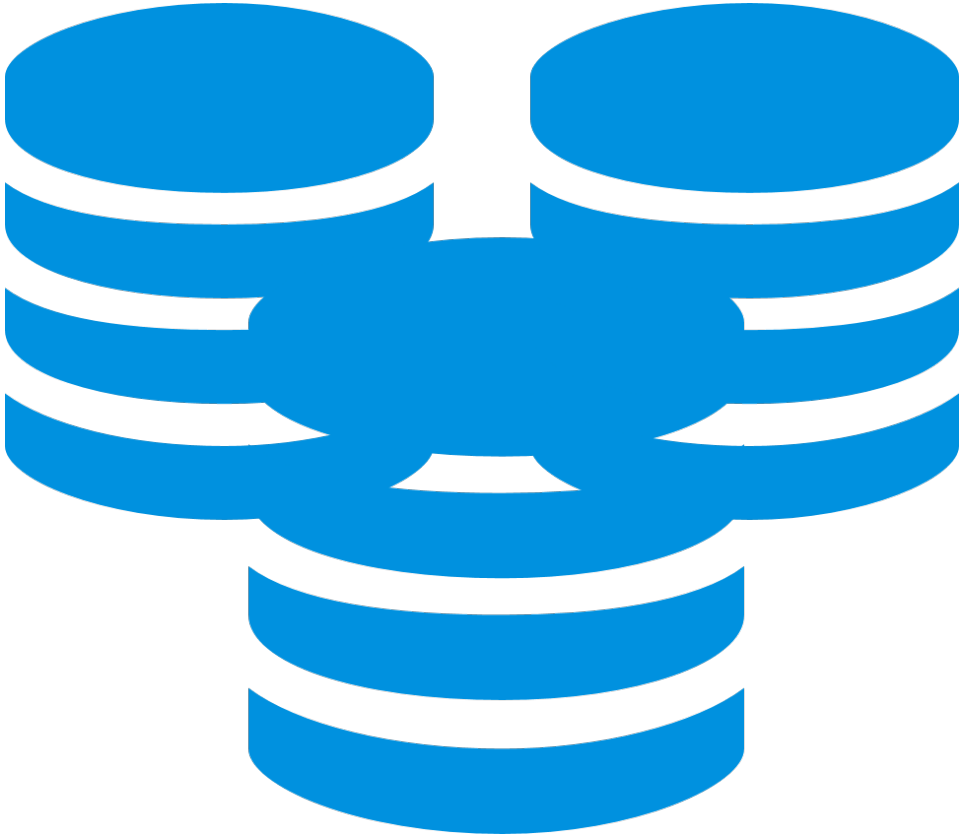
- Implementation of Febrile Infant Clinical Decision Rule (PIs: Mahajan/Kuppermann)



Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

Datasets and Big Data

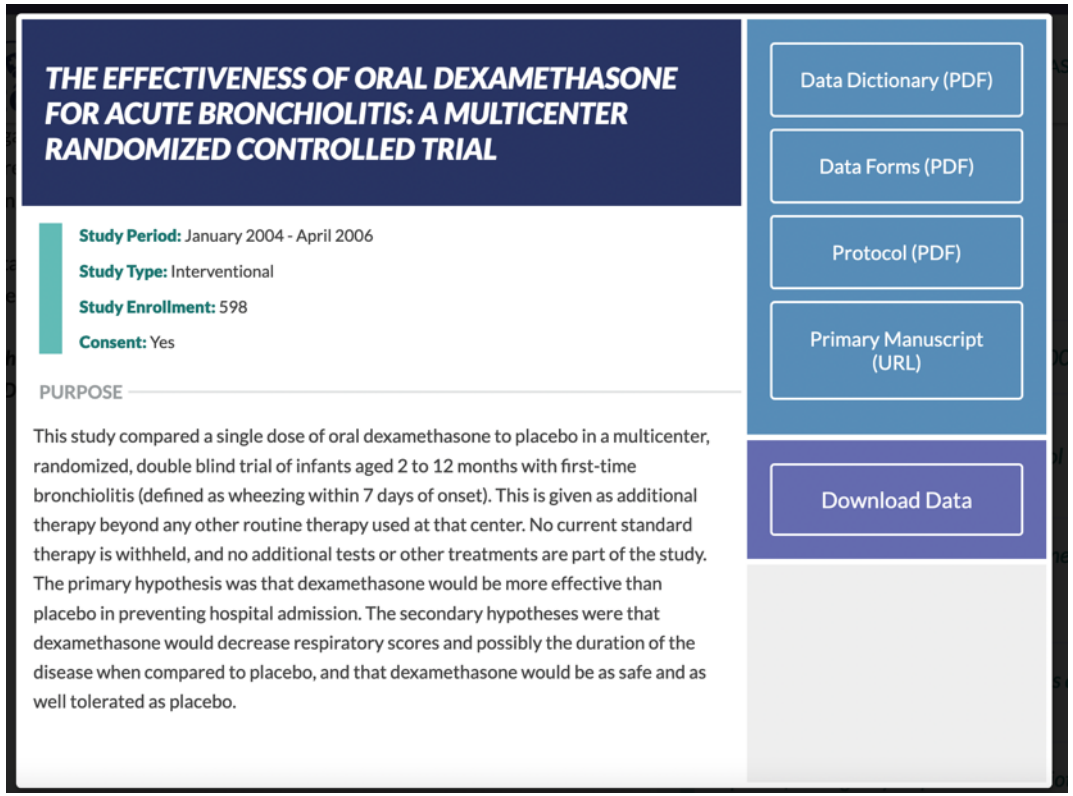


Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care
Applied Research Network

PECARN Public Use Datasets

- Federally-funded data released 3 years after lock
- Complete, de-identified study data available
- Currently 15 datasets available for use



https://pecarn.org/datasets/

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

PECARN Registry Project

- Funded by AHRQ in 2012
- Objective: Create medical record registry via compete EHR data extraction from multiple sites
- Potential Uses
  - Grant preparation and future research
  - Quality improvement
  - Funded research
    - Predictive modeling, risk assessment, machine learning
    - Comparative effectiveness
    - Linked for prospective enrollment

Children's Hospital Colorado
Section of Emergency Medicine

Deakyne S and Alpern ER; The PECARN Registry: A Multicenter Electronic Health Record Registry of Pediatric Emergency Care. Appl Clin Inform. 2018 Apr;9(2):366-376.

PECARN
Pediatric Emergency Care Applied Research Network

PECARN Registry

- Participating EDs
  - Initially 4 sites; now 12
  - 10 Epic EHR and 2 Cerner
- Complete EHR ED visits
- Transfers monthly to DCC

Cumulative Totals 2012-2020

Data point	Total
Sites	12
Encounters	5,184,410
Patients	1,918,346
Diagnoses	21,843,323
Lab Tests	5,272,065
Lab Results	38,621,682
Microbiology Tests	2,184,617
Microbiology Results	2,842,939
Medication Orders	7,294,339
Medication Administrations	7,959,884
Radiology Tests	1,990,308
Narrative Documents	28,105,263
Providers included in report cards	1,643

Children's Hospital Colorado
Section of Emergency Medicine

Deakyne S and Alpern ER; The PECARN Registry: A Multicenter Electronic Health Record Registry of Pediatric Emergency Care. Appl Clin Inform. 2018 Apr;9(2):366-376.

PECARN
Pediatric Emergency Care Applied Research Network

PECARN Registry Variables

- Patient Identifiers: Patient number, encounter number
- Demographics: Date of birth (DOB), sex, race, ethnicity, zip, payer
- Visit Information: Triage category, chief complaint, arrival mode
- Date/Time: notification, ED door, sort/triage, discharge
- Providers: Provider ID, provider role, provider D/T
- Vitals: Vitals D/T, T, HR, RR, SBP, DBP, oxygen saturation, weight
- Medications: Current; ED (D/T); discharge
- Clinical Assessments: Asthma score, Pain score, Glasgow Coma Scale (GCS)
- **Narrative: Narrative D/T, author type, narrative**
- Radiology: Order D/T, start D/T, avail D/T, report D/T, report
- Labs (including Micro): Lab D/T result
- Procedures: CPT, ICD9, ICD10
- Diagnosis: ICD9, e-codes, ICD10
- Disposition: ED disposition, Hospital discharge D/T, Vital status

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

PECARN Registry: Data Flow

Courtesy, Elizabeth R.Alpern, MD, MSCE

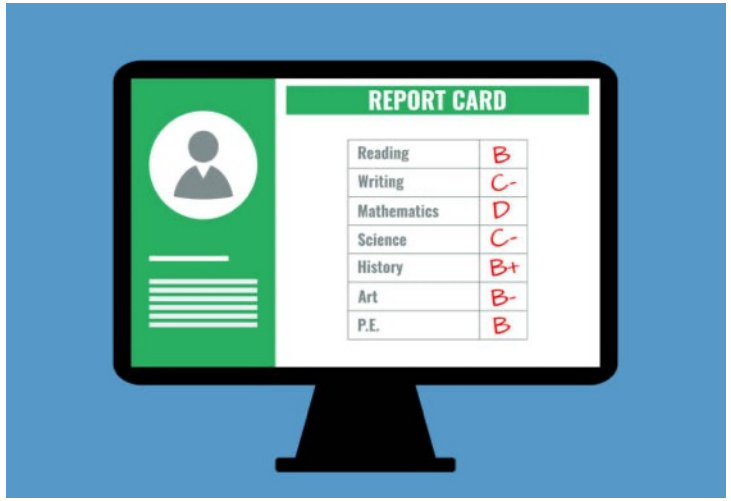
Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

Bringing Registry Data to the Provider

- Automated feedback
  - Associated with improvements in care
  - Assists with sustainability of change

- Report cards



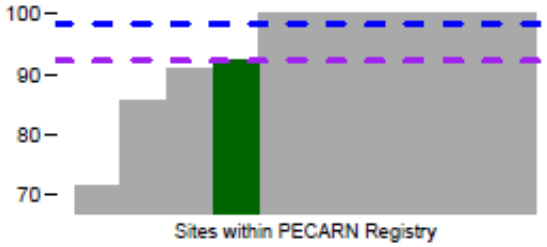
Children's Hospital Colorado
Section of Emergency Medicine

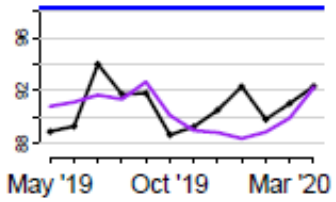
PECARN
Pediatric Emergency Care
Applied Research Network

Monthly Site Report Cards

Systemic corticosteroids given in the ED

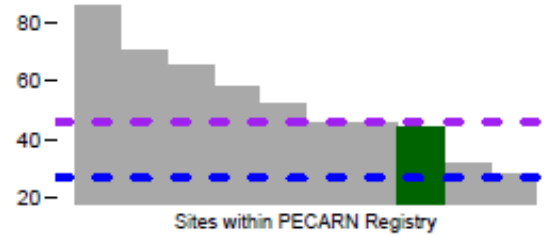
Site	92.3% (N=52)
Network	92.2%
ABC	98.3%

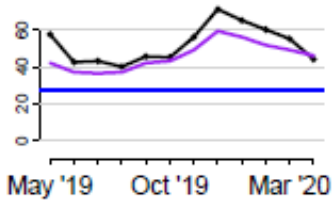




Time (min) to first beta-agonist treatment

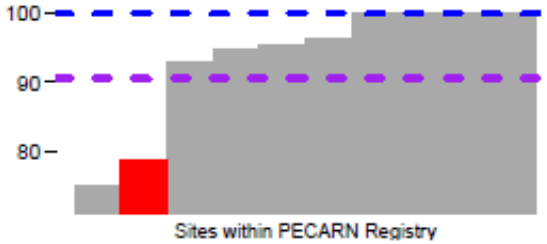
Site (med[IQR])	44 [30,60] (N=52)
Network (med[IQR])	46 [29,72]
ABC	27

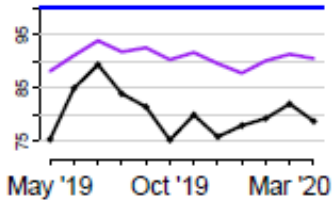




Asthma score documented while in the ED

Site	78.8% (N=52)
Network	90.6%
ABC	100%





Children's Hospital Colorado
Section of Emergency Medicine

Courtesy, Elizabeth R.Alpern, MD, MSCE

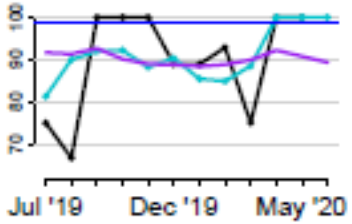
PECARN
Pediatric Emergency Care Applied Research Network

Semi-annual Provider Report Card

Respiratory Diseases (Asthma): *All Respiratory Diseases performance measures include only visits of patients ≥2 years of age with an asthma diagnosis and 2 or more doses of beta-agonist (based on weight) given in the ED (regardless of disposition except where noted)*

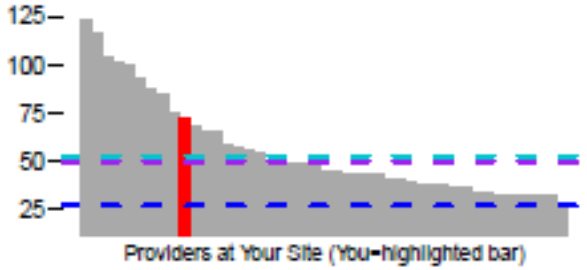
Systemic corticosteroids given in the ED

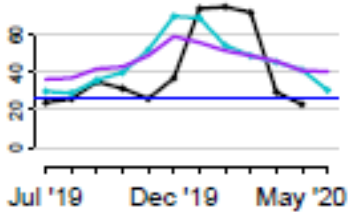
You	90% (N=30)
Your Site	87.3%
Network	89.2%
Site ABC	98.2%
Network ABC	98.5%



Time (min) to first beta-agonist treatment

You (med[IQR])	72 [37,111] (N=30)
Your Site (med[IQR])	53 [29,108]
Network (med[IQR])	50 [29,87]
Site ABC	28
Network ABC	27





Children's Hospital Colorado
Section of Emergency Medicine

Courtesy, Elizabeth R.Alpern, MD, MSCE

PECARN
Pediatric Emergency Care Applied Research Network

PECARN Registry: Process

Patient EHR

All ED Visits

Monthly Data Transmission

validation

De-identification

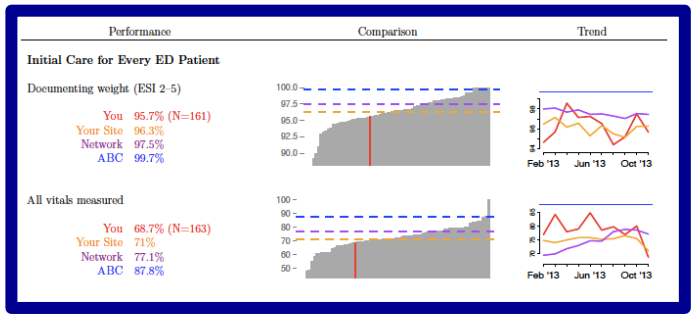
Data Coordinating Center

PECARN Registry

Natural Language Processing (NLP)

Performance Measures

Benchmarks
Site specific
Provider specific



Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

PECARN Registry Funding

- AHRQ Funded 2011-2015

- Current Ongoing Funding
  - Data Coordinating Center
  - Project funding
  - Participating sites: Annual fee

- Project specific grant funding
  - Validation of new variables
  - Data management
  - Statistical analysis

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care
Applied Research Network

PECARN Registry Related/Linked Studies

PED Screen R01HD087363 (Elizabeth Alpern)

- Pediatric Sepsis EHR Registry, Clinical Outcomes, and Predictive Model Research Strategy.
- This study will create a multi-centered pediatric emergency care sepsis registry derived from EHR data, develop and validate methods to identify children at risk of severe sepsis, and develop predictive model to identify patients at risk of developing sepsis.

IMPROVE R01HD091302 (Amy Drendel)

- The Effect of Emergency Department and After-Emergency Department Analgesic Treatment on Pediatric Long Bone Fracture Outcomes.
- The overall goal is to evaluate and provide evidence for both ED and post-ED pain treatment for all children with acute fracture-related pain. Uniquely, this study prospectively tracks the full patient experience from ED visit to home.

SCIENCE U01HL143477 (David Brousseau)

- Implementation of evidence-based care for the acute treatment of sickle cell disease pain.
- Identify the barriers and facilitators to NHLBI guideline adherent care for pain in SCD, allowing for successful design of a multi-center hybrid 3 implementation trial to improve the experience of children with SCD presenting in acute pain.

Disparities in ED Care R03MD011654 (Monika Goyal)

- Detecting Racial and Ethnic Disparities in Pediatric Emergency Care Using the PECARN Data Registry
- detect and document racial and ethnic disparities in the management of acute pain among children presenting to emergency departments (ED) with long bone fractures and those diagnosed with appendicitis.

Thank you!!!!

- Acknowledgments

  Elizabeth R. Alpern, MD, MSCE

  Peter S. Dayan, MD, MSc

- CHCO PECARN Colleagues

  Lalit Bajaj, MD, MPH

  Sara Deakyne

  Kathleen Adelgais, MD, MPH

  Jennifer Sadlowski

  Gonzalo Lerner

  Kathleen Grice

  Mimi Munroe

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care
Applied Research Network

Pediatric Emergency Research Networks

- Global network of networks
- 8 member PEM networks
- Studies
  - H1N1 pandemic
  - Practice patterns
  - COVID-19 pandemic

Children's Hospital Colorado
Section of Emergency Medicine

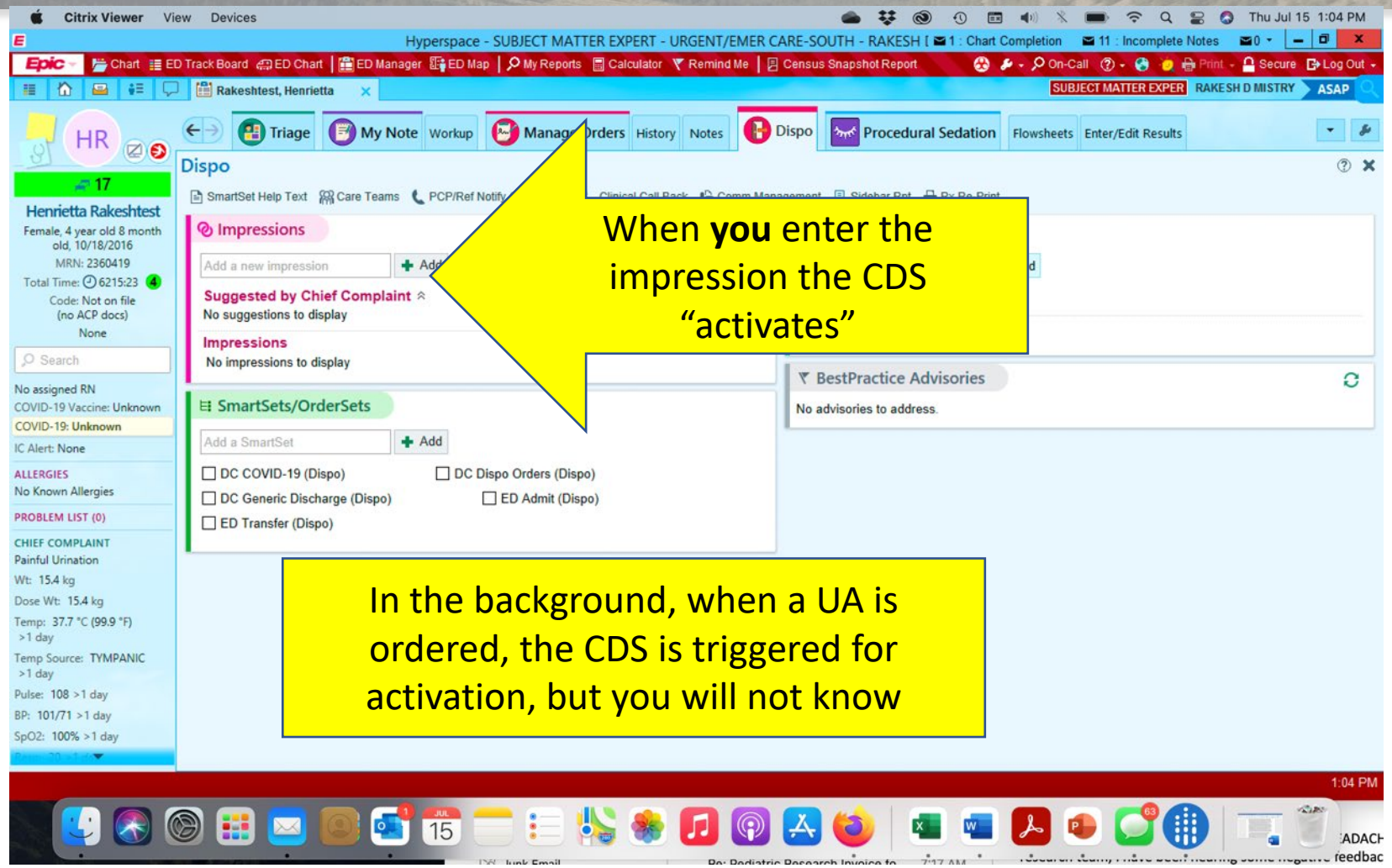
Klassen TP et al. . The Pediatric Emergency Research Network (PERN): A decade of global research cooperation in paediatric emergency care. Emerg Med Australas. 2021 Oct;33(5):900-910

PECARN
Pediatric Emergency Care Applied Research Network

UTI CDS Appearance

Children's Hospital Colorado
Section of Emergency Medicine

UTI CDS

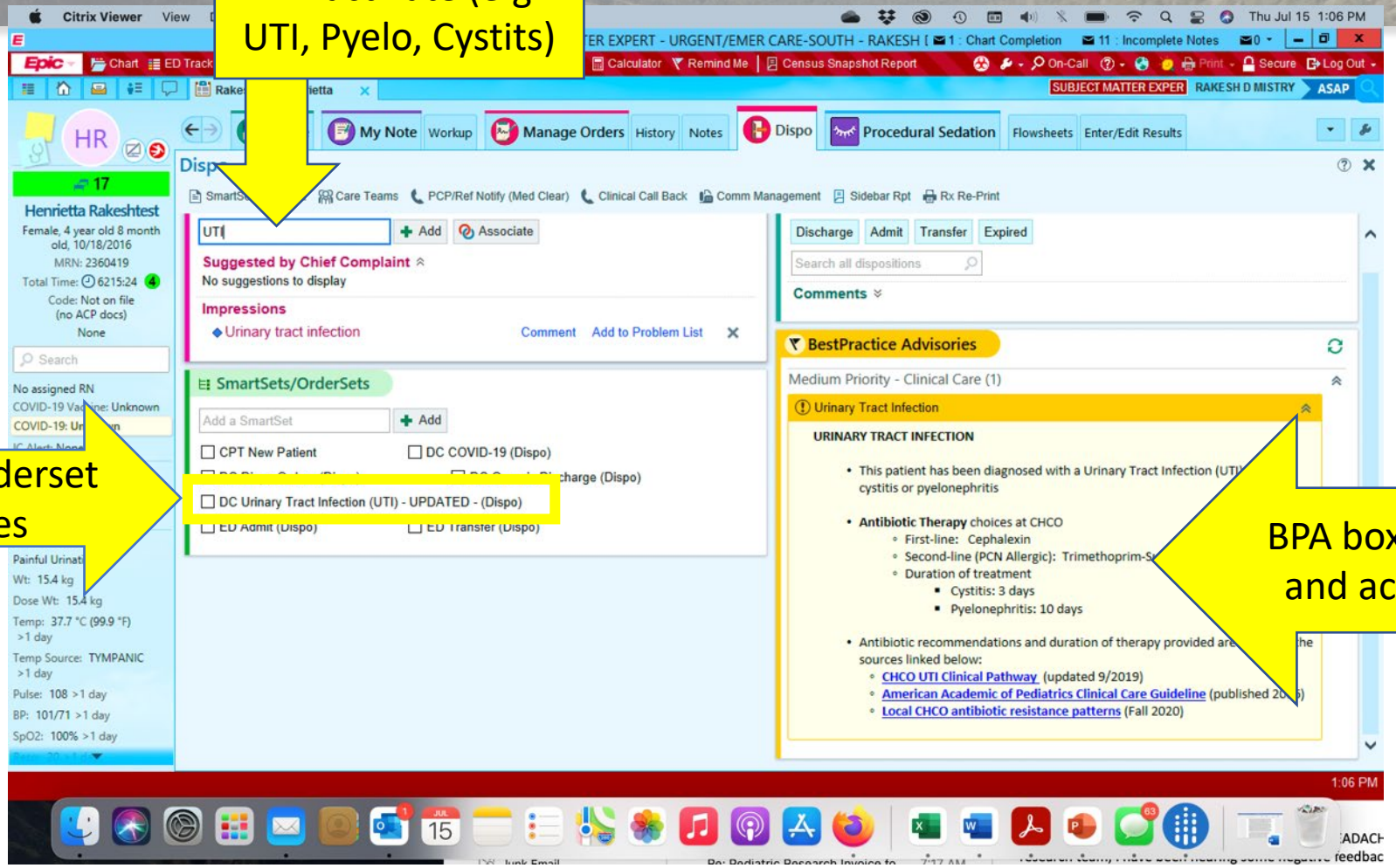


Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

UTI CDS

Broad impressions will activate (e.g. UTI, Pyelo, Cystits)



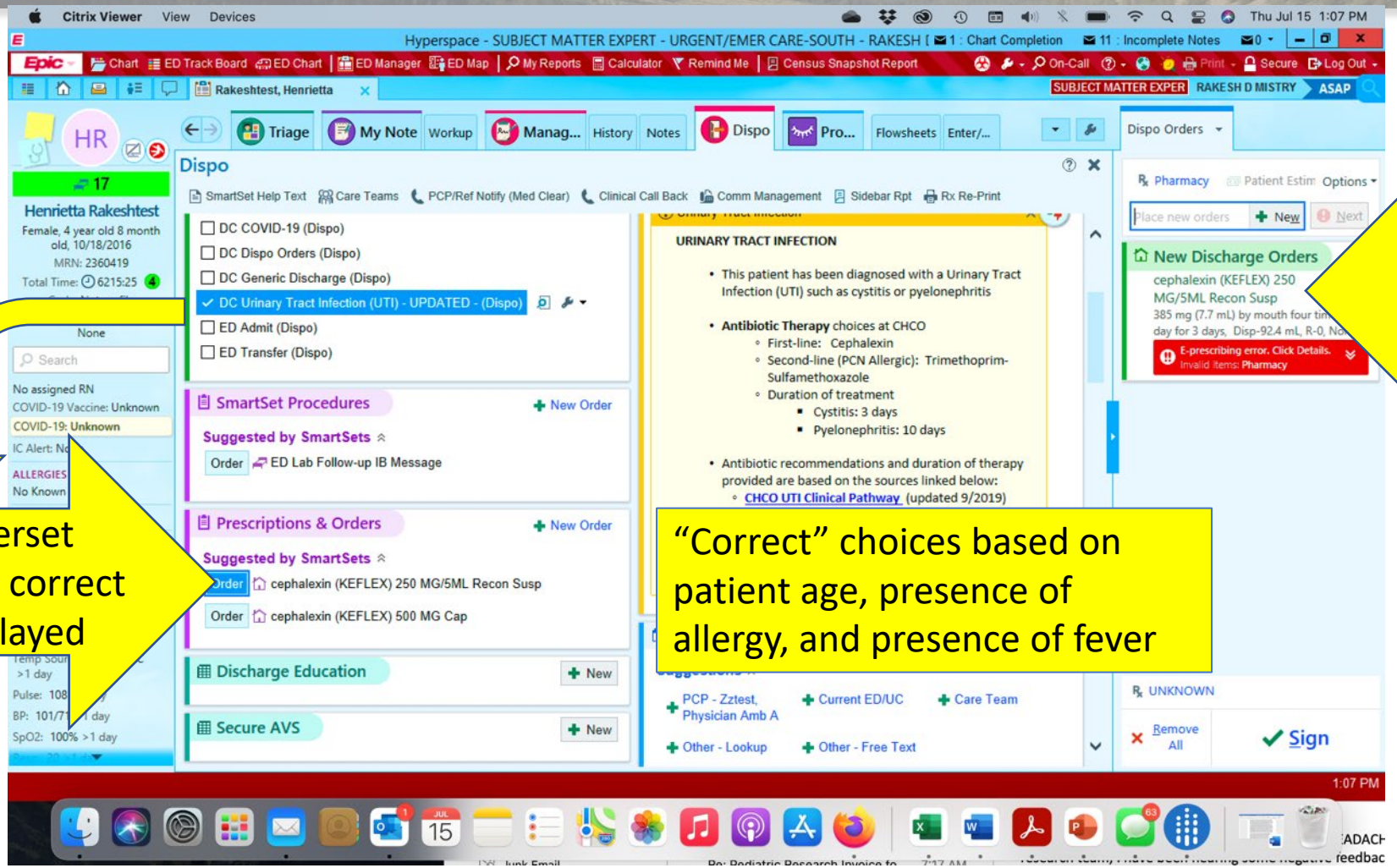
New CDS orderset populates

BPA box with guideline info and active links if desired

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

UTI CDS



When orderset checked, only correct choice displayed

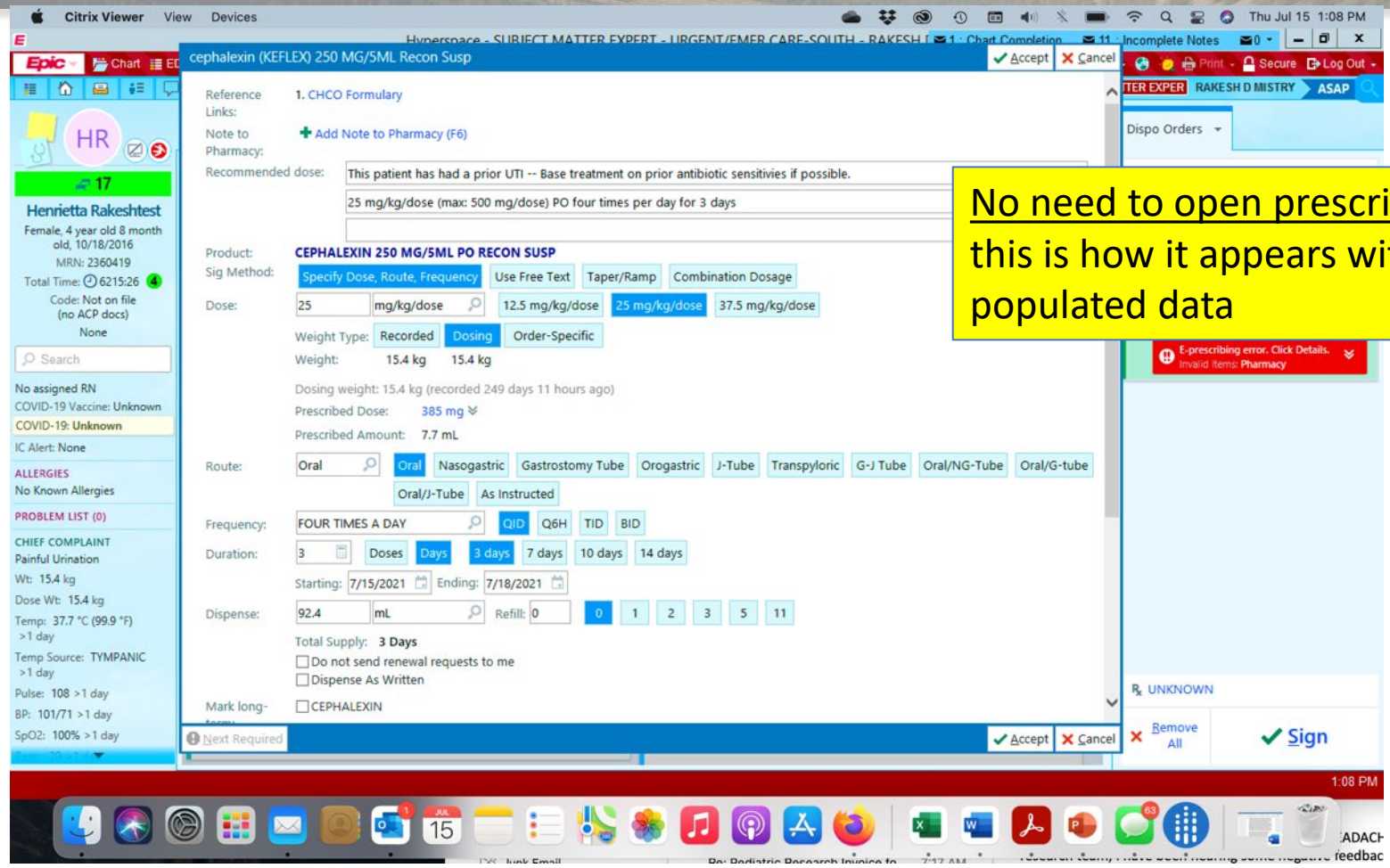
"Correct" choices based on patient age, presence of allergy, and presence of fever

Antibiotic prescription fully prepopulated for dose and duration. You only need to "sign"!!!!

Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

UTI CDS



Children's Hospital Colorado
Section of Emergency Medicine

PECARN
Pediatric Emergency Care Applied Research Network

Project Wins:

Technology has been developed to extract data for all emergency department visits, accomplish substantial de-identification of the extract prior to transmission to the Data Coordinating Center (DCC), and produce a data warehouse registry to use for quality improvement and research.

Quality Assurance: Comprehensive data quality assurance rules are automated to assess data quality and validation of the transmitted data. Monthly data quality reports are constructed for each site by month and entire year data breakdown to facilitate effective and efficient data quality review.

Report Cards: Data from the Registry is used to assess stakeholder prioritized quality of care performance measures and determine benchmarks for the metrics. Site-level report cards are populated from the Registry and distributed monthly and semi-annually. Provider-level report cards are distributed semi-annually.

Benefits:

- Captures ALL patients to ED
- Captures wide range of data (EHR reality; includes text)
- ED specific data (lacking in many other sources)
- Allows for organization of data to facilitate analysis
- Allows for ongoing temporal collection of data leading to responsive analysis (Network-level, Site-level)
- Allows for active linkage for prospective studies
- Innovative grants with proven success
- Scalable (3 waves of entry) and maintainable (reasonable IT effort)

Challenges:

- EHRs are ever-changing
- Each new site that joins is going to have a new challenge or identify a problem that every prior site missed
- Site ongoing IT collaboration
- Consistence of staffing over time

Children's Hospital Colorado
Section of Emergency Medicine