

Avoidable Imaging Initiative

Traumatic Brain Injury CT Prediction Rules in Children
Optimizing Uptake of Clinical Decision Support in the Electronic Health Record
Data Collection- CEDR and Quality/Performance Measures

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TCPi

Transforming Clinical
Practices Initiative



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Traumatic Brain Injury CT Prediction Rules in Children:

Generating/Validating the Evidence, then Translating to Practice



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Disclosure

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

Objectives

- ◆ Briefly review the PECARN head trauma CT prediction rules derivation / validation
- ◆ Describe how PECARN is translating the TBI Prediction Rules into practice

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

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 \geq 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

A

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

Yes

CT recommended

13.9% of population
4.4% risk of ciTBI

No

Occipital or parietal or temporal scalp haematoma, or history of LOC ≥5 s, or severe mechanism of injury‡, or not acting normally per parent

Yes

Observation versus CT on the basis of other clinical factors including:

- Physician experience
- Multiple versus isolated§ findings
- Worsening symptoms or signs after emergency department observation
- Age <3 months
- Parental preference

32.9% of population
0.9% risk of ciTBI

No

53.2% of population
<0.02% risk of ciTBI

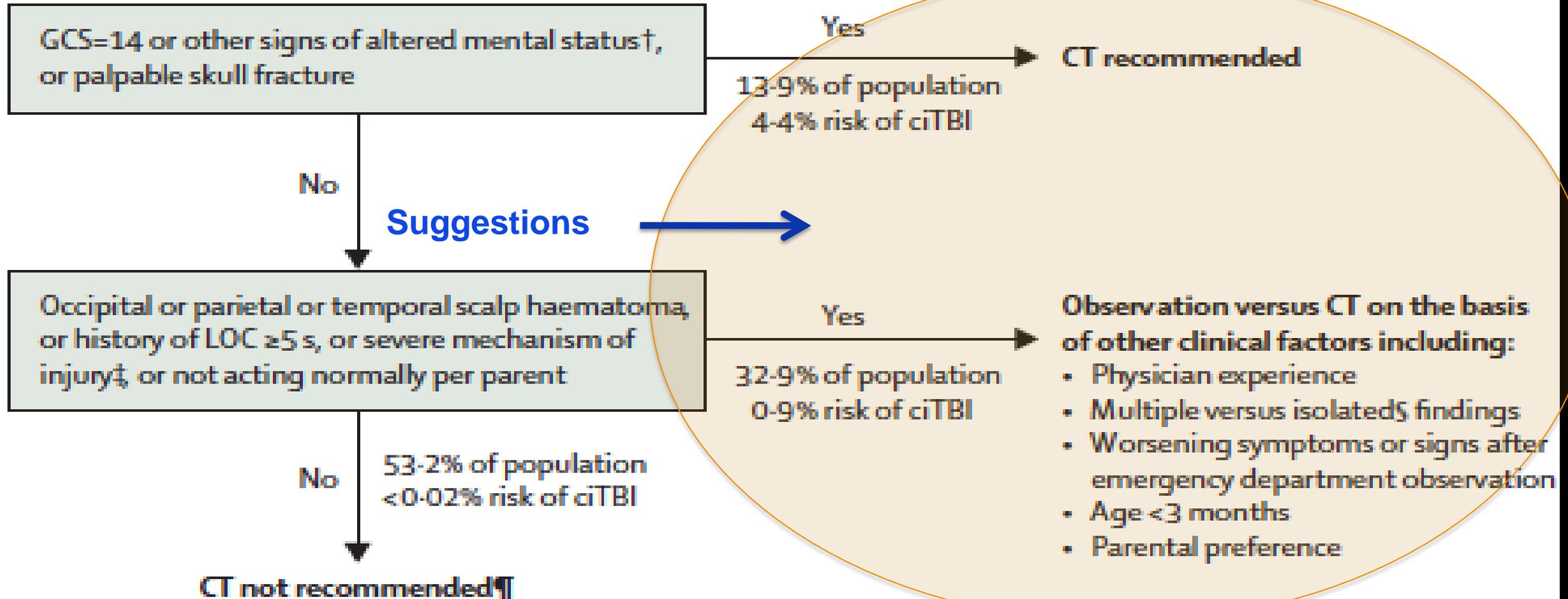
CT not recommended¶

The Rule

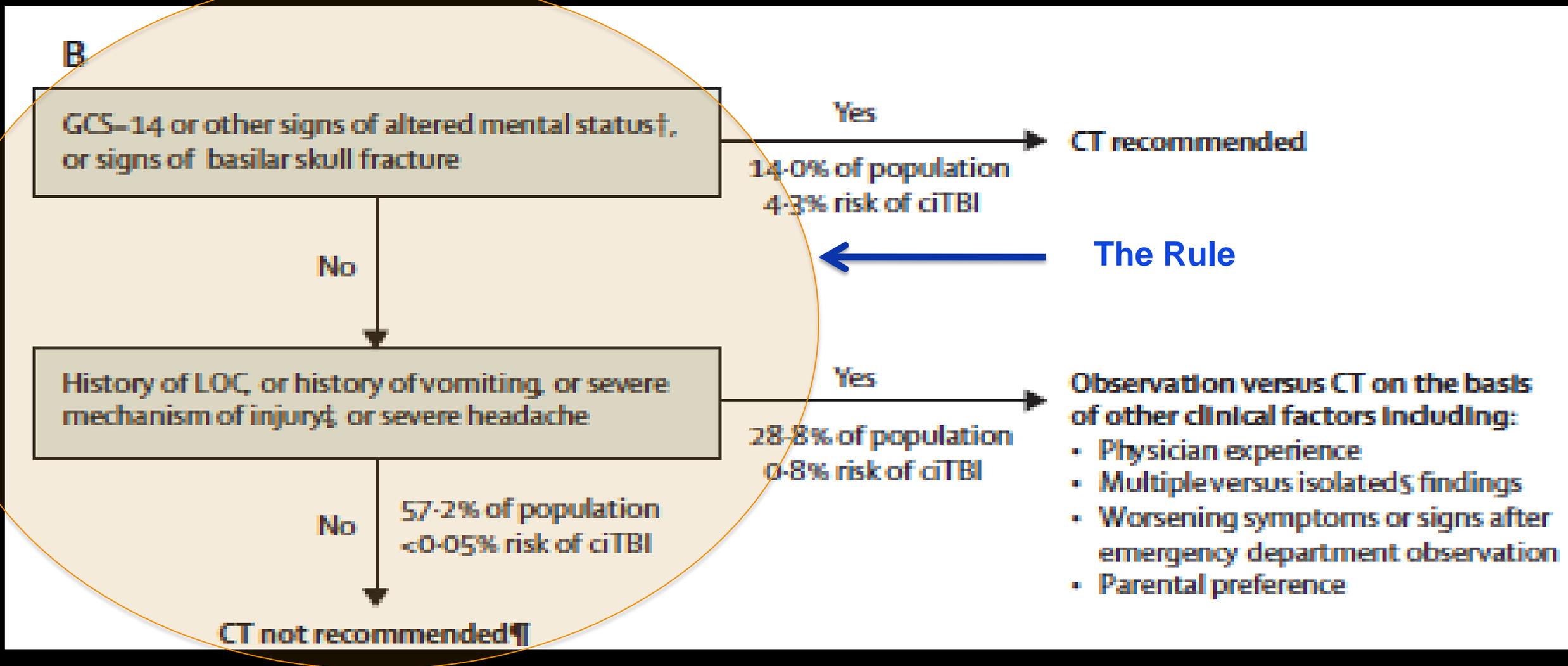


Recommendations for children younger than 2

A



Recommendations for children 2 years and older



Recommendations for children 2 years and older

B

GCS-14 or other signs of altered mental status†, or signs of basilar skull fracture

Yes

14.0% of population
4.3% risk of cTBI

CT recommended

No

Suggestions →

History of LOC, or history of vomiting, or severe mechanism of injury‡, or severe headache

Yes

28.8% of population
0.8% risk of cTBI

Observation versus CT on the basis of other clinical factors including:

- Physician experience
- Multiple versus isolated§ findings
- Worsening symptoms or signs after emergency department observation
- Parental preference

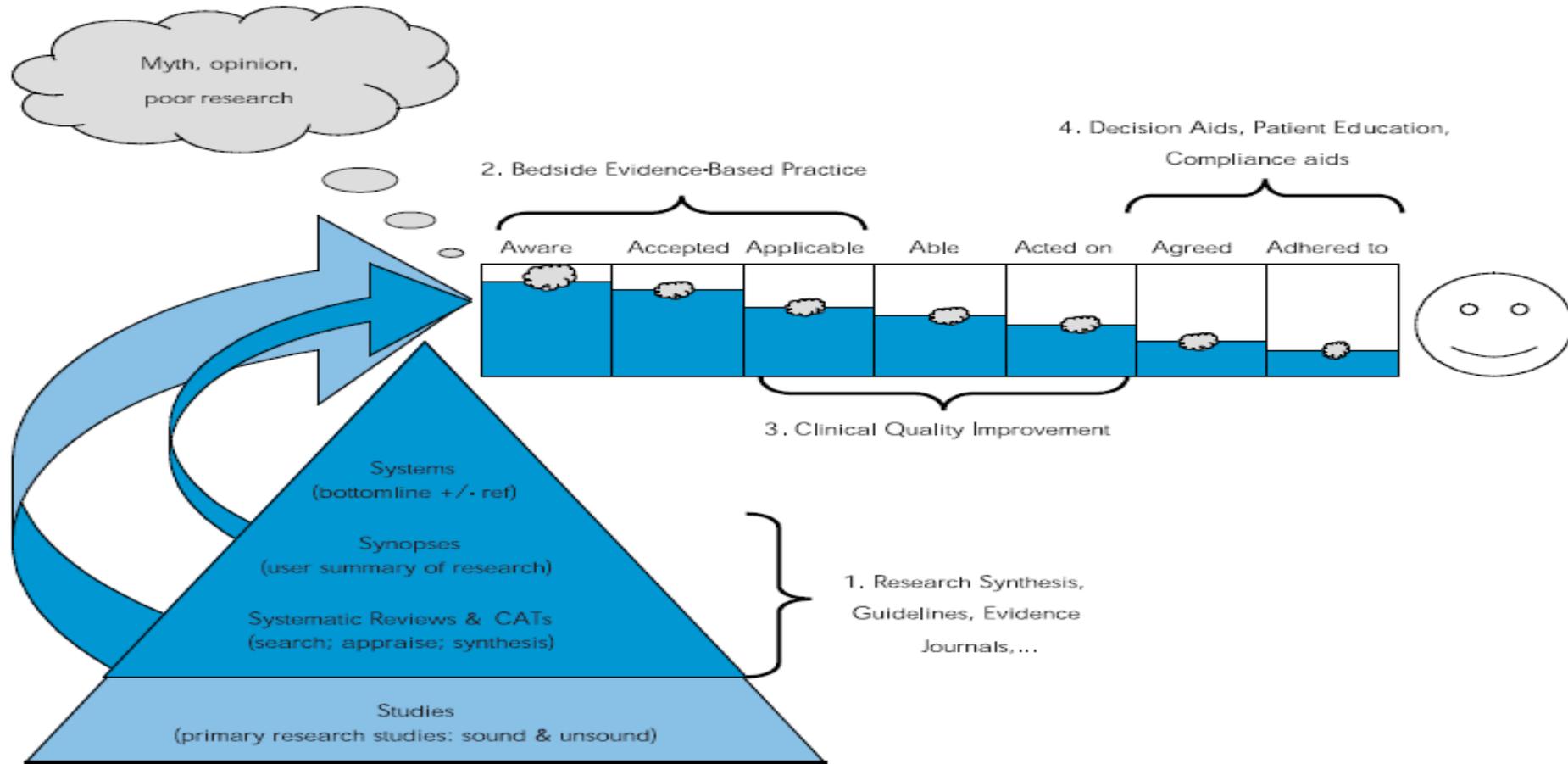
No

57.2% of population
<0.05% risk of cTBI

CT not recommended¶

How to get clinicians to use the prediction rules?

Knowledge Translation Pipeline

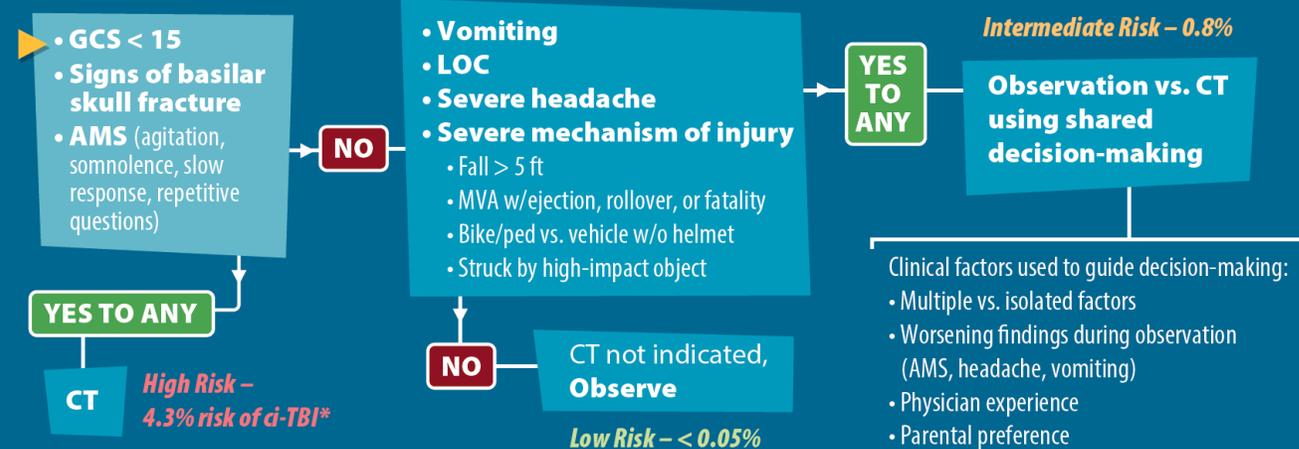


The research-to-practice pipeline. New research, of varying soundness, is added to the expanding pool and enters practice both directly or is reviewed, summarised, and systematised (delay) before entering practice, with leakage occurring at each of several stages between awareness and patient outcome. Different knowledge translation disciplines focus on different parts of the pipeline (1-4).

Pediatric Head Trauma CT Decision Guide

Children 2 years and older

2 YEARS
& OLDER

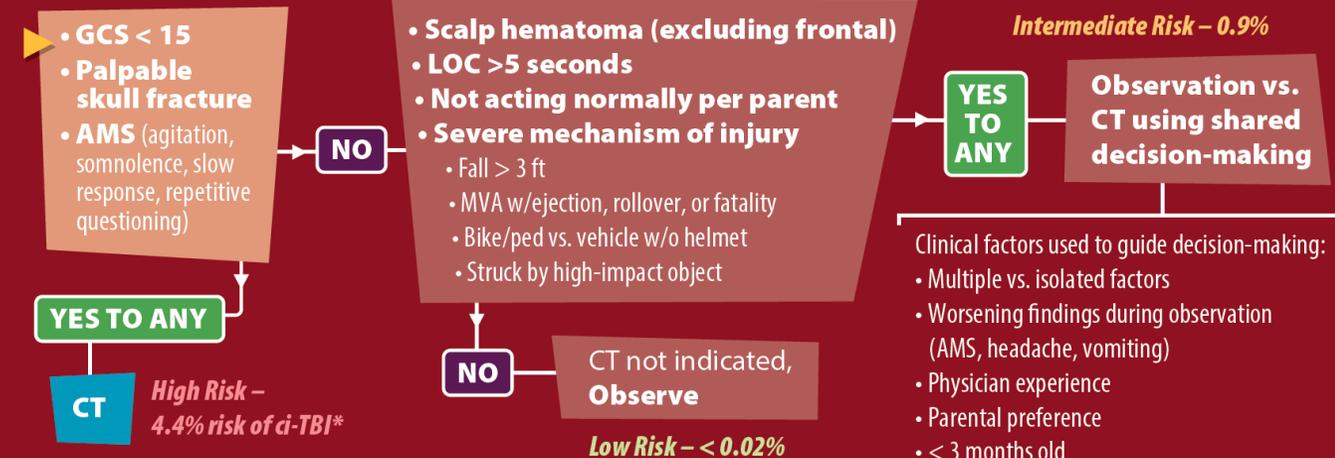


*ci-TBI: risk of clinically important TBI needing acute intervention, based on PECARN validated prediction rules

Pediatric Head Trauma CT Decision Guide

Children younger than 2 years

UNDER
2 YEARS



*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 for Children Using Computerized Clinical Decision Support: *A Multi-center Trial*

Traumatic Brain Injury – Knowledge Translation Study Group; for the Pediatric Emergency Care Applied Research Network (PECARN), the Clinical Research on Emergency Services and Treatment (CREST) network, and Partners HealthCare System

This study was supported by the American Recovery and Reinvestment Act-Office of the Secretary (ARRA OS): Grant #S02MC19289-01-00. PECARN is supported by the Health Resources and Services Administration (HRSA), Maternal and Child Health Bureau (MCHB), Emergency Medical Services for Children (EMSC) Program through the following cooperative agreements: U03MC00001, U03MC00003, U03MC00006, U03MC00007, U03MC00008, U03MC22684, and U03MC22685

Aims

Primary: To determine whether implementing the PECARN TBI prediction rules using an intervention centered around computerized clinical decision support (CDS) decreases CTs in children with minor blunt head trauma at very low risk of ciTBIs

Secondary: To determine whether CDS that provides risk data for ciTBI for all children with minor blunt head trauma decreases CT use

Methods

Computer-Based Decision Support Development and Pilot

- ◆ Perform focus groups
- ◆ Perform ED work flow assessments
- ◆ Develop EHR blunt head injury template
- ◆ Develop CDS
- ◆ Pilot testing

Methods

Patient assessment

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

Neurologic

Alert Responds to voice Responds to pain Unresponsive Sleeping/no distress

LOC Alert/decreased activity Appropriate for developmental level Oriented x 3

Combative Sleeping with distress Appropriate for developmental level

Pupils Equal and Reactive, Anterior Yes

Fontanelle Flat

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



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 Severe Unable to determine

Other signs of altered mental status? No Yes

Temporal, parietal, or occipital scalp hematoma? No Yes

GCS

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
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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 occipital scalp hematoma? No Yes

Methods

Clinical decision support

- ◆ Clinician received a statement no matter what was entered (*clear in focus groups*)
- ◆ Formatted similarly across statements
 - Recommendation
 - Risk estimate of clinically-important TBI
 - Management options (if relevant)

▼ 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

Results

- ◆ Lower than expected baseline CT rates
 - Secular trends
- ◆ Modest, variable decreases in CT rates for patients at very-low risk and for all with minor head trauma
- ◆ No missed ciTBIs in patients at very-low risk

Conclusions

- ◆ Computerized CDS helps to safely decrease CT rates
- ◆ Provision of both recommendations and risk information helpful
 - Some clinicians want “directive” assistance
 - Others want risks for shared decision-making
- ◆ Unanticipated diffusion of information and secular trends likely decreased impact
- ◆ Novel methods for dissemination always needed



Optimizing Clinical Decision Support in the Electronic Health Record



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Dustin W. Ballard & David R. Vinson

<http://kpcrest.net>



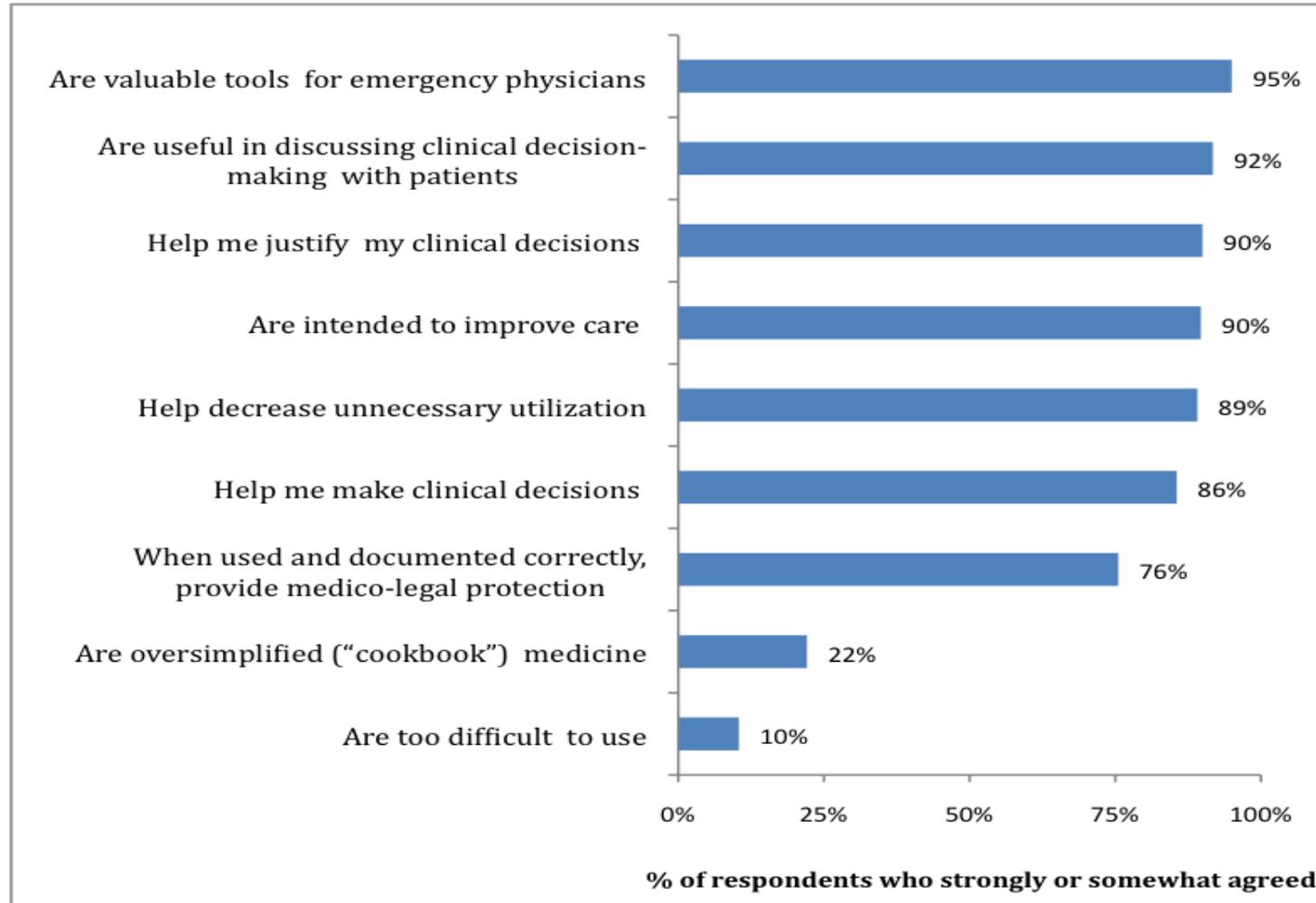
Background

- **Implementation science** is a new field of emphasis
- Historically, **knowledge translation** has taken a decade or longer to diffuse
- **Clinical decision support (CDS) through the EHR** holds promise
- **Adoption** of clinical decision support tools by clinicians is **often limited by technical and workflow barriers**





Physician Survey on Clinical Prediction Rules



RISTRA (Risk STRAtification)

Multiple Clinical Qs

- Adult chest pain
- Pediatric Abd Pain
- Atrial fibrillation
- Others...





Assisting site-of-care decision-making

- **Background**

- Most ED pts with PE are **hospitalized** despite evidence
- We **need help** identifying pts who are low risk
 - Pulmonary Embolism Severity Index (**PESI**)
 - 11 weighted variables
- We used RISTRA **to integrate an auto-populating electronic PESI** into our clinical workflow

Ncalhctestdm, Testamb MRN: 110002843275, Room/Bed SACED, None Wt (kg) None Allergies Co-trimoxazole, Ethinyl Estradio... Isolation None

DOB: 10/19/2012, Female, 24 M

ED Navigator

Refresh ED Navigator Procedure Disch PIT Nav Stentor eConsult Web Links Calculator SmartSets **R** RISTRA

Meds (16): Prednisone Daily-vite Allergies (3): Problems (7): Female Breast Can' Dm 1

Review/SnapShot

Results Review Synopsis Notes Orders Problem List History Demographics Work/Activity Stat...

Arrival BestPractice Refresh Chief C Arrival ED Vita ED Arriva

BestPractice Refresh Chief C Arrival ED Vita ED Arriva

test pt for Secure Rx

Expect Means of Arrival Escorted By Social Services

gent Taxi Social Services





CREST NETWORK
CLINICAL RESEARCH ON EMERGENCY SERVICES AND TREATMENTS



RISTRA
A Risk Stratification Tool



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INNOVATION FUND FOR TECHNOLOGY



CDS

RISTRA ? Close

RISTRA  Aso1va

Name: Last, First; MR#: XXXXXXXXXX

PULMONARY EMBOLISM SEVERITY INDEX (PESI) ⓘ

	YES	NO	Age: <input type="text" value="35"/>	YES	NO
Altered Mental Status:	<input type="radio"/>	<input checked="" type="radio"/>	Temperature <36° C:	<input type="radio"/>	<input checked="" type="radio"/>
Male:	<input type="radio"/>	<input checked="" type="radio"/>	Respiratory Rate ≥ 30/min:	<input checked="" type="radio"/>	<input type="radio"/>
Cancer:	<input type="radio"/>	<input checked="" type="radio"/>	Heart Rate ≥ 110/min:	<input type="radio"/>	<input checked="" type="radio"/>
Heart Failure:	<input checked="" type="radio"/>	<input type="radio"/>	Systolic BP <100 mmHg:	<input checked="" type="radio"/>	<input type="radio"/>
Lung Disease:	<input type="radio"/>	<input checked="" type="radio"/>	O2 Saturation <90%:	<input type="radio"/>	<input checked="" type="radio"/>

DATA IMPORTED FROM HC. PLEASE CHECK, EDIT & REFRESH AS NEEDED.

3



CDS

RISTRA

CREST NETWORK

Aso1va

Name: Last, First; MR#: XXXXXXXXXX

PESI Points	PESI Class
85	II

Point Sum	PESI Class	Approx 30 day Mortality	Site of initial care
≤ 64	I	< 2%	Outpt management is often possible
65-85	II	< 2%	Outpt management is often possible
86-105	III	~ 5%	Inpatient care is often indicated
106-125	IV	~ 10%	Inpatient care is often indicated
≥ 126	V	~ 20%	Inpatient care is often indicated

BACK

NEXT

5



Two Concurrent Studies

- **What Factors Increase Tool Use? (14 EDs)**
 - **10 “active” EDs** w/on-site champions = intervention
 - Tool access with serial education, iterative physician-specific audits, incentives for first 3 enrollments
 - **4 “passive” EDs** w/ neither champion nor promotion
 - Tool access and only an initial education session
- **Pragmatic Implementation Study (21 EDs)**
 - 10 active EDs vs 11 non-active
 - **Compare rates** of home discharge and safety outcomes



Results of USE study (n=662)

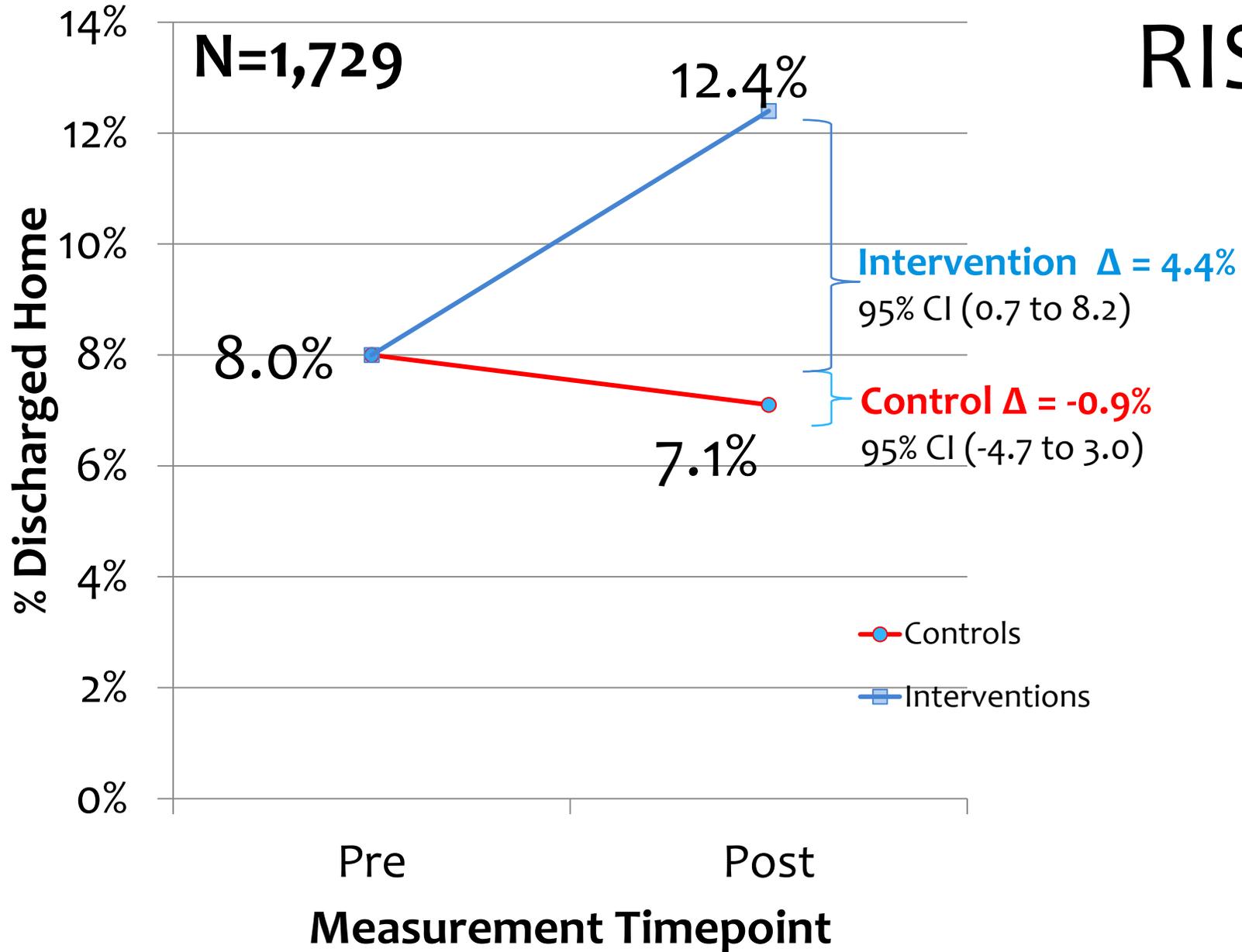
**67% vs.
13%**

	Characteristics		Reference	OR	95% CI	
Facility	Site	Active	Passive	31.1	11.7	83.0
	Low ED Volume	Yes	No	1.7	1.1	2.7
	Acuity 1 Patient	Yes	No	1.2	0.7	2.3
Provider	Sex	Female	Male	0.9	0.5	1.6
	Age	40+	<40	0.6	0.4	1.1
	Clinical Load	5+	<5	0.9	0.6	1.4
Patient	PESI Class	I, II	III+	1.7	1.1	2.5

Compared to mean facility ED census

Lower PE Severity = more likely to activate

RISTRA Impact



Safety outcomes were unchanged

- 5d PE-related return visit rate (6.5%)
- 30d all-cause mortality (0.7%)



Conclusions

- **Performing active on-site tool promotion** significantly increased odds of e-CDS tool activation
- **Active promotion** of an eCDS tool with an auto-populating PESI increased home DC rates without increasing 5d return visits or 30d mortality

THANK YOU VERY MUCH



Clinical Emergency Data Registry (CEDR) Imaging Measures

November 17, 2016

Dr. Arjun Venkatesh MD, MBA, MHS

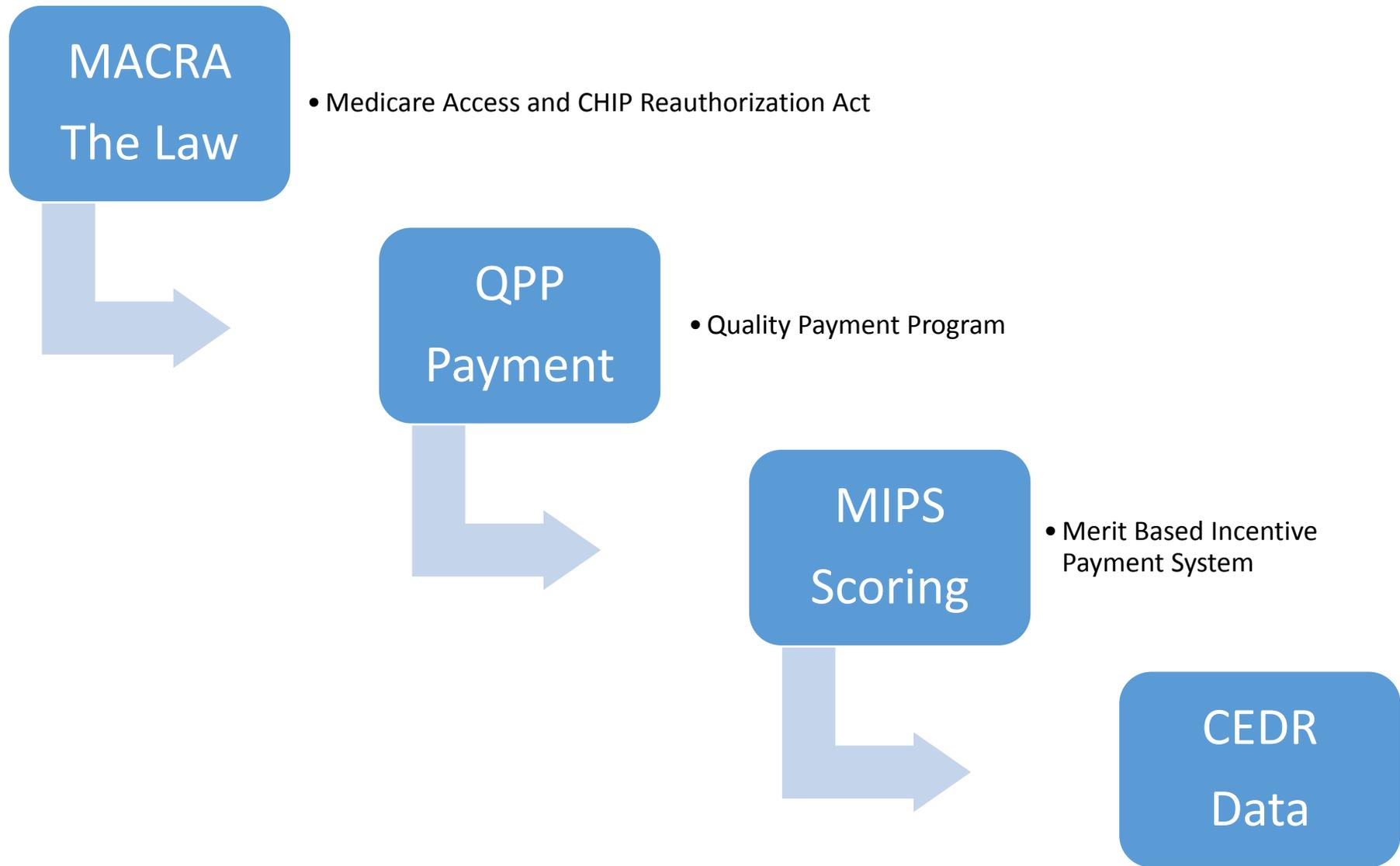
Disclosures

- Centers for Medicare and Medicaid Innovation: ACEP TCPI
- Contracted with Centers for Medicare and Medicaid Services to develop hospital outcome and efficiency measures

Disclaimer

The project described was supported by Funding Opportunity Number CMS-1L1-15-002 from the U.S. Department of Health & Human Services, Centers for Medicare & Medicaid Services. The contents provided are solely the responsibility of the authors and do not necessarily represent the official views of HHS or any of its agencies.

Alphabet Soup



What is a QCDR?

- QCDRs such as CEDR are quality reporting registries for the CMS Merit-based Incentive Payment System (MIPS)
- QCDRs are an alternative to “claims based reporting”
- QCDRs include unique quality measures
- QCDRs are approved by supported by CMS to:
 - Move quality measure development to clinicians
 - Give “credit” for several MIPS scoring categories



What is CEDR?

- Developed by ACEP to support emergency clinician participation in MIPS
- First and only emergency medicine specialty registry at a national level
- Successfully reported for physicians in 13 EDs during its 2015 pilot
- Facilitate emergency care research through the identification of practice patterns, trends and outcomes in emergency care



CEDR Participation

	2015	2016
Number of Providers	262	797
Number of Patient Visits	458,263	780,513*
Number of ED Engaged	13	36
Number of EMR/EDIS	4	14
Performance Measures	27	42

***In Progress – Anticipated 1.7 million patient visits**



What is an eCQM

- eCQM = electronic clinical quality measure
- Uses structured EHR data to ensure clinically relevant quality measures
- Uses a standard language
 - Value Set Authority Center (VSAC)
 - Measure Authoring Tools
- Requires mapping between CEDR and your hospital-based EHR

Mappable EHRs

EMR			
Agility	EyeDoc EMR	Maxim Eyes SQL	NextGen
AI Med	EYEMD EMR	MD Office	Open EMR
AllMeds	GE Centricity	MDIntelleSys	Origin
Allscripts*	GEMMS	MDsuite	Practice Partners **
Amazing Charts	Glow Stream	MedEvolve	Practice Studio
American Medical Software	gMed	Medflow	Prime Clinical System
Aprima	Greenway Intergy**	MEDHOST EDIS	Prognosis**
Cerner**	Greenway/Primesuite	Medics DocAssistant	Pulse EHR**
Chart Maker Clinical	HCIT	MedInformatix	Quickview EMR
ChartLogic**	iFA**	Medisoft**	RheumDocs**
Chartmaker Medical Suite	iMedicWare (cloud based)	Meditech	SoapWare
Compulink	IMS	Medstreaming	SRS EHR
Custom EHR	Integrity	Merge Financials	SuiteMed IMS
Cybox EHR	Intergy / Sage	MicroMD	TriMed EHR
DigiDMS	IO Practiceware	Misys (Allscripts)**	TSystem
eClinicalWorks*	Key Chart	MOSAIQ	UniCharts**
eMDs**	Lytec MD	My Vision Express	Varian - Aria
eMedRec	MacPractice MD	NeoMed	VersaForm**
EPIC**	Management Plus	Netconnect**	VersaSuite
Exam Writer	Mastermind EHR	NexTech	Vitera EMR



Imaging Measures

- Emergency Department Utilization of CT for Minor Blunt Head Trauma for Patients Aged 18 Years and Older
- Emergency Department Utilization of CT for Minor Blunt Head Trauma for Patients Aged 2 Through 17 Years
- Appropriate Emergency Department Utilization of CT for Pulmonary Embolism

Percentage of emergency department visits for patients aged 18 years and older who presented within 24 hours of a minor blunt head trauma with a Glasgow Coma Scale (GCS) score of 15 and who had a head CT for trauma ordered by an emergency care provider who have an indication for a head CT



Head CT Adult

Numerator	Emergency department visits for patients who have an indication for a head CT
Denominator	All emergency department visits for patients aged 18 years and older who presented within 24 hours of a minor blunt head trauma with a Glasgow Coma Scale (GCS) score of 15 and who had a head CT for trauma ordered by an emergency care provider
Denominator Exclusions	<ul style="list-style-type: none"> • Ventricular shunt • Brain tumor • Multisystem trauma • Pregnancy • Currently taking any of the following antiplatelet medications*: <ul style="list-style-type: none"> • ASA/dipyridamole • clopidogrel • prasugrel • ticlopidine • ticagrelor • Cilostazol

Indications

Minor Trauma and..

- Severe headache
- Vomiting
- Age 65 years and older
- Physical signs of a basilar skull fracture (signs include haemotympanum, “raccoon” eyes, cerebrospinal fluid leakage from the ear or nose, Battle’s sign)
- Focal neurological deficit
- Coagulopathy
- Thrombocytopenia
- Currently taking any of the following anticoagulant medications*:
 - apixaban, argatroban, bivalirudin, dabigatran, dalteparin, desirudin, enoxaparin, fondaparinux, heparin, lepirudin, low molecular weight heparin, rivaroxaban, tinzaparin, warfarin
- Dangerous mechanism

LOC or amnesia and ...

- Headache
- Age 60 years and older, and less than 65 years
- Drug/alcohol intoxication
- Short-term memory deficits
- Evidence of trauma above the clavicles (physical location, any trauma to the head or neck [ie, laceration, abrasion, bruising, ecchymosis, hematoma, swelling, fracture])
- Posttraumatic seizure



Head CT Adult

Percentage of emergency department visits for patients aged 2 through 17 years who presented within 24 hours of a minor blunt head trauma with a Glasgow Coma Scale (GCS) score of 15 and who had a head CT for trauma ordered by an emergency care provider who are classified as low risk according to the PECARN prediction rules for traumatic brain injury



Head CT Pediatric

<p>Numerator</p>	<p>Emergency department visits for patients who are classified as low risk according to the Pediatric Emergency Care Applied Research Network (PECARN) prediction rules for traumatic brain injury.</p>
<p>Denominator</p>	<p>All emergency department visits for patients aged 2 through 17 years who presented within 24 hours of a minor blunt head trauma with a Glasgow Coma Scale (GCS) score of 15 and who had a head CT for trauma ordered by an emergency care provider.</p>
<p>Denominator Exclusions</p>	<ul style="list-style-type: none"> • Ventricular shunt • Brain tumor • Coagulopathy • Thrombocytopenia

Head CT Pediatric

“Low risk”

- No signs of altered mental status (eg, agitation, somnolence, repetitive questioning, slow response to verbal communication)
- No signs of basilar skull fracture (signs include hemotympanum, “raccoon” eyes, cerebrospinal fluid leakage from the ear or nose, Battle’s sign)
- No LOC
- No vomiting
- No severe mechanism (i.e., 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 5 feet; or head struck by a high-impact object)
- No severe headache

Percentage of emergency department visits during which patients aged 18 years and older had a CT pulmonary angiogram (CTPA) ordered by an emergency care provider, regardless of discharge disposition, with either moderate or high pre-test clinical probability for pulmonary embolism OR positive result or elevated D-dimer level.



PE CT

<p>Numerator</p>	<p>Emergency department visits for patients with either:</p> <p>Moderate or high pre-test clinical probability for pulmonary embolism*</p> <p>OR</p> <p>Positive result or elevated D-dimer level</p>
<p>Denominator</p>	<p>All emergency department visits during which patients aged 18 years and older had a CT pulmonary angiogram (CTPA) ordered by an emergency care provider, regardless of discharge disposition</p>
<p>Denominator Exclusions</p>	<p>Pregnancy</p>

Metrics

- How will you get this clinical data?
- What if we the data is missing?
- Why aren't the measures risk adjusted?



Hot Topics

CMS/MIPS

- Do I have to report these imaging measures?
- What about that HTN screening metric?
- Why not pick “easier” metrics?

- Avoidable CT imaging for adult emergency department patients with recurrent renal colic

Coming Attractions

- Avoiding imaging for adult emergency department patients with atraumatic back pain

Wave II Starts March 2017

- Simple utilization measures
- Require ED billing diagnosis and CT utilization data
- CT Utilization
 - Non contrast Head CT/100 ED trauma visits
 - Chest CT with IV contrast/100 ED visits
 - Non contrast Head CT/100 Syncope visits
 - Non contrast Abdomen CT/100 flank pain visits
 - Lumbar XR/CT/MRI/100 back pain visits
- CT Yield
 - Intracranial hemorrhages/Non-contrast Head CT
 - Pulmonary Embolism/Chest CT with IV contrast

EQUAL Metrics

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Avoidable Imaging Webinar:
Thursday, December 8
1:00pm-2:00pmEST

ACEP E-QUAL Network Resources and More
Information:

www.acep.org/equal

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