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Avoidable Imaging Learning Collaborative:

2008 Mild Traumatic Brain Injury Clinical Policy

Success Story – BWH Head and PE CTs with Clinical Decision Support

Using the Canadian CT Head Rule to Reduce Unnecessary Imaging

Presenters

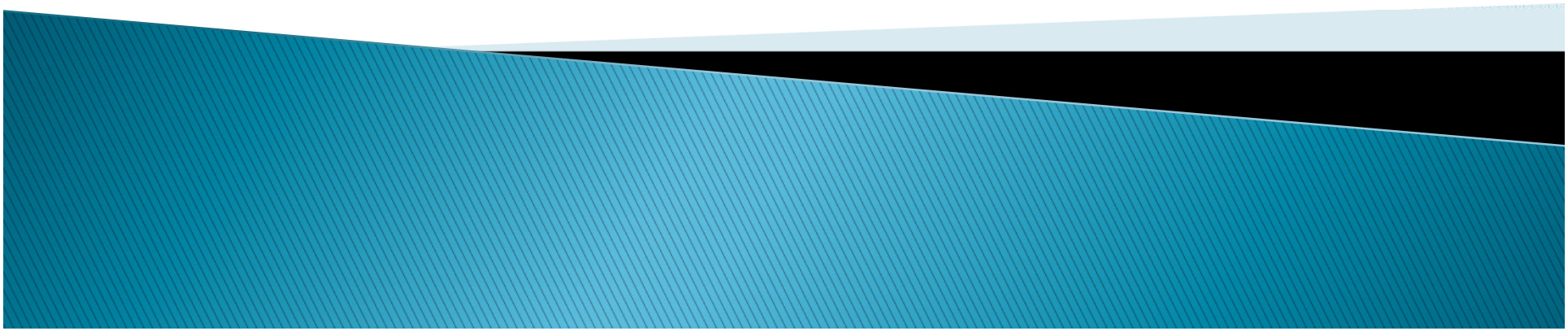
Michael D. Brown, MD, MSc

Ali S. Raja, MD, MBA, MPH

Ian Stiell, MD, MSc, FRCPC

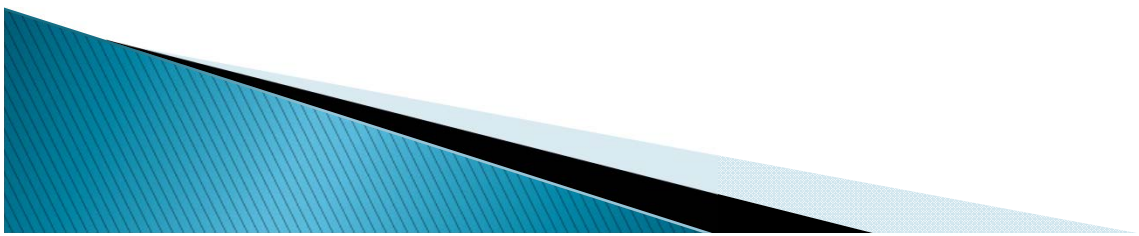
2008 Mild Traumatic Brain Injury Clinical Policy

Michael D Brown, MD, MSc
Chair, ACEP Clinical Policies Committee



2008 Mild TBI Clinical Policy

- Provide historical context
  - Developed by ACEP in collaboration with CDC
  - Search and grading conducted 10 years ago
- Critical Question 1 most relevant to “avoidable imaging”
  - Who needs head CT?
- Critical Q 2 & 3 address roles of MRI and biomarkers
  - Lack of evidence for Level A or Level B recommendations
- Critical Q 4 addresses disposition following negative CT
  - Yes, may be discharged….except inadequate data for bleeding disorders, anticoagulation, antiplatelets, previous neurosurgery



2008 Mild TBI Clinical Policy

- Guideline intended for adults with blunt head trauma
  - Present to ED within 24 hours of injury
  - GCS 14 or 15
  - 16 years or older

- Exclusions
  - Penetrating trauma
  - Multisystem trauma
  - Age < 16
  - GCS < 14

- Primary outcome: acute traumatic intracranial lesion on CT

Level A Recommendation

- Head CT **indicated** with LOC or amnesia only if one or more of the following is present:
  - Headache
  - Vomiting
  - Age > 60 years
  - Drug or alcohol intoxication
  - Deficits in short-term memory
  - Trauma above the clavicle
  - Post-traumatic seizure
  - GCS < 15
  - Focal neurologic deficit
  - Coagulopathy

Level B Recommendation

- Head CT **should be considered** with no LOC or amnesia if any of the following:
  - Focal neurologic deficit
  - Vomiting
  - Severe headache
  - Age $\geq$ 65 years
  - Signs of basilar skull fracture
  - GCS $<$ 15
  - Coagulopathy
  - Dangerous mechanism of injury*

Class I Study by Smits et al

- GCS 13-14 or 15 with a "risk factor"
- N = 3,181 in Netherlands
- Primary outcome: any traumatic finding on CT
  - New Orleans Criteria adapted
    - Se = 99% (98 to 100%)
    - **Sp = 3%** (1 to 5%)
    - LR+ = 1; LR- = 0.3
  - Canadian Rule adapted
    - Se = 85% (81 to 89%)
    - **Sp = 40%** (37 to 42%)
    - LR+ = 1.4
    - LR- = 0.4

JAMA. 2005;294(12)

Class II Study by Stiell et al

- Enrolled 2,707 with GCS 13-15
- Subgroup analysis with GCS = 15 (n = 1822)
- Secondary outcome: clinically important injury
  - New Orleans Se = 100%; **Sp = 13%** (11 to 14%)
    - LR+ = 1
    - LR – = 0.1
  - Canadian Rule Se = 100%; **Sp = 51%** (48 to 53%)
    - LR+ = 1.7
    - LR – = 0.3

JAMA. 2005;294(12)

Success Story – BWH Head and PE CTs with Clinical Decision Support

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Vice Chairman - Department of Emergency Medicine, Massachusetts General Hospital
Senior Faculty - Brigham and Women's Hospital Center for Evidence-Based Imaging
Associate Professor of Emergency Medicine and Radiology - Harvard Medical School
Executive Director, Harvard Medical School Library of Evidence

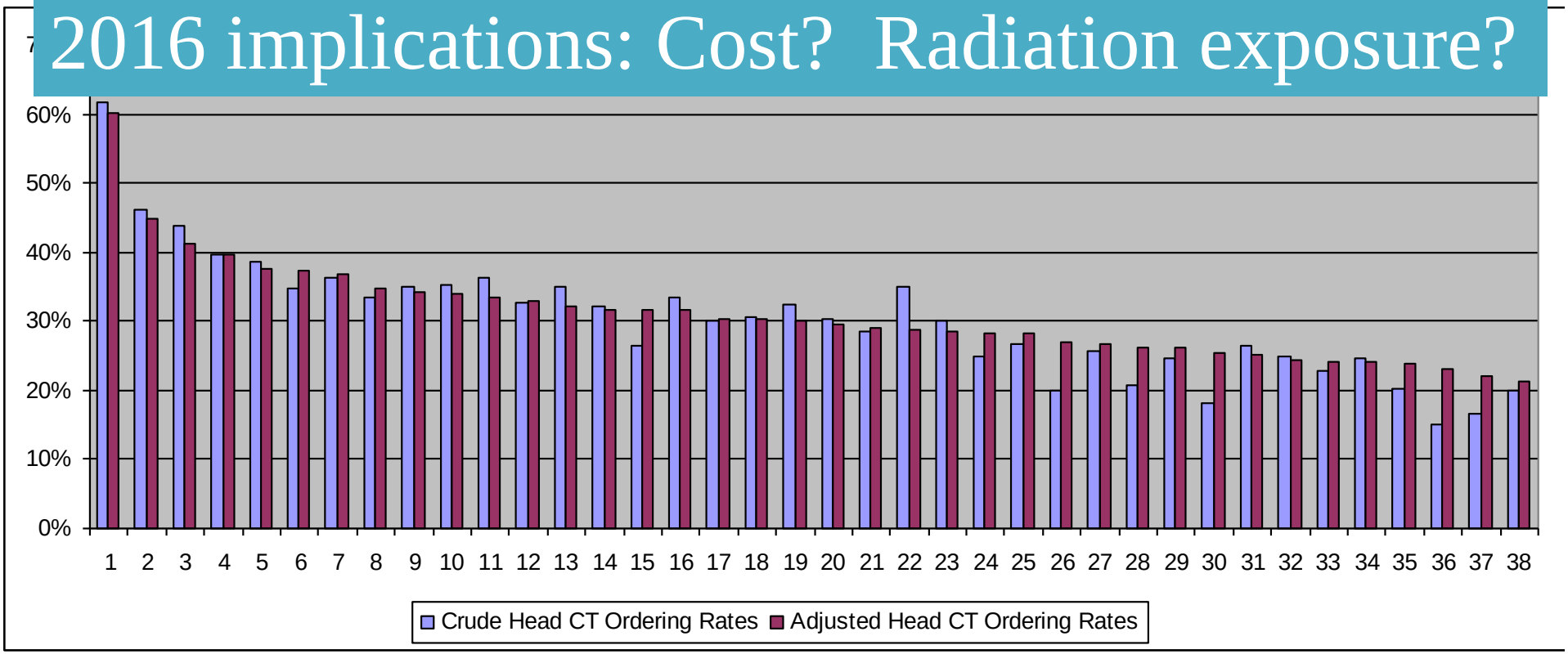
@AliRaja_MD

Financial Conflicts of Interest:

None

Head CT ordering rates: BWH ED in 2009

2016 implications: Cost? Radiation exposure?



3-fold inter-physician variation (21.2%-60.1%) remained after multivariable adjustment

Prevedello L, et al. **Am J Med. 2012 Apr;125(4):356-64.**

Order #:1 Modified from #:0 Reque
Order: HEAD - ED- CT
Special View(s):

Pertinent History/Reason for Exam:
wrong place, wrong time

Contraindications:
Comments:
Physician Name/Pager: ed

Diabetic: Not Diabetic
Latex Allergy: None Known- No Latex Allergy
CREAT: 64 UMOL/L 2013-07-31
EGFR: >120 ML/MIN 2013-07-31

Clinical Decision Support for *Adaptive* Data Collection

Decision Support

Please answer both questions below:

1. Did your patient experience loss of consciousness?

- ○ Yes
- ○ No
- ○ Unknown

2. Does any of the following apply to your patient:

- Post traumatic seizure
- Glascow coma scale < 15 at presentation
- Glascow coma scale deterioration >= 2 points (1 hour after presentation)
- Transfer from another hospital
- Bleeding disorder/anti-coagulant therapy
- Vomiting >= 1 episode
- Postraumatic amnesia >= 4 hour
- Clinical signs of skull fracture

  - ○ Yes
  - ○ No

This information is presented to assist you in providing care to your patients. It is your responsibility to exercise your independent medical knowledge and judgment in providing what you consider to be in the best interest of the patient.

Submit Cancel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BWH
MGH
1811

Lesson One

One Specialty Cannot Implement Imaging CDS Alone

The CT-PE Problem

Life-threatening diagnosis +

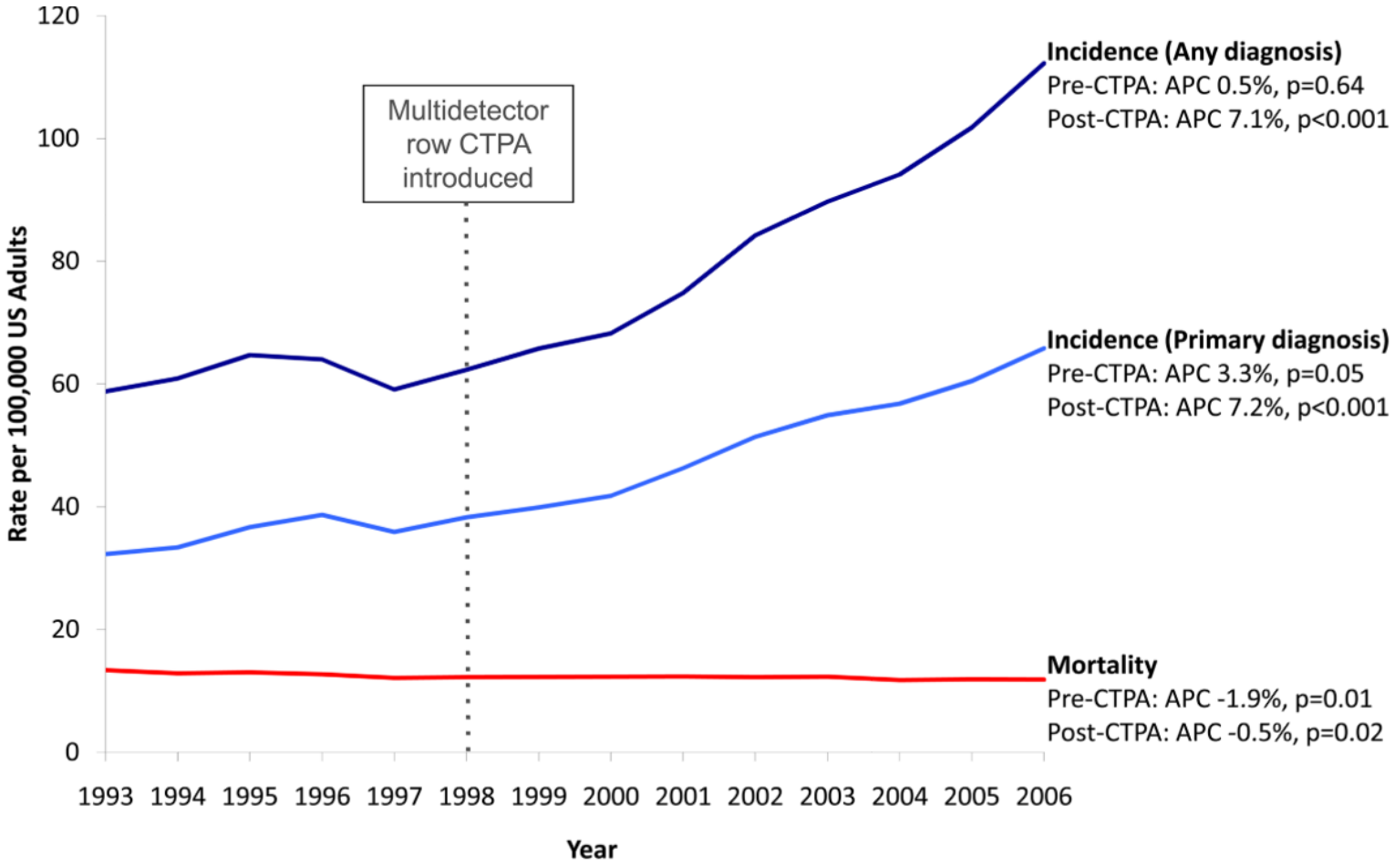
Low-threshold for missed diagnosis +

Readily available definitive diagnostic test +

No physician consequences for over-testing =

Rapidly increasing PE-protocol CT ordering

Incidence and mortality of pulmonary embolism in the United States, 1993–2006



Wiener,. Schwartz, Woloshin. Arch Intern Med. 2011 May 9; 171(9): 831–837.

Solutions?

Emergency Medicine Interventions:

- Failed
  - Not integrated into imaging requests
  - Education only, Not point-of-care

Radiology Interventions:

- Failed
  - Presented novel information at the point-of care, halting flow
  - No internal champions

Effect of Computerized Clinical Decision Support on the Use and Yield of CT Pulmonary Angiography in the Emergency Department[1]

Ali S. Raja, MD, MBA, MPH
Ivan K. Ip, MD, MPH
Luciano M. Prevedello, MD

Radiology

Purpose: To determine the effect of evidence-based clinical decision support (CDS) on the use and yield of computed tomo-

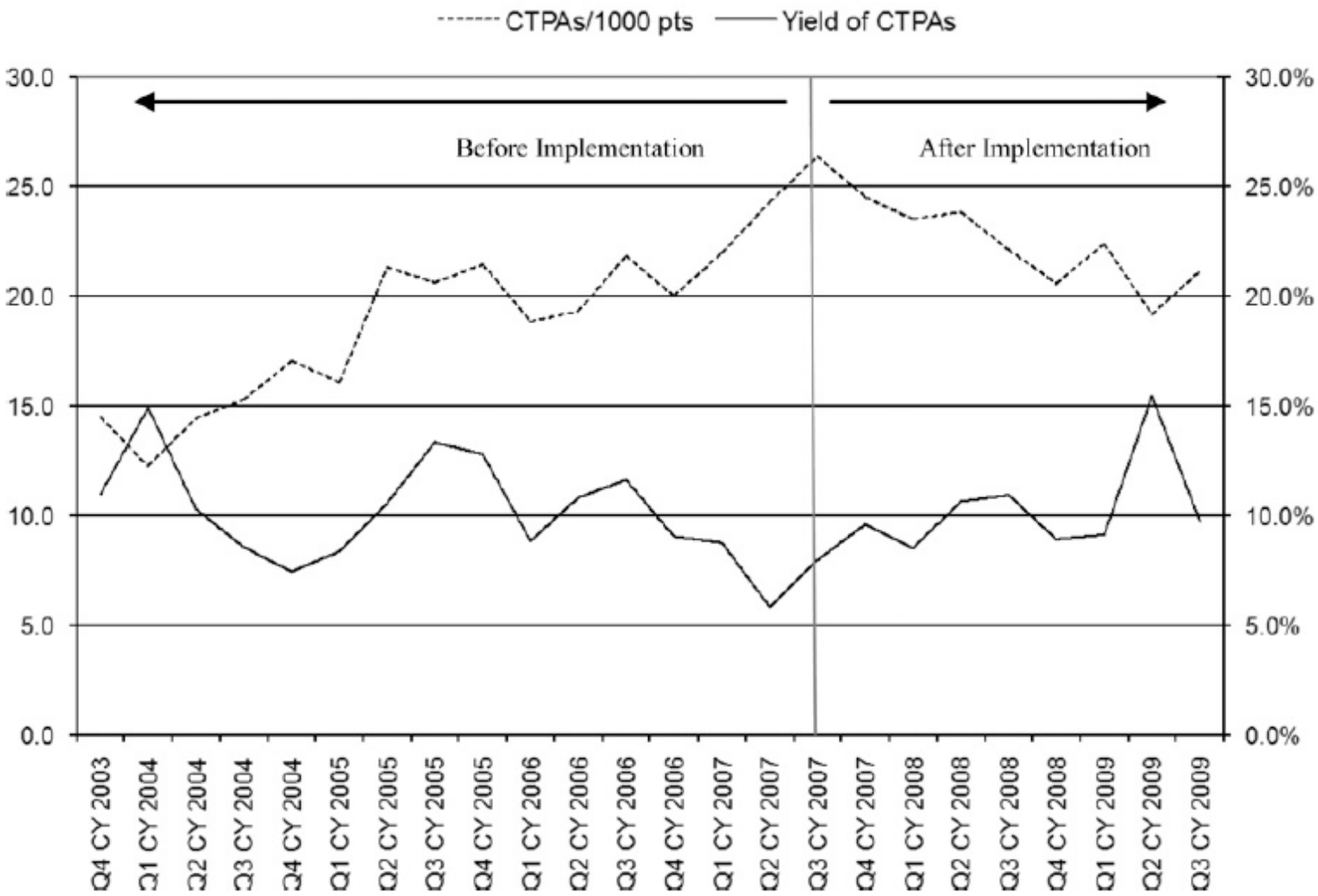


Figure 3: Graph shows CT pulmonary angiography (*CTPA*) use and yield before and after CDS implementation. *CY* = calendar year, *Q1* = first quarter, *Q2* = second quarter, *Q3* = third quarter, *Q4* = fourth quarter.

ners.org/?siteRef=10841 - Percipio - Windows Internet Explorer

BWH **Ordering Physician:** Khorasani, Ramin, MD MPH **Site:** Brigham ED Logoff

Welcome to Percipio - BWFAPP3-ORM1

Decision Support **Order Placement**

Patient Name: Oetest, Carol		PERCIPIO MRN: M8652089	
Birth Date: February 2, 1974	Age: 36 years	Gender: Unknown	Phone Number:
Ordering Physician: N/A		Payor: BWH - Medicare	
Exam: **CT Chest Pulmonary Embolism**		Order ID: 14450931	

Decision Support

To accurately assess the probability of pulmonary embolism in this patient based on Well's Criteria you MUST check all that apply below.

- ☐ Clinical Signs and Symptoms of DVT
- ☐ PE is #1 Diagnosis, or Equally Likely
- ☐ Heart Rate >100
- ☐ Immobilization at least 3 days, or Surgery in the Previous 4 weeks
- ☐ Previous, objectively diagnosed PE or DVT
- ☐ Hemoptysis
- ☐ Malignancy with Treatment within 6 months, or palliative
- ☐ None of the Above

Please see "More Info" for references.

This information is presented to assist you in providing care to your patients. It is your responsibility to exercise your independent medical knowledge and judgment in providing what you consider to be in the best interest of the patient.

Submit

More Info

Feedback

ers.org/?siteRef=10841 - Percipio - Windows Internet Explorer

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Ordering Provider: **Khorasani, Ramin, MD MPH**		Payor: BWH - Medicare	
Exam: **CT Chest Pulmonary Embolism**		Order ID: 14450931	
Created By: N/A		Ordering Site: Brigham ED	

Decision Support

Based on the information you have provided, your patient is not at high risk for Pulmonary Embolism. Published guidelines suggest measuring a D-Dimer to aide in the decision to obtain a CT. A negative D-Dimer result in combination with the absence of high risk as defined by the Wells Criteria, may safely exclude PE in a large proportion of patients with suspected PE.

This information is presented to assist you in providing care to your patients. It is your responsibility to exercise your independent medical knowledge and judgment in providing what you consider to be in the best interest of the patient.

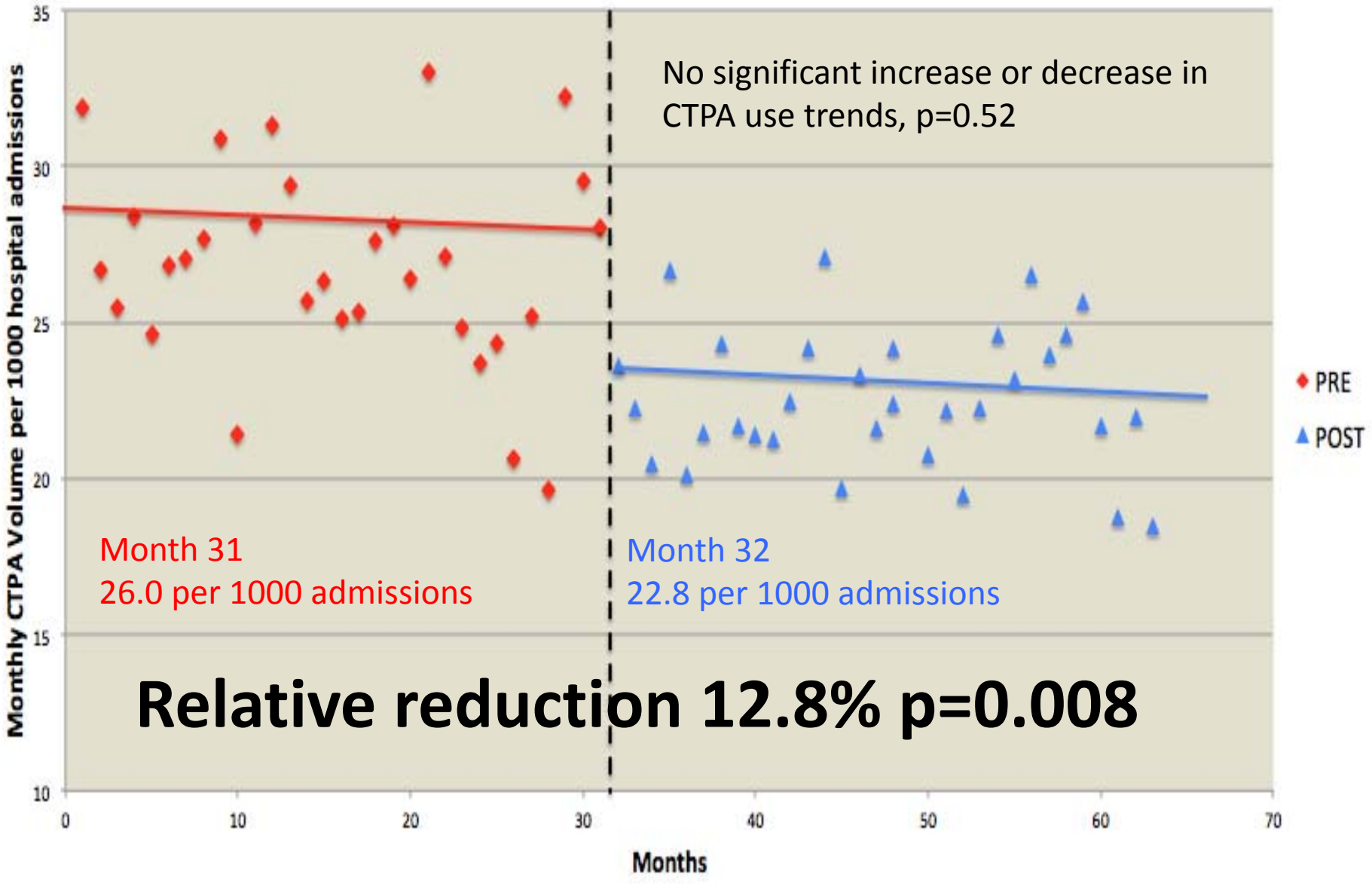
Cancel Ignore

More Info

Feedback

Inpatient CTPA USE

Dunne R, et al. Radiology. February 2015.



Impact of effective CDS on *"Choosing Wisely"* Initiatives

- **CT for suspected pulmonary embolism: (ACEP)**
  - ED use ↓ 20%; yield up 69% over 2 years
  - Inpatient use ↓ 13% over one month, then stable
- **MRI for low back pain: (ACP)**
  - Outpatients: MRI use ↓ 30% on day of PCP visit; ↓ 12.3% within 30 days of index PCP visit
- **CT for minor traumatic brain injury (ACEP)**
  - 13.4% ↓ in use of CT in ED

All above now published or in press in peer reviewed journals

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Lesson Two

CDS Must be Based on High Quality Evidence

CMS
Medicare Imaging Demonstration (MID: 11/2011-9/2013)

- Designed as an alternate to preauthorization, MID assessed impact of CDS based on a broad set of professional society guidelines
- Evidence was limited to ONLY these MID guidelines
- BWH used same ‘syringe’ as used in prior CDS

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MID: BWH Convenership
83,064 orders in the intervention period

Alert/Behavior	Control	Intervention	P value
Actionable alerts	7.9%	5.7%	<0.001
Alerts ignored	---	98.9% (n=82,188)	N/A
Exams modified	---	1.07% (n=903)	N/A
Exams cancelled	---	0.03% (n=23)	N/A

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Protecting Access to Medicare Act (2014)

Ordering professionals advanced imaging services *must* be exposed to evidence-based Appropriate Use Criteria (AUC) via CDS

- Consequence for failure—imaging provider will not be paid

Harvard Medical School eLibrary of Evidence

PAMA rules: Key provisions

- Specified AUC will be developed and published by "qualified provider-led entities"
  - qPLE must have rigorous processes to assess and grade the evidence using a multidisciplinary team, and then publish evidence-based criteria online
  - Implementation date initially January 2017, now delayed

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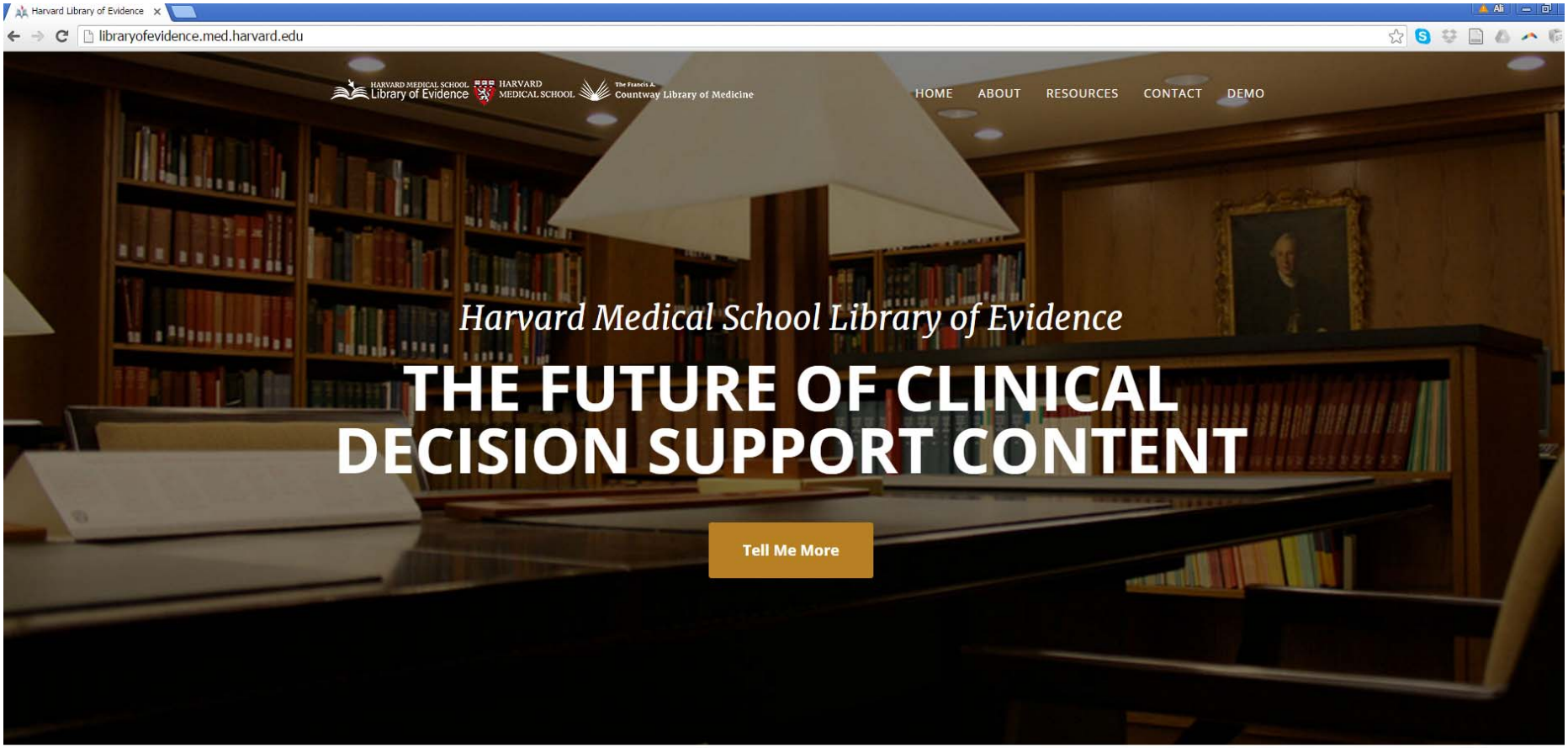
Lesson Two

CDS Must be Based on High Quality Evidence



ABOUT THE LIBRARY OF EVIDENCE

The effective use of a clinical decision support system means patients get the right tests, the right medications, and the right treatment, particularly for chronic

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- A national public domain repository of objectively scored, health IT consumable evidence from any source designed to
  - Accelerate adoption of CDS for imaging
  - Highlight high priority clinical conditions where strong evidence is lacking to stimulate discovery

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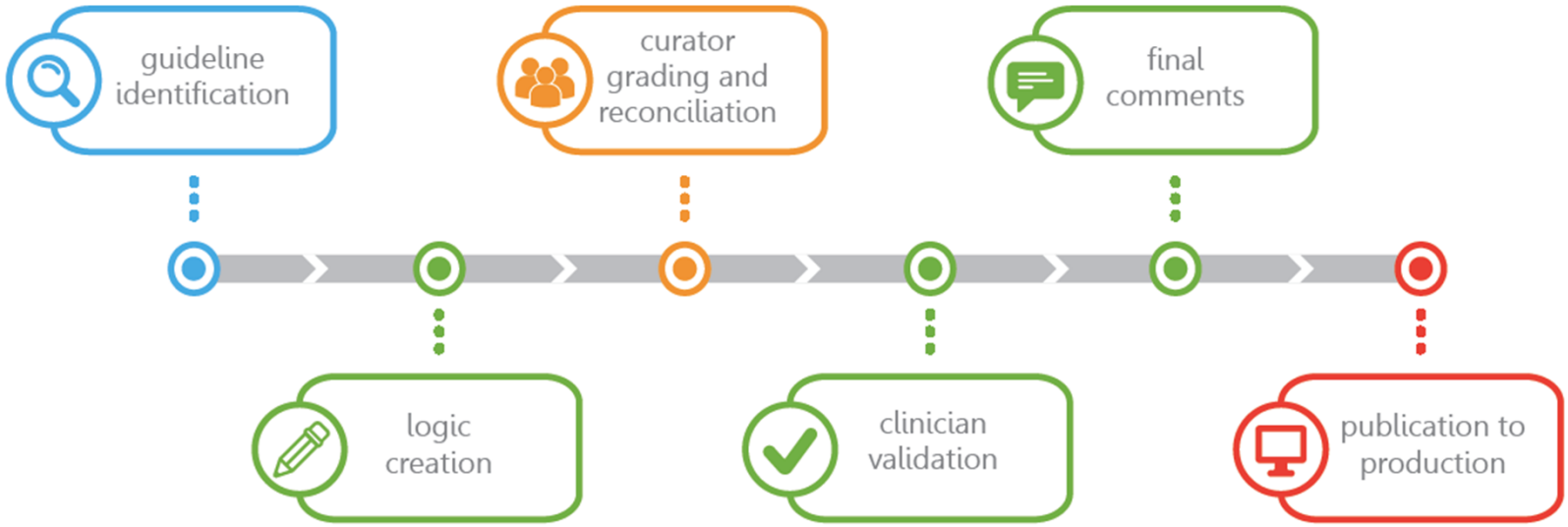

- leadership
- administration
- providers
- librarians

Sample piece of clinical logic:

IF ([Loss of consciousness] **OR** [Post-Traumatic Amnesia]) **AND NOT** ([Focal neurologic deficit] **OR** [Coagulopathy] **OR** [Vomiting] **OR** [GCS<15] **OR** [Severe headache] **OR** [Physical signs of basal skull fracture] **OR** [Dangerous mechanism of injury] **OR** [Trauma >24h ago] **OR** [Hemodynamically unstable]) **AND** [Age ≤60] **THEN NOT** [CT Head]

HARVARD MEDICAL SCHOOL | *Library of Evidence*

CREATE NEW ENTRY | Ramin Khorasani

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Search in guideline name, dx/symptom or piece of logic

Filter by: Modality | Body Region | Contrast | 1a x | 1b x | 1c x | 2a x | 2b x | 2c x | Oxford Grade | USPSTF | FILTER

Professional Society | Choosing Wisely | Endorsed by

Quick Filters: All (374) | Choosing Wisely (7) | Oxford Grade 1-2 (37) | Oxford Grade 1-4 (39)

LIBRARY currently displaying **1-37** of **37** results | EXPORT

Dx/Symptom	Source Type	Publisher	Choosing Wisely	Endorsed by Professional Society	Imaging Modality	Body Region	Contrast	Final Oxford Grade	Strength of Evidence	Final USPSTF	Select All Select None
Minor Head Trauma	Local best practice		N		CT	Head	N/A	1a	|||||||||	Non-I	☐

Source Title: BWH Percipio - Minor Head Trauma
Source Type: Local best practice

Source Link:

Piece of Clinical Logic:
IF NOT ([LOC] **OR** [Post-Traumatic Amnesia]) **AND NOT** ([Focal neurologic deficit] **OR** [Coagulopathy] **OR** [Vomiting] **OR** [GCS<15] **OR** [Headache] **OR** [Physical evidence of trauma above the clavicles] **OR** [Deficits in short-term memory] **OR** [Post-traumatic seizure] **OR** [Drug] **OR** [alcohol intoxication] **OR** [Trauma more than 24h ago] **OR** [Hemodynamically unstable]) **AND** [Age <65] **THEN NOT** [CT Head]

Validating Clinician Name: Ivan Ip
Curator Name: David Osterbur
Curator Name: Julia Whelan

Grading Dates: Mar 4, 2015
Public Comment:

OPEN

Lesson Three

CDS is only the First Step

AJR FOCUS ON:

Effects of Performance Feedback Reports on Adherence to Evidence-Based Guidelines in Use of CT for Evaluation of Pulmonary Embolism in the Emergency Department: A Randomized Trial

Ali S. Raja[1,2,3,4]
Ivan K. Ip[1,2,4,5]
Ruth M. Dunne[1,2,4]
Jeremiah D. Schuur[1,3,4]
Angela M. Mills[6]
Ramin Khorasani[1,2,4]

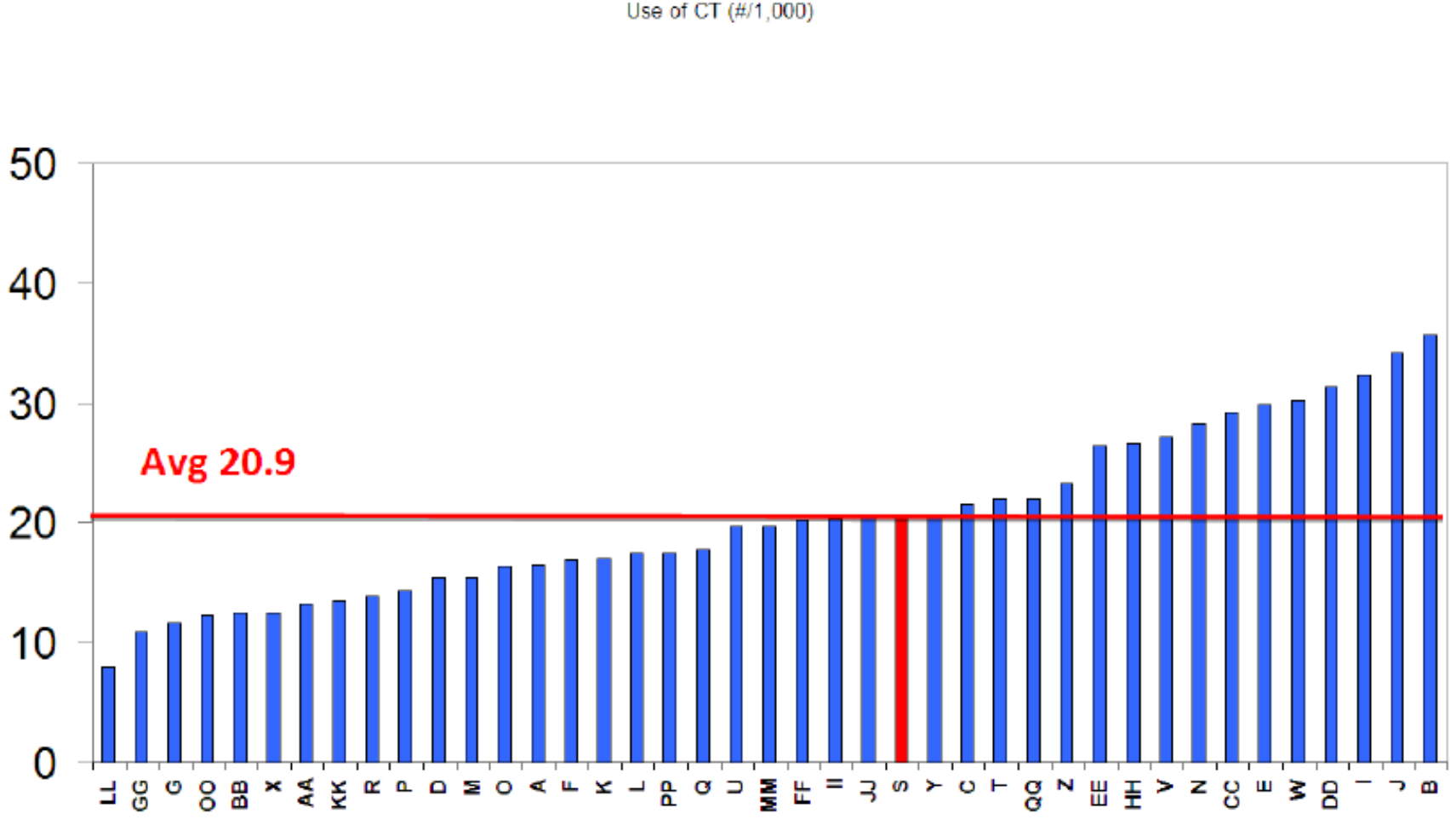
OBJECTIVE. The purpose of this study was to assess whether implementing emergency department (ED) physician performance feedback reports improves adherence to evidence-based guidelines for use of CT for evaluation of pulmonary embolism (PE) beyond that achieved with clinical decision support (CDS) alone.

SUBJECTS AND METHODS. This prospective randomized controlled trial was conducted from January 1, 2012, to December 31, 2013, at an urban level 1 adult trauma center ED. Attending physicians were stratified into quartiles by use of CT for evaluation of PE in

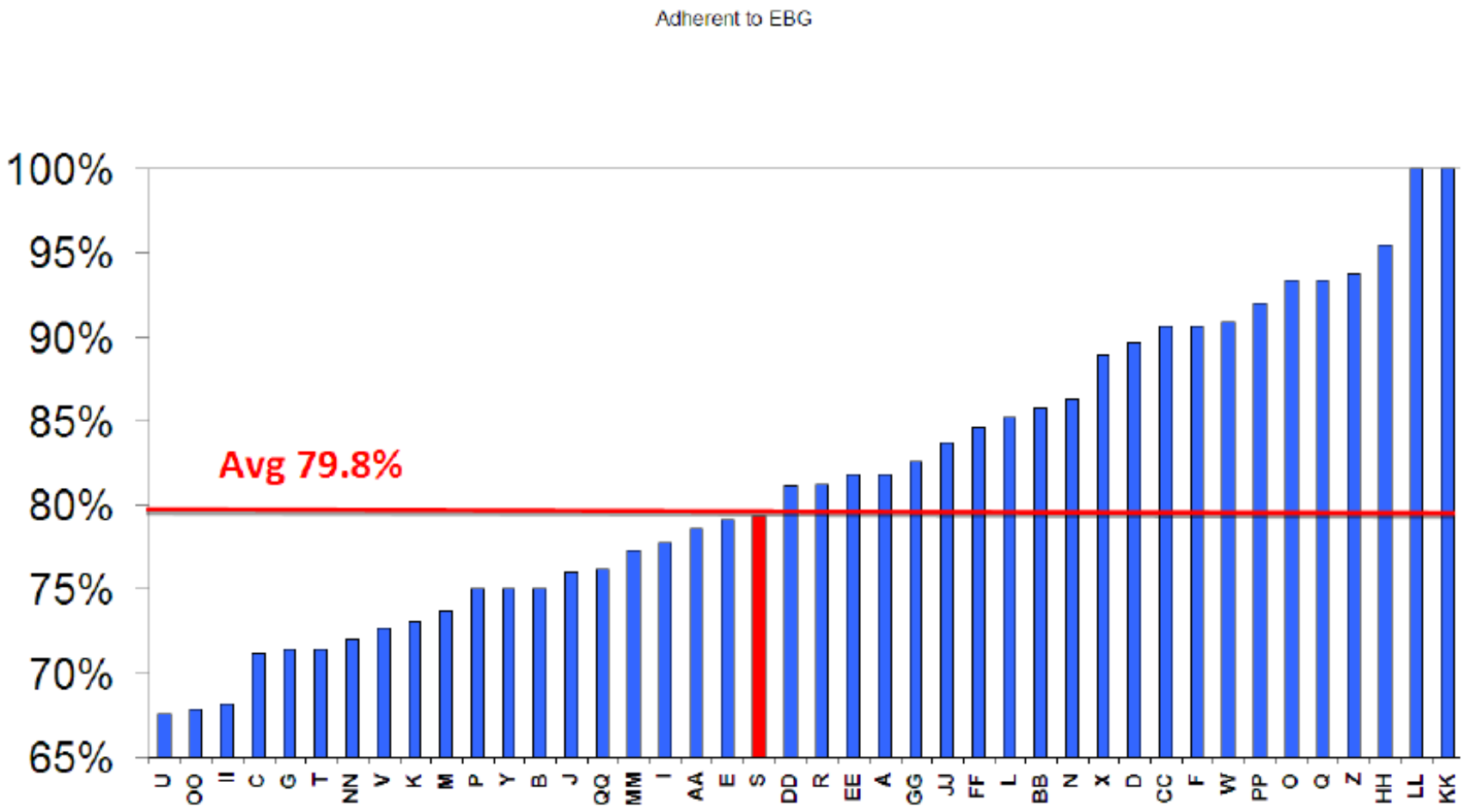
TABLE 2: Outcomes in Control and Intervention Groups

Outcome	Group	Period[a]	Value[b]	*p*
Adherence to evidence-based guidelines (%)	Control	Before	78.8 (476/604)	0.5235
		After	77.2 (421/545)	
	Intervention	**Before**	**78.3 (426/544)**	**0.0043**
		After	**85.2 (404/474)**	

Use
(# PE CTs / 1,000 ED pts seen)



Adherence to Evidence-Based Guidelines
(Using Wells +/- D-dimer)



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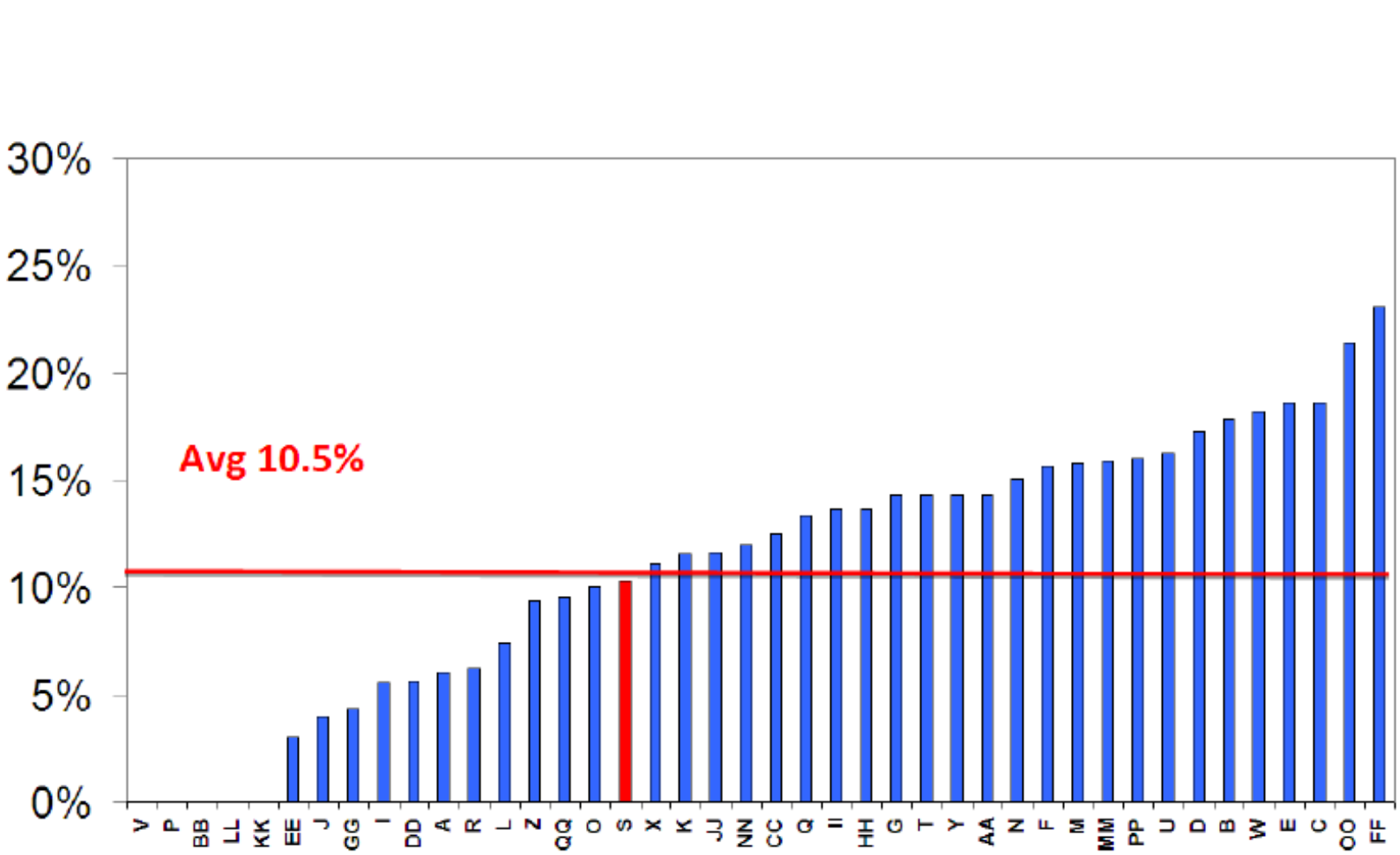
% Yield
(Positive PE CTs/All PE CTs)



Impact of CDS-enabled Interventions on Documented Adherence to Evidence

Imaging/ Condition	Reference	Type	Control	Intervention	P value
Head CT/ ED minor trauma (ACEP)	Gupta JAMIA 2014	Education only	49%	76%	< 0.001
Chest CT/ED PE (NQF)	Raja Acad Rad 2014	Education only	57%	76%	<0.01
Chest CT/ED PE (NQF)	Raja AJR 2015	Add MD feedback	78%	85%	<0.05
LS MRI/ ambulatory (ACP)	Ip American J Med 2013	Add peer to peer, MD feedback	78%	96%	<0.005

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Lessons Learned

1 One Specialty Cannot Implement Imaging CDS Alone

2 CDS Must be Based on High Quality Evidence

3 CDS is only the First Step

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Success Story – BWH Head and PE CTs with Clinical Decision Support

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Using the Canadian CT Head Rule to Reduce Unnecessary Imaging

American College of Emergency Physicians®
ADVANCING EMERGENCY CARE

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Institut de recherche de l'Hôpital d'Ottawa

Ian Stiell MD MSc FRCPC

uOttawa
Faculté de médecine
Faculty of Medicine

- Professor, Dept of Emergency Medicine, U of Ottawa
- Distinguished Professor and Clinical Research Chair, U of Ottawa
- Senior Scientist, Ottawa Hospital Research Institute
- **Disclosures: none**

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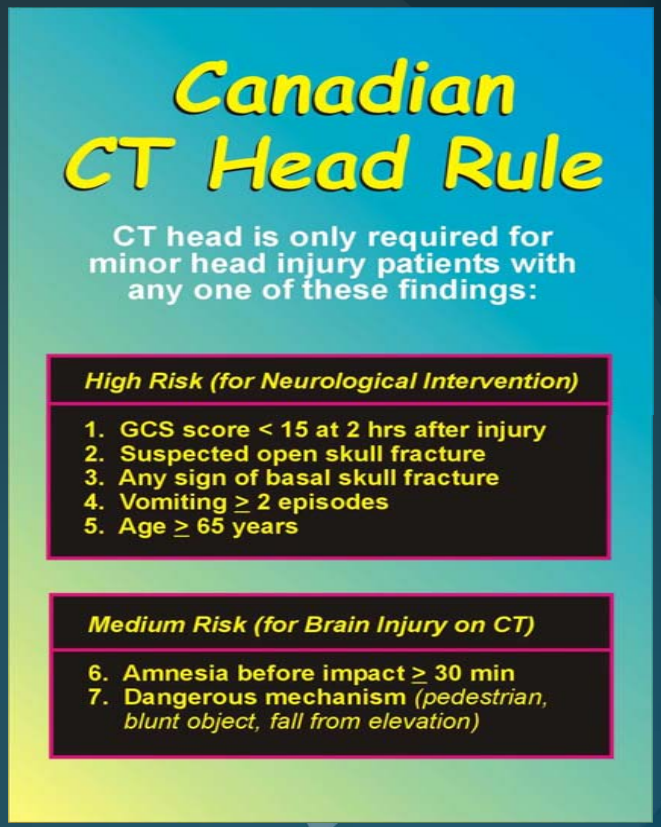
Canadian CT Head Rule:
Learning Objectives

- **To understand the evidence behind the Canadian CT Head Rule**
- **To review how to use the CCHR on your patients**



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Minor Head Injury: The Clinical Problem

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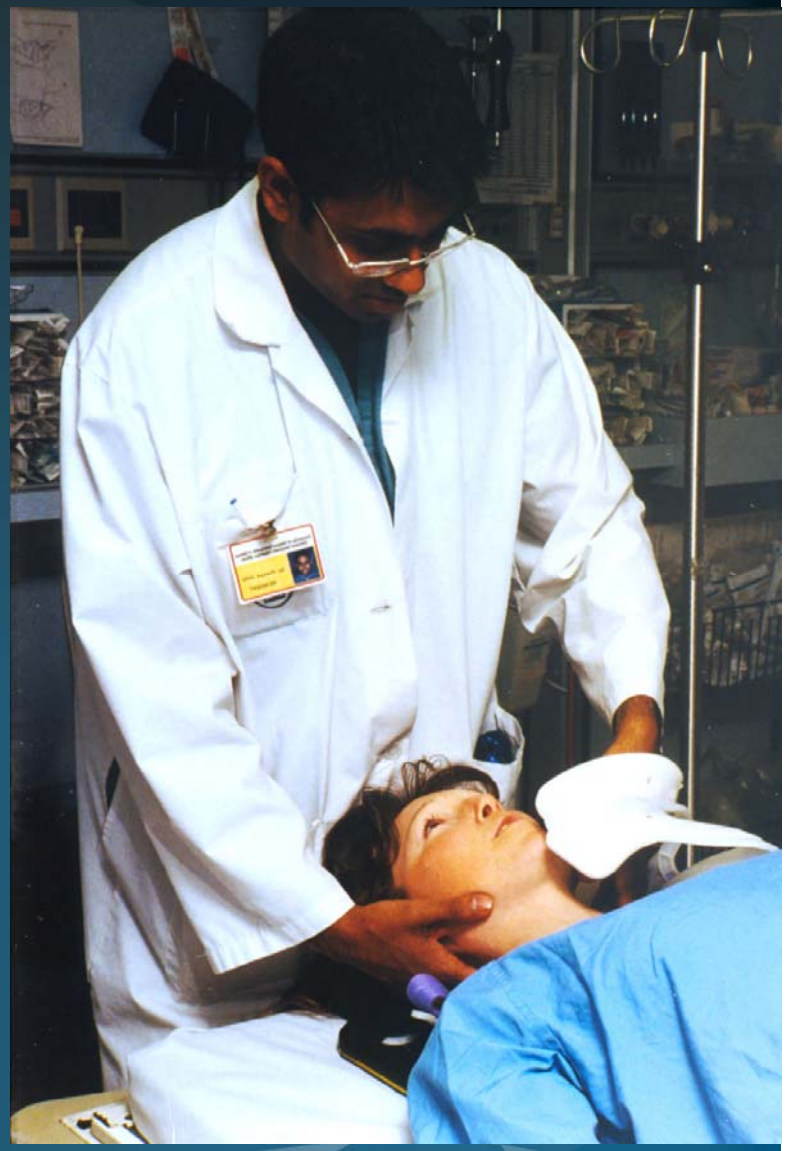
- 6,000,000 head injury cases / year in Canadian and U.S. EDs
- Classic minor head injury:
  - Transient neurological impairment
  - GCS 13-15
- <1% risk of epidural hematoma and need for intervention
- Yield of CT very low in North America



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Minor Head Injury: Case Study #1

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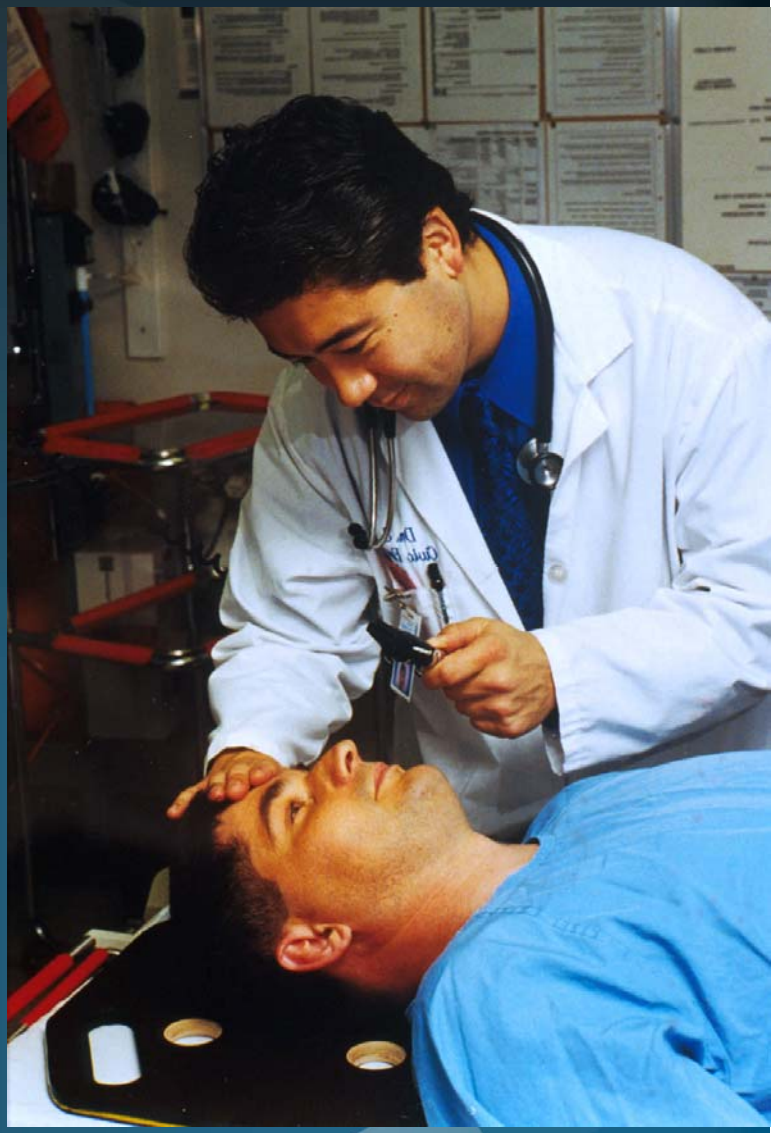
- 45 y.o. male knocked out x 1 minute with baseball bat
- headache, no amnesia, no vomiting
- Pmh = 0; Meds = 0
- Alert, contusion forehead, GCS=15, neuro = N
- ***What do you do?***
  - ***CT head***
  - ***Observe***
  - ***Discharge with no imaging***



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Minor Head Injury: Case Study #2

- 75 y.o. female walked into door, no loss of consciousness
- Laceration eyebrow, no amnesia, no vomiting
- Pmh = HTN; Meds = diuretic
- Alert, 2 cm laceration eyebrow, GCS=15, neuro = N
- ***What do you do?***
  - ***CT head***
  - ***Observe***
  - ***Discharge with no imaging***

Canadian CT Head Rule

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Variation (N=1,699)
Annals EM 1997

Derivation (N=3,121)
The Lancet 2001

Validation (N=2,707)
JAMA 2005

Implementation (N=4,531)
CMAJ 2010

Canadian CT Head Rule

CT head is only required for minor head injury patients with any one of these findings:

High Risk (for Neurological Intervention)

1. GCS score < 15 at 2 hrs after injury
2. Suspected open skull fracture
3. Any sign of basal skull fracture
4. Vomiting ≥ 2 episodes
5. Age ≥ 65 years

Medium Risk (for Brain Injury on CT)

6. Amnesia before impact ≥ 30 min
7. Dangerous mechanism *(pedestrian, blunt object, fall from elevation)*

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ORIGINAL CONTRIBUTION

JAMA 2005

Comparison of the Canadian CT Head Rule and the New Orleans Criteria in Patients With Minor Head Injury

Ian G. Stiell, MD, MSc, FRCPC
Catherine M. Clement, RN
Brian H. Rowe, MD, MSc
Michael J. Schull, MD, MSc
Robert Brison, MD, MPH

Context Current use of cranial computed tomography (CT) for minor head injury is increasing rapidly, highly variable, and inefficient. The Canadian CT Head Rule (CCHR) and New Orleans Criteria (NOC) are previously developed clinical decision rules to guide CT use for patients with minor head injury and with Glasgow Coma Scale (GCS) scores of 13 to 15 for the CCHR and a score of 15 for the NOC. However, uncertainty about the clinical performance of these rules exists.

[redacted]

JAMA 2005

Table 4. Sensitivity and Specificity of the 2 Rules for Patients With Glasgow Coma Scale Score of 15

Result of Assessment	Canadian CT Head Rule		New Orleans Criteria	
	Injury	No Injury	Injury	No Injury
Neurosurgical Intervention				
Positive	8	430	8	1595
Negative	0	1384	0	219
Sensitivity, %	100 (95% CI, 63-100)		100 (95% CI, 63-100)	
Specificity, %	76.3 (95% CI, 74-78)		12.1 (95% CI, 11-14)	
Clinically Important Brain Injury				
Positive	97	853	97	1506
Negative	0	872	0	219
Sensitivity, %	100 (95% CI, 96-100)		100 (95% CI, 96-100)	
Specificity, %	50.6 (95% CI, 48-53)		12.7 (95% CI, 11-14)	

Abbreviations: CI, confidence interval; CT, computed tomography.

JAMA 2005

Table 5. Sensitivity and Specificity of the Canadian CT Head Rule for Patients With Glasgow Coma Scale Score of 13 to 15

Result of Assessment	Canadian CT Head Rule: Injury	Canadian CT Head Rule: No Injury
Neurosurgical Intervention		
Positive	41	918
Negative	0	1748
Sensitivity, %	100 (95% CI, 91-100)	
Specificity, %	65.6 (95% CI, 64-67)	
Clinically Important Brain Injury		
Positive	231	1458
Negative	0	1018
Sensitivity, %	100 (95% CI, 98-100)	
Specificity, %	41.1 (95% CI, 39-43)	

Abbreviations: CI, confidence interval; CT, computed tomography.

CMAJ RESEARCH

A prospective cluster-randomized trial to implement the Canadian CT Head Rule in emergency departments

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Previously published at www.cmaj.ca

- 4,531 patients in 12 EDs
- No missed injuries
- Barriers to KT

Conclusions: Canadian CT Head Rule

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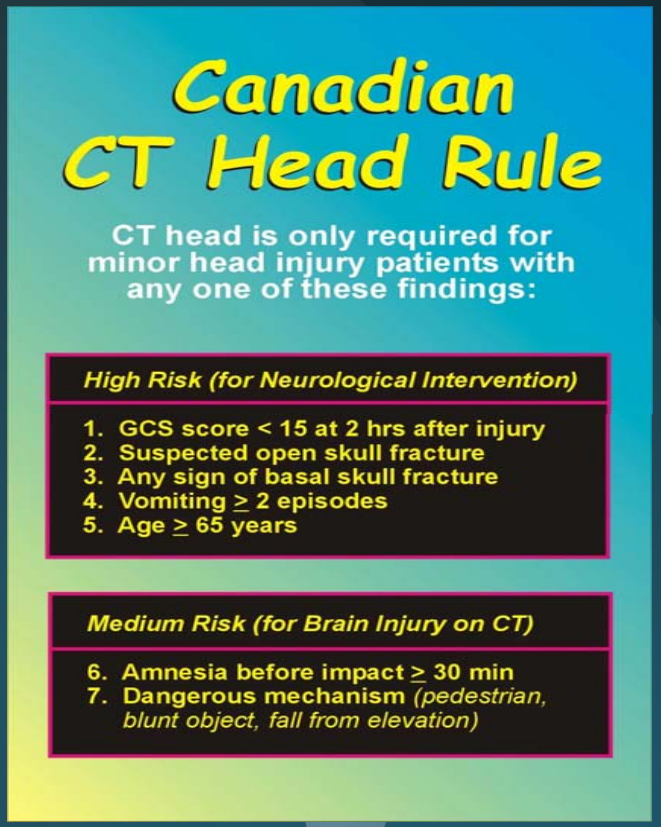
- Accurate and reliable for CT imaging in minor head injury patients
- Could safely limit use of imaging
- Also ensures that patients at risk receive CT in a timely manner



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How to Use the Canadian CT Head Rule

Canadian CT Head Rule

CT head is only required for minor head injury patients with any one of these findings:

High Risk (for Neurological Intervention)

1. GCS score < 15 at 2 hrs after injury
2. Suspected open skull fracture
3. Any sign of basal skull fracture
4. Vomiting ≥ 2 episodes
5. Age ≥ 65 years

Medium Risk (for Brain Injury on CT)

6. Amnesia before impact ≥ 30 min
7. Dangerous mechanism *(pedestrian, blunt object, fall from elevation)*

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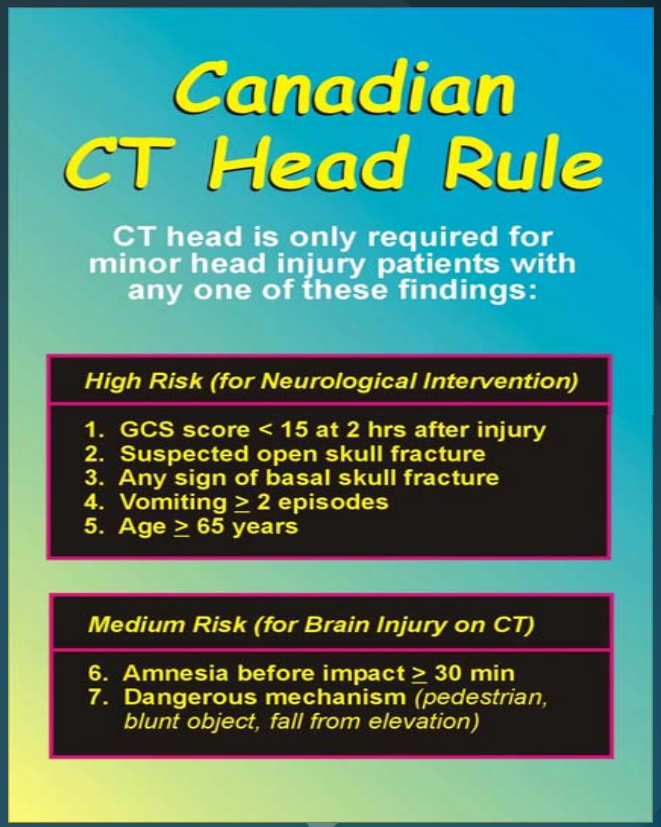
The Canadian CT Head Rule Should Only be Used for these Patients:

- Minor head injury with one of:
  - Witnessed loss of consciousness
  - Amnesia for the injury
  - Confusion after the injury
- GCS 13-15 on ED arrival
- Injury < 24 hours



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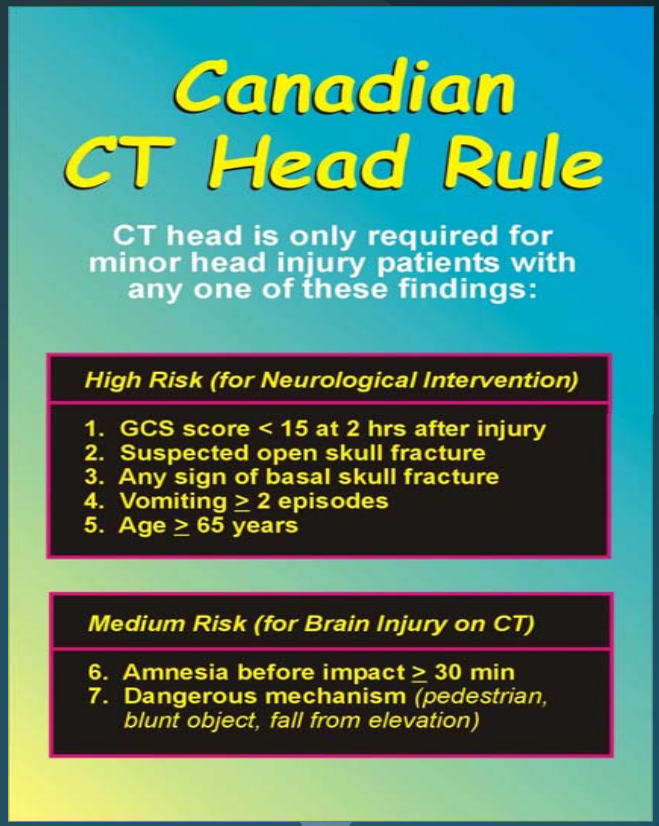
The Canadian CT Head Rule Should <u>Not</u> be Used for these Patients:

- < 16 years of age
- Minimal head injury <u>without</u>:
  - Loss of consciousness
  - Amnesia
  - Confusion
- GCS < 13
- Major trauma (head, chest, abdomen, # femur, hypotension)
- Oral anticoagulants



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7. **Dangerous mechanism** (pedestrian, occupant ejected, fall from elevation)

Canadian CT Head Rule

Dangerous Mechanism of Injury

1. Pedestrian struck by a vehicle
2. Occupant ejected from motor vehicle
3. Fall from elevation ≥ 3 feet or 5 stairs

Minor Head Injury: Case Study #1

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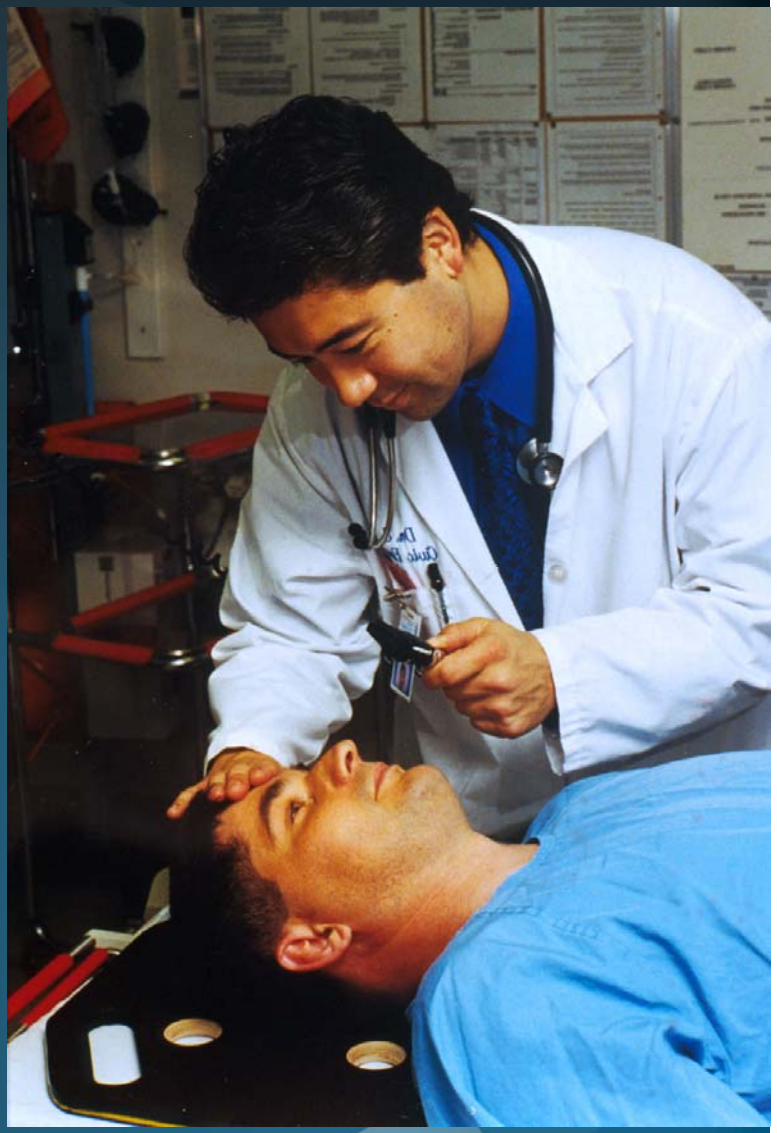
- 45 y.o. male knocked out x 1 minute with baseball bat
- headache, no amnesia, no vomiting
- Pmh = 0; Meds = 0
- Alert, contusion forehead, GCS=15, neuro = N
- ***What do you do?***
  - ***Discharge with no imaging***



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Minor Head Injury: Case Study #2

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- 75 y.o. female walked into door, no loss of consciousness
- Laceration eyebrow, no amnesia, no vomiting
- Pmh = HTN; Meds = diuretic
- Alert, 2 cm laceration eyebrow, GCS=15, neuro = N
- ***What do you do?***
  - ***Discharge with no imaging***

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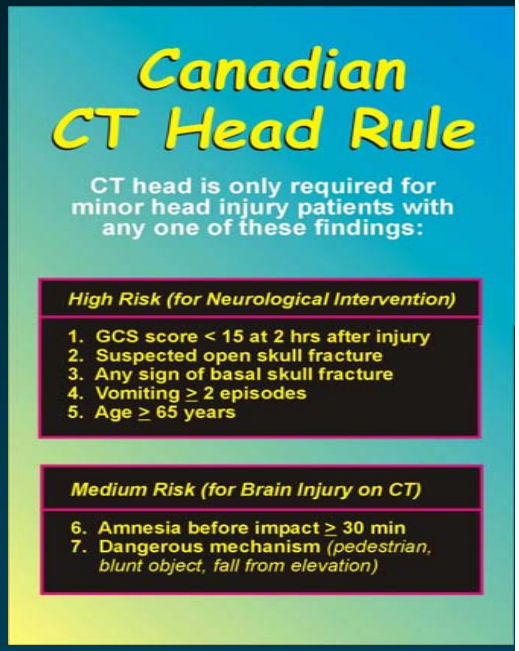
The Canadian CT Head Rule: Tips and Precautions

- The Rule can be safely used for patients who have been drinking if they are cooperative
- Patients without a history of loss of consciousness, amnesia, or confusion rarely need a CT scan
- Patients >65 do not need a scan just based on their age if they do not have this history



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The Canadian CT Head Rule: Learning Aids

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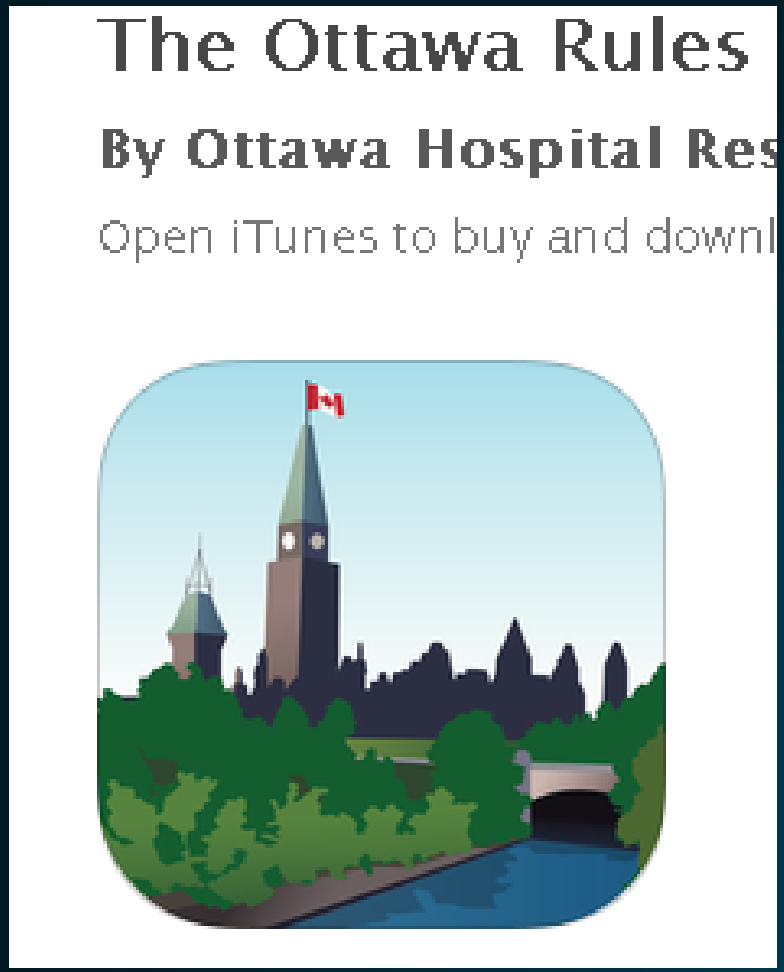
The Canadian CT Head Rule: Learning Aids



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Emergency Medicine Research:

Good Patient Care Requires Good Evidence

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Avoidable Imaging Webinar:
Thursday, September 15
1:00pm-2:00pmEST

ACEP E-QUAL Network Resources and More Information:
www.acep.org/equal

Contact Nalani Tarrant (Project Manager):
ntarrant@acep.org