

# American College of Radiology Appropriateness Criteria<sup>®</sup>

## Head Trauma



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# Introduction to the ACR Appropriateness Criteria ®

- Evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition.
- By employing these guidelines, providers enhance quality of care and contribute to the most efficacious use of radiology.
- The guidelines are developed by expert panels in diagnostic imaging, interventional radiology, and radiation oncology.
- Each panel includes leaders in radiology and other specialties. There are 201 topics with 983 variants in the May 2014 version.

# ACR Value-Based Practice Quality Improvement (PQI) Project

- Seeks to improve the appropriate selection of imaging exams by:
  - Engaging radiologists in research about the patterns of imaging exams performed by their practice
  - Empowering radiologists with educational strategies for working with referring physicians to improve their selection of imaging exams, and
  - Evaluating and reporting on the relative effectiveness of educational strategies.

# ACR PQI Project

- Utilize evidence-based ACR AC to evaluate the rate of appropriate versus inappropriate exams being ordered for a specific imaging study before and after educational interventions with referring clinicians.

# ACR PQI Project

- **Recording baseline data: phase 1**
  - Select a study for which they experience frequent inappropriate referrals from either referring physicians and measure the prevalence of this occurrence over a certain period of time. The level of exam appropriateness is determined by the ACR AC (discussed later).
- **Action plan for improvement: phase 2**
  - Intervention plan to educate the referring physicians re ACR AC.
- **Reassess and document improvement: phase 3**
  - Repeat the process described for Phase 1. The centrally collected data stored by the ACR will allow comparison of individual practices to peer data.

# Background: Head trauma

- Craniocerebral injuries are common cause of hospital admission following trauma.
- Imaging (and CT in particular) plays a crucial role in detecting lesions which require immediate neurosurgical intervention.
- Clinical guidelines may be helpful in reducing unnecessary CTs in patients with minor head injuries (GCS 13-15).

# CT in head trauma

- Advantages
  - Sensitive for demonstrating mass effect, ventricular size, osseous injuries, acute hemorrhage
  - Widespread availability
  - Rapid scanning
- Disadvantages/limitations
  - May miss small nonhemorrhagic lesions (contusions adjacent to bony prominences or small DAI)
  - Relatively insensitive for detection of intracranial pressure/ cerebral edema
  - Ionizing radiation

# Diagnostic approach

- Glasgow Coma Scale (GCS)
- New Orleans Criteria
- Canadian CT Head Rule
- Pediatric patients - Pediatric Emergency Care Applied Research Network (**PECARN**) criteria
- Vascular injuries
- Role of MRI in head trauma

# Glasgow Coma Scale (GCS)

		<b>Adults</b>	<b>Infants/Children</b>
Eye opening	4	Spontaneous	Spontaneous
	3	To voice	To voice
	2	To pain	To pain
	1	None	None
Verbal	5	Oriented	Alert, normal vocalization
	4	Confused	Cries but consolable
	3	Inappropriate words	Persistently irritable
	2	Incomprehensible words	Restless, agitated, moaning
	1	None	None
Motor response	6	Obeys commands	Spontaneous, purposeful
	5	Localizes pain	Localizes pain
	4	Withdraws	Withdraws
	3	Abnormal flexion	Abnormal flexion
	2	Abnormal extension	Abnormal extension
	1	None	None

<sup>a</sup> Score is calculated by adding the scores of the best motor response, best verbal response, and eye opening. Scores range from 3 (the lowest) to 15 (normal).

- Classification of brain injuries:
  - Minor: GCS 13-15
  - Moderate : GCS 9-12
  - Severe : GCS 8 or less

# New Orleans Criteria

- Developed based on clinical findings in a series of 520 patients
- Prospectively validated in a group of 909 patients
- Sensitivity of the 7 findings that make up the criteria combined was 100%
  - All patients with positive CT scans had at least one of the findings

# New Orleans Criteria

## Any acute traumatic intracranial lesion

- Subdural hematoma
- Epidural hematoma
- Parenchymal hematoma
- Subarachnoid hemorrhage
- Cerebral contusion
- Depressed skull fracture

# Canadian CT Head Rule

- Developed from a large, prospective cohort study conducted in 10 Canadian hospitals with 3121 patients.
- High-risk factors were 100% sensitive for predicting need for neurosurgical intervention.
- Evidence indicates this rule may be more specific with regard to clinical outcomes than the New Orleans Criteria.

# Canadian CT Head Rule

For patients with GCS 13-15 after witnessed traumatic loss of consciousness, CT is only required for patients with any of the following findings:

## High risk for neurological intervention

1. GCS <15 at two hours after injury
2. Suspected open or depressed skull fracture
3. Any sign of basal skull fracture†
4. Two or more episodes of vomiting
5.  $\geq 65$  years of age

## Medium risk for brain injury detection by CT imaging

1. Amnesia before impact of 30 or more minutes
2. Dangerous mechanism‡

Exclusion criteria: no history of trauma, GCS <13, age <10 years, warfarin use or coagulopathy, obvious open skull fracture

† Hemotympanum, raccoon eyes, cerebrospinal fluid, otorrhea or rhinorrhea, and Battle's sign.

‡ A pedestrian struck by motor vehicle, an occupant ejected from a motor vehicle, or a fall from an elevation of  $\geq 3$  feet or 5 stairs.

# Head trauma – Pediatric patients

- The aforementioned criteria are considered valid only in adults.
- Clinical criteria have been less reliable in children, especially those under 2 years of age.
- More liberal use of CT may be warranted in children, but this should be weighed against radiation dose considerations.



## Five Things Physicians and Patients Should Question

1

### Antibiotics should not be used for apparent viral respiratory illnesses (sinusitis, pharyngitis, bronchitis).

Although overall antibiotic prescription rates for children have fallen, they still remain alarmingly high. Unnecessary medication use for viral respiratory illnesses can lead to antibiotic resistance and contributes to higher health care costs and the risks of adverse events.

2

### Cough and cold medicines should not be prescribed or recommended for respiratory illnesses in children under four years of age.

Research has shown these products offer little benefit to young children and can have potentially serious side effects. Many cough and cold products for children have more than one ingredient, increasing the chance of accidental overdose if combined with another product.

3

### Computed tomography (CT) scans are not necessary in the immediate evaluation of minor head injuries; clinical observation/Pediatric Emergency Care Applied Research Network (PECARN) criteria should be used to determine whether imaging is indicated.

Minor head injuries occur commonly in children and adolescents. Approximately 50% of children who visit hospital emergency departments with a head injury are given a CT scan, many of which may be unnecessary. Unnecessary exposure to x-rays poses considerable danger to children including increasing the lifetime risk of cancer because a child's brain tissue is more sensitive to ionizing radiation. Unnecessary CT scans impose undue costs to the health care system. Clinical observation prior to CT decision-making for children with minor head injuries is an effective approach.

4

### Neuroimaging (CT, MRI) is not necessary in a child with simple febrile seizure.

CT scanning is associated with radiation exposure that may escalate future cancer risk. MRI also is associated with risks from required sedation and high cost. The literature does not support the use of skull films in the evaluation of a child with a febrile seizure. Clinicians evaluating infants or young

# Head trauma – Pediatric patients

- CT scans are not necessary in the immediate evaluation of minor head injuries.
- Clinical observation/Pediatric Emergency Care Applied Research Network (**PECARN**) criteria should be used to determine whether imaging is indicated.

# PECARN Clinical prediction rules for traumatic brain injury

- The PECARN Head Injury Prediction Rules were developed through the largest study ever done on pediatric head injury.
  - Derivation (n=33,785) and validation (n=8,627) of clinical decision rule for deciding which pediatric patient with head trauma can be safely discharged without obtaining a head CT.
- Validated in multiple settings : shown to have a sensitivity of 100% (specificity 55-62%) for any clinically important traumatic brain injury and any injury requiring neurosurgery.

# PECARN Clinical prediction rules for traumatic brain injury

## Prediction rule for traumatic brain injury - PECARN

### Age < 2 years

1. Altered mental status<sup>†</sup>
2. Severe mechanism of injury<sup>‡</sup>
3. Loss of consciousness  $\geq$  5 seconds
4. Palpable skull fracture
5. Non-frontal scalp hematoma
6. Abnormal behavior

### Age $\geq$ 2 years

1. Altered mental status<sup>†</sup>
2. Severe mechanism of injury<sup>‡</sup>
3. Any loss of consciousness
4. Signs of basilar skull fracture
5. History of vomiting
6. Severe headache

Children with no clinical factors are classified as “low risk”.

<sup>†</sup> GCS 14, agitation, sleepiness, slow response or repetitive questioning

<sup>‡</sup> Motor vehicle crash with patient ejection, death or another passenger or “rollover”, pedestrian or cyclist without helmet struck by vehicle, fall (  $>1\text{m}$  for children  $<2\text{yrs}$ ;  $>1.5\text{m}$  for children  $\geq 2\text{yrs}$ ), or head struck by “high-impact” object

# Detection of vascular injuries

- Vascular injuries are typically seen with penetrating trauma, basal skull fracture, or neck trauma.
- Cerebral infarction is infrequently seen with head injury; when it does occur, it is commonly due to compression from intracranial mass lesions.
- CTA and MRA have largely replaced angiography as the screening tool of choice for detecting traumatic vascular injuries.
  - Conventional angiography is primarily used for problem-solving and is usually NOT the initial study of choice.

# Role of MRI in head trauma

- MRI is very sensitive for detecting and characterizing subacute and chronic brain injuries, and may have a role in predicting post-traumatic outcomes.
- MRI is unlikely to alter management of surgical injuries, but it offers much-improved depiction of medically stable injuries.
  - Contusions and secondary effects of trauma: edema, hypoxic-ischemic encephalopathy
  - Diffuse axonal injury (DAI)
  - DWI with ADC mapping provides rapid detection of cytotoxic injury

# Radiation safety

- Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure.
- Relative radiation level (RRL) are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure.

# Relative radiation dose information

## American College of Radiology ACR Appropriateness Criteria®

**Clinical Condition:** Head Trauma

**Variant 1:** Minor or mild acute closed head injury (GCS  $\geq 13$ ), without risk factors or neurologic deficit.

Radiologic Procedure	Rating	Comments	RRL*
CT head without contrast	7	Known to have low yield.	⊕⊕⊕
MRI head without contrast	4		○
MRA head and neck without contrast	3	Rarely indicated with mild trauma.	○
MRA head and neck without and with contrast	3		○
CT head without and with contrast	3		⊕⊕⊕
CTA head and neck with contrast	3	Rarely indicated with mild trauma.	⊕⊕⊕
MRI head without and with contrast	2		○
CT head with contrast	1		⊕⊕⊕
X-ray head	1		⊕
FDG-PET/CT head	1		⊕⊕⊕⊕
US transcranial with Doppler	1		○
Arteriography cervicocerebral	1		⊕⊕⊕
Tc-99m HMPAO SPECT head	1		⊕⊕⊕⊕

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

\*Relative Radiation Level

### Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
○	0 mSv	0 mSv
⊕	<0.1 mSv	<0.03 mSv
⊕⊕	0.1-1 mSv	0.03-0.3 mSv
⊕⊕⊕	1-10 mSv	0.3-3 mSv
⊕⊕⊕⊕	10-30 mSv	3-10 mSv
⊕⊕⊕⊕⊕	30-100 mSv	10-30 mSv

\*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".

# ACR AC Recommendations- Summary

- Adult patients: CT without contrast is first-line study in all cases of closed-head injury; clinical criteria may be used to determine whether it is necessary
  - Glasgow Coma Scale (GCS)
  - New Orleans Criteria
  - Canadian CT Head Rule
- Pediatric patients
  - Pediatric Emergency Care Applied Research Network (**PECARN**) criteria
- Vascular injuries : CTA and MRI
- Role of MRI in head trauma : detects subacute and chronic brain injuries, and may have a role in predicting post-traumatic outcomes

# References

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- Please refer to the most updated version at <http://www.acr.org/Quality--Safety/Appropriateness---Criteria>

# Thank you!



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