ER
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Background

- Mild head injury (GCS 14~15) in child : need CT or not?
- Child is sensitive to radiation, esp. in younger than 2 years old
- CT increases risks of radiation-induced malignancy (The estimated rate of lethal malignancies from CT is between 1 in 1000 and 1 in 5000 paediatric cranial CT)

Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study

Nathan Kuppermann, James F Holmes, Peter S Dayan, John D Hoyle, Jr, Shireen M Atabaki, Richard Holubkov, Frances M Nadel, David Monroe, Rachel M Stanley, Dominic A Borgialli, Mohamed K Badawy, Jeff E Schunk, Kimberly S Quayle, Prashant Mahajan, Richard Lichenstein, Kathleen A Lillis, Michael G Tunik, Elizabeth S Jacobs, James M Callahan, Marc H Gorelick, Todd F Glass, Lois K Lee, Michael C Bachman, Arthur Cooper, Elizabeth C Powell, Michael J Gerardi, Kraig A Melville, J Paul Muizelaar, David H Wisner, Sally Jo Zuspan, J Michael Dean, Sandra L Wootton-Gorges, for the Pediatric Emergency Care Applied Research Network (PECARN)*

Lancet 2009; 374: 1160–70

to derive and validate prediction rules for ciTBI to identify children at very low risk of ciTBI after blunt head trauma for whom CT might be unnecessary

Methods

- younger than 18 years
- presenting within 24 h of head trauma with Glasgow Coma Scale scores of 14–15 in 25 North American emergency departments.
- The researchers derived and validated age-specific prediction rules for ciTBI
- clinically-important traumatic brain injuries (ciTBI) : death from traumatic brain injury, neurosurgery, intubation >24 h, or hospital admission ≥2 nights).

Case report form

Mechanism of injury

- Occupant in motor vehicle crash (with documentation of ejection, rollover, death of other passenger, speed, restraint use)
- Pedestrian struck by vehicle
- Bicycle rider struck by automobile (with documentation of helmet use)
- Bicycle collision or fall (with documentation of helmet use)
- Other wheeled transport crash (with documentation if motorised or not)
- Fall to ground from standing, walking, or running
- Walked or ran into stationary object
- Fall from height (with estimated height)
- Fall down stairs (with number of stairs)
- Sport-related (with documentation of sport type, helmet use)
- Assault
- Head struck by object (unintentional)
- Other mechanism of injury

Clinical variables: history and symptoms

- Post-traumatic amnesia: inability to recall entire traumatic event
- History of loss of consciousness: a period of unconsciousness, categorised by duration (<5 s, 5–60 s, 1–5 min, and >5 min)
- Post-traumatic seizure: tonic and/or clonic jerking activity occurring after the traumatic event, categorised as occurring within or after 30 min of the injury, with duration categorised
- Headache : categorised as currently present or not, severity (mild [barely noticeable], moderate, or severe [intense]), location of headache, and timing of onset
- Vomiting: classified according to the presence or absence of a history of vomiting, number of episodes (once, twice, or more than two episodes), and when vomiting started
- Dizziness: any sensation of vertigo, sense of physical imbalance, or postural instability while in the emergency department
- Parental report of whether the patient is acting normally: whether patient is at baseline or not

Case report form

Clinical variables: physical examination findings

- GCS score: applied to patients older than 2 years of age[23]
- Paediatric GCS score: applied to children aged 2 years or younger[24]
- Other signs of altered mental status: defined by agitation, somnolence, repetitive questioning, or slow response to verbal communication
- Bulging anterior fontanelle: if fontanelle open
- Signs of basilar skull fracture: such as retro-auricular bruising (Battle's sign), periorbital bruising (raccoon eyes), haemotympanum, cerebral spinal fluid otorrhoea, or cerebral spinal fluid rhinorrhoea
- Palpable skull fracture: on digital inspection, or unclear on the basis of swelling or distortion of the scalp
- Scalp haematoma: swelling of the scalp (including the forehead), recorded by size as small (barely palpable <1 cm), medium (1–3 cm) or large (>3 cm), by location (frontal, temporal-parietal, or occipital), and by character (boggy or firm)
- Neurological deficits: any abnormality of the cranial nerves, motor or sensory examinations, or deep tendon reflexes
- Suspected alcohol or drug intoxication

Other information collected on case report form

- Any signs of trauma above the clavicles (and location): including lacerations, abrasions, and haematomas
- Presence of other substantial (non-cranial) trauma: fractures, intra-abdominal injuries, intrathoracic injuries, or lacerations requiring operating-room repair*
- Was the patient observed in the emergency department after initial evaluation to decide whether to obtain CT?
- Indications for CT scan (if CT obtained)
- Disposition: home, general ward, intensive care unit, operating room, death

Traumatic brain injury outcome definitions

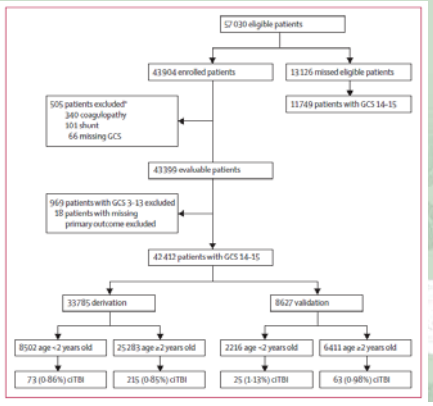
Clinically-important traumatic brain injury (ciTBI)
Defined by any of the following descriptions:

- Death from traumatic brain injury
- Neurosurgical intervention for traumatic brain injury
  - Intracranial pressure monitoring
  - Elevation of depressed skull fracture
  - Ventriculostomy
  - Haematoma evacuation
  - Lobectomy
  - Tissue debridement
  - Dura repair
  - Other
- Intubation of more than 24 h for traumatic brain injury*
- Hospital admission of 2 nights or more for the traumatic brain injury in association with traumatic brain injury on CT†
  - Hospital admission for traumatic brain injury defined by admission for persistent neurological symptoms or signs such as persistent alteration in mental status, recurrent emesis due to head injury, persistent severe headache, or ongoing seizure management

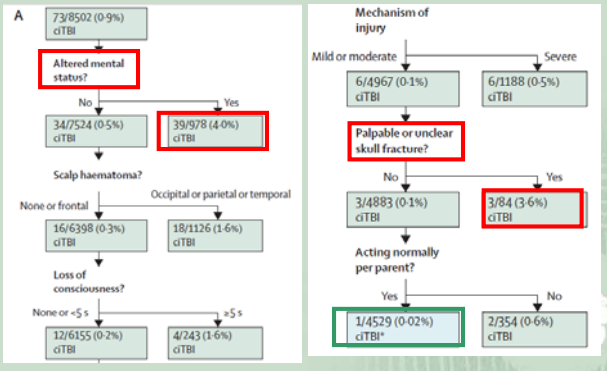
Traumatic brain injury on CT
Defined by any of the following descriptions:

- Intracranial haemorrhage or contusion
- Cerebral oedema
- Traumatic infarction
- Diffuse axonal injury
- Shearing injury
- Sigmoid sinus thrombosis
- Midline shift of intracranial contents or signs of brain herniation
- Diastasis of the skull
- Pneumocephalus
- Skull fracture depressed by at least the width of the table of the skull‡

Flow chart



The prediction rule for children < 2 years

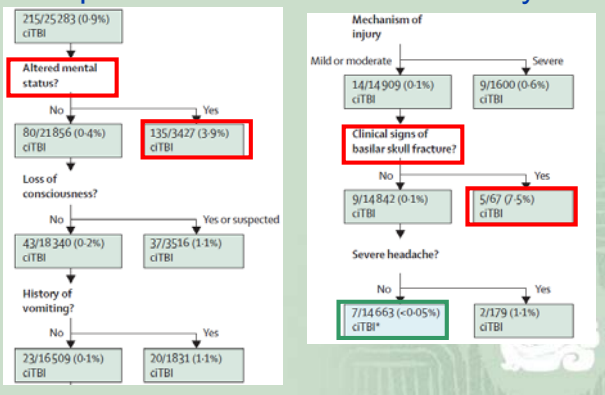


The prediction rule for children < 2 years

	Derivation			Validation		
	ciTBI	No ciTBI	Total	ciTBI	No ciTBI	Total
Any predictor present	72	3901	3973	25	1015	1040
No predictor present	1	4528	4529	0	1176	1176
Total	**73**	**8429**	**8502**	**25**	**2191**	**2216**

	Derivation	Validation
Prediction rule sensitivity (95% CI)	98·6% (92·6–99·97)	100·00% (86·3–100·00)
Prediction rule specificity (95% CI)	53·7% (52·6–54·8)	53·7% (51·6–55·8)
Negative predictive value (95% CI)	99·9% (99·88–99·999)	100·00% (99·7–100·00)
Positive predictive value (95% CI)	1·8% (1·4–2·3)	2·4% (1·6–3·5)
Negative likelihood ratio (95% CI)	0·03 (0·001–0·14)	0·0 (0–0·26)

The prediction rule for children > 2 years



The prediction rule for children > 2 years

	Derivation			Validation		
	ciTBI	No ciTBI	Total	ciTBI	No ciTBI	Total
Any predictor present	208	10 412	10 620	61	2550	2611
No predictor present	7	14 656	14 663	2	3798	3800
Total	**215**	**25 068**	**25 283**	**63**	**6348**	**6411**

	Derivation	Validation
Prediction rule sensitivity (95% CI)	96·7% (93·4–98·7)	96·8% (89·0–99·6)
Prediction rule specificity (95% CI)	58·5% (57·9–59·1)	59·8% (58·6–61·0)
Negative predictive value (95% CI)	99·95% (99·9–99·98)	99·95% (99·81–99·99)
Positive predictive value (95% CI)	2·0% (1·7–2·2)	2·3% (1·8–3·0)
Negative likelihood ratio (95% CI)	0·06 (0·03–0·11)	0·05 (0·01–0·19)

The prediction rule for children

- Normal mental status
- No scalp haematoma except frontal

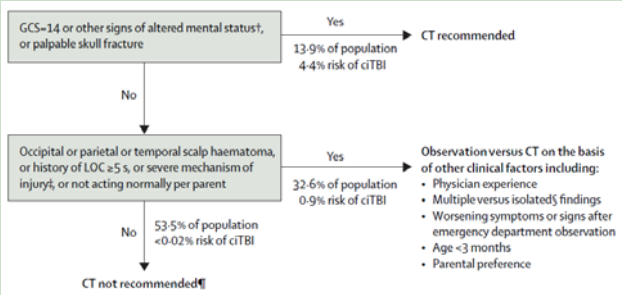
One of above not suitable:ciTBI>4% => CT

- Loss of consciousness < 5 s
- Non-severe injury mechanism
  - -- not falls of more than 0.9 m (for < 2 y/o)
  - -- not falls of more than 1.5 m (for >2 y/o)
- No palpable skull fracture
- Normal behavior per patient (for < 2 y/o)
- No severe headache (for >2 y/o)

One of above not suitable:ciTBI 0.9% => CT /obsevation

none of above not suitable:ciTBI 0.02% => obsevation

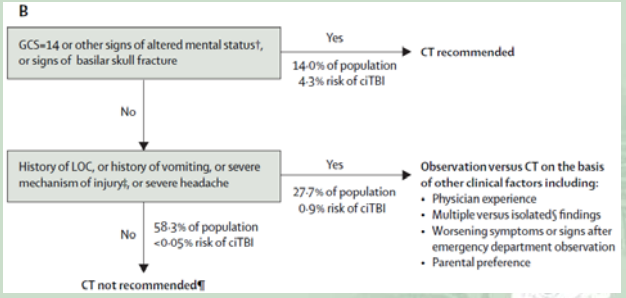
CT algorithm for children <2 years



PECARN

Paediatric Emergency Care Applied Research Network

CT algorithm for children >2 years



PECARN

Paediatric Emergency Care Applied Research Network

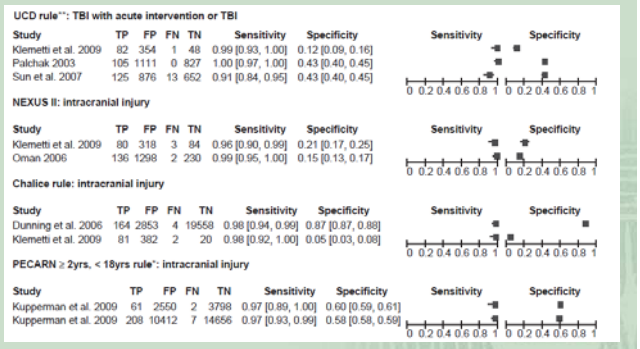
Clinical decision rules for children with minor head injury: a systematic review

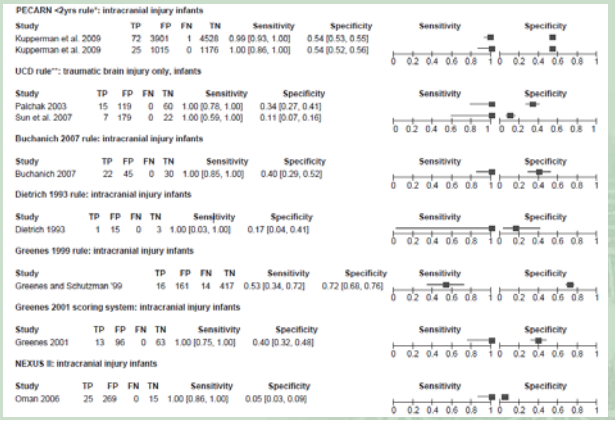
Alastair Pickering,[1] Susan Harnan,[2] Patrick Fitzgerald,[2] Abdullah Pandor,[2] Steve Goodacre[1]

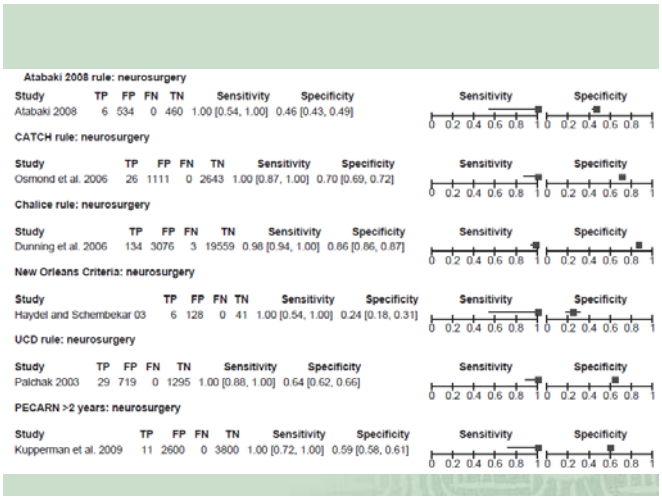
Arch Dis Child 2011;**96**:414–421

What this study adds

- Comparing the diagnostic accuracy of existing decision rules has identifi ed what appears to be the best for this population.
- Significant differences exist in criteria used to test these rules and their future development should focus on using standard definitions that would allow more direct comparisons between rules







DISCUSSION

- The most validated appears to be the PECARN rule.

DISCUSSION

Table 2 Clinical relevance: positive predictive values from selected large cohort studies

Study/rule	TP	FP	FN	TN	PPV (%)	Scans/ICI identified
PECARN	269	12962	9	18454	2.0	49.2
Da Dalt	22	478	0	3298	4.4	22.7
CHALICE	164	2853	4	19558	5.4	18.4
CATCH	167	1802	3	1809	8.5	11.8
UCD	105	1111	0	827	8.6	11.6
NEXUS II[18]	136	1298	2	230	9.4	10.5
Infants						
PECARN	97	4916	1	5704	1.9	51.7
Oman	25	269	0	15	8.5	11.8
UCD	15	119	0	60	11.2	8.9
NSI						
PECARN[2–18]	11	2600	0	3800	0.4	237.4
CATCH	26	1111	0	2643	2.2	43.7
UCD	29	719	0	1295	3.9	25.7
CHALICE	134	3076	3	19559	4.2	23.9
PECARN (<2)	5	1035	0	1176	0.5	208

DISCUSSION

- For identifying one clinically significant ICI (using the positive predictive values)
  PECARN scan approximately 50 children.
  CHALICE scan 18 children
- For identifying one neurosurgical injury
  PECARN scan over 200 children
  CHALICE scan 24 children

CHALICE :Children's Head Injury Algorithm for the Prediction of Important Clinical Events Rule

Sedation and anesthesia for CT: emerging issues for providing high-quality care

Charles G. Macias · Corrie E. Chumpitazi

Pediatr Radiol (2011) 41 (Suppl 2):S517–S522

1.If CT is needed, the sedation is necessary for quality of CT
2.what sedation drug is suitable for child/infant?

ideal procedural sedation agent

- a rapid onset of action,
- few side effects,
- a short duration of action,
- minimal to no effect on respiratory rate or hemodynamics,
- provides airway protection,
- Readily reversible,
- allows for smooth recovery with no additional side effects

Monitoring

- Continuous monitoring
  -- oxygen saturation
  -- heart rate,
- intermittent recording (no more than every 5 min)
  -- respiratory rate
  -- blood pressure
- End tidal carbon dioxide monitoring (ETCO2)
  (CO2 changes prior to oxygen desaturation)
- An RSS 4 (moderate, Responds to commands) or RSS 5 (deep, Brisk response to light glabellar tap)
  -- adequate sedation depth to tolerate CT or MRI.

Chloral hydrate

- not safe
  (overall adverse event rates of 0.5% with pentobarbital vs. 2.7% with chloral hydrate)
- fails to produce adequate sedation
  (2–6% aborted procedure)

Midazolam

- short-acting benzodiazepine with sedative, anxiolytic, muscle relaxant and amnesic effects
- orally, intranasally or intravenously , with intramuscular injection resulting in slow and unpredictable absorption
- Contraindications
  1.acute narrow angle glaucoma,
  2.uncontrolled pain,
  3.existing central nervous system depression
  4.shock
- reversible by flumazenil

Midazolam

- 6 months to 6 years of age
  IV:0.2 mg/kg IV, with 0.1 mg/kg additional boluses to maximum 0.5 mg/kg.
  6.9% insignificant desaturations within a 1-h observation period

  mucosal atomizer with lidocaine spray (10 mg/puff) for minimizing discomfort
- Medical staff and parents both reported satisfaction with the sedation

Pentobarbital

- short-acting,high successful rate (99%)
- reliably obtain adequate blood levels for sedation

< 12 months

- oral (dose 4–8 mg/kg)
  --lower complications rates, but a longer time to sedation
- IV (dose 2–6 mg/kg)
  --abnormal saturations(0.2% oral vs. 0.9% IV)
- Stronger than Midazolam

Etomidate

- rapid onset of sedative effect,
- brief half-life,
- short recovery time
- minimal effect on the respiratory and cardiovascular systems.
- But 10% oxygen desaturation to <90% or apnea
- 20–45% myoclonus
- The fastest, the shortest, but the highest failure rate

Table 4 Common agents used in pediatric procedural sedation for CT sedation [31, 32, 35, 36, 38–40]

Agent	Modality/dose	Onset	Duration	Side effects	Successful sedation
Midazolam	PO 0.3–0.75 mg/kg IN 0.2–0.4 mg/kg IV 0.05–0.1 mg/kg up to 0.5 mg/kg total dose (repeat dose of 0.05 mg/kg)	5–10 min 10 min 1 min	60 min 60 min 30 min	Respiratory depression, hypotension, headache, nausea, emesis, cough, dizziness	97.9%
Pentobarbital	PO 4–5 mg/kg (repeat dose of 2 mg/kg) IV 2–6 mg/kg (repeat dose of 1–2 mg/kg)	10–20 min 1–2 min	45–100 min 45–60 min	Respiratory depression, nausea, vomiting	97%
Etomidate	IV 0.2–0.3 mg/kg	1–3 min	10–15 min	Myoclonus, transient adrenocortical dysfunction	76.5–99.5%

Thank you!!!