UNIVERSITÀ
DEGLI STUDI
DI PADOVA

Corso di Laurea in Medicina e Chirugia
Corso Integrato di Pediatria Generale e Specialistica
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# TRAUMA CRANICO

Prof . L. Da Dalt

# OBIETTIVI EDUCATIVI

**Conoscere:**

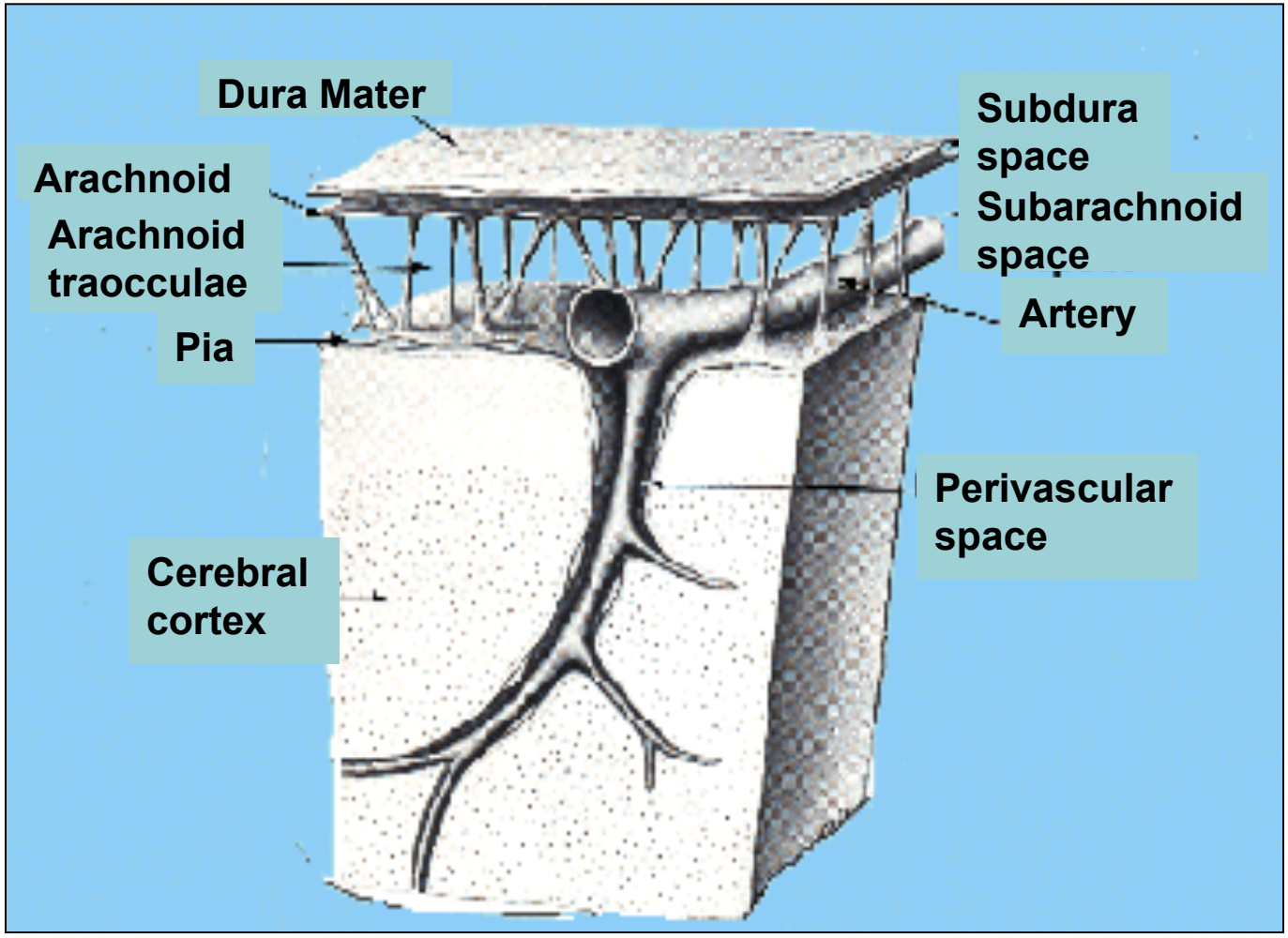
- la rilevanza del problema (dati epidemiologici)
- i diversi tipi di TC
- le possibili complicanze acute del TC e le basi fisiopatologiche di queste
- l'approccio diagnostico

# Trauma cranico

- Capo più grande
- Ossa meno resistenti
- Collo con muscolatura più debole
- Dura madre più adesa alla teca
- Vene a ponte più lunghe

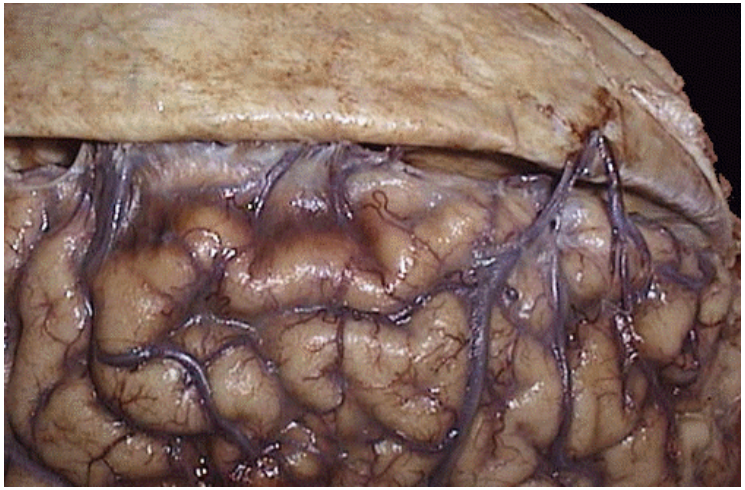
- Trauma cranico molto frequente
- Fratture della volta più comuni
- Più frequente la dinamina “shaking”
- Ematoma extradurale meno comune dell’ematoma sottodurale

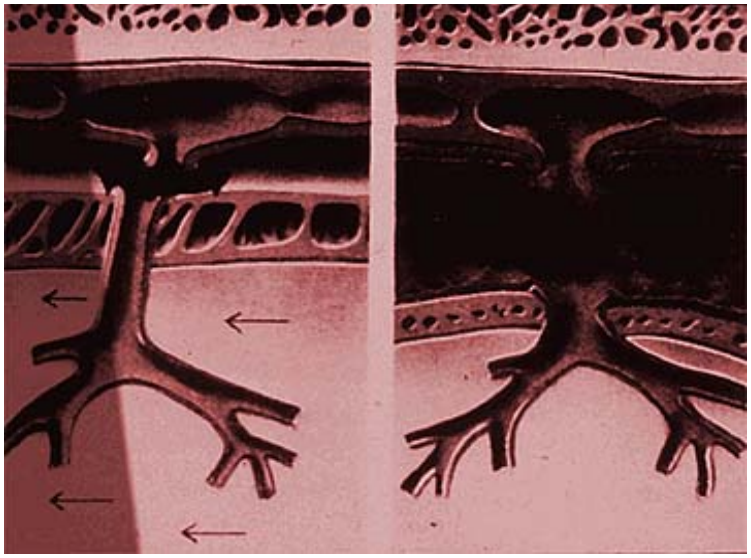
# CENI DI ANATOMIA



# Cenni di anatomia

**Vene a ponte – sottili vene che emergono dalla sostanza dell'encefalo e che passando attraverso la spazio subdurale, si svuotano nei seni della dura**





# BACKGROUND

**Il trauma cranico è uno dei motivi più frequenti di accesso in Ps Pediatrico**

**Lesioni cerebrali traumatiche sono causa di morte e disabilità nei bambini, giustificando circa il 30% dei decessi nella popolazione pediatrica**

**La maggior parte dei bambini (> 90%) che richiedono una valutazione medica dopo un trauma, presentano un trauma cranico minore**

**Un ridotto numero di bambini che appaiono in buone condizioni generali, hanno una lesione intracranica**

# DATI EPIDEMIOLOGICI

**Regione Veneto**

**Indagine di sorveglianza**

**18.000 TC**

- **3/10 bambini durante i primi 14 anni di vita accedono al Pronto Soccorso per TC**
- **5-10% viene ricoverato**
- **1/1500 muore entro i 14 anni per un TC**

# DINAMICA PIU' COMUNE DEL TRAUMA

- Caduta
- Impatto contro corpo contundente
- Incidenti stradali
- Schiacciamento
- Abuso

# Epidemiology of Blunt Head Trauma in Children in U.S. Emergency Departments

**TO THE EDITOR:** Traumatic brain injury is the leading cause of death and disabilities in children older than 1 year of age.[1] Detailed data about head trauma in children are needed to better understand the rates and unique age-related risks of injury. We examined the characteristics of children with blunt head trauma from a large, prospective, observational study conducted in the United States through the Pediatric Emergency Care Applied Research Network (PECARN).

We previously derived and validated prediction rules for clinically important traumatic brain injuries in children with minor blunt head trauma in 25 PECARN emergency departments from 2004 through 2006.[2] In this planned secondary analysis, we provide clinical details for the entire cohort of children with head injuries of all severities, ranging from 3 (deep coma) to 15 (normal neurologic status) on the Glasgow Coma Scale (GCS). We categorized children into three age groups (<2 years, 2 to 12 years, and 13 to 17 years) and three categories of head-injury severity on the basis of the initial GCS score (mild [GCS score, 14 or 15], moderate [GCS score, 9 to 13], and severe [GCS score, ≤8]).

Of the 57,030 eligible patients, 43,904 (77%) were enrolled. After exclusions, the final study population was 43,399, and of these patients 98% had mild head trauma. (The patients' demographic characteristics and mechanisms of injury are described in Table 1, and in Table S1 and Fig. S1 in the Supplementary Appendix, available with the full text of this letter at NEJM .org.) Falls were the most frequent mechanism of injury for children under the age of 12 years. Injuries among adolescents were more frequently caused by assaults, sports activities, and motor vehicle crashes. The top three mechanisms of injury according to age group are provided in Table S2 in the Supplementary Appendix.

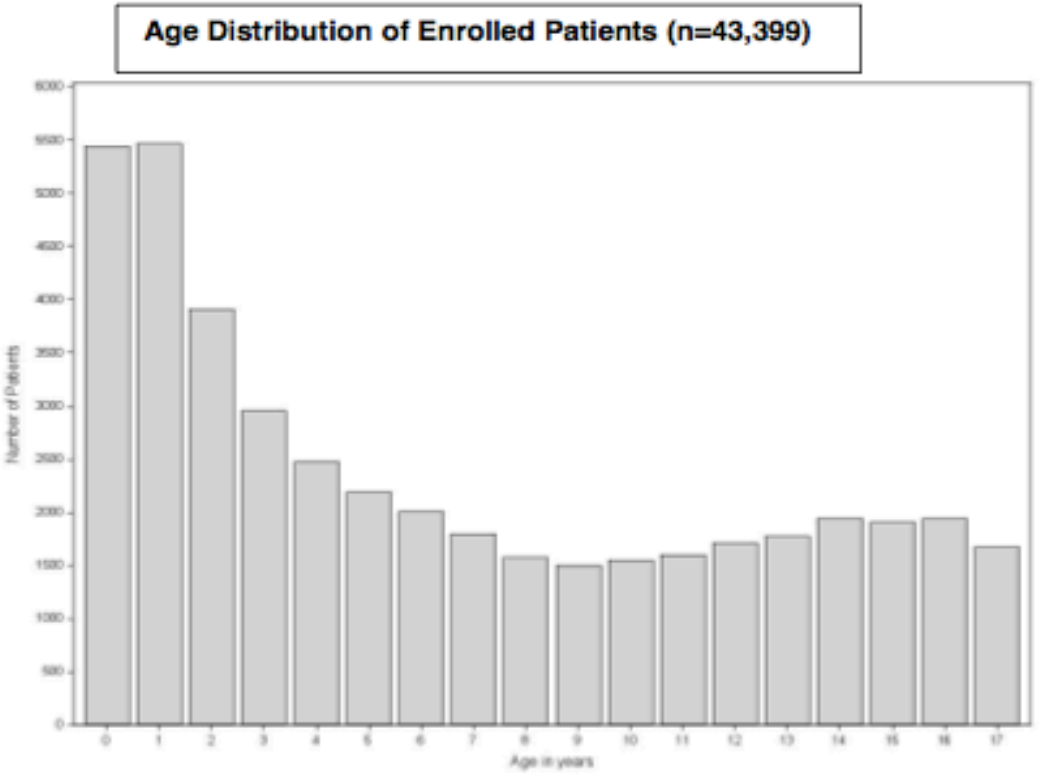
**Table 1. Demographic Characteristics and Mechanisms of Injury in Children with Head Trauma.**

| Variable | Traumatic Brain Injury on CT (N=1157)* | No Traumatic Brain Injury on CT (N=14,751) | No CT (N=27,491) | All Patients (N=43,399) |
|---|---|---|---|---|
| Age — no. (%) | | | | |
| <2 yr | 335 (29) | 3,161 (21) | 7,416 (27) | 10,912 (25) |
| 2–12 yr | 536 (46) | 7,006 (47) | 15,715 (57) | 23,257 (54) |
| 13–17 yr | 286 (25) | 4,584 (31) | 4,360 (16) | 9,230 (21) |
| Score on Glasgow Coma Scale — no. (%) | | | | |
| 3–8 | 214 (18) | 113 (1) | 27 (<1) | 354 (<1) |
| 9–13 | 160 (14) | 430 (3) | 25 (<1) | 615 (1) |
| 14–15 | 783 (68) | 14,208 (96) | 27,439 (99) | 42,430 (98) |
| Admitted to hospital — no. (%) | 1057 (92) | 3,140 (21) | 349 (1) | 4,546 (10) |
| Isolated head injury — no. (%) | 857 (74) | 12,210 (83) | 25,570 (93) | 38,637 (89) |
| Head injury plus other substantial injury — no. (%) | 291 (25) | 2,476 (17) | 1,800 (7) | 4,567 (11) |
| Death — no. (%) | 51 (4) | 3 (<1) | 24 (<1) | 78 (<1) |

# GLASGOW COMA SCALE (GCS)

- ✓ **Trauma cranico minore : GCS 14-15**
- ✓ **Trauma cranico Maggiore: GCS ≤ 13**

**Supplemental Figure 1**



| | | | | |
|---|---|---|---|---|
| Mechanism of injury | | | | |
| Occupant in motor vehicle crash | | | | |
| All patients — no. (%) | 183 (16) | 1,628 (11) | 2,099 (8) | 3,910 (9) |
| Restraint used — no./total no. (%) | 88/183 (48) | 994/1628 (61) | 1413/2099 (67) | 2495/3910 (64) |
| Pedestrian struck by moving vehicle — no. (%) | 124 (11) | 813 (6) | 496 (2) | 1,433 (3) |
| Bicycle rider struck by automobile | | | | |
| All patients — no. (%) | 45 (4) | 270 (2) | 241 (1) | 556 (1) |
| Helmet worn — no./total no. (%) | 3/45 (7) | 36/270 (13) | 26/241 (11) | 65/556 (12) |
| Bicycle crash or fall from bike while riding | | | | |
| All patients — no. (%) | 50 (4) | 701 (5) | 950 (3) | 1,701 (4) |
| Helmet worn — no./total no. (%) | 3/50 (6) | 137/701 (20) | 174/950 (18) | 314/1701 (18) |
| Other motorized-transport crash — no. (%) | 39 (3) | 339 (2) | 173 (1) | 551 (1) |
| Fall from standing position or while walking or running — no. (%) | 44 (4) | 1,506 (10) | 3,183 (12) | 4,733 (11) |
| Collision with stationary object while walking or running — no. (%) | 9 (1) | 431 (3) | 2,015 (7) | 2,455 (6) |
| Fall from elevation | | | | |
| Any distance — no. (%) | 366 (32) | 3,688 (25) | 7,829 (28) | 11,883 (27) |
| <3 ft (<1 m) — no./total no. (%) | 76/366 (21) | 1345/3688 (36) | 4673/7829 (60) | 6094/11,883 (51) |
| 3–10 ft (1–3 m) — no./total no. (%) | 208/366 (57) | 1959/3688 (53) | 2941/7829 (38) | 5108/11,883 (43) |
| >10 ft (>3 m) — no./total no. (%) | 68/366 (19) | 268/3688 (7) | 82/7829 (1) | 418/11,883 (4) |
| Unknown — no./total no. (%) | 14/366 (4) | 116/3688 (3) | 133/7829 (2) | 263/11,883 (2) |
| Fall down stairs — no. (%) | 46 (4) | 734 (5) | 2,128 (8) | 2,908 (7) |
| Sports activity — no. (%) | 46 (4) | 1,573 (11) | 1,360 (5) | 2,979 (7) |
| Assault — no. (%) | 37 (3) | 1,095 (7) | 1,884 (7) | 3,016 (7) |
| Accidental blow to head — no. (%) | 55 (5) | 623 (4) | 2,480 (9) | 3,158 (7) |
| Other or unknown mechanism — no. (%) | 113 (10) | 1,350 (9) | 2,653 (10) | 4,116 (9) |

| | | | | |
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| Bicycle rider struck by automobile | | | | |
| All patients — no. (%) | 45 (4) | 270 (2) | 241 (1) | 556 (1) |
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| Bicycle crash or fall from bike while riding | | | | |
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| Accidental blow to head — no. (%) | 55 (5) | 623 (4) | 2,480 (9) | 3,158 (7) |
| Other or unknown mechanism — no. (%) | 113 (10) | 1,350 (9) | 2,653 (10) | 4,116 (9) |

**Supplemental Table 2**

**Top 3 Injury Mechanisms by Age Group**

| | Frequency (%) |
|---|---|
| Children < 2 years of age | |
| Fall from elevation | 5,887 (54%) |
| Fall down stairs | 1,533 (14%) |
| Fall to ground from standing/walking/running | 979 (9%) |
| Children 2 - 12 years of age | |
| Fall from elevation | 5,653 (24%) |
| Fall to ground from standing/walking/running | 3,189 (14%) |
| Object struck head - accidental | 2,181 (9%) |
| Children 13 - 17 years of age | |
| Assault | 2,186 (24%) |
| Sports | 1,751 (19%) |
| Occupant in motor vehicle crash | 1,659 (18%) |

# SEVERE MECHANISM OF TRAUMA

- **Motor vehicle collisions and**
  - **Ejection**
  - **Other passenger death**
  - **Rollover**
  - **Pedestrian**
  - **Unhelmeted byciclist**
- **Fall >3 feet (0.9m) if < 2 yo**
- **Fall > 5 feet (1.5m) if ≥2 yo**
- **Head hit by high impact object**

*Kupperman N, Lancet, September 12, 2009*

# CONSEGUENZE DEL TRAUMA

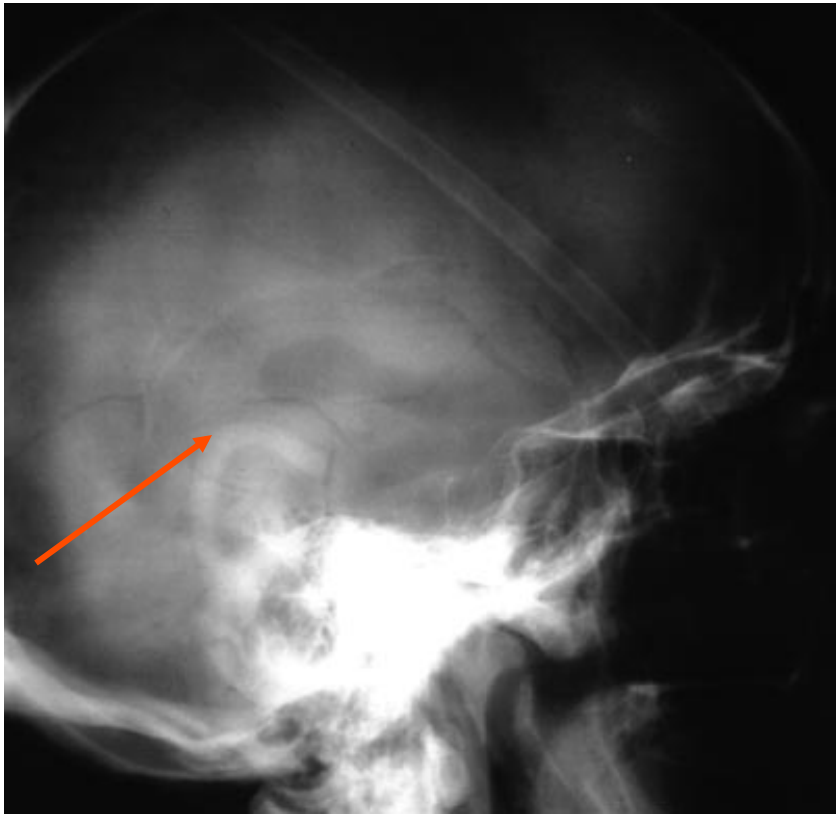
- Fratture della volta cranica
- Fratture della base cranica
- Lesioni intracraniche

# FRATTURE DELLA VOLTA CRANICA

**Tipologia:**

- **Lineari ( >90%)**
- **Depresse**
- **Diastasate**
- **Penetranti (lacerazione cute)**

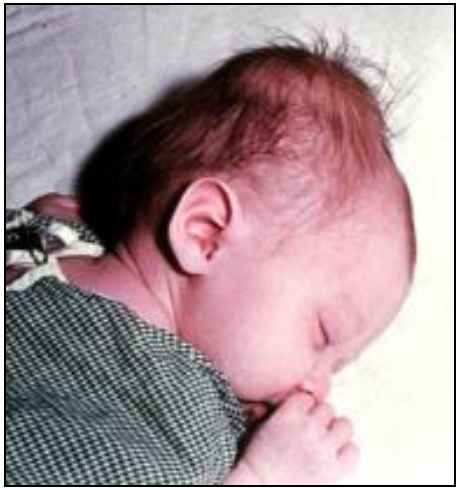
**Le f. lineari non richiedono terapia; possono accompagnarsi a ematoma dello scalpo (cefaloematoma; ematoma sottogaleale)**

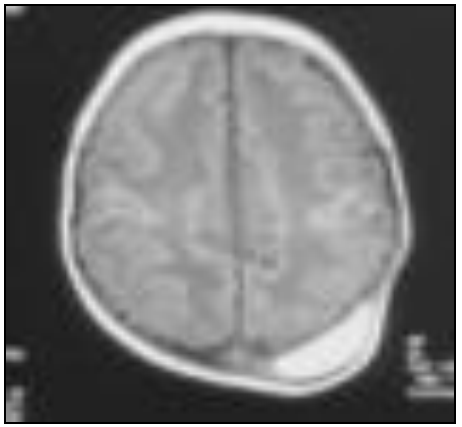


# SEGNI DI FRATTURA DELLA VOLTA CRANICA

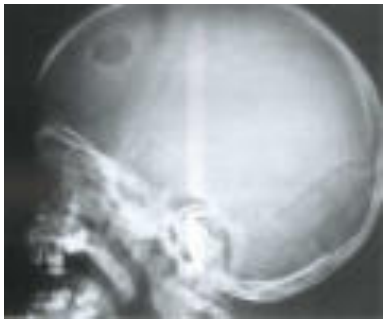
**Cefaloematoma:** raccolta di sangue sottoperiostea, dura, non cavalcante le suture

**Ematoma sottogaleale**: raccolta di sangue tra l'osso e la galea, molle, ampio, cavalcante le suture





# FRATTURE DELLA VOLTA CRANICA



**La presenza di frattura è un fattore di rischio per lesione intracranica (max. b < 2 anni - rischio lesione intracranica circa 1%))**

**Sede a maggior rischio di complicanze intracraniche: parieto-temporale, occipitale (non frontale)**

**NB: Molti bambini con fratture della volta cranica non hanno lesione intracranica e l'assenza di fratture non esclude la presenza di lesione**

# SEGNI DI FRATTURA DELLA BASE CRANICA

**Ecchimosi peri-orbitarie**
***Raccoon's sign***
**(frattura base anteriore)**

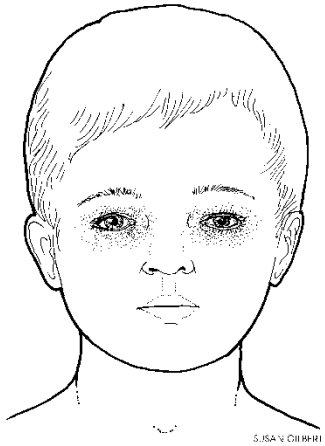


*Figure 19: Head Trauma*
Bruising around eyes indicating possible head trauma

**Ecchimosi retro-auricolare**
***Battle's sign***
**(frattura ossa temporale)**

**Emotimpano**

**Oto-rino-liquorrea**

# POSSIBILI LESIONI INTRACRANICHE

- Ematoma subdurale
- Ematoma epidurale
- Emorragia intra-parenchimale
- Contusione parenchimale
- Edema cerebrale diffuso
- Danno assonale diffuso
- ……..

# 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, September 12, 2009***

## LESIONE RADIOLOGICA

**Traumatic brain injury on CT**

Defined by any of the following descriptions:

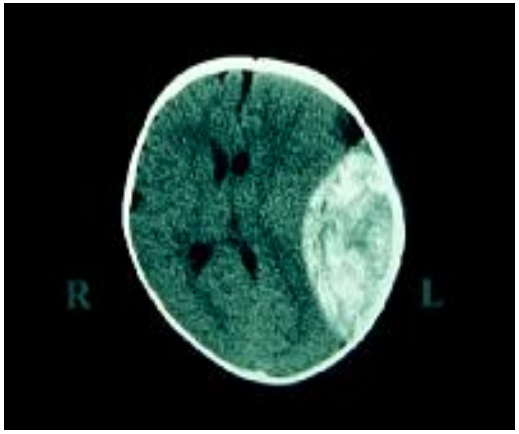
- Intracranial haemorrhage or contusion
- Cerebral oedema
- Traumatic infarction
- Diffuse axonal injury
- Shearing injury
- Sigmoid sinus thrombosis
- Midline shift of intracranial contents or signs of brain herniation
- Diastasis of the skull
- Pneumocephalus
- Skull fracture depressed by at least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

*The 24-h period of endotracheal intubation for traumatic brain injury was used to avoid misclassification of patients who might need brief intubation for airway protection for CT imaging, transfer between hospitals, or caused by altered consciousness from anticonvulsant medication use. †The 2-night definition was created to exclude those children routinely admitted for overnight observation because of minor CT findings that do not need any specific intervention.[10] ‡Skull fractures were not regarded as traumatic brain injuries on CT unless the fracture was depressed by at least the width of the skull. This is because children with isolated non-depressed skull fractures typically do not need specific therapy or hospital admission.[25,26]

# EMATOMA EPIDURALE

## Definizione

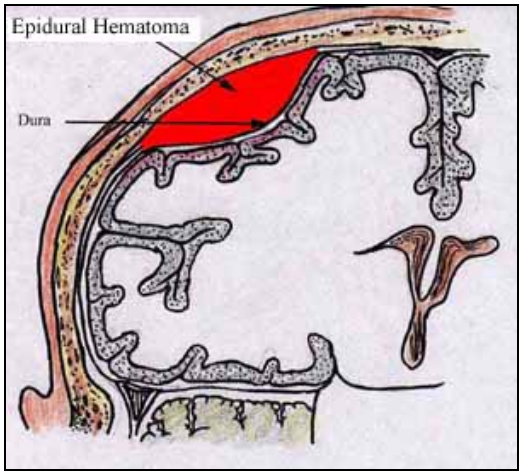
**Spandimento di sangue nello spazio extra-durale da rottura traumatica delle arterie meningee di medio calibro o da stiramento delle vene durali per trauma diretto (max nella regione temporale)**




## Complicanza

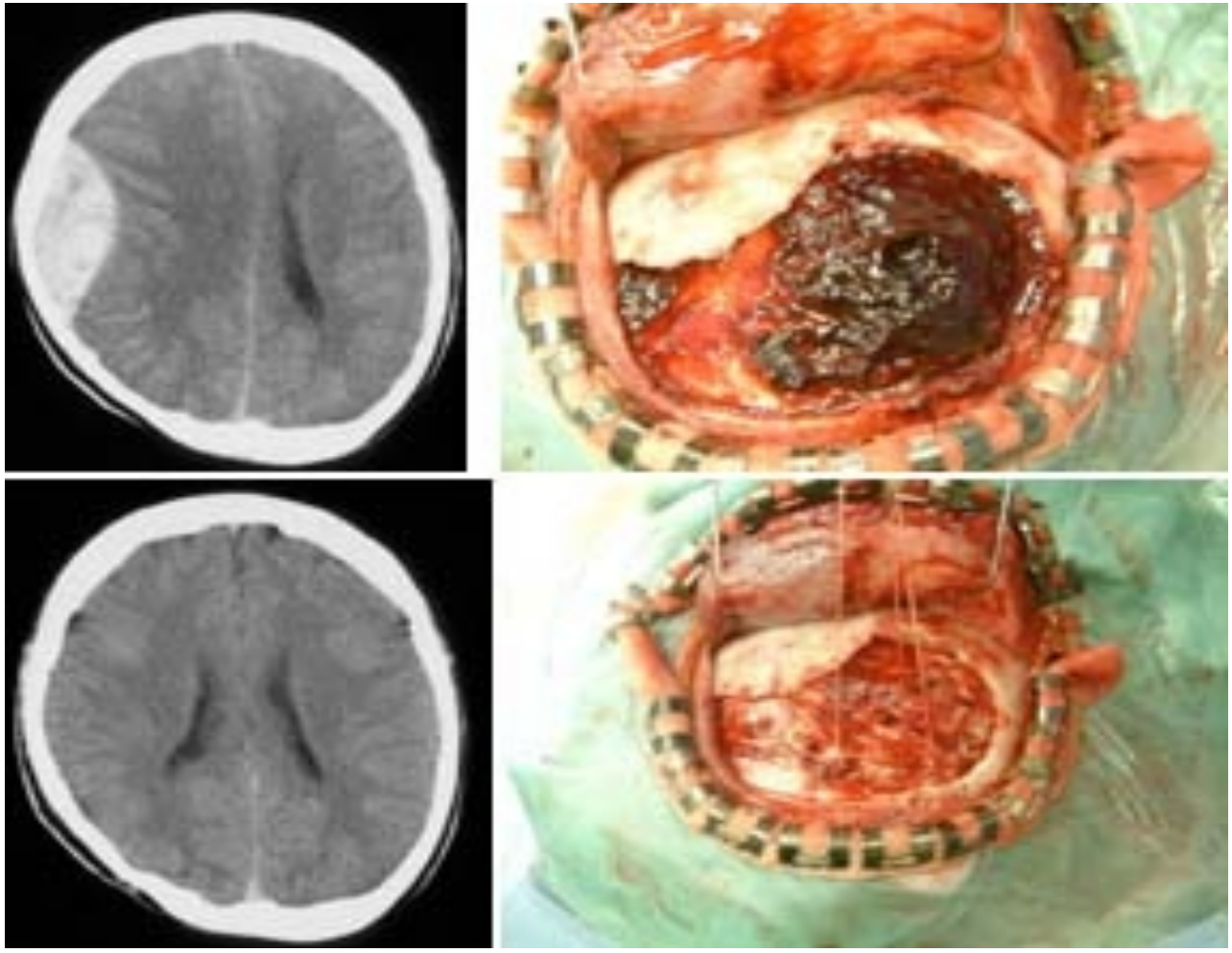
**Espansione più o meno rapida (a seconda se sanguinamento arterioso e venoso) con successiva erniazione**

**DANNO CEREBRALE SECONDARIO**




**Nel bambino il 75% degli ematomi epidurali è di origine arteriosa**

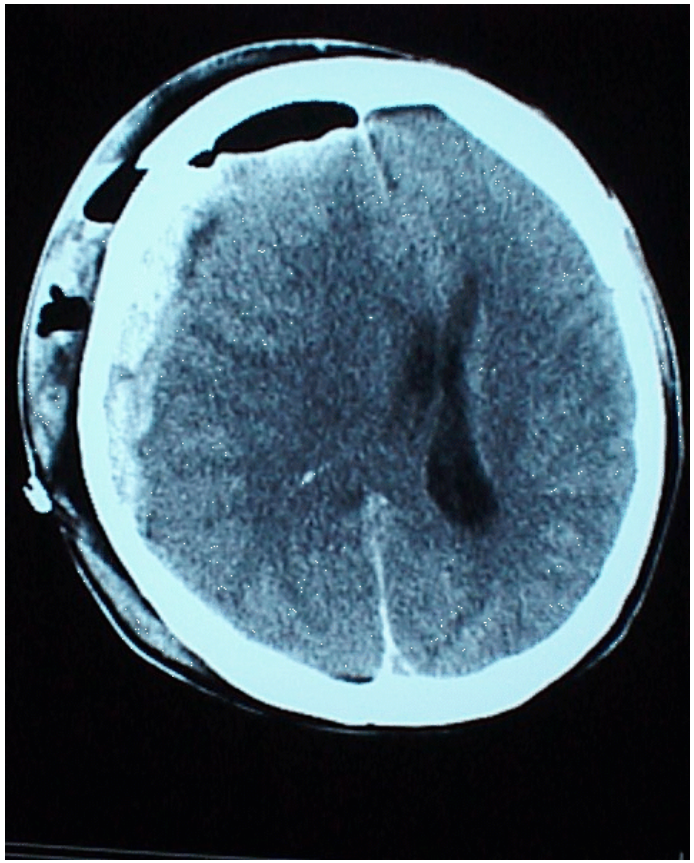
# EMATOMA EPIDURALE



# EMATOMA SUBDURALE (ES)

## Definizione

**Spandimento di sangue tra la dura e il mantello cerebrale, successivo alla rottura delle vene a ponte**

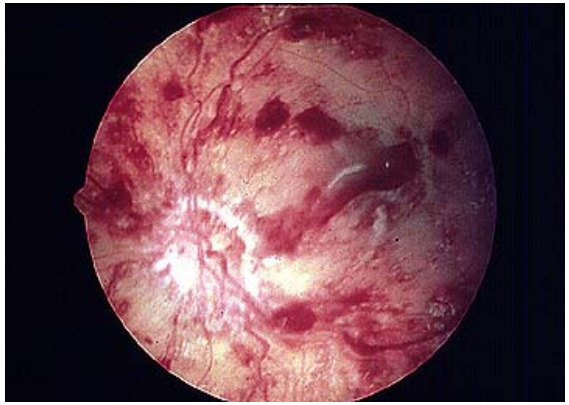


## Complicanza

**L'ES (mono o bilaterale), espandendosi, esercita un effetto massa che compromette la funzionalità cerebrale e può causare un'erniazione cerebrale e DANNO CEREBRALE SECONDARIO.**

# EMATOMA SUBDURALE (ES)

**Più del 50% degli ematomi subdurali si accompagnano ad emorragia retinica**



# EDEMA DIFFUSO CEREBRALE

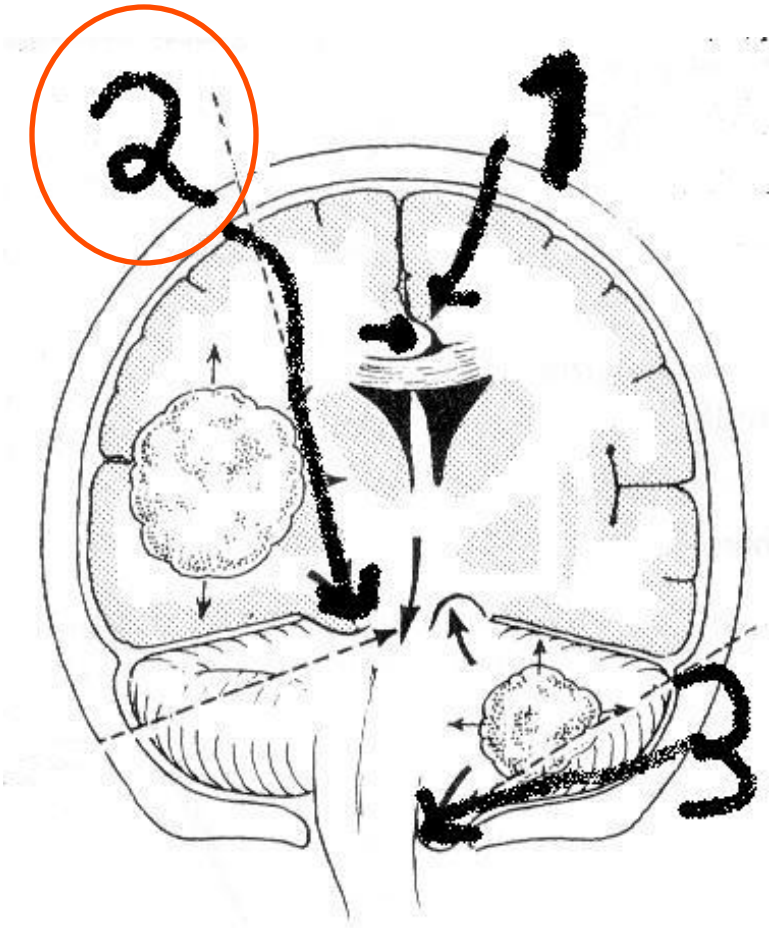
**Nel bambino per motivi non ancora del tutto noti l'edema cerebrale si instaura e regredisce più rapidamente**

**TAC cerebrale: contusione frontale sinistra con diffuso edema cerebrale in un bambino di 11 anni a seguito di tamponamento stradale**

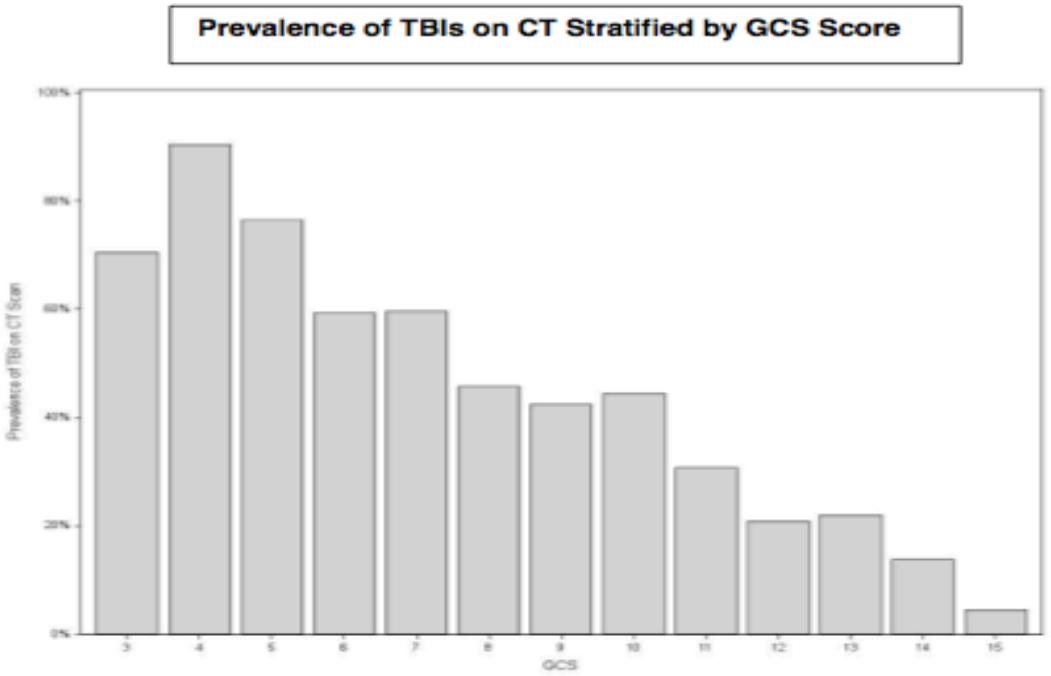
# ERNIAZIONE CEREBRALE

## Manifestazioni cliniche più comuni

- Compressione del 3^ n. cranico – midriasi monolaterale e ptosi
- Decerebrazione e coma per compressione mesencefalica
- Idrocefalo per compressione dell'acquedotto
- Impegno delle tonsille cerebellari attraverso il forame occipitale→ impegno del tronco → bradipnea, bradicardia-arresto cardiorespiratorio.



**Supplemental Figure 4**



**Supplemental Table 3**

**Intracranial Findings on CT by Age**

| | < 2 years | 2 - 12 years | 13 -17 years | Overall |
|---|---|---|---|---|
| | N = 335 | N = 536 | N = 286 | N = 1,157* |
| Subdural hematoma | 106 (32%) | 140 (26%) | 80 (28%) | 326 (28%) |
| Subarachnoid hemorrhage | 84 (25%) | 122 (23%) | 77 (27%) | 283 (24%) |
| Cerebral contusion | 40 (12%) | 127 (24%) | 87 (30%) | 254 (22%) |
| Pneumocephalus | 26 (8%) | 148 (28%) | 70 (24%) | 244 (21%) |
| Cerebral hemorrhage/intracerebral Hematoma | 47 (14%) | 106 (20%) | 77 (27%) | 230 (20%) |
| Extra-axial hematoma | 71 (21%) | 92 (17%) | 28 (10%) | 191 (17%) |
| Cerebral edema | 20 (6%) | 73 (14%) | 50 (17%) | 143 (12%) |
| Epidural hematoma | 43 (13%) | 65 (12%) | 30 (10%) | 138 (12%) |
| Midline shift/shift of brain structures | 33 (10%) | 57 (11%) | 44 (15%) | 134 (12%) |
| Diastasis of the skull | 27 (8%) | 41 (8%) | 12 (4%) | 80 (7%) |
| Intraventricular hemorrhage | 14 (4%) | 24 (4%) | 19 (7%) | 57 (5%) |
| Shear injury | 2 (1%) | 12 (2%) | 11 (4%) | 25 (2%) |
| Cerebellar hemorrhage | 5 (1%) | 10 (2%) | 8 (3%) | 23 (2%) |
| Diffuse axonal Injury | 0 (0%) | 7 (1%) | 9 (3%) | 16 (1%) |
| Herniation | 1 (0%) | 7 (1%) | 4 (1%) | 12 (1%) |
| Traumatic infarction | 2 (1%) | 3 (1%) | 3 (1%) | 8 (1%) |
| Sigmoid sinus thrombosis | 0 (0%) | 1 (0%) | 0 (0%) | 1 (0%) |

*556 patients had more than one TBI visualized on CT scan

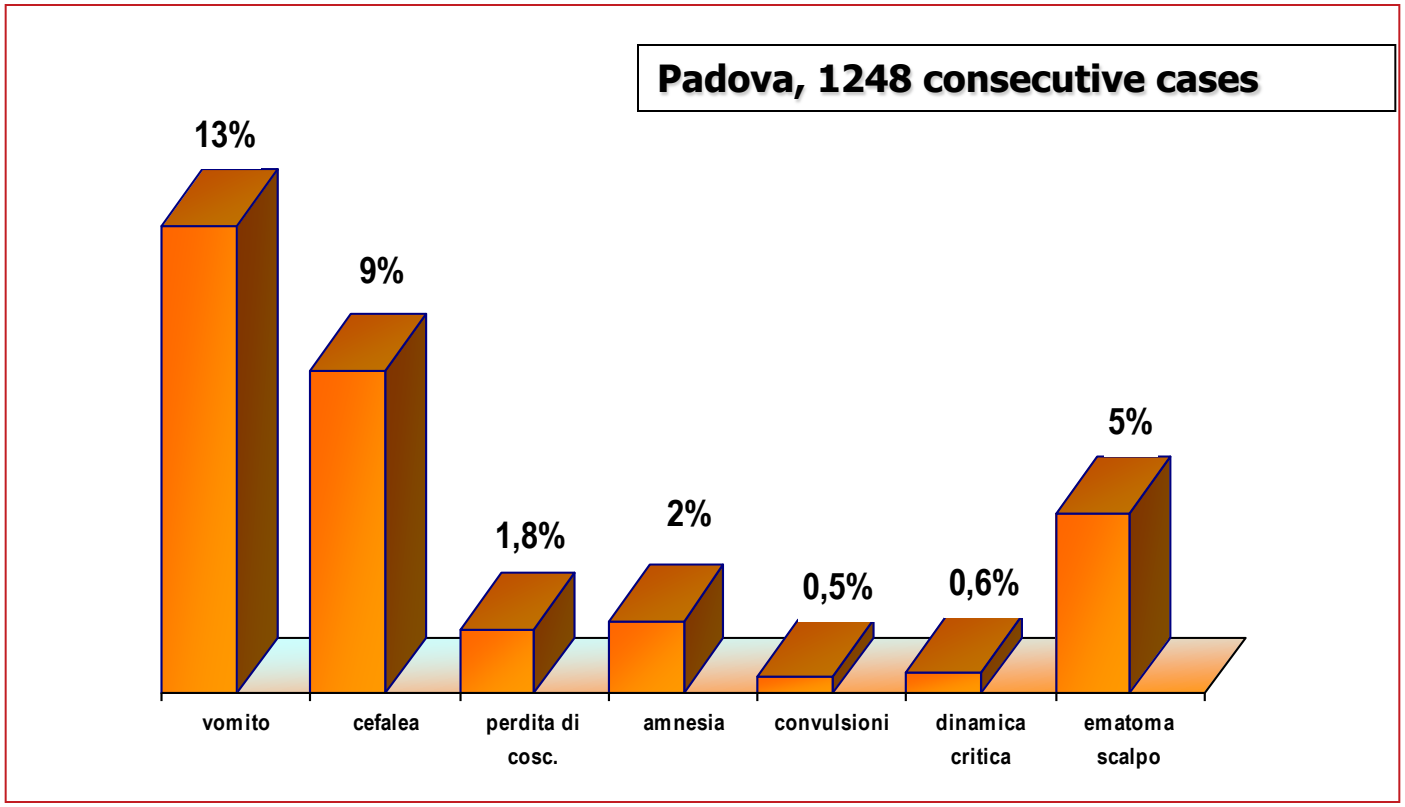
# SEGNI/SINTOMI COMUNI DOPO TRAUMA CRANICO

- Vomito
- Cefalea

- Perdita di coscienza transitoria
- Alterazione persistente dello stato di coscienza
- Amnesia
- Convulsioni
- Segni neurologici focali

- Segni di frattura della volta
- Segni di frattura della base
- ……

# SEGNI / SINTOMI PIU' COMUNI




**Nessuno di tali segni/sintomi predice con accuratezza la presenza di lesione intracranica**

# TRAUMA CRANICO MAGGIORE

- **GCS ≤ 13**
- **Segni neurologici focali**

**RISCHIO DI LESIONE INTRACRANICA 30-80%**

# TRAUMA CRANICO MINORE

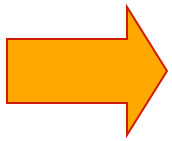
- GCS 14-15
- Assenza di segni neurologici focali

**RISCHIO DI LESIONE INTRACRANICA circa 1%**

# TRAUMA CRANICO MINORE

**Alla prima valutazione obiettiva**

- **normale stato di coscienza**
- **assenza di anomalie neurologiche di**
- **segni neurologici focali**
- **assenza di segni clinici di frattura della base o**
- **della volta complicata**



**RISCHIO DI LESIONE INTRACRANICA circa 1%**

**± all'anamnesi**

- **perdita di coscienza transitoria o transitoria letargia**
- **amnesia**
- **cefalea o vomito**
- **breve convulsione**

**American Accademy of Pediatric, 1999**

# GLASGOW COMA SCALE (GCS)

**Glasgow coma scale and pediatric Glasgow coma scale**

| Sign | GCS* | PGCS• | Score |
|---|---|---|---|
| Eye opening | Spontaneous | Spontaneous | 4 |
| | To command | To sound | 3 |
| | To pain | To pain | 2 |
| | None | None | 1 |
| Verbal response | Oriented | Age-appropriate vocalization, smile, or orientation to sound, interacts (coos, babbles), follows objects | 5 |
| | Confused, disoriented | Cries, irritable | 4 |
| | Inappropriate words | Cries to pain | 3 |
| | Incomprehensible sounds | Moans to pain | 2 |
| | None | None | 1 |
| Motor response | Obeys commands | Spontaneous movements (obeys verbal command) | 6 |
| | Localizes pain | Withdraws to touch (localizes pain) | 5 |
| | Withdraws | Withdraws to pain | 4 |
| | Abnormal flexion to pain | Abnormal flexion to pain (decorticate posture) | 3 |
| | Abnormal extension to pain | Abnormal extension to pain (decerebrate posture) | 2 |
| | None | None | 1 |
| **Best total score** | | | **15** |

The GCS is scored between 3 and 15, 3 being the worst, and 15 the best. It is composed of three parameters: best eye response (E), best verbal response (V), and best motor response (M). The components of the GCS should be recorded individually; for example, E2V3M4 results in a GCS of 9. A score of 13 or higher correlates with mild brain injury; a score of 9 to 12 correlates with moderate injury; and a score of 8 or less represents severe brain injury. The pediatric Glasgow coma scale was validated in children 2 years of age or younger.

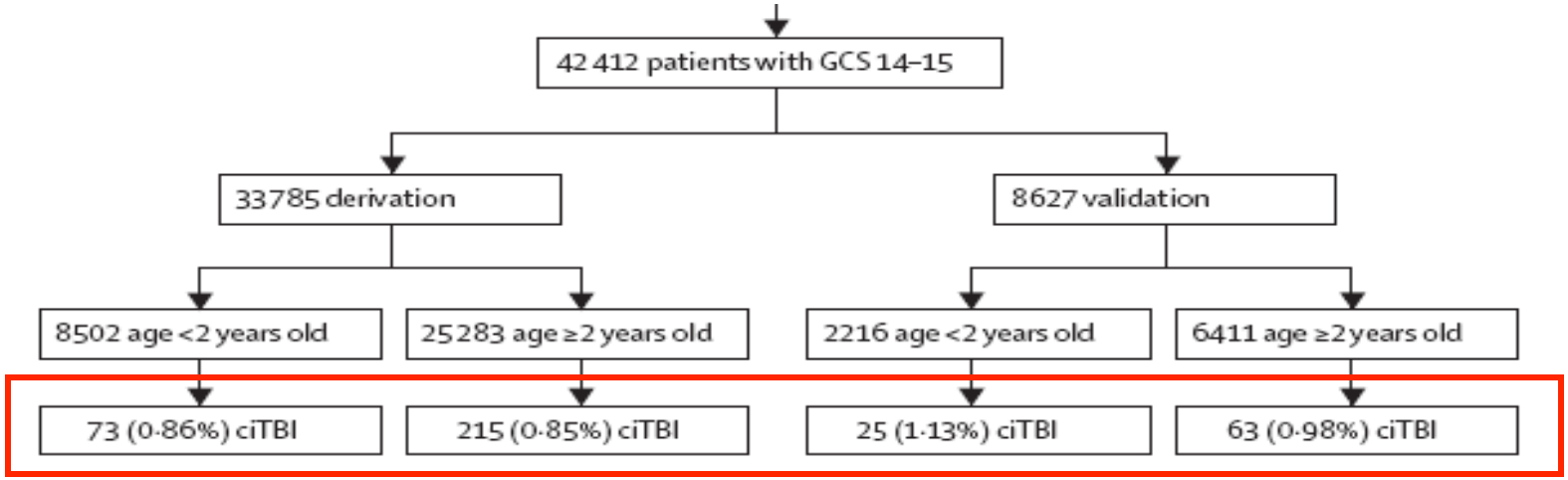
* Data from: Teasdale, G and Jennett, B. Assessment of coma and impaired consciousness. A practical scale. Lancet 1974; 2:81.

• Data from: Holmes, JF, Palchak, MJ, MacFarlane, T, Kuppermann, N. Performance of the pediatric Glasgow coma scale in children with blunt head trauma. Acad Emerg Med 2005; 12:814.

# 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, September 12, 2009*



# TRAUMA CRANICO COMMOTIVO (TC MINORE)

**Trauma Cranico seguito da breve (durata variabile) e reversibile alterazione dello stato di coscienza ± associata ad amnesia relativa al fatti immediatamente precedenti e successivi al trauma; si possono associare vomito/cefalea**

# TAC CEREBRALE

**La TAC cerebrale è il gold standard per l'individuazione di lesioni intracraniche post traumatiche in urgenza.**

**NB:** **costi**

**esposizione radiante**

**necessità di sedazione**

# Cancer risk in 680 000 people exposed to computed tomography scans in childhood or adolescence: data linkage study of 11 million Australians



***BMJ 2013***

## What is already known on this topic

CT scanning rates have risen substantially since the 1980s. Although large doses of ionising radiation are known to cause cancer, there is uncertainty about the risks following the lower doses from CT scans (5-50 mGy per organ)

A recent study of 180 000 young people exposed to CT scans in the United Kingdom found an increasing risk of leukaemia and brain cancer with increasing radiation dose

## What this study adds

Among 680 000 Australians exposed to a CT scan when aged 0-19 years, cancer incidence was increased by 24% (95% confidence interval 20% to 29%) compared with the incidence in over 10 million unexposed people. The proportional increase in risk was evident at short intervals after exposure and was greater for persons exposed at younger ages

By 31 December 2007, with an average follow-up of 9.5 years after exposure, the absolute excess cancer incidence rate was 9.38 per 100 000 person years at risk

Incidence rates were increased for most individual types of solid cancer, and for leukaemias, myelodysplasias, and some other lymphoid cancers

# Estimated Risks of Radiation-Induced Fatal Cancer from Pediatric CT

David J. Brenner[1]
Carl D. Elliston[1]
Eric J. Hall[1]
Walter E. Berdon[2]

AJR:176, February 2001

**CONCLUSION**

*The best available risk estimates suggest that paediatric CT will result in significantly lifetime radiation risk over adult CT.*

*The lifetimes attributable risk of mortality for leukaemia or solid organ malignancy from a single pediatric head CT ranges from approximately 1:2000 for infants to 1:5000 for older children*

REVIEW ARTICLE

CURRENT CONCEPTS

# Computed Tomography — An Increasing Source of Radiation Exposure

David J. Brenner, Ph.D., D.Sc., and Eric J. Hall, D.Phil., D.Sc.

N Engl J Med 2007;357:2277-84.

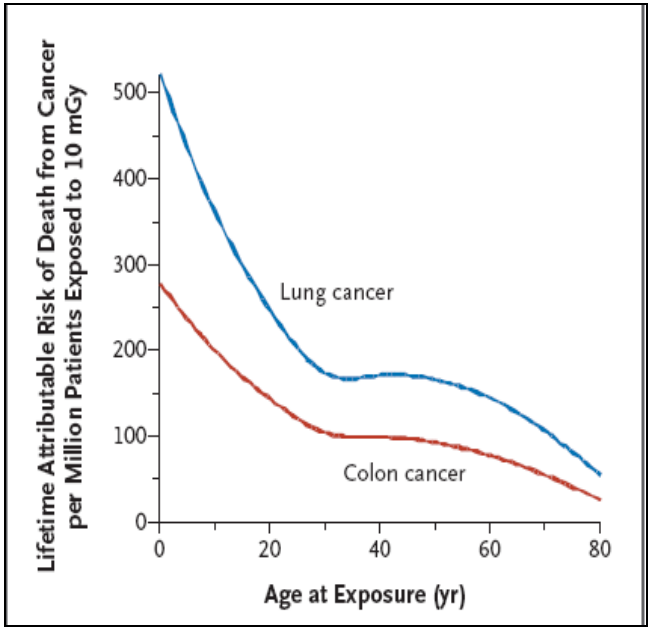



**Figure 4. Estimated Dependence of Lifetime Radiation-Induced Risk of Cancer on Age at Exposure for Two of the Most Common Radiogenic Cancers.**

Cancer risks decrease with increasing age both because children have more years of life during which a potential cancer can be expressed (latency periods for solid tumors are typically decades) and because growing children are inherently more radiosensitive, since they have a larger proportion of dividing cells. These risk estimates, applicable to a Western population, are from a 2005 report by the National Academy of Sciences[25] and are ultimately derived from studies of the survivors of the atomic bombings. The data have been averaged according to sex.

# Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study

*Mark S Pearce, Jane A Salotti, Mark P Little, Kieran McHugh, Choonsik Lee, Kwang Pyo Kim, Nicola L Howe, Cecile M Ronckers, Preetha Rajaraman, Sir Alan W Craft, Louise Parker, Amy Berrington de González*

*Lancet 2012*

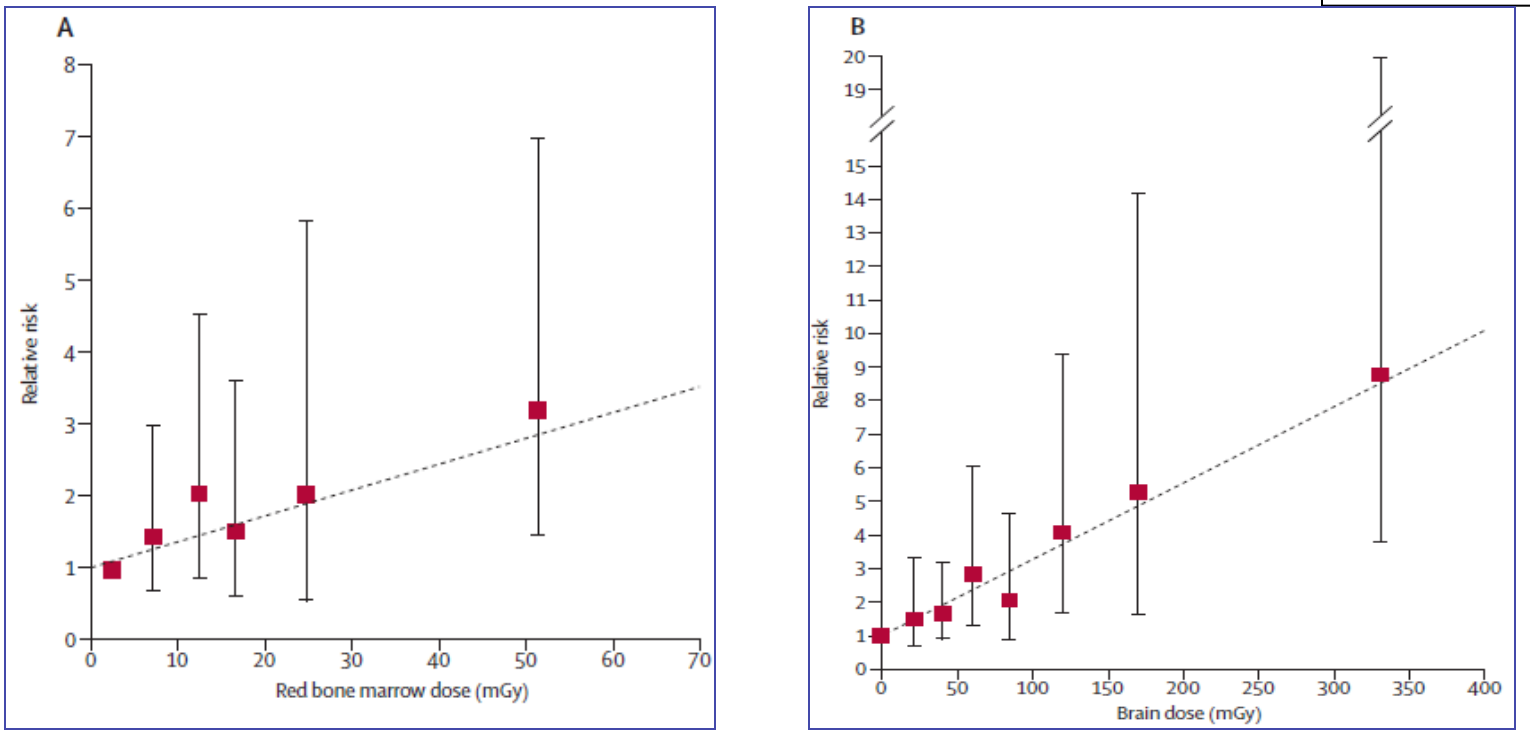



***Figure:*** **Relative risk of leukaemia and brain tumours in relation to estimated radiation doses to the red bone marrow and brain from CT scans**
(A) Leukaemia and (B) brain tumours. Dotted line is the fitted linear dose-response model (excess relative risk per mGy). Bars show 95% CIs.

# Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study

*Mark S Pearce, Jane A Salotti, Mark P Little, Kieran McHugh, Choonsik Lee, Kwang Pyo Kim, Nicola L Howe, Cecile M Ronckers, Preetha Rajaraman, Sir Alan W Craft, Louise Parker, Amy Berrington de González*

*Lancet 2012*

**Interpretation** Use of CT scans in children to deliver cumulative doses of about 50 mGy might almost triple the risk of leukaemia and doses of about 60 mGy might triple the risk of brain cancer. Because these cancers are relatively rare, the cumulative absolute risks are small: in the 10 years after the first scan for patients younger than 10 years, one excess case of leukaemia and one excess case of brain tumour per 10 000 head CT scans is estimated to occur. Nevertheless, although clinical benefits should outweigh the small absolute risks, radiation doses from CT scans ought to be kept as low as possible and alternative procedures, which do not involve ionising radiation, should be considered if appropriate.

# Effect of low doses of ionising radiation in infancy on cognitive function in adulthood: Swedish population based cohort study

Per Hall, Hans-Olov Adami, Dimitrios Trichopoulos, Nancy L Pedersen, Pagona Lagiou, Anders Ekbom, Martin Ingvar, Marie Lundell, Fredrik Granath

BMJ VOLUME 328 3 JANUARY 2004

## What this study adds

Intellectual development is adversely affected when the infant brain is exposed to ionising radiation at doses equivalent to those from computed tomography of the skull

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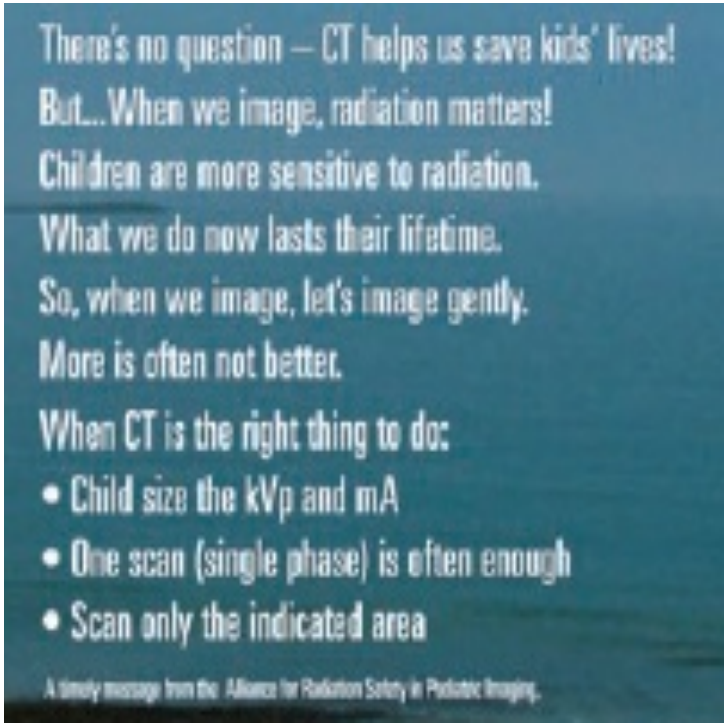
Diagnostic evaluation of children with minor head injures needs to be re-evaluated

# From the Guest Editor's Notebook

## The *Image Gently* Campaign: Working Together to Change Practice

AJR:190, February 2008




The goal of the management of children with apparently mild head trauma is
to identify those at significant risk of traumatic brain injury who may require immediate intervention or close follow-up while limiting unnecessary neuroimaging procedures

# TAC CEREBRALE: INDICAZIONI

**Trauma cranico maggiore**

**SEMPRE**

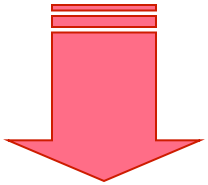
# TAC CEREBRALE: INDICAZIONI

**Trauma cranico minore**

**LETTURA CONTROVERSA**

# PREDICTION RULES

**Considering that no single clinical feature reliably predicts the presence of TBI with sufficient sensitivity**



**more recently investigators have sought to derive "clinical prediction rules", that use a combination of clinical variables obtained from history or clinical examination in order to improve the accuracy in identifying children with TBI**

Luglio-Settembre 2012 • Vol. 42 • N. 165 • pp. 00-00 TERAPIA D'URGENZA

# Trauma cranico minore: aggiornamenti nell'approccio diagnostico

Silvia Bressan*, Liviana Da Dalt**

*Prospettive in Pediatria,2012*

**Tabella II.**
Sintesi dei predittori delle *clinical prediction rules* analizzate.

| PREDITTORI DI LESIONE INTRACRANICA | Greenes 2001 | Heydell 2003* | PaltchacK 2003 | Oman 2006 | Dunning 2006°° | Da Dalt 2006 | Sun 2007 | Atabaki 2008§ | Kupperman 2009 | Osmond 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Alterazione stato di coscienza | (inclusi solo asintomatici) | + | + GCS <15 | + GCS <15 | + GCS <14 | + GCS <15 | + GCS <15 | + GCS <15 | + GCS <15 | + GCS <15 |
| Segni neurologici focali | | | | + | + | + | | | | |
| Segni di frattura della base | | | + | + | + | + | + | + | + | + |
| Ematoma dello scalpo (< 2 aa) o di segni di frattura della volta | + | | + | + | + | + | + | + | + | + |
| PDC/amnesia | | + | | + | + | + | | | + | |
| Vomito persistente | | + | + | + | + (≥3) | | + | | + | |
| Comportamenti anomali | | | | + | | | | + | + | + # |
| Cefalea | | + | + | | | + | + | | + | + |
| Convulsioni | | + | | | + | | | | | |
| Dinamica ad alta energia ** | | | | | + | | | + | + | + |
| Discoagulopatie | | | | + | | | | | | |
| Sospetto maltrattamento | | | | | + | | | | | |

* Tra i criteri della *clinical prediction rule* di Heydell e colleghi compaiono anche: intossicazione da alcool o droghe o segni di trauma sopra le clavicole; in tale studio sono inoltre inclusi solo pazienti con GCS di 15 poiché gli autori ritengono un GCS < 15 un'indicazione alla TAC cerebrale.
°° GCS < 15 sotto l'anno d'età; tra i criteri è inclusa anche la sonnolenza.
§ Tra i criteri della *clinical prediction rule* di Atabaki e colleghi compaiono anche: alterazioni dello stato di coscienza, veritigini-capogiro-stordimento, deficit del sensorio.
# Irritabilità all'esame obiettivo per i bambini d'età < 2 anni.
** incidente stradale a velocità >40 km/h-come pedone, ciclista o passeggero- o caduta da >3m o trauma da proiettile o corpo contundente ad alta energia per Dunning; trauma in bicletta per Atabaki; v figura 1 per Kupperman; scontro tra veicoli motorizzati o cadute da >3m o 5 scalini o da bicicletta senza caschetto protettivo per Osmond.

# PREDICTION RULES: BAMBINI < 2 AA

- Perdita di coscienza
- Alterazione dello stato di coscienza
- Comportamento non normale secondo i genitori
- Ematoma scalpo occipitale/parietale/temporale
- Frattura della teca cranica palpabile
- Meccanismo di trauma severo

**Valore predittivo negativo: 99,9% (IC 99,98- 99,999)**

*Lancet, September 12, 2009*

# PREDICTION RULES: BAMBINI > 2 AA

- Perdita di coscienza
- Alterazione dello stato coscienza
- Vomiti ripetuti
- Cefalea severa
- Segni di sospetto di frattura della base
- Meccanismo di trauma severo

**Valore predittivo negativo: 99,95% (IC 99,9- 99,998)**

*Lancet, September 12, 2009*

# MECCANISMO SEVERO DI TRAUMA

- Incidente stradale in auto con
  - espulsione di un passeggero
  - morte di un altro passeggero
  - rollover
- Incidente stradale auto contro
  - pedone
  - ciclista senza caschetto protettivo
- Caduta > 0,9mt se bambino < 2aa
- Caduta > 1,5mt se bambino > 2aa
- Impatto con un oggetto ad alta velocità

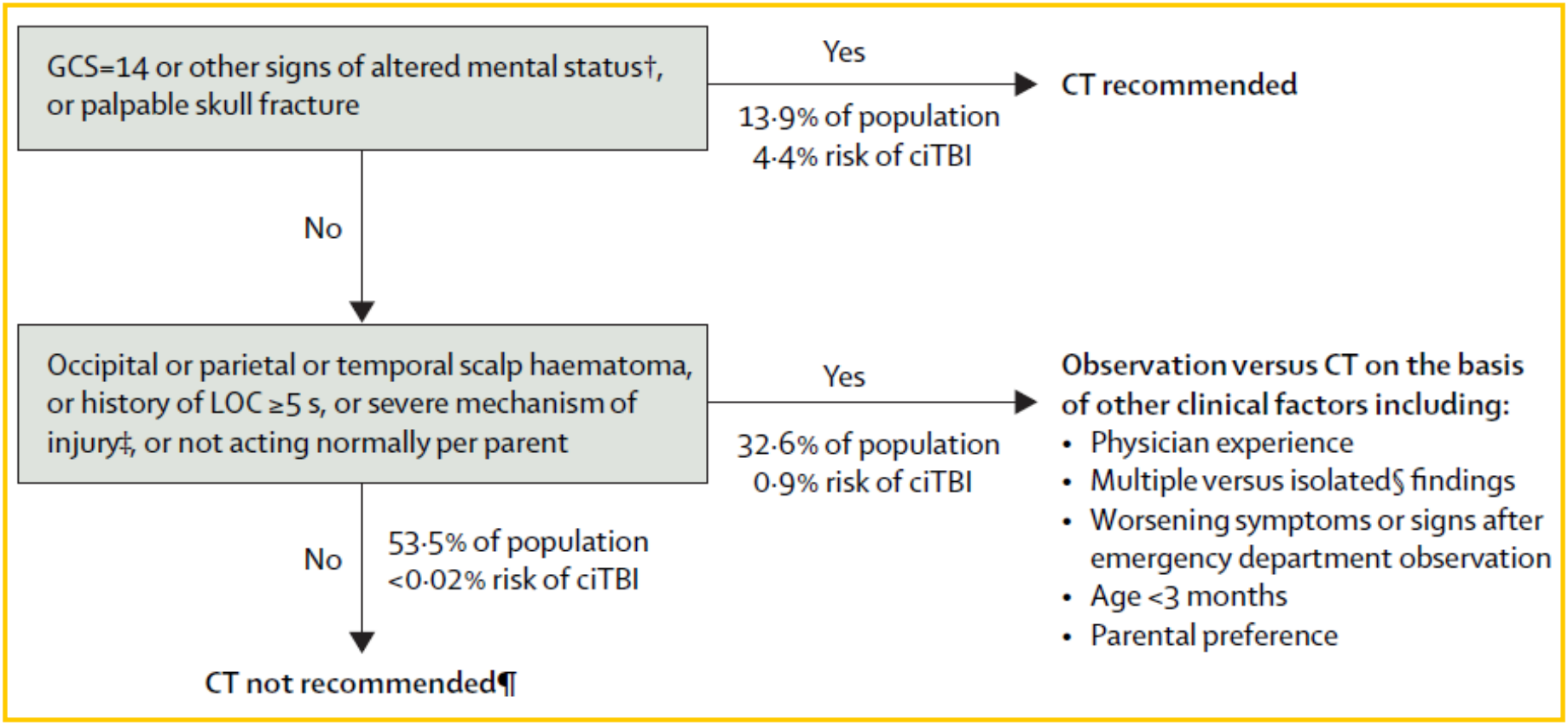
*Lancet, September 12, 2009*

# QUANDO ESEGUIRE LA TAC CEREBRALE?

Optimum strategy depends crucially on the a priori probability of pathology, which, in turn, depends on the distribution of injury severity in the population under consideration.

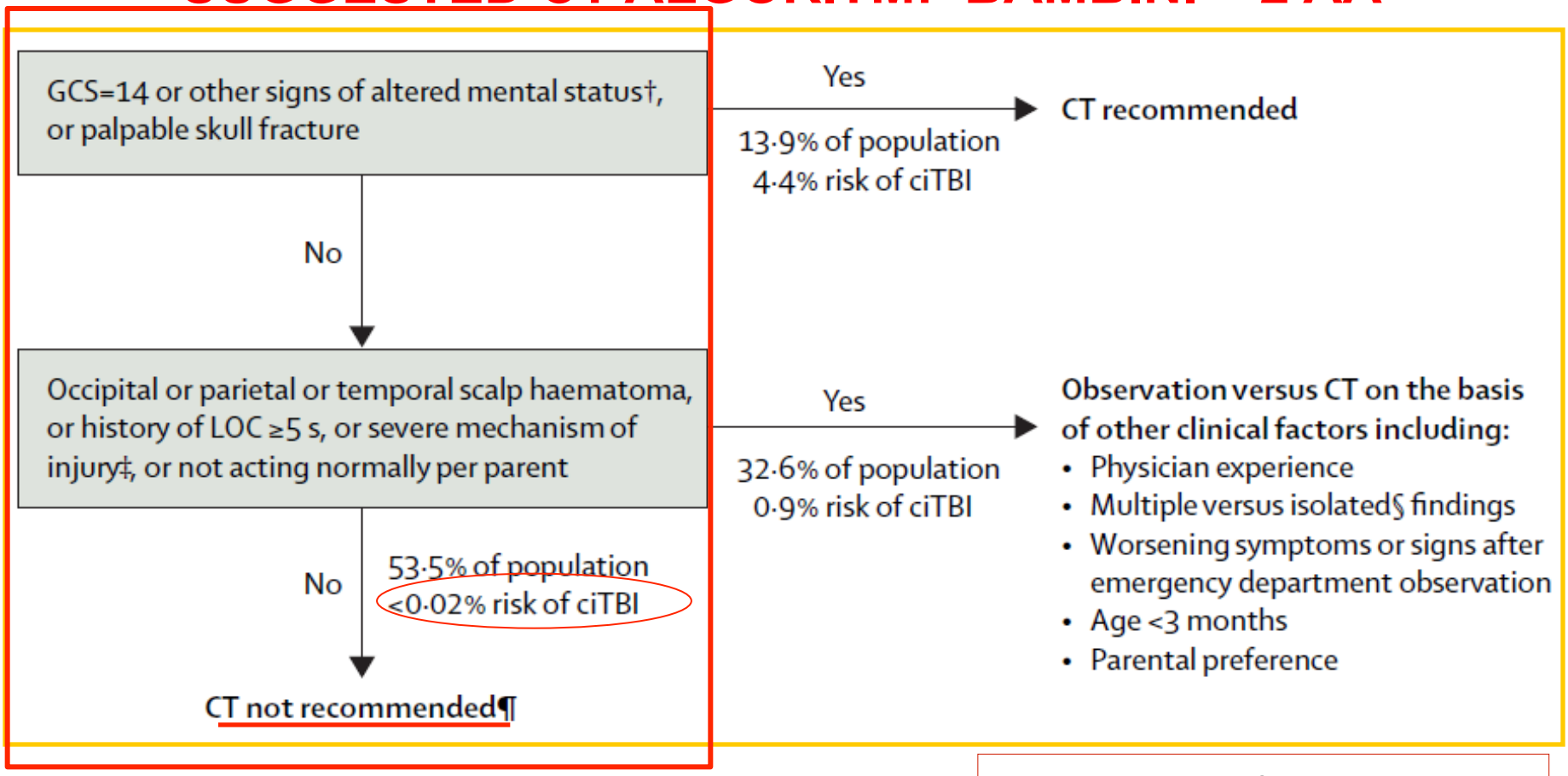
***Fosyth, ADC Online First, September 2, 2013***

# SUGGESTED CT ALGORITM: BAMBINI < 2 AA



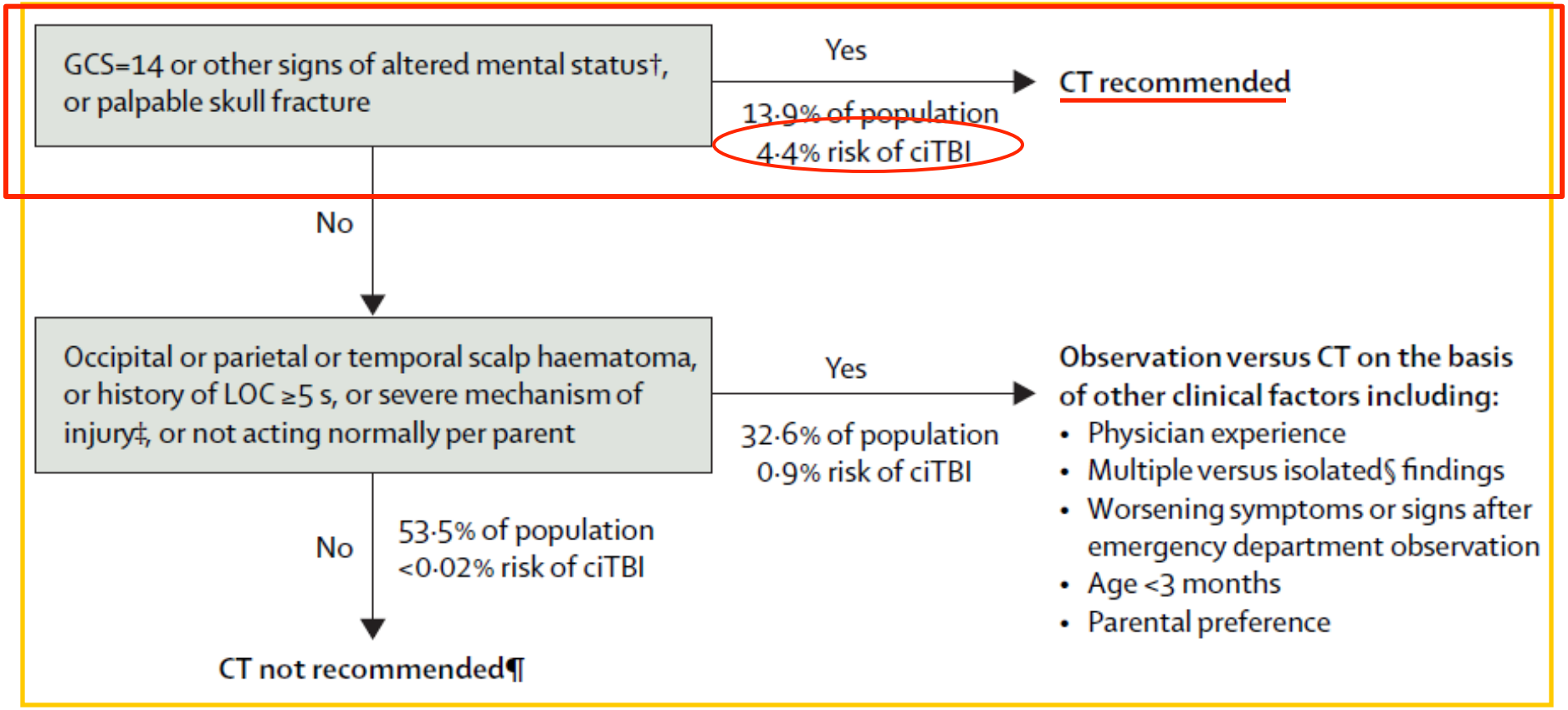

*Lancet, September 12, 2009*

# SUGGESTED CT ALGORITM: BAMBINI < 2 AA



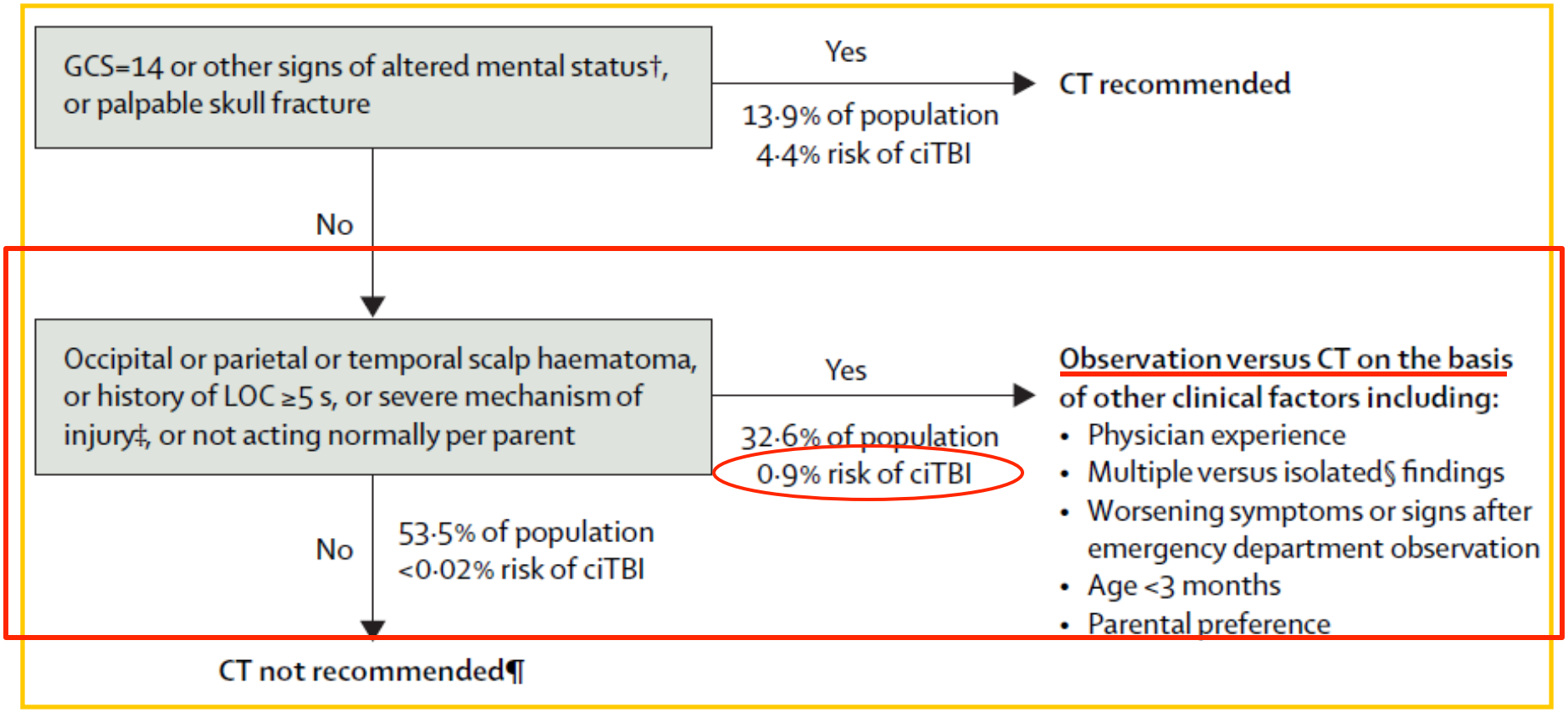

*Lancet, September 12, 2009*

# SUGGESTED CT ALGORITM: BAMBINI < 2 AA



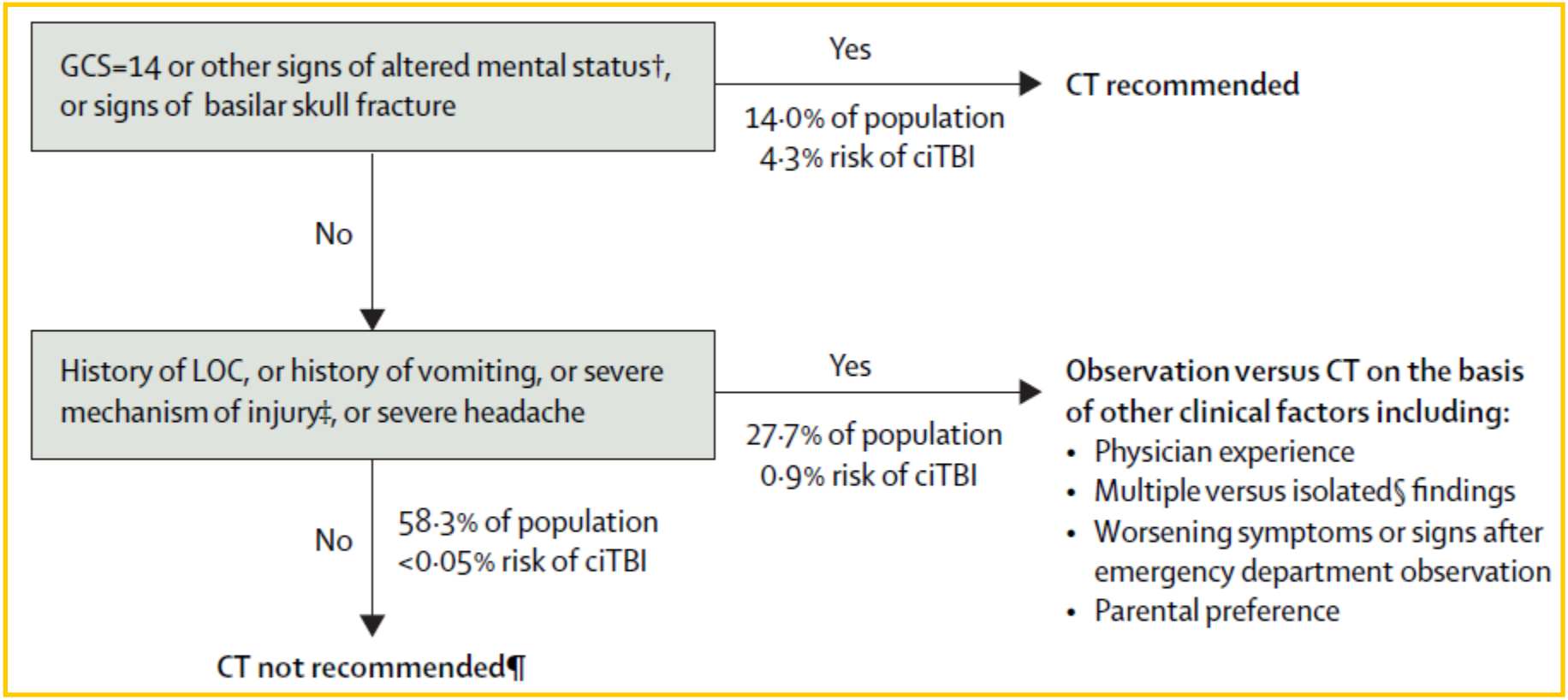

*Lancet, September 12, 2009*

# SUGGESTED CT ALGORITM: BAMBINI < 2 AA



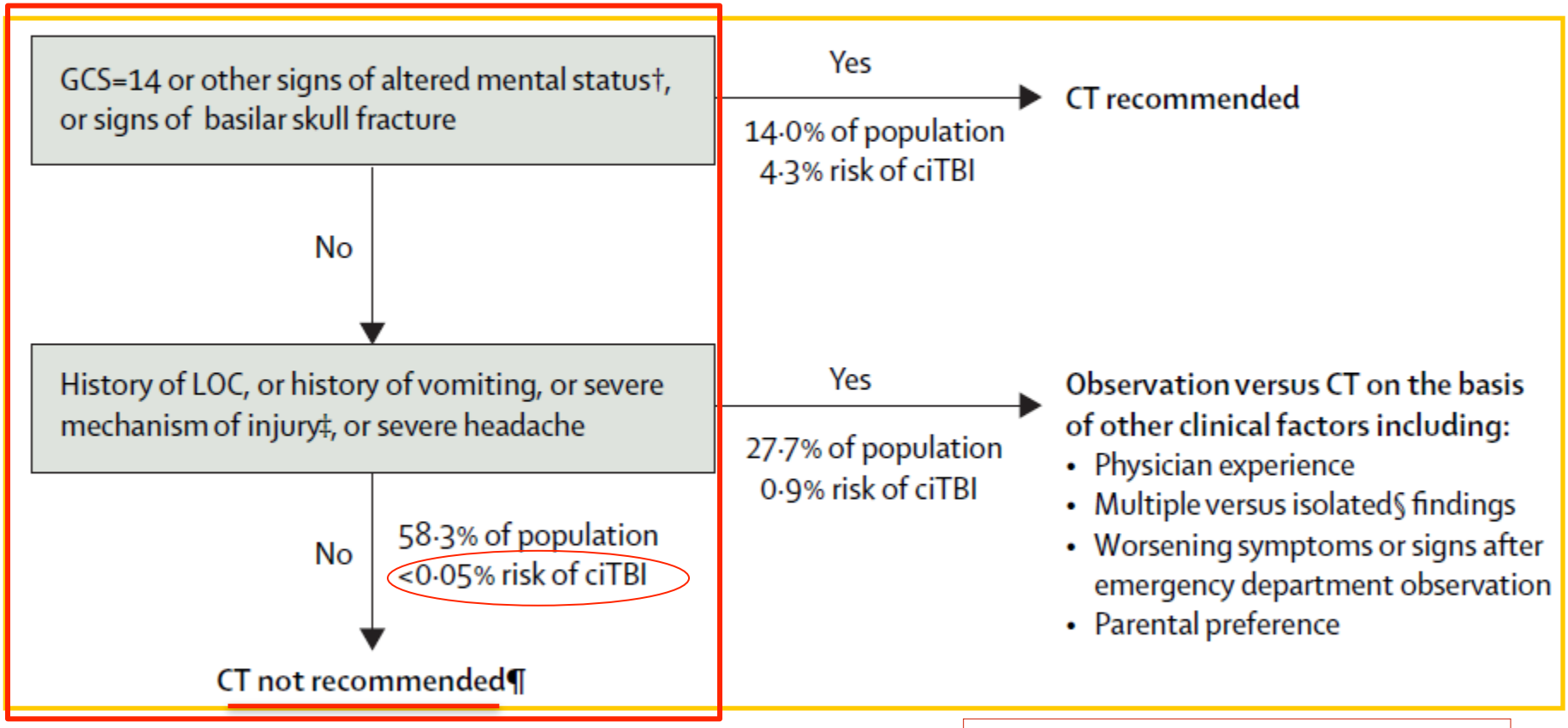

*Lancet, September 12, 2009*

# SUGGESTED CT ALGORITM: BAMBINI > 2 AA



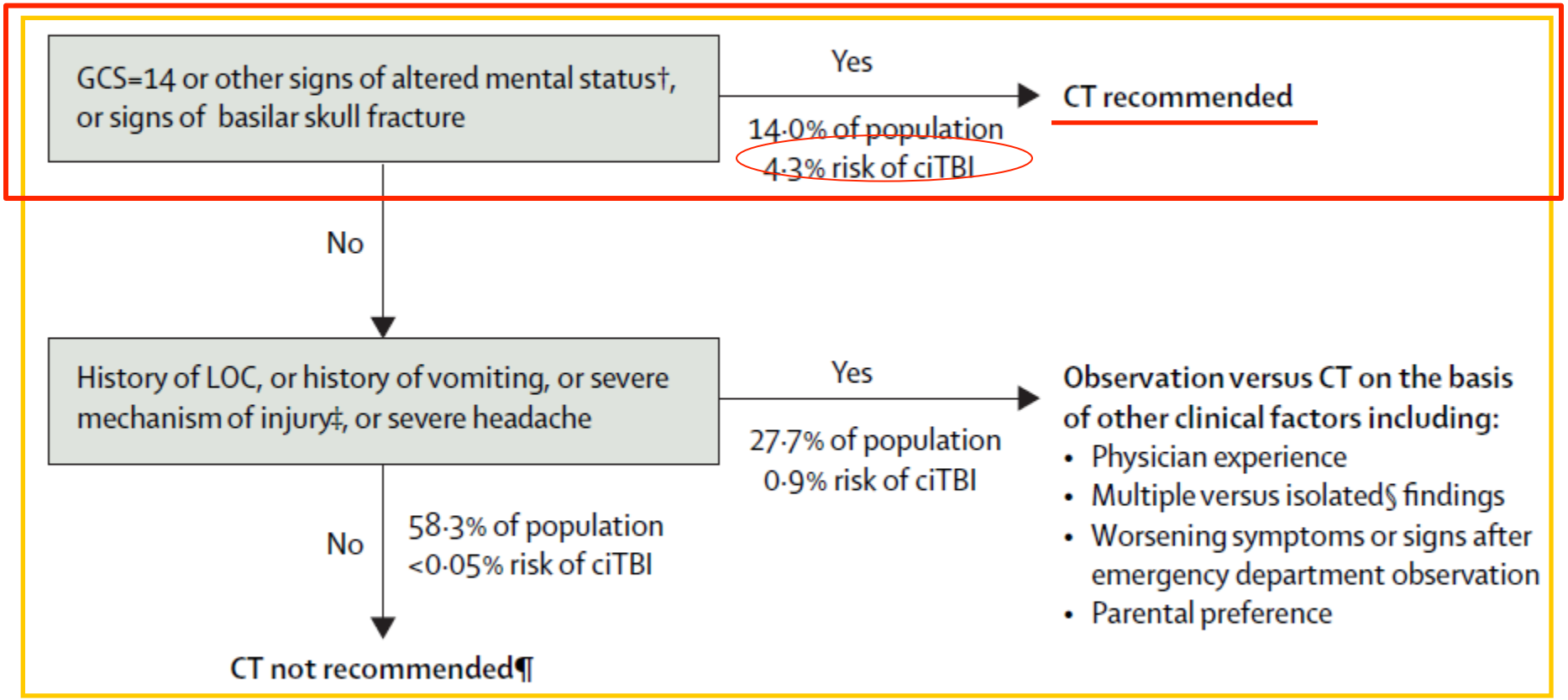

*Lancet, September 12, 2009*

# SUGGESTED CT ALGORITM: BAMBINI > 2 AA



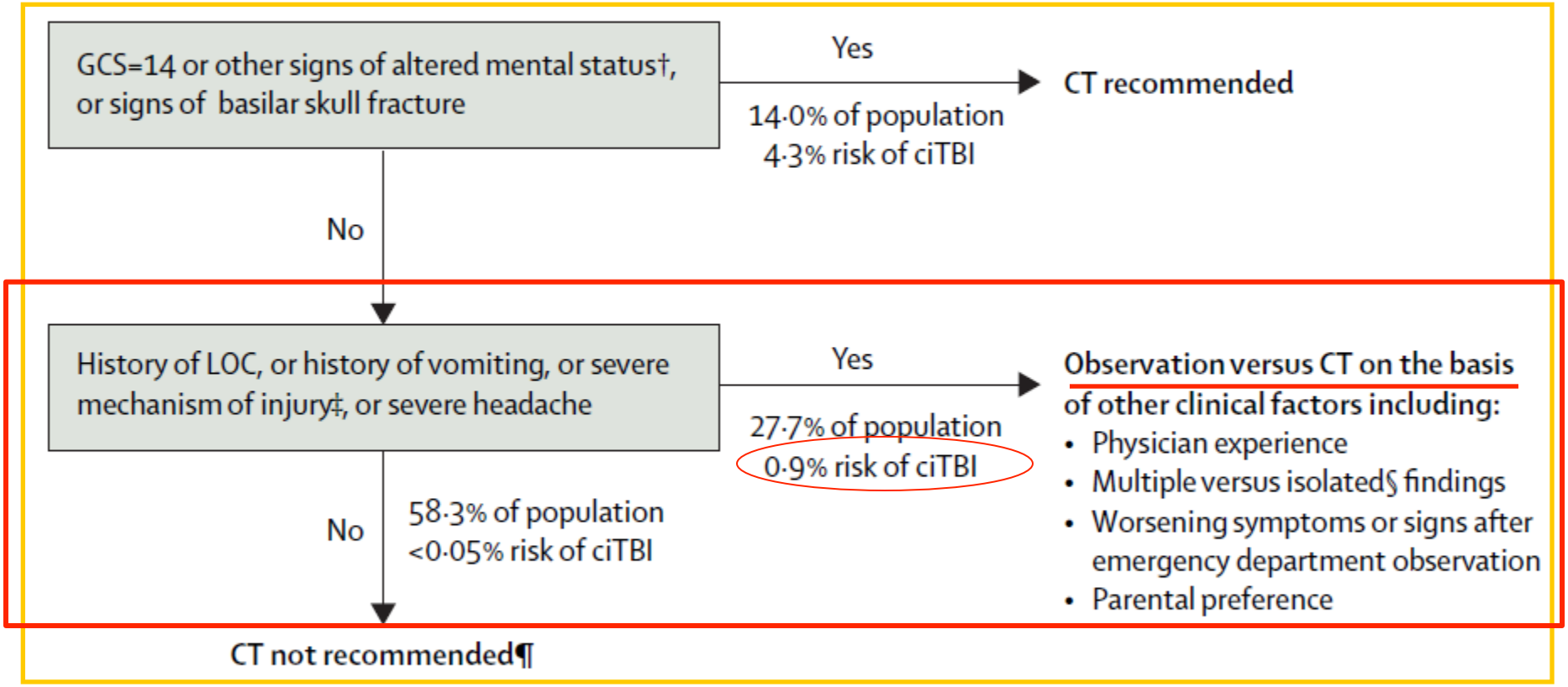

*Lancet, September 12, 2009*

# SUGGESTED CT ALGORITM: BAMBINI > 2 AA




*Lancet, September 12, 2009*

# SUGGESTED CT ALGORITM: BAMBINI > 2 AA




*Lancet, September 12, 2009*

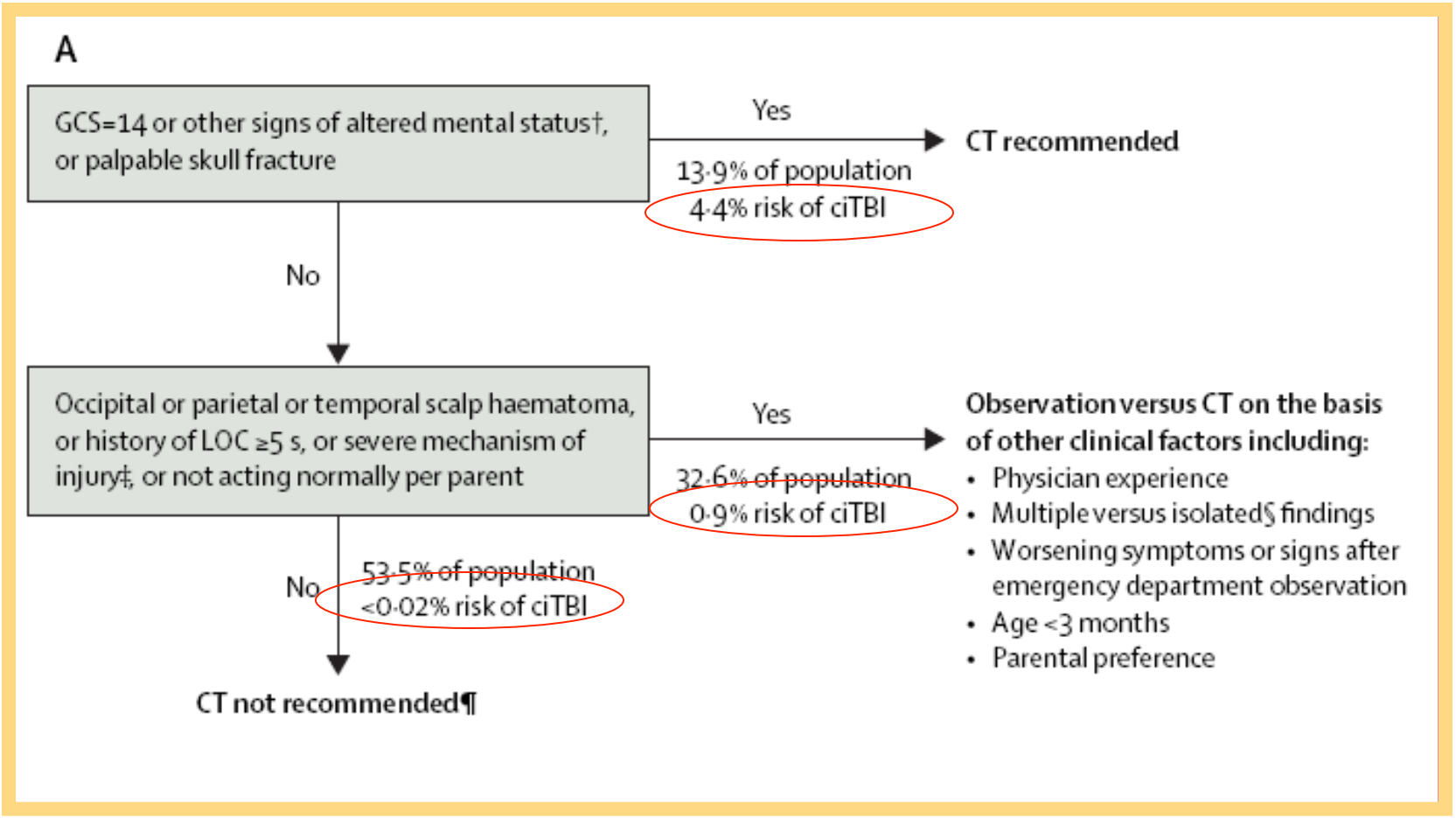
# SEVERE MECHANISM OF TRAUMA

- **Motor vehicle collisions and**
  - **Ejection**
  - **Other passenger death**
  - **Rollover**
  - **Pedestrian**
  - **Unhelmeted byciclist**
- **Fall >3 feet (0.9m) if < 2 yo**
- **Fall > 5 feet (1.5m) if ≥2 yo**
- **Head hit by high impact object**

*Kupperman N, Lancet, September 12, 2009*

# Suggested CT algorythm

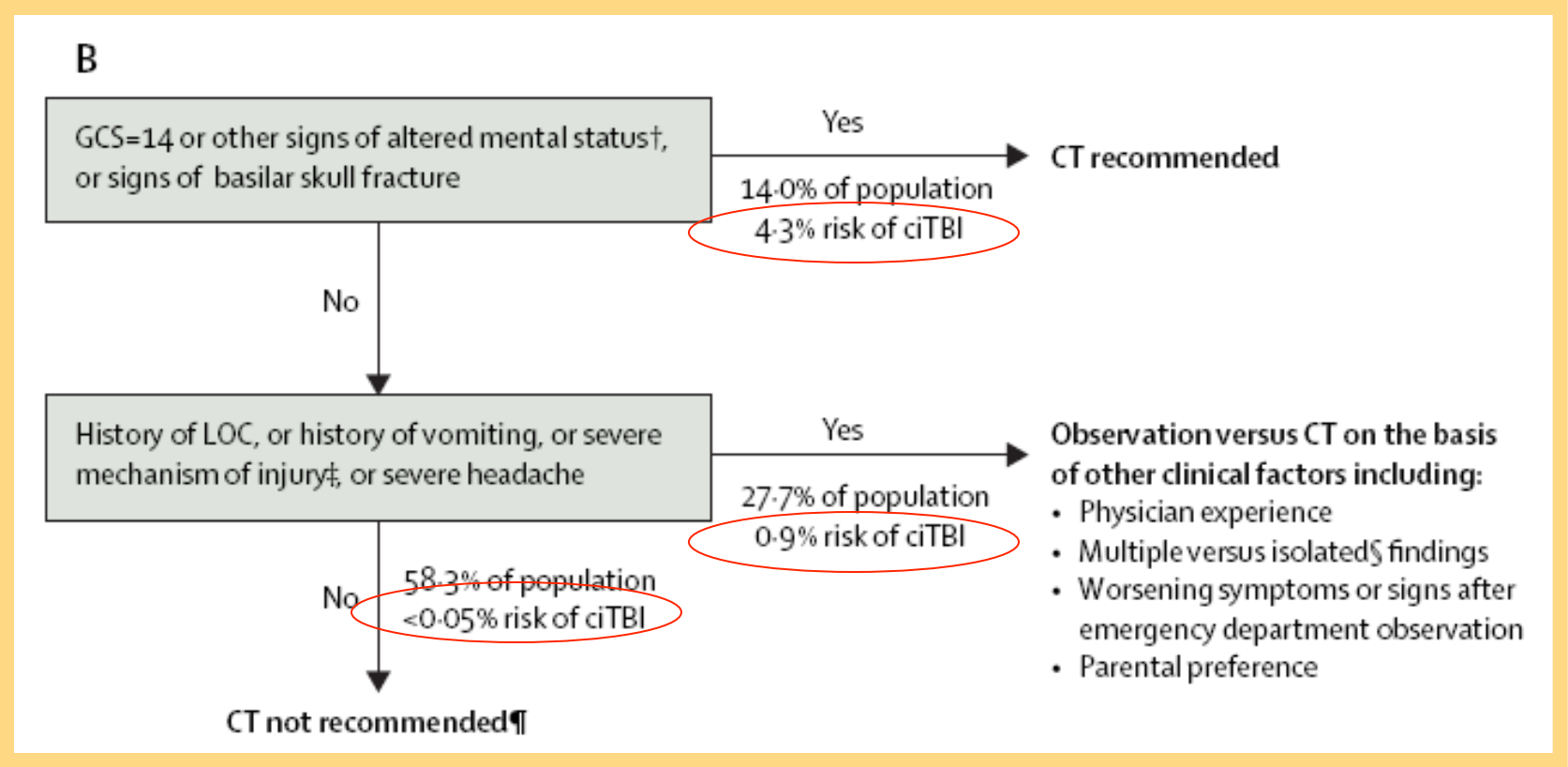
## Children < 2 aa




*Kupperman N, Lancet, September 12, 2009*

# Suggested CT algorythm

## Children > 2 aa




*Kupperman N, Lancet, September 12, 2009*

# Suggested CT algorythm

*Kupperman N, Lancet, September 12, 2009*

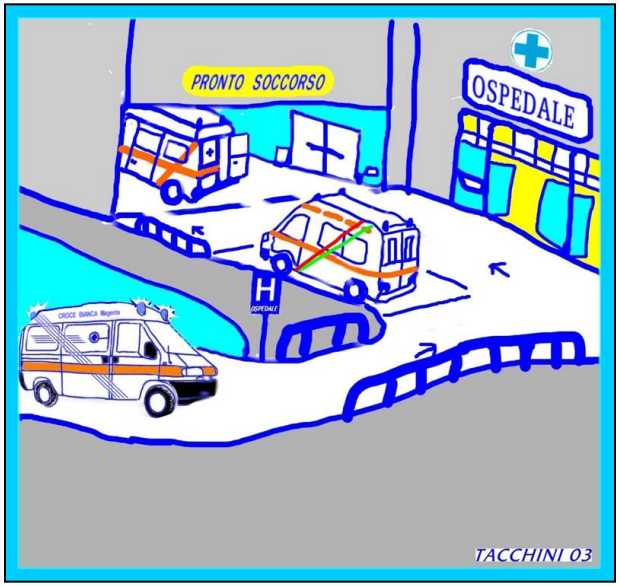
✓ **The algorithmic approach proposed in the study is likely to gain wide acceptance for management of head-injured children given its scientific rigor and easy to use**

✓ **The rules my might not be perfect, but represent the best current scientific evidence**

# TRAUMA CRANICO MINORE

## UN' ALTERNATIVA ALLA TAC IMMEDIATA

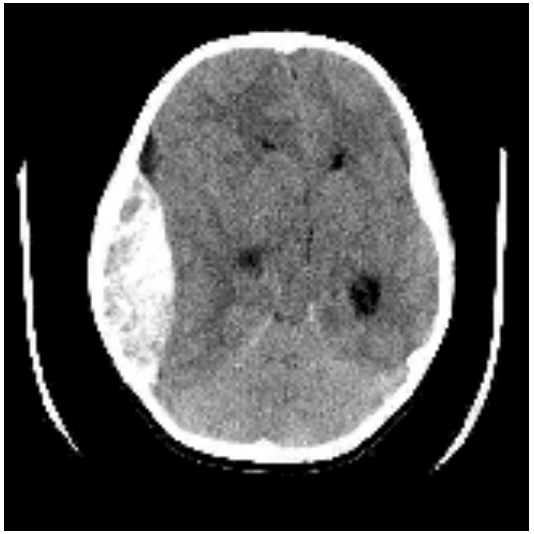
**E'**
**L' OSSERVAZIONE IN OSPEDALE**
**PER 12-24 ORE**




# CRITERI PER LA DIMISSIONE E/O GESTIONE DOMICILIARE DEL BAMBINO CON TC MINORE

- Bambino sveglio, asintomatico, con esame neurologico normale
- Abitazione relativamente vicina all'ospedale
- Genitori attendibili
- Non sospetto di maltrattamento
- TAC cerebrale (se eseguita) negativa

# "PITFALLS"



**In un bambino con TC dalla dinamica confusa ed incerta, contraddittoria od incoerente all'entità del trauma**

**la diagnosi di "abuso e/o maltrattamento"**

**va sempre presa in considerazione**

**6-10% dei bambini piccoli portati all'attenzione clinica per un TC sono vittima di maltrattamenti**