The Emergency Management of Mild TBI: Where are we now and where are we headed?

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Disclosures

- Abbott Diagnostics: speakers fees, research support
- BrainBox: research support
- BioMerieux: Scientific Advisory Board

TBI: Goals in Emergency Department

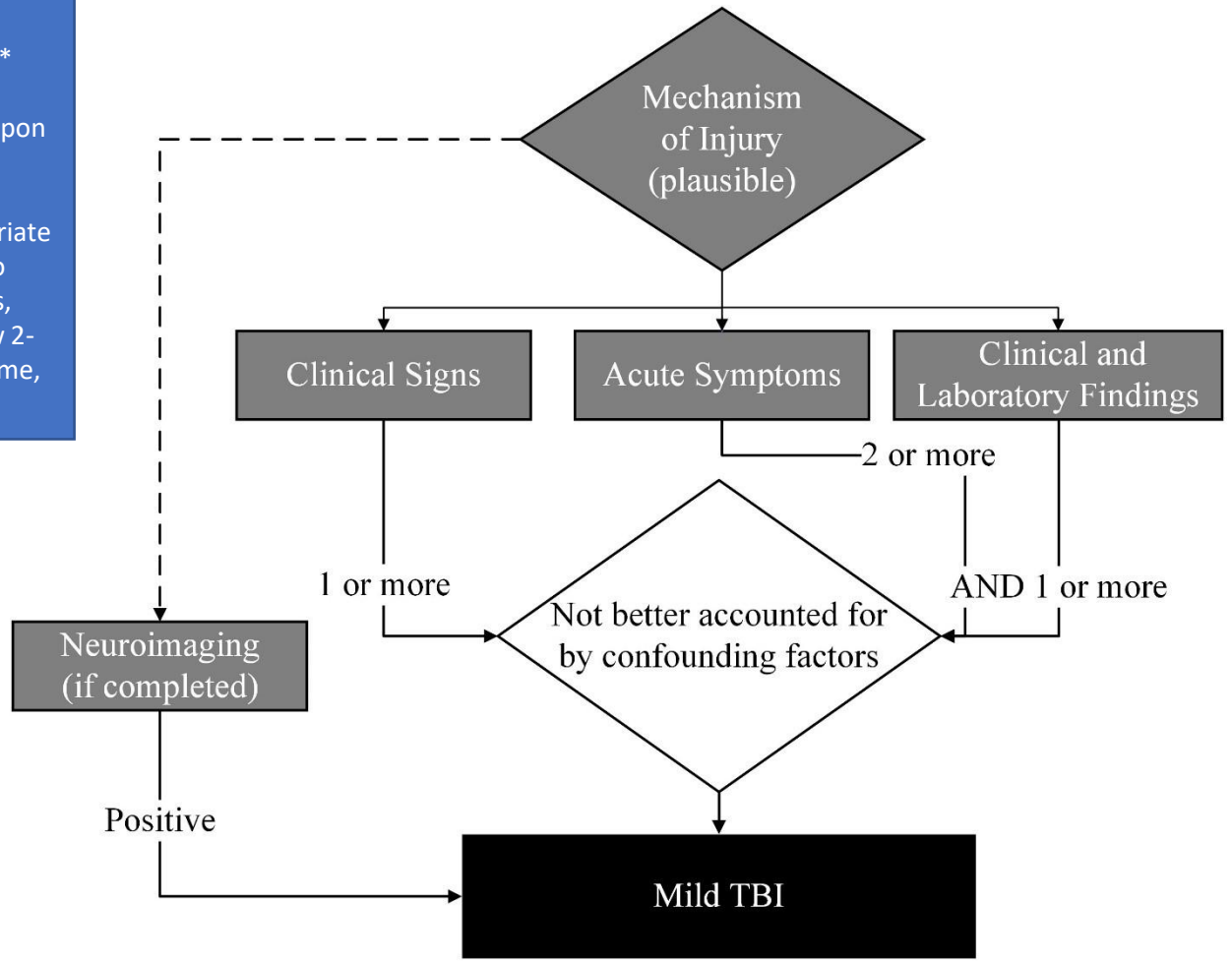
- Recognition
- Evaluate for ICH
- Safe DC Instructions

2023 ACRM Diagnostic Criteria for Mild TBI

CLINIC SIGNS ≥1 of the following:

1. LOC
2. Objective evidence of altered MS*
3. Amnesia
4. Observed motor incoordination upon standing, seizure or tonic posturing

*reduced responsiveness, inappropriate response to external stimuli, slow to respond to questions or instructions, agitated behavior, inability to follow 2-part commands, disorientation to time, place or situation



NEUROIMAGING

Trauma-related intracranial abn on either:

1. CT
2. MRI

ACUTE SYMPTOMS ≥2 of the following:

Immediately post-injury
1. Feeling confused
2. Feeling disoriented
3. Feeling dazed

Within 72 hours of injury
4. HA
5. Nausea
6. Dizziness
7. Balance problems
8. Vision problems
9. Sensitivity to light
10. Sensitivity to noise
11. Feeling slowed down
12. Mental fog
13. Difficulty concentrating
14. Memory problems
15. Uncharacteristic emotional lability
16. Irritability

CLINICAL & LAB FINDINGS ≥1 of the following:

Within 72 hours of injury
1. Cognitive impairment on acute clinical exam
2. Balance impairment on acute clinical exam
3. Oculomotor impairment or symptom provocation in response to vestibular-oculomotor challenge on acute clinical exam
4. Elevated blood biomarkers indicative of intracranial injury

Silverberg ND. *Arch Phys Med & Rehab*. (2023)

Recognition of mild TBI: Not So Easy!

> 50% missed in ED settings

ACUTE CONCUSSION EVALUATION (ACE)
Emergency Department (ED) Version v1.4
Gerard Gioia, PhD[1] & Micky Collins, PhD[2]
[1]Children's National Medical Center
[2] University of Pittsburgh Medical Center

Military Acute Concussion Evaluation (MACE)
Defense and Veterans Brain Injury Center

Recognition

ED CONCUSSION SCREEN

NURSE/Initial SCREEN (Trauma Patients with GCS 13-15)

1. **Was there a blunt force or deceleration/acceleration event?**
   - ☐ No — **No Trigger**
   - ☐ Yes – Next Question

2. **Was there Alteration of consciousness or mental status (Temporary Confusion; Bell Rung; Seeing Stars; Dazed)?**
   - ☐ No — **No Trigger**
   - ☐ Yes
     - Trigger Auto Diagnosis Code, or
     - Auto D/C AVS Concussion Instruction
     - Trigger embedded H&P
     - Trigger Pop up to consider concussion

Recognition

Embedded Fields for eMR

3. **Mechanism**

☐ MVC	☐ Sports Injury	☐ Blast
☐ Pedestrian-MVC	☐ Fall	☐ Assault
☐ Blunt Object	☐ Poly Trauma	

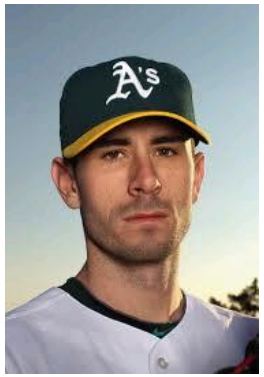
4. **Alteration of consciousness or mental status characteristics**
(Check all that apply)

W – Eye Witnesses or Observed in ED
P - Patient Report

W P

☐ ☐Loss of Consciousness
☐ ☐Amnesia or memory loss (memory loss before or after the event)
☐ ☐Seizure
☐ ☐Confusion or brief mental status change (Bell Rung; Seeing Stars; Dazed)
☐ ☐Repeats questions, answers questions slowly

Evaluate for Intracranial Hemorrhage



Brandon McCarthy

5-10% of Mild TBI

Clinical Decision Rules to Evaluate for Intracranial Hemorrhage

Table 1. Findings used by 7 clinical decision rules for CT scanning in mild traumatic brain injury.

Clinical Finding	Canadian	NCWFNS	New Orleans	NEXUS-II	NICE	Scandinavian
GCS score	<15 At 2 h	<15	<15	Abnormal alertness, behavior	<15 At 2 h	<15
Amnesia	Retrograde >30 min*	Any	Antegrade	—	Retrograde >30 min	Any
Suspected fracture	Open, depressed, basal	Any	Any injury above clavicles	Any	Open, depressed, basal	Basal, depressed, confirmed
Vomiting	Recurrent	Any	Any	Recurrent	Recurrent	—
Age, y	≥65	—	>60	≥65	≥65†	—
Coagulopathy	—	Any	—	Any	Any†	Any
Focal deficit	—	Any	—	Any	Any	Any
Seizure	—	History	Any	—	Any	Any
LOC	If GCS=14	Any	—	—	—	Any
Visible trauma	—	—	Above clavicles	Scalp hematoma	—	Multiple injuries
Headache	—	Any	Severe	—	—	—
Injury mechanism	Dangerous*†	—	—	—	Dangerous††	—
Intoxication	—	Abuse history	Drug, alcohol	—	—	—
Previous neurosurgery	—	Yes	—	—	—	Shunt

NCWFNS, Neurotraumatology Committee of the World Federation of Neurosurgical Societies; *NICE*, National Institute of Clinical Excellence; —, indicates the item is not considered an indication for CT scanning by author(s) of the rule; *LOC*, loss of consciousness.

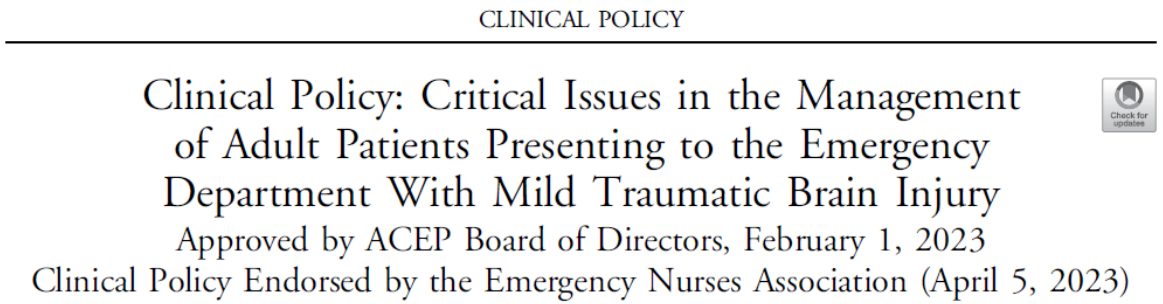
*Used to determine medium risk for the Canadian Rule.

†CT scan only if also loss of consciousness or any amnesia.

††Dangerous injury mechanism=ejected from motor vehicle, pedestrian struck by motor vehicle, fall of >3 feet or 5 steps.

Which CDR to use

- Canadian CT Head Rule (Level A)
- NOC / NEXUS (Level B)
- Don’t use CDR if on anticoags/antiplts (Level C)



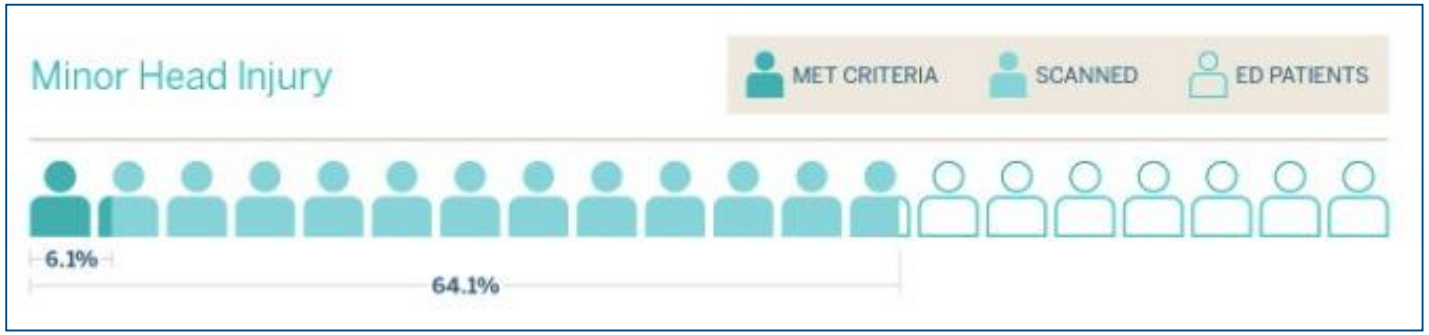
CLINICAL POLICY

Clinical Policy: Critical Issues in the Management of Adult Patients Presenting to the Emergency Department With Mild Traumatic Brain Injury

Approved by ACEP Board of Directors, February 1, 2023

Clinical Policy Endorsed by the Emergency Nurses Association (April 5, 2023)

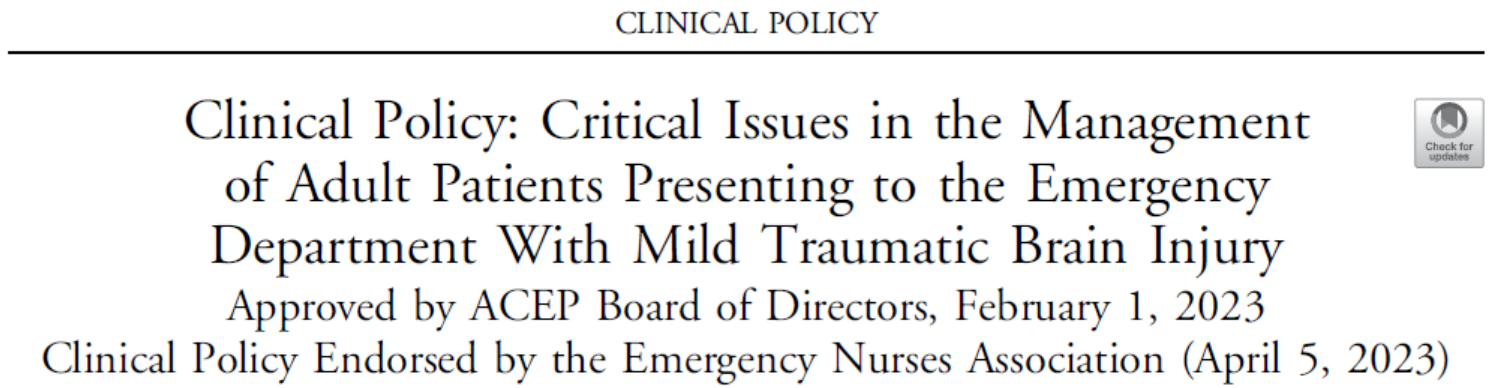
CDRs are under utilized



https://www.advisory.com/research/physician-executive-council/prescription-for-change/2015/02/head-ct-scan-overuse

Safe to DC after a single neg CT?

- Yes (Level B)



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Discharge Instructions

Provide DC instructions that

- Indicate a concussion has occurred
- Educate regarding early management (rest)
- Don’t conflict with current RTP guidelines

Parents may specifically request to be cleared by EP

- Advise NO return to contact sports until cleared by a HCP familiar with concussion management
- RTP is a 6-step, multi-day process
- These cannot be accomplished in an ED setting

CDC Discharge Instructions

Mild Traumatic Brain Injury and Concussion:
Information for Adults

Discharge Instructions

You were seen today for a mild traumatic brain injury (mild TBI) or concussion.

- **Use this handout to help you watch for changes in how you are feeling or acting and to help you feel better.**
- **Be sure to let a family member or friend know about your injury and the types of symptoms to look out for. They may notice symptoms before you do and can help you.**
- **Schedule a follow-up appointment with your regular doctor.**

Due to your injury, you may need to take some time off from things like work or school. If so, ask your doctor for written instructions about when you can safely return to work, school, sports, or other activities such as driving a car, riding a bike, or operating heavy equipment.

Watch for Danger Signs

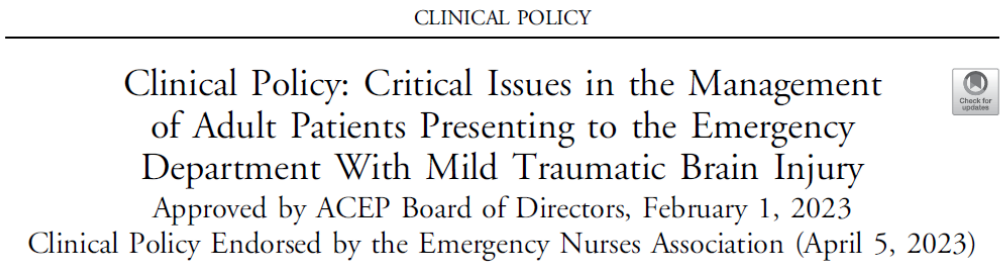
In rare cases, a dangerous blood clot that crowds the brain against the skull can develop after a TBI. The people checking on you should call 911 or take you to an emergency department right away if you have:

- A headache that gets worse and does not go away
- Significant nausea or repeated vomiting
- Unusual behavior, increased confusion, restlessness, or agitation
- Drowsiness or inability to wake up
- Slurred speech, weakness, numbness, or decreased coordination
- Convulsions or seizures (shaking or twitching)
- Loss of consciousness (passing out)

More information on mild TBI and concussion, as well as tips to help you feel better, can be found at **www.cdc.gov/TraumaticBrainInjury.**

Who to refer for TBI After-care

- PCS plus >1 Risk factor (LOC, female, GCS<15, psych hx, assault, acute intoxication). (Level C)
- Don’t use biomarkers to predict risk (Level C)



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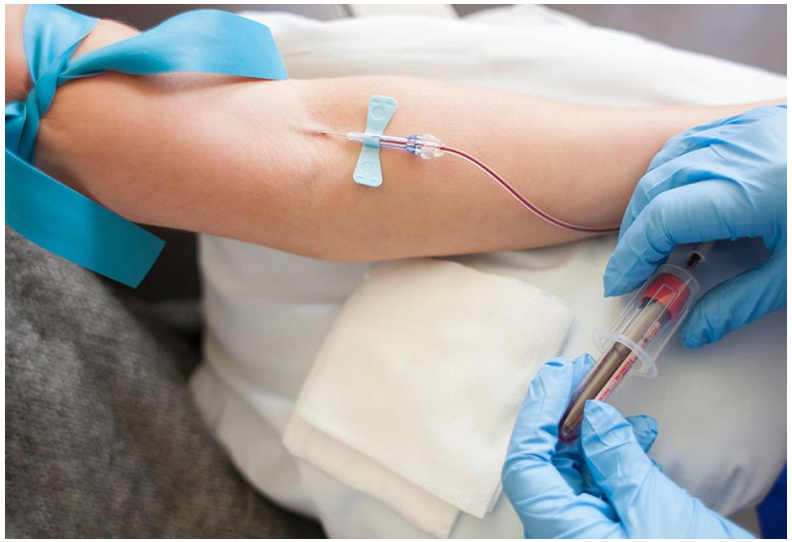
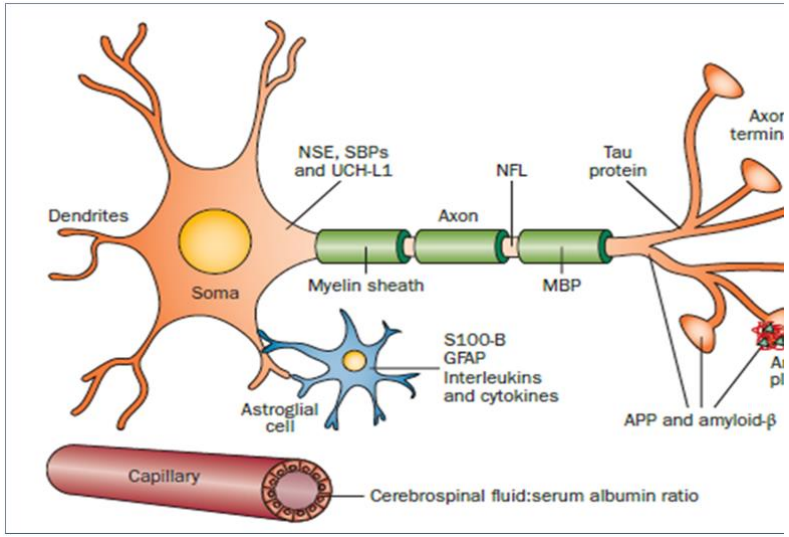
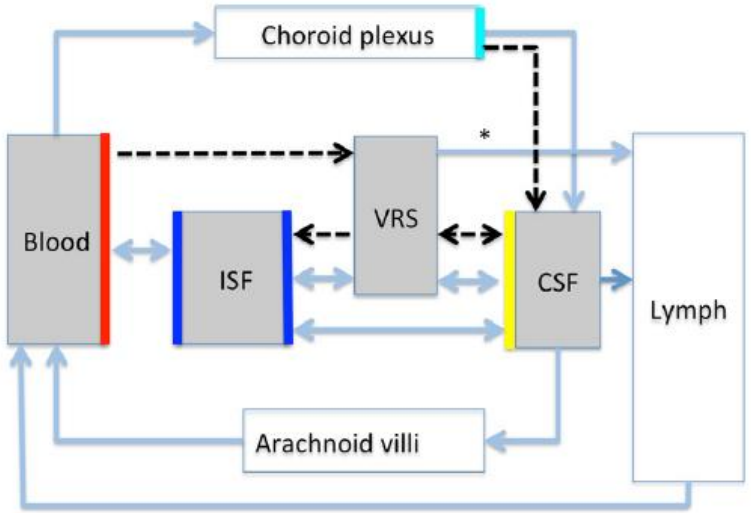
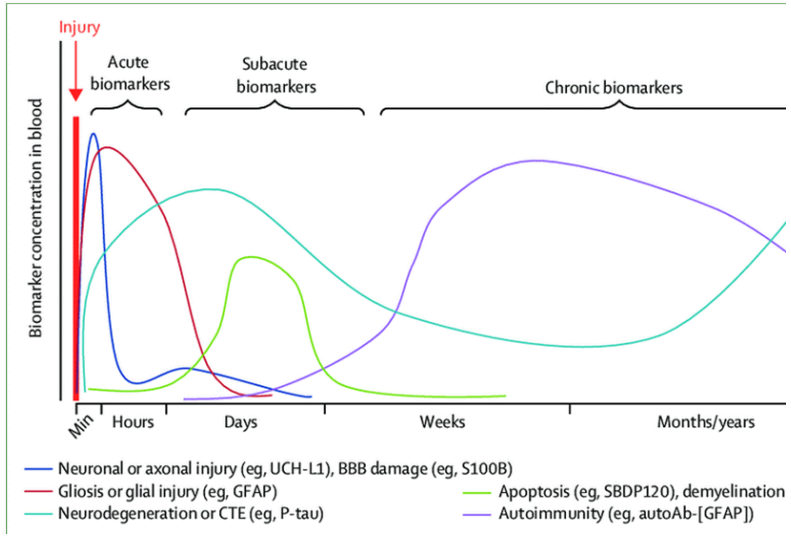
Can we do better than this?

Blood-based Brain Biomarkers









Key Events in Evolution of TBI Biomarkers

1995

Increased serum concentrations of protein S-100 after minor head injury: a biochemical serum marker with prognostic value?

TOR INGEBRIGTSEN
Department of Neurosurgery, University Hospital of Tromsø, Norway
BERTIL ROMNER
POUL KONGSTAD
Department of Neurosurgery, University Hospital of Lund, Sweden
BODIL LANGBAKK
Department of Clinical Chemistry, University Hospital of Tromsø, Norway

2000

Comparative Study > Brain Inj. 2000 Dec;14(12):1047-55. doi: 10.1080/02699050050203540.

The clinical value of serum S-100 protein measurements in minor head injury: a Scandinavian multicentre study

T Ingebrigtsen [1], B Romner, S Marup-Jensen, M Dons, C Lundqvist, J Bellner, C Alling, S E Børgesen

Affiliations + expand

PMID: 11147577 DOI: 10.1080/02699050050203540

2005

SHOCK, Vol. 25, No. 5, pp. 446–453, 2006

SERUM S-100B CONCENTRATION PROVIDES ADDITIONAL INFORMATION FOR THE INDICATION OF COMPUTED TOMOGRAPHY IN PATIENTS AFTER MINOR HEAD INJURY

A PROSPECTIVE MULTICENTER STUDY

Peter Biberthaler,* Ulrich Linsenmeier,† Klaus-Juergen Pfeifer,† Michael Kroetz,† Thomas Mussack,* Karl-Georg Kanz,* Eduard F.J. Hoecherl,‡ Felix Jonas,‡ Ingo Marzi,§ Phillip Leucht,§ Marianne Jochum,¶ and Wolf Mutschler*

2013

GUIDELINE Open Access

Scandinavian guidelines for initial management of minimal, mild and moderate head injuries in adults: an evidence and consensus-based update

Johan Undén[1*], Tor Ingebrigtsen[2] and Bertil Romner[3], for the Scandinavian Neurotrauma Committee (SNC)

2018

Serum GFAP and UCH-L1 for prediction of absence of intracranial injuries on head CT (ALERT-TBI): a multicentre observational study

Jeffrey J Bazarian, Peter Biberthaler*, Robert D Welch, Lawrence M Lewis, Pal Barzo, Viktoria Bogner-Flatz, P Gunnar Brolinson, Andras Büki, James Y Chen, Robert H Christenson, Dallas Hack, J Stephen Huff, Sandeep Johar, J Dedrick Jordan, Bernd A Leidel, Tobias Lindner, Elizabeth Ludington, David O Okonkwo, Joseph Ornato, W Frank Peacock, Kara Schmidt, Joseph A Tyndall, Arastoo Vossough, Andy S Jagoda*

2018

Biomarker Work Group

Draft Recommendations at ACUTE post-TBI time points (0-24 hrs)

GFAP

COU: Emergency Department, athletic training room

Indications

- Head CT screen
- Predict microhemorrhages on MRI when CT is normal
- Aid to diagnosis
- Predicts global functional outcome

UCH-L1

COU: ED, AT room

Indications

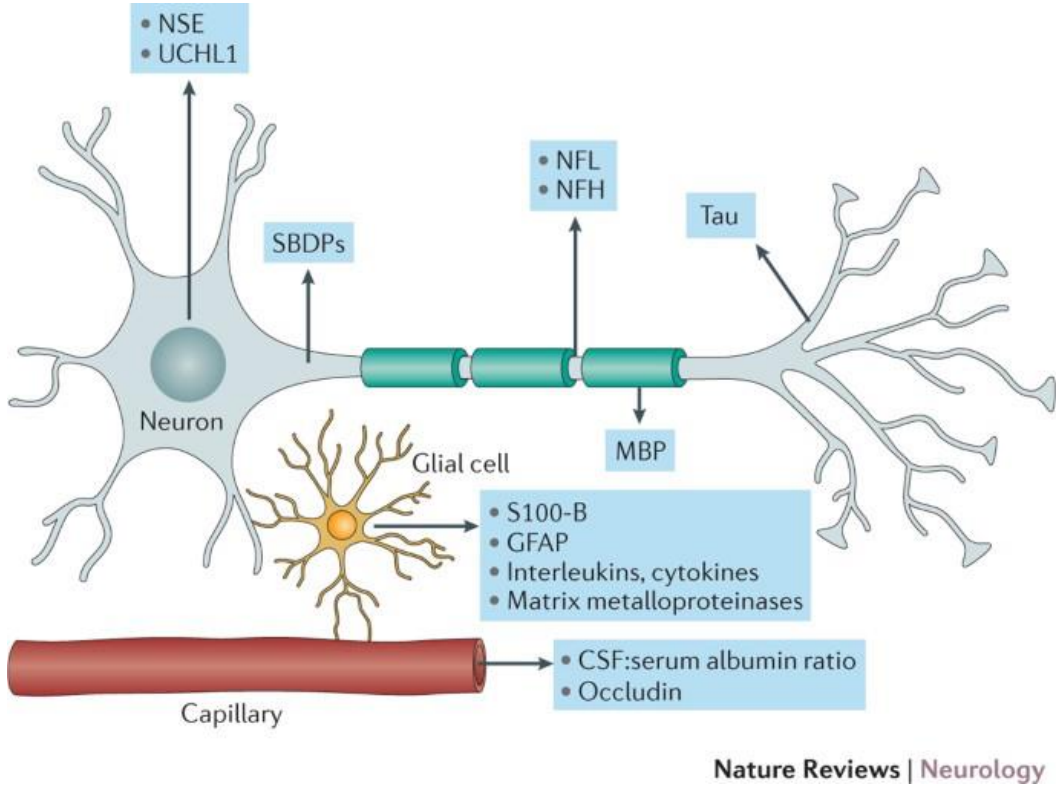
- Head CT screen
- Aid to diagnosis
- Predicts global functional outcome

S100B

COU: ED, AT room

Indications

- Head CT screen
- Aid to diagnosis
- Predicts global functional outcome



Clinical Decision Rules vs GFAP and UCH-L1

Result of assessment	Clinical decision rule		
	CCHR	NOC	NEXUS II
Rule finding, No. of patients			
Positive, injury/no injury	23/218	23/274	19/156
Negative, injury/no injury	0/108	0/52	4/170
Sensitivity, % (95% CI)	100 (82-100)	100 (82-100)	83 (60-94)
Specificity, % (95% CI)	33 (28-39)	16 (12-20)	52 (47-58)
PPV, % (95% CI)	10 (6-14)	8 (5-12)	11 (7-17)
NPV, % (95% CI)	100 (96-100)	100 (91-100)	98 (94-99)
Likelihood ratio (95% CI)	1.50 (1.39-1.61)	1.19 (1.13-1.25)	1.73 (1.39-2.15)
Unnecessary CTs, No. (%)[a]	218/349 (62)	274/349 (79)	156/349 (45)
Area Under ROC	0.67	0.58	0.67

Result of assessment	Biomarker		
	GFAP	UCH-L1	GFAP and UCH-L1
GFAP level cutoff 67 pg/mL, UCH-L1 level cutoff 189 pg/mL[a]			
Biomarker finding, No. of patients			
Positive, injury/no injury	20/113	22/232	23/245
Negative, injury/no injury	3/213	1/94	0/81
Sensitivity, % (95% CI)	87 (65-97)	96 (76-100)	100 (82-100)
Specificity, % (95% CI)	65 (60-70)	29 (24-34)	25 (20-30)
PPV, % (95% CI)	15 (10-23)	9 (6-13)	9 (6-13)
NPV, % (95% CI)	99 (96-100)	99 (93-100)	100 (94-100)
Likelihood ratio (95% CI)	2.50 (2.02-3.12)	1.34 (1.20-1.50)	1.33 (1.25-1.42)
Unnecessary CT, No. (%)[b]	113/349 (32)	232/349 (66)	245/349 (70)
Area Under ROC	0.76	0.62	0.62

	CCHR + GFAP	NOC + GFAP
AUC	0.88	0.85
95% CI	[0.81-0.95]	[0.77-0.94]

Papa L, et al. *JAMA Network Open*. 2022;5(3):e221302


How Do We Get
There?
NEXT EXIT

THANK YOU