OCTOBER 2024

Pediatric Imaging: Balancing the Risks and Benefits

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No disclosures

Learning Objectives

1. Define risks associated with ionizing radiation in children
2. Understand resources available to guide imaging decisions in pediatric trauma patients
3. Describe how indications for radiologic evaluation of injured children differ from adults

Why does it matter how we image children??

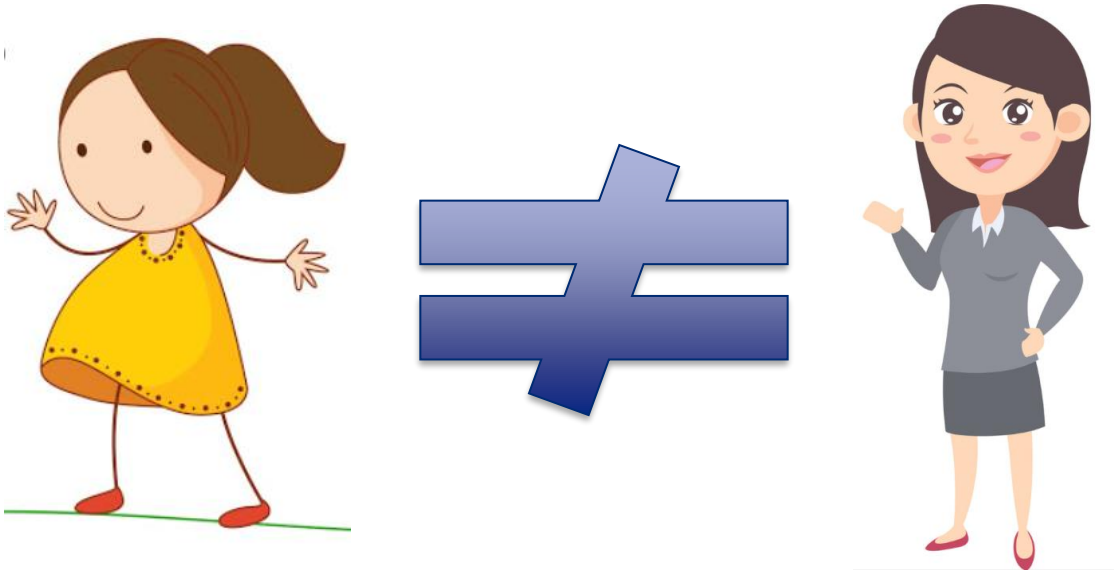
A) Actually it doesn't matter, radiation isn't that bad

B) Kids are basically little adults so we should image them the same

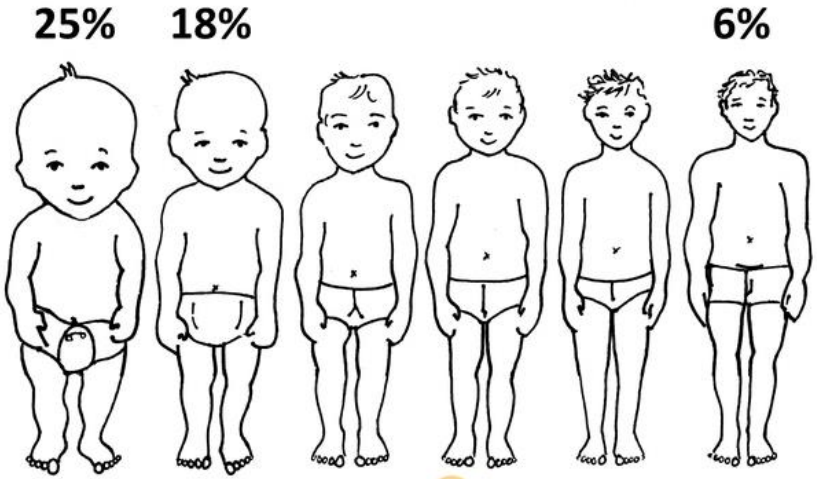
C) Management of kids' injuries is similar to adults so we can treat them the same

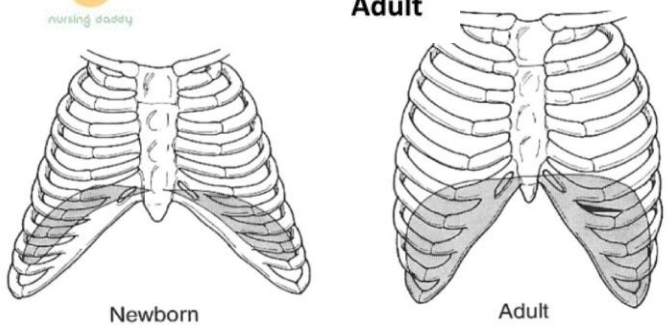
D) None of the above

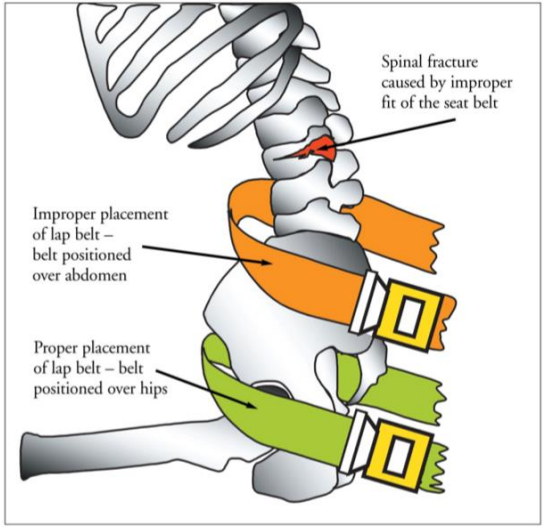
We all know children are not little adults



It makes sense that they SHOULD NOT be imaged like adults







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Risks of Radiation

- Ionizing radiation
  - 100 to 500 times greater with CT compared to conventional radiography
- Children – more sensitive to radiation induced carcinogenesis
  - Tissues are still growing
  - More years ahead of them to develop cancer

Radiation Exposure with Abdominal CT

Number of CT scans leading to 1 case of cancer

Age	Girls	Boys
<5	300	670
5-9	390	730
10-14	370	760

Miglioretti et al *JAMA Pediatr* 2013

Radiation Risk

- No amount of radiation is documented safe in kids
  - 50 mGy TRIPLES the risk of Leukemia
  - 60 mGy TRIPLES the risk of brain cancer
  - One neck CTA=600 CXR!!
- Injury patterns are different in kids
- Management of trauma is different in kids

Variation in radiation dose across centers

- American College of Radiology benchmarks for radiation in kids
- CT head – 23-55 mGy
- CT A/P – 2.7 – 26 mGy

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IMAGE WISELY

JAMA Surgery | Original Investigation

Risk of Hematologic Malignant Neoplasms From Abdominopelvic Computed Tomographic Radiation in Patients Who Underwent Appendectomy

Kyung Hee Lee, MD, PhD; Seungjae Lee, MS; Ji Hoon Park, MD, PhD; Sung Soo Lee, MS; Hae Young Kim, MD, PhD; Won Jin Lee, MD, PhD; Eun Shil Cha, PhD; Kwang Pyo Kim, PhD; Woojoo Lee, PhD; Ji Yun Lee, MD; Kyoung Ho Lee, MD, PhD

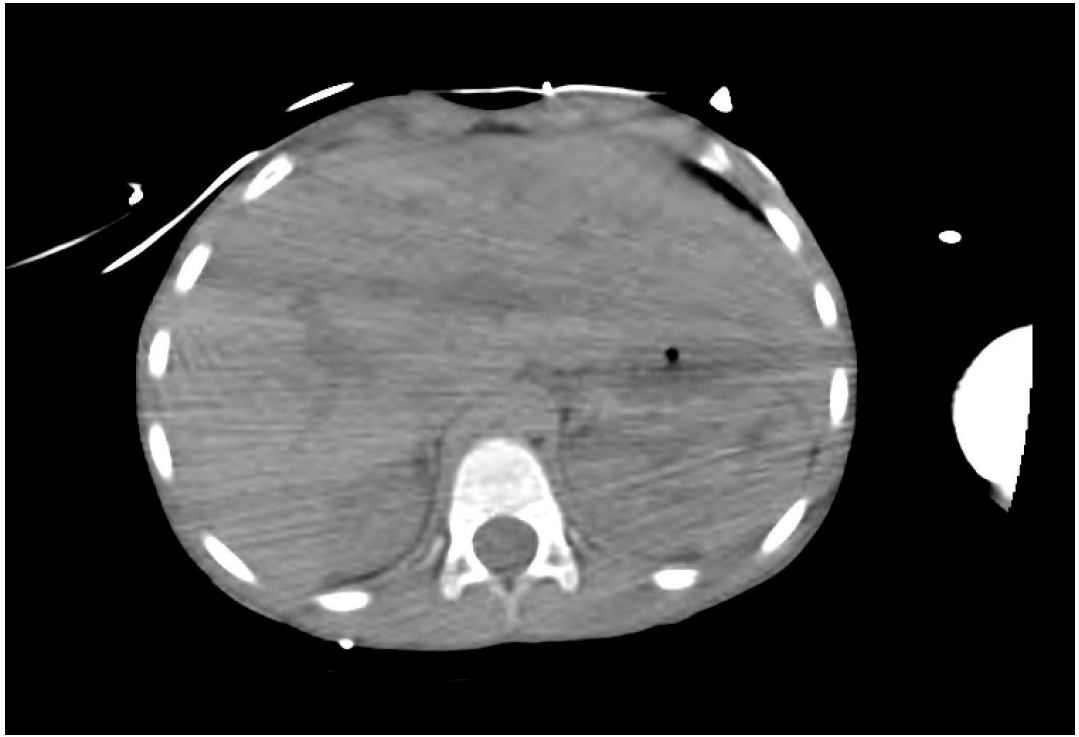
- Nationwide population-based cohort study in South Korea
- Assessed 825,820 pts who underwent appendectomy from 2005-15
- Pts divided into CT-exposed (n = 306,727) or CT-unexposed (n = 519,093) groups
- CT-exposed group had an elevated risk only for leukemia (IRR 1.40, P = .005).

Lee KH et al *JAMA Surg* 2021

With that being said:

- Follow ATLS
- Perform primary survey and use imaging as an adjunct based on clinical info-NOT MECHANISM (for the most part)

If you are going to image kids, don’t do it halfway!



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ACS tqip TRAUMA QUALITY IMPROVEMENT PROGRAM

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ACR AMERICAN COLLEGE OF RADIOLOGY
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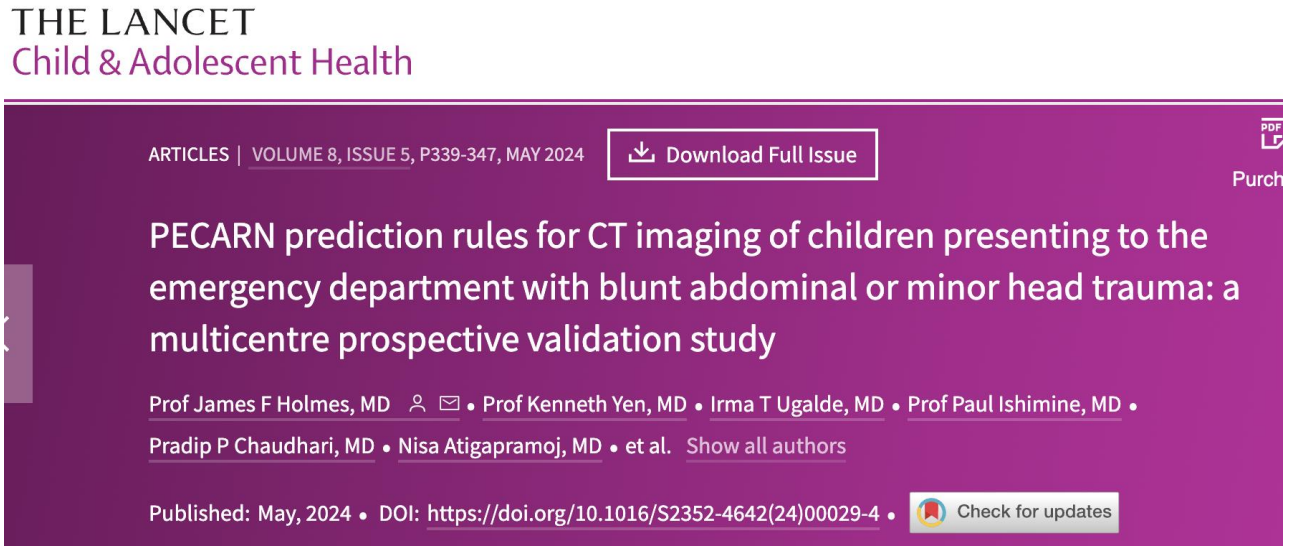
Starting from the top: head



A 3 mo falls off the counter onto a tile floor, vomited x 2, now sleepy, and has “boggy” scalp What do you do:

A) Tell mom to give Tylenol and call PCP in the AM if pt not back to normal

B) Direct pt to hospital-baby needs head CT

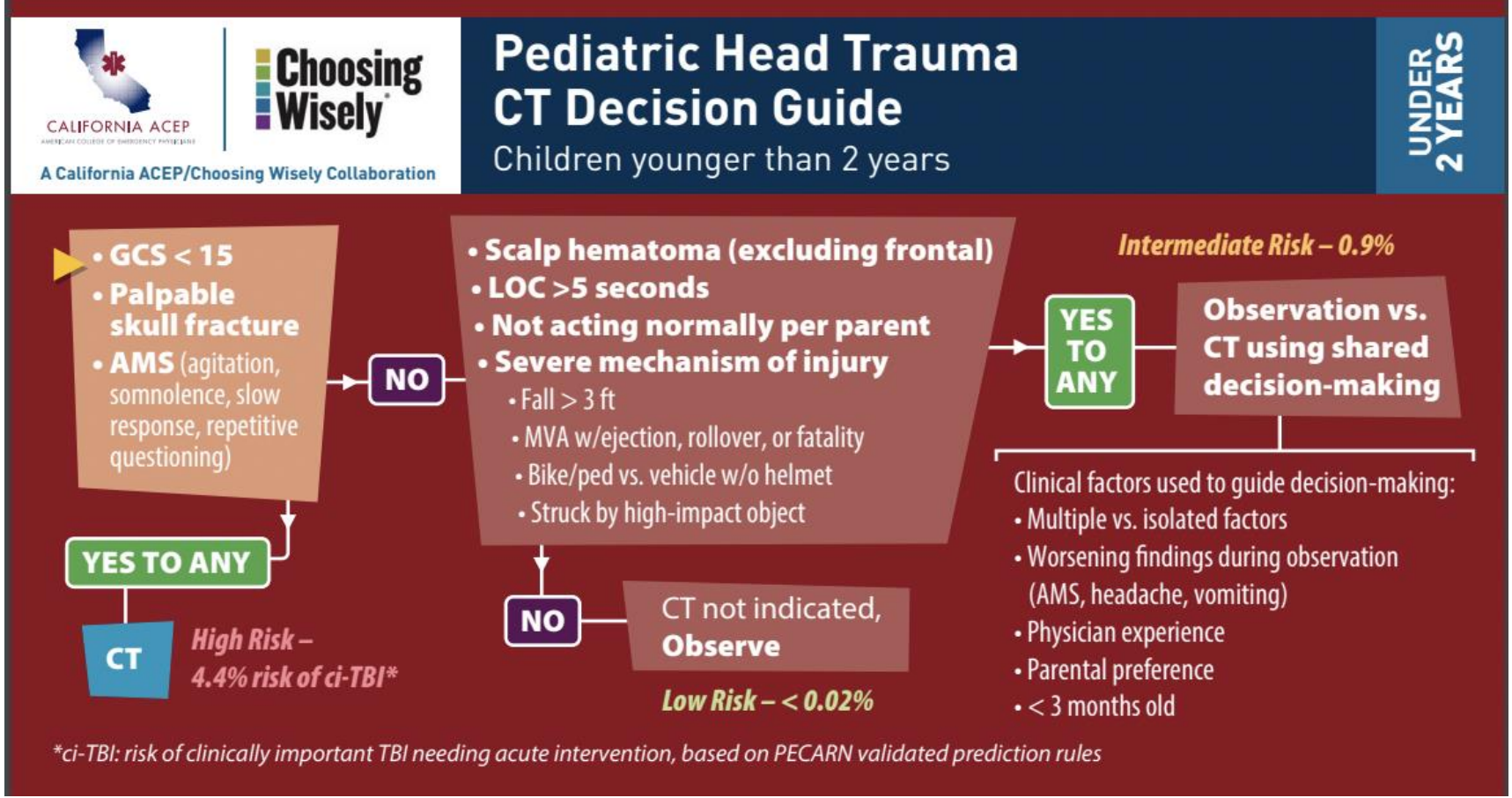
C) Apply an ice pack and hope for the best

D) None of the above

Who does not need a CT – PECARN Rule

- Rule negative if none present
- Under 2 years
  - GCS <15 or altered mental status (slow to respond, agitation, sleepiness, confusion, repetitive questioning)
  - Non-frontal scalp hematoma
  - LOC >5 seconds (under 2)
  - Palpable skull fracture or unclear due to swelling
  - Acting abnormal per parent/guardian
  - Severe mechanism (MVC with ejection, death of another passenger, rollover, pedestrian or bicyclist without helmet, fall >3 ft, head struck by high impact object)

- Rule negative if none present
- Over 2 years
  - GCS <15 or altered mental status (slow to respond, agitation, sleepiness, confusion, repetitive questioning)
  - Any LOC
  - Vomited since injury
  - Clinical signs of basilar skull fracture
  - Severe headache (8-10)
  - Severe mechanism (MVC with ejection, death of another passenger, rollover, pedestrian or bicyclist without helmet, fall >3 ft, head struck by high impact object



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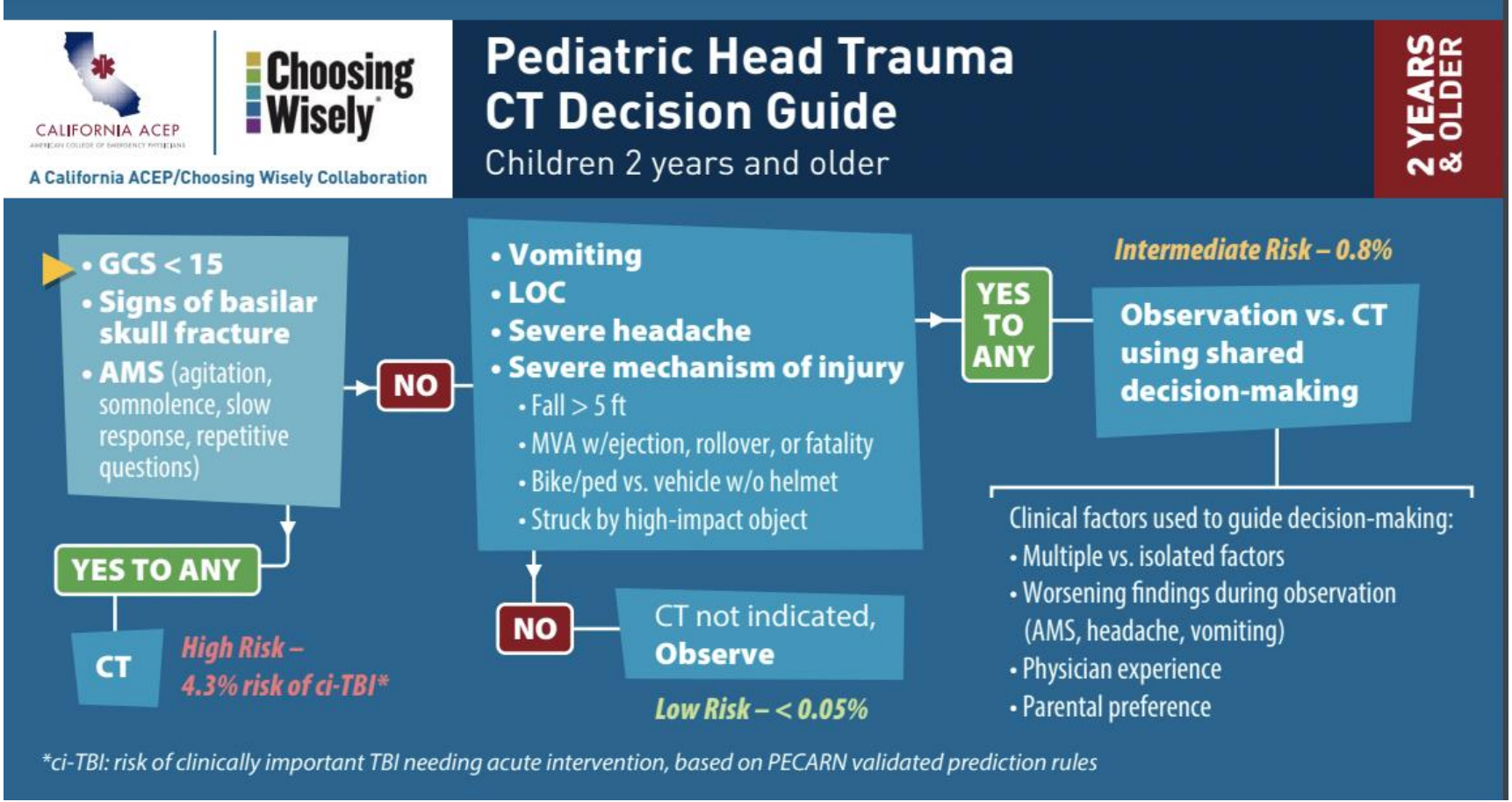
12yo m unhelmeted skateboarder, falls and hits head. He has a headache, vomited x 3, and asked you, “Hey, what happened?” repeatedly in the last 5 min. What do you do:

A) Tell mom to give Tylenol and call PCP in the AM if pt not back to normal

B) Direct pt to hospital-child needs head CT

C) Apply an ice pack and hope for the best

D) None of the above



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Cervical Spine Clearance

Practice Guideline > J Bone Joint Surg Am. 2019 Jan 2;101(1):e1. doi: 10.2106/JBJS.18.00217.

Pediatric Cervical Spine Clearance: A Consensus Statement and Algorithm from the Pediatric Cervical Spine Clearance Working Group

Martin J Herman [1], Kristin O Brown [1], Paul D Sponseller [2], Jonathan H Phillips [3], Philip M Petrucelli [4], Darshan J Parikh [4], Kush S Mody [4], Julie C Leonard [5], Matthew Moront [6], Douglas L Brockmeyer [7], Richard C E Anderson [8], Adam C Alder [9], John T Anderson [10], Robert M Bernstein [11], Timothy N Booth [9], Bruno P Braga [9], Patrick J Cahill [12], Jeanne M Joglar [9], Jeffrey E Martus [13], Jo-Ann O Nesiama [9], Joshua M Pahys [14], Karl E Rathjen [15], Anthony I Riccio [15], Jacob F Schulz [16], Anthony A Stans [17], Manish I Shah [18], William C Warner Jr [19], Burt Yaszay [20]

American Academy of Pediatrics

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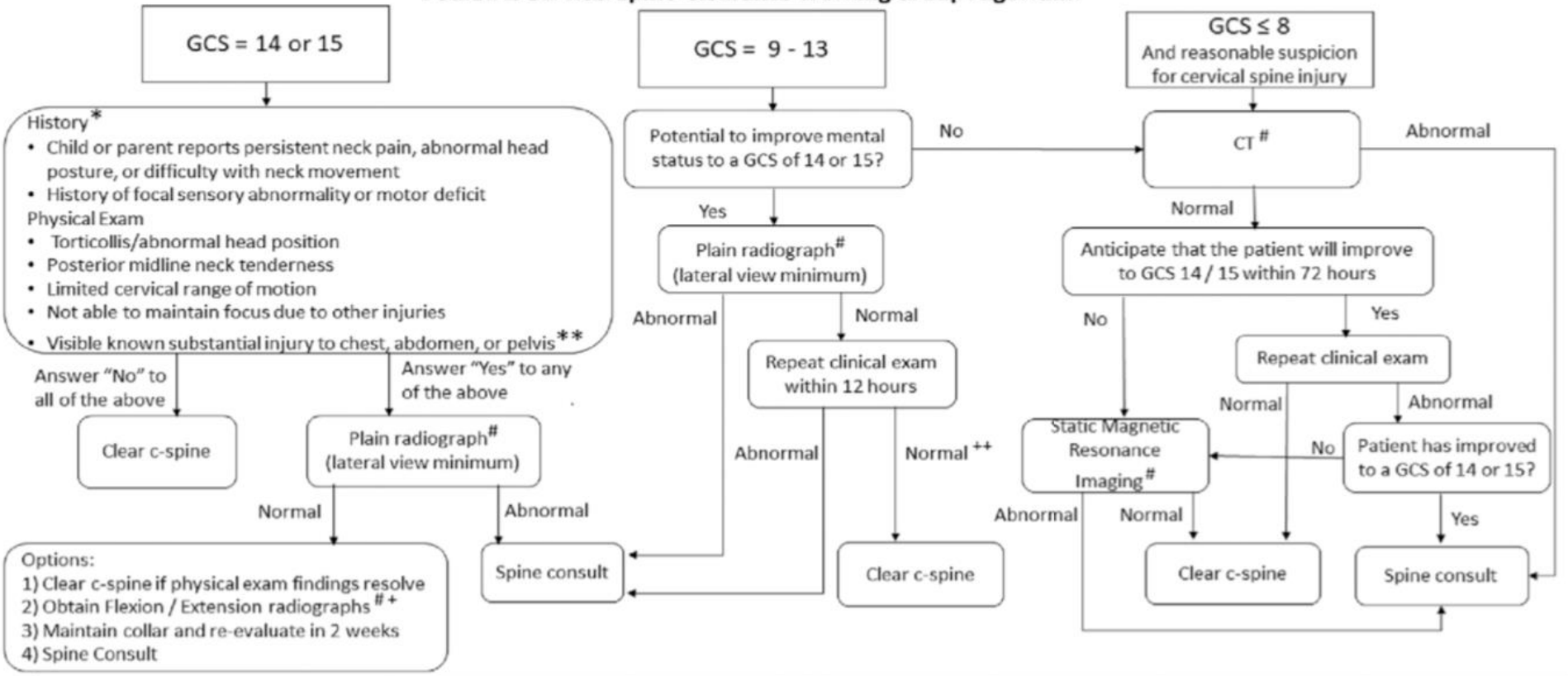
Pediatric Cervical Spine Clearance Working Group Algorithm



*Stronger consideration for imaging should be given towards patients with the following mechanisms of injury (MOI): diving, axial load, clothes-lining and high-risk MVC (HR-MVC), however the literature findings are controversial. HR-MVC is defined as a head-on collision, rollover, ejected from the vehicle, death in the same crash, or speed > 55mph

**Substantial injury is defined as an observable injury that is life-threatening, warrants surgical intervention, or warrants inpatient observation.

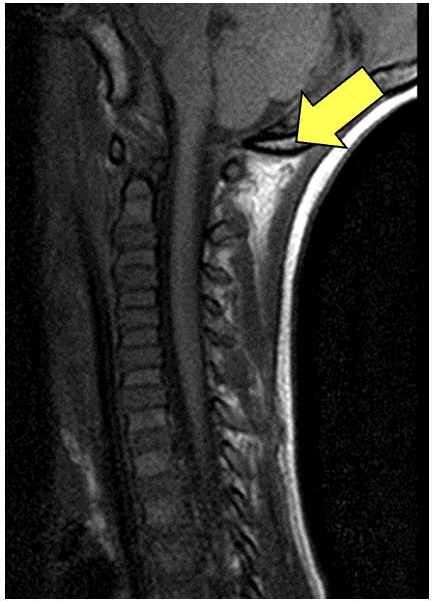
#All Imaging should be read by an attending physician

+ Adequate Flexion / Extension is defined as ≥ 30 degrees of flexion and ≥ 30 degrees of extension

++Patient has achieved GSC 14 – 15 and no longer presents with abnormal head posture, persistent neck pain, or difficulty in neck movement

When/how to clear a c spine

- When can you clear without imaging:
  - GCS 14 or 15
  - No pain on exam
  - No focal sensory/motor deficits
  - No abnormal head/neck posture
  - No limitation to range of motion
- When to get a 2-view plain film (need lateral view):
  - Any of the above
- When to clear after 2-view plain film
  - Xray normal (need lateral view)
  - Physical exam findings resolved
- What to do if Xray normal but still pain on exam
  - Leave in c-collar
  - Spine consult



C Spine Clearance in an obtunded child

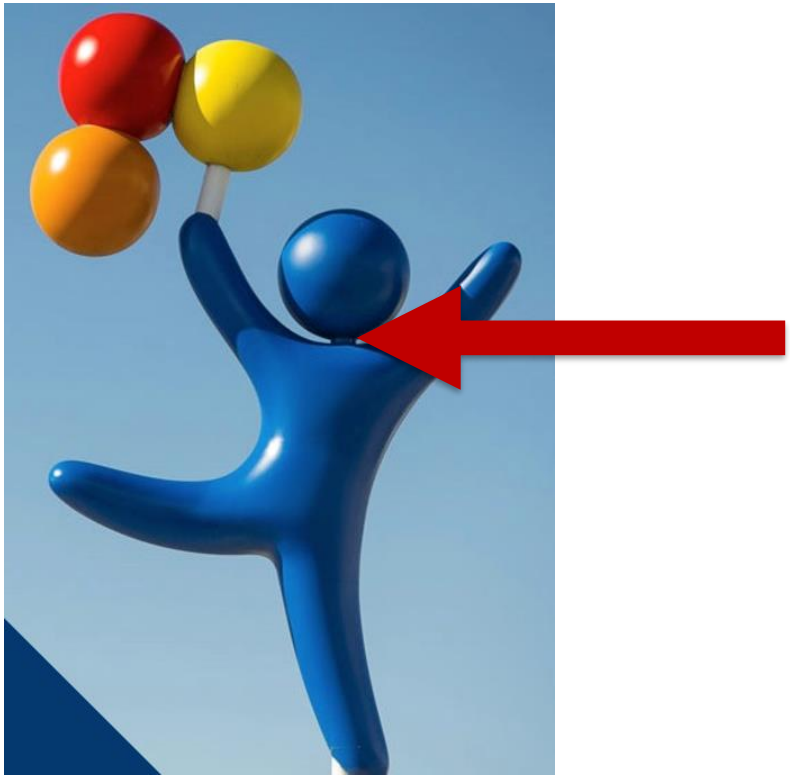
- Negative helical CT is adequate to clear a c-spine and remove a collar in adults
- This is not true in kids, still need an MRI to clear the C-spine
- Age at which children become adults is unknown

- Recent data from Western Pediatric Surgery Research Consortium – 6 children (0.4%) with normal CT of the c spine required surgical fixation, halo placement or long term immobilization

Bottom line – It is always safe to leave c-collar on and transfer

3 yo f involved in an MVC with image below. Child is running around, reports no pain, parents says she's acting normal. What do you do:

A) Tell mom to give Tylenol and call PCP in the AM if pt has issues
B) Direct pt to hospital/ED-child needs CTA of the neck
C) Apply an ice pack and hope for the best
D) None of the above



Blunt Carotid or Vertebral artery Injury (BCVI)

BCVI

- Rare injury related to blunt trauma to the head, face, or neck
- Difficult to diagnose based on physical exam
- Associated with stroke and high mortality rate
- Need prompt diagnosis and anticoagulation
- Risk in adults – 1-3%; 5-20% stroke risk
- Risk in pediatrics – up to 1.3%
  - Stroke rate may be as high as 29%
  - Mortality 3-19%

Nickoles et al. *J Trauma Acute Care Surg* 2023

TQIP Data – Pediatric Stroke Risk

Grade	N	Stroke Rate (%)
1-2	1657	58 (3.5)
3	47	2 (4.3)
4	490	25 (5.1)
5	838	26 (3.1)

Age	N	Stroke Rate (%)	Number untreated (%)
0-6	301	19 (6.3)	222 (77.4)
7-11	300	6 (2)	245 (64.5)
12-14	400	12 (3)	245 (64.5)
15-18	2055	74 (3.6)	677 (33.9)

Catherine Dawson-Gore MD

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Many screening tools available
None are great in kids

- Prospective cohort of pediatric blunt trauma patients – 2,284
- 6 institutions
- CTA or 2 week follow up to determine rate of missed BCVI
- Rate of BCVI – 1.6%
- Two patients with BCVI who met no screening criteria

		Met Criteria, n (%)	Received Diagnostic Imaging, n (%)	Missed BCVI, n (%)	No. CTAs to Detect One BCVI
Adult criteria	Memphis	437 (29.9)	220 (50.3)	2 (8.3)	19.9
	Denver	198 (13.6)	114 (57.6)	6 (25.0)	11.0
	Expanded Denver	533 (36.5)	216 (40.5)	3 (12.5)	25.4
	EAST	267 (18.3)	133 (49.8)	5 (20.8)	14.1
Pediatric criteria	Utah	71 (4.9)	47 (66.2)	13 (54.2)	6.5
	McGovern	169 (11.6)	91 (53.8)	6 (25.0)	9.4

Nickoles et al. *J Trauma Acute Care Surg* 2023

Memphis Criteria

- base of skull fracture with involvement of the carotid canal
- base of skull fracture with involvement of petrous temporal bone
- cervical spine fracture
- neurological exam findings not explained by neuroimaging
- Horner syndrome
- Le Fort II or III fracture pattern
- neck soft tissue injury (e.g. seatbelt sign, hanging, hematoma)

Expanded Denver Criteria

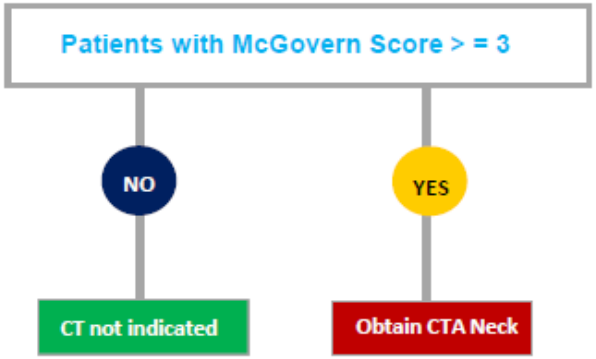
High-energy transfer mechanism plus any of the following [4]:

- Le Fort II or III displaced midface fracture
- mandible fracture
- complex skull fracture (e.g., involving frontal bone and orbit)
- base of skull fracture (sphenoid, petrous temporal, clivus, and occipital condyle fractures)
- scalp degloving
- cervical spine fracture, subluxation, or ligamentous injury at any level
- severe traumatic brain injury with Glasgow coma scale <6
- near hanging with hypoxic-ischemic (anoxic) brain injury
- clothesline type injury or seat belt abrasion with significant swelling, pain, or altered mental status
- traumatic brain injury with thoracic injuries
- upper rib fractures
- thoracic vascular injuries
- blunt cardiac rupture

BCVI

McGovern BCVI Prediction Score

Characteristic	Points
GCS < or = 8	1
Focal neuro deficit	2
Carotid canal fracture	2
High speed MVA or ped struck	2
Petros temporal bone fracture	3
Cerebral infarct on CT	3



YES Note: CTA neck not recommended in patients with an isolated seat belt mark on the neck.

Am J Surg. 2019 Jul;218(1):100-105. doi: 10.1016/j.amjsurg.2018.10.006. Epub 2018 Oct 15.

Cervical seatbelt sign is not associated with blunt cerebrovascular injury in children: A review of the national trauma databank.

Leraas HJ[1], Kuchibhatla M[2], Nag UP[3], Kim J[3], Ezekian B[3], Reed CR[3], Rice HE[4], Tracy ET[4], Adibe OO[5].

Found kids w/BCVI more commonly had the following when compared to adults w/BCVI:

- GCS≤8, seatbelt sign
- basilar skull fracture
- mid-facial fracture
- mandibular fracture
- Coma

Isolated seat belt sign does not indicate increased risk of BCVI nor does in mandate CTA Neck

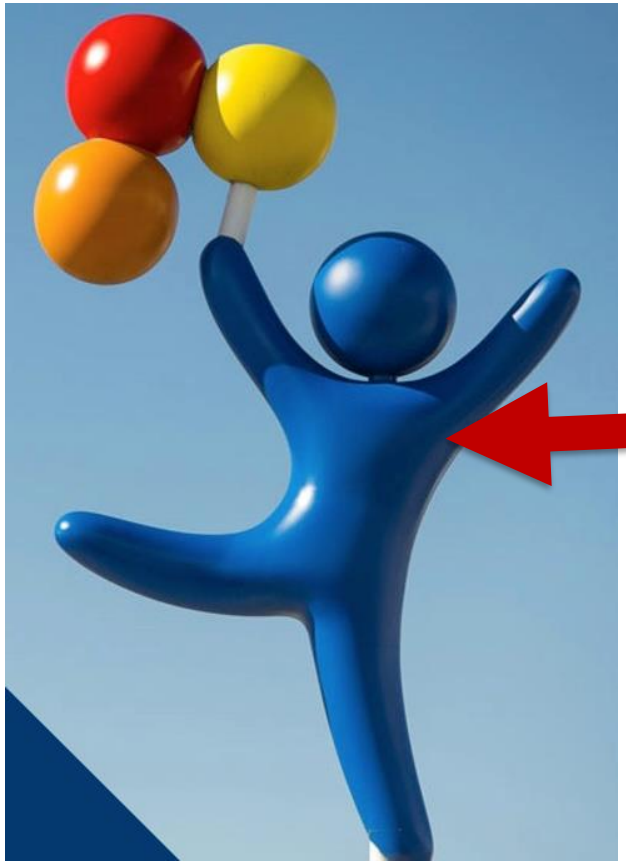
You are in the ED and asked to evaluate a 5 yo child involved in an MVC, reported as “high speed w/rollover, possible fatality at the scene.” Child is talking easily, 99% on RA, no chest wall injuries on exam

A) CT chest/abdomen/pelvis, sounds like a scary mechanism and you don’t want to miss an injury

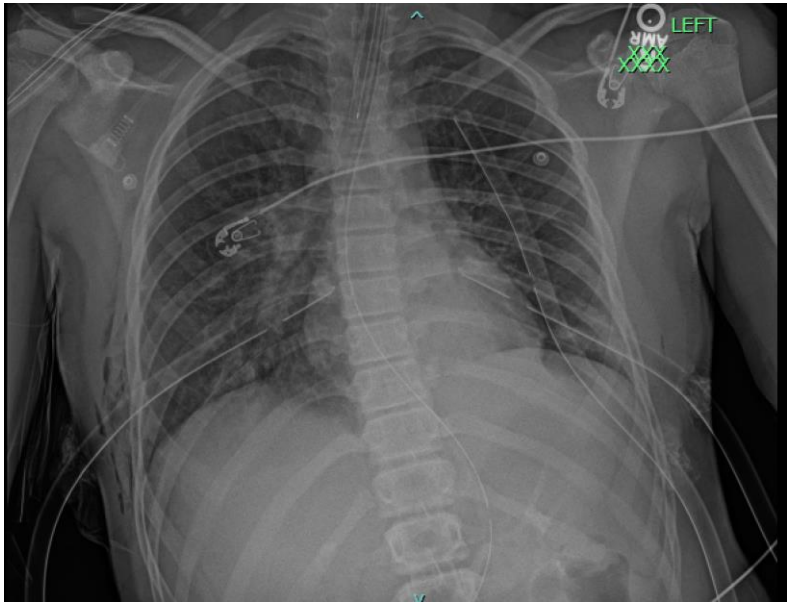
B) Obtain a CXR

C) Watch him for 8 hours in the ED and send him home if no need for O2

D) None of the above



Chest



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If the CXR is normal, very low risk of clinically significant injury on CT chest

2 Cite Share

Chest computed tomography imaging for blunt **pediatric trauma**: not worth the radiation risk.

Holscher CM, Faulk LW, Moore EE, Cothren Burlew C, Moore HB, Stewart CL, Pieracci FM, Barnett CC, Bensard DD.

J Surg Res. 2013 Sep;184(1):352-7. doi: 10.1016/j.jss.2013.04.044. Epub 2013 May 24.

PMID: 23746760

INTRODUCTION: A child's risk of developing cancer from radiation exposure associated with **computed tomography** (CT) **imaging** is estimated to be as high as 1/500. ...METHODS: **Pediatric** (<15 y) **trauma** team evaluations over 6 y at an academ ...

3 Cite Share

Diagnostic **Imaging** in **pediatric** thoracic **trauma**.

Piccolo CL, Ianniello S, Trinci M, Galluzzo M, Tonerini M, Zeccolini M, Guglielmi G, Miele V.

Radiol Med. 2017 Nov;122(11):850-865. doi: 10.1007/s11547-017-0783-1. Epub 2017 Jul 4.

PMID: 28674910 Review.

Pulmonary contusions and rib fractures are the most frequent **injuries** occurring. **Chest X-ray** is the first **imaging** modality of choice to identify patients presenting with life-threatening conditions (i.e., tension pneumothorax, huge hemothorax, a ...

4 Cite Share

Limiting **chest computed tomography** in the evaluation of **pediatric** thoracic **trauma**.

Golden J, Isani M, Bowling J, Zagory J, Goodhue CJ, Burke RV, Upperman JS, Gayer CP.

J Trauma Acute Care Surg. 2016 Aug;81(2):271-7. doi: 10.1097/TA.0000000000001110.

PMID: 27192472

BACKGROUND: **Computed tomography** (CT) of the **chest** (**chest** CT) is overused in blunt **pediatric** thoracic **trauma**. **Chest** CT adds to the diagnosis of thoracic injury but rarely changes patient management. We sought to identify a subset of ...

5 Cite Share

Use of **Chest Computed Tomography** for Blunt **Pediatric Chest Trauma**: Does It Change Clinical Course?

Holl EM, Marek AP, Nygaard RM, Richardson CJ, Hess DJ.

Pediatr Emerg Care. 2020 Feb;36(2):81-86. doi: 10.1097/PEC.0000000000002040.

PMID: 31904738

INTRODUCTION: Given the concern for radiation-induced malignancy in children and the fact that risk of severe **chest** injury in children is low, the risk/benefit ratio must be considered in each child when ordering a **computed tomography** (CT) scan after blunt ...

6 Cite Share

Computed tomography is not justified in every **pediatric** blunt **trauma** patient with a suspicious mechanism of injury.

Hershkovitz Y, Zoarets I, Stepansky A, Kozer E, Shapira Z, Klin B, Halevy A, Jeroukhimov I.

Am J Emerg Med. 2014 Jul;32(7):697-9. doi: 10.1016/j.ajem.2014.04.024. Epub 2014 Apr 18.

PMID: 24856745

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- Obtain CXR in ALL ACTIVATED TRAUMAS
  - If they meet trauma criteria, they probably need a CXR
- ONLY CT chest if:
  - Wide mediastinum on CXR
  - Concern for vascular injury w/penetrating trauma
  - Simple PTX or hemothorax
  - Pulm contusion
  - Single rib fx

You evaluate a pt involved in an MVC and see this on exam. What do you do:

A) FAST exam and only scan the abdomen if FAST positive
B) Order a CT abdomen WITHOUT IV contrast
C) Order a CT abdomen WITH IV contrast
D) None of the above

FAST in Pediatric Blunt Abdominal Trauma

- Focused abdominal sonography for trauma (FAST)
  - Widely used in adult settings to rapidly identify bleeding
  - High sensitivity and specificity (>95%)
- FAST in children to specifically dx intraabdominal injury (IAI) more challenging
  - Small spaces
  - Technically more difficult
  - Spleen/liver capsule less likely to tear
- CT higher sensitivity
  - Risk of malignancy from radiation exposure

Is the Child Hemodynamically stable?

- If yes – you have time and can think about CT scan vs observation
- If No – Use FAST
- FAST – Focused Abdominal Sonography for Trauma
  - Sensitivity – 51% (95% CI 31-73%)
  - Specificity – 96% (95% CI 93-98%)
  - Positive predictive value – 48% (95% CI 28-69%)
  - Negative predictive value – 97% (95% CI 94-98%)
- Positive FAST suggests hemoperitoneum
- Negative FAST aids little in decision making

› Acad Emerg Med. 2011 May;18(5):477–82. doi: 10.1111/j.1553-2712.2011.01071.x.

Test characteristics of focused assessment of sonography for trauma for clinically significant abdominal free fluid in pediatric blunt abdominal trauma

J Christian Fox [1], Megan Boysen, Laleh Gharahbaghian, Seric Cusick, Suleman S Ahmed, Craig L Anderson, Michael Lekawa, Mark I Langdorf

Surgery. 2010 Oct;148(4):695-700; discussion 700-1. doi: 10.1016/j.surg.2010.07.032. Epub 2010 Aug 30.

FAST scan: is it worth doing in hemodynamically stable blunt trauma patients?

Bala Natarajan [1], Prateek K Gupta, Samuel Cemaj, Megan Sorensen, Georgios I Hatzoudis, Robert Armour Forse

- Adult Retrospective Study
- 2,105 patients; 118 false negative FASTs, 37% required surgery
- Conclusions:
  - Negative FAST without confirmatory CT will lead to missed injuries
  - Positive FAST requires CT confirmation to characterize injuries and decide on operative vs non-operative management

Focused assessment with sonography for trauma in children after blunt abdominal trauma: A multi-institutional analysis

Bennett W. Calder, MD, Adam M. Vogel, MD, Jingwen Zhang, MS, Patrick D. Mauldin, PhD, Eunice Y. Huang, MD, Kate B. Savoie, MD, Matthew T. Santore, MD, KuoJen Tsao, MD, Tiffany G. Ostovar-Kermani, MD, Richard A. Falcone, MD, M. Sidney Dassinger, MD, John Recicar, Jeffrey H. Haynes, MD, Martin L. Blakely, MD, Robert T. Russell, MD, Bindi J. Naik-Mathuria, MD, Shawn D. St Peter, MD, David P. Mooney, MD, Chinwendu Onwubiko, MD, Jeffrey S. Upperman, MD, Jessica A. Zagory, MD, *and* **Christian J. Streck, MD**, *Charleston, South Carolina*

- Prospective enrollment, 14 level 1 PTCs
  - Children <16 with blunt abdominal trauma
- 2188 kids; 829 had a FAST; 340 had a CT; 97 with IAI
  - 27 received acute intervention
- Accuracy did not improve at centers who did more FAST
- CT utilization – low correlation between FAST and CT use
  - Rate of CT after FAST – 41%
  - Rate of CT without FAST – 46%
- 81 injuries among 70 false negative FASTs

The Utility of the Focused Assessment With Sonography in Trauma Examination in Pediatric Blunt Abdominal Trauma

A Systematic Review and Meta-Analysis

Tian Liang, MD,† Eric Roseman, MD,*† Melanie Gao, BA,*† and Richard Sinert, DO*†*

- Eight prospective studies with 2135 pts
- Pooled sensitivity 35%, specificity 96%
- Hemodynamically stable child presenting with BAT, positive FAST means IAI likely
  - But FAST was designed for hemodynamically unstable
- Negative FAST exam cannot preclude further diagnostic workup for IAI
- So……..what are the indications for CT

Liang T Pediatr Emerg Care. 2021 Feb 1;37(2):108-118

Abdomen/Pelvis

Clinical Trial > Ann Emerg Med. 2013 Aug;62(2):107-116.e2.
doi: 10.1016/j.annemergmed.2012.11.009. Epub 2013 Feb 1.

Identifying children at very low risk of clinically important blunt abdominal injuries

James F Holmes [1], Kathleen Lillis, David Monroe, Dominic Borgialli, Benjamin T Kerrey, Prashant Mahajan, Kathleen Adelgais, Angela M Ellison, Kenneth Yen, Shireen Atabaki, Jay Menaker, Bema Bonsu, Kimberly S Quayle, Madelyn Garcia, Alexander Rogers, Stephen Blumberg, Lois Lee, Michael Tunik, Joshua Kooistra, Maria Kwok, Lawrence J Cook, J Michael Dean, Peter E Sokolove, David H Wisner, Peter Ehrlich, Arthur Cooper, Peter S Dayan, Sandra Wootton-Gorges, Nathan Kuppermann, Pediatric Emergency Care Applied Research Network (PECARN)

Observational Study > J Am Coll Surg. 2017 Apr;224(4):449-458.e3.
doi: 10.1016/j.jamcollsurg.2016.12.041. Epub 2017 Jan 24.

Identifying Children at Very Low Risk for Blunt Intra-Abdominal Injury in Whom CT of the Abdomen Can Be Avoided Safely

Christian J Streck [1], Adam M Vogel [2], Jingwen Zhang [3], Eunice Y Huang [4], Matthew T Santore [5], Kuojen Tsao [6], Richard A Falcone [7], Melvin S Dassinger [8], Robert T Russell [9], Martin L Blakely [10], Pediatric Surgery Research Collaborative

What is the PECARN rule?

Abdominal Trauma IAI Prediction Rule (rule considered negative if none of the variables are present)

- Abdominal pain
- Vomited since the time of injury
- Glasgow Coma Scale score < 14
- Absent or decreased breath sounds
- Evidence of thoracic wall trauma (erythema, abrasions, ecchymosis, subcutaneous air, laceration, etc.)
- Evidence of abdominal wall trauma (seat belt sign, erythema, abrasions, ecchymosis, subcutaneous air, laceration, etc.)
- Abdominal tenderness

Appendix Table 5: Emergency department CT rates in patients who were prediction rule positive.

	Abdominal Trauma (N = 7,484)* % (95% CI)	Head Trauma < 2 years (N = 5,639)* % (95% CI)	Head Trauma ≥ 2 years (N = 14,319)* % (95% CI)
One variable documented positive	520/1,639; 31.7% (29.5, 34.0%)	409/1,767; 23.1% (21.1, 25.2%)	2,128/5,372; 39.6% (38.3, 40.9%)
Two variables documented positive	694/1,347; 51.5% (48.8%, 54.2%)	356/613; 58.1% (54.1, 62.0%)	1,698/2,170; 78.2% (76.5, 80.0%)
Three variables documented positive	484/676; 71.6% (68.0, 75.0%)	200/228; 87.7% (82.7, 91.7%)	562/597; 94.1% (91.9, 95.9%)
Four variables documented positive	243/297; 82.8% (78.0, 86.9%)	68/73; 93.2% (84.7, 97.7%)	134/137; 97.8% (93.7, 99.5%)
Five variables documented positive	30/34; 88.2% (72.5, 96.7%)	13/13; 100% (79.4, 100%)	22/24; 91.7% (73.0, 99.0%)
Six variables documented positive	3/3; 100% (36.8, 100%)	4/5; 80% (28.4, 99.5%)	2/2; 100% (22.4, 100%)
Seven variables documented positive	0	Not applicable	Not applicable

Data stratified based on the number of predictor variables documented as positive for the prediction rules

*Individual predictor variables left blank in 58 cases in the abdominal trauma cohort, 8 cases in head trauma cohort under 2 years, and 33 cases in head trauma cohort 2 years and older.

PEDSRC Rule

Observational Study > J Am Coll Surg. 2017 Apr;224(4):449-458.e3.
doi: 10.1016/j.jamcollsurg.2016.12.041. Epub 2017 Jan 24.

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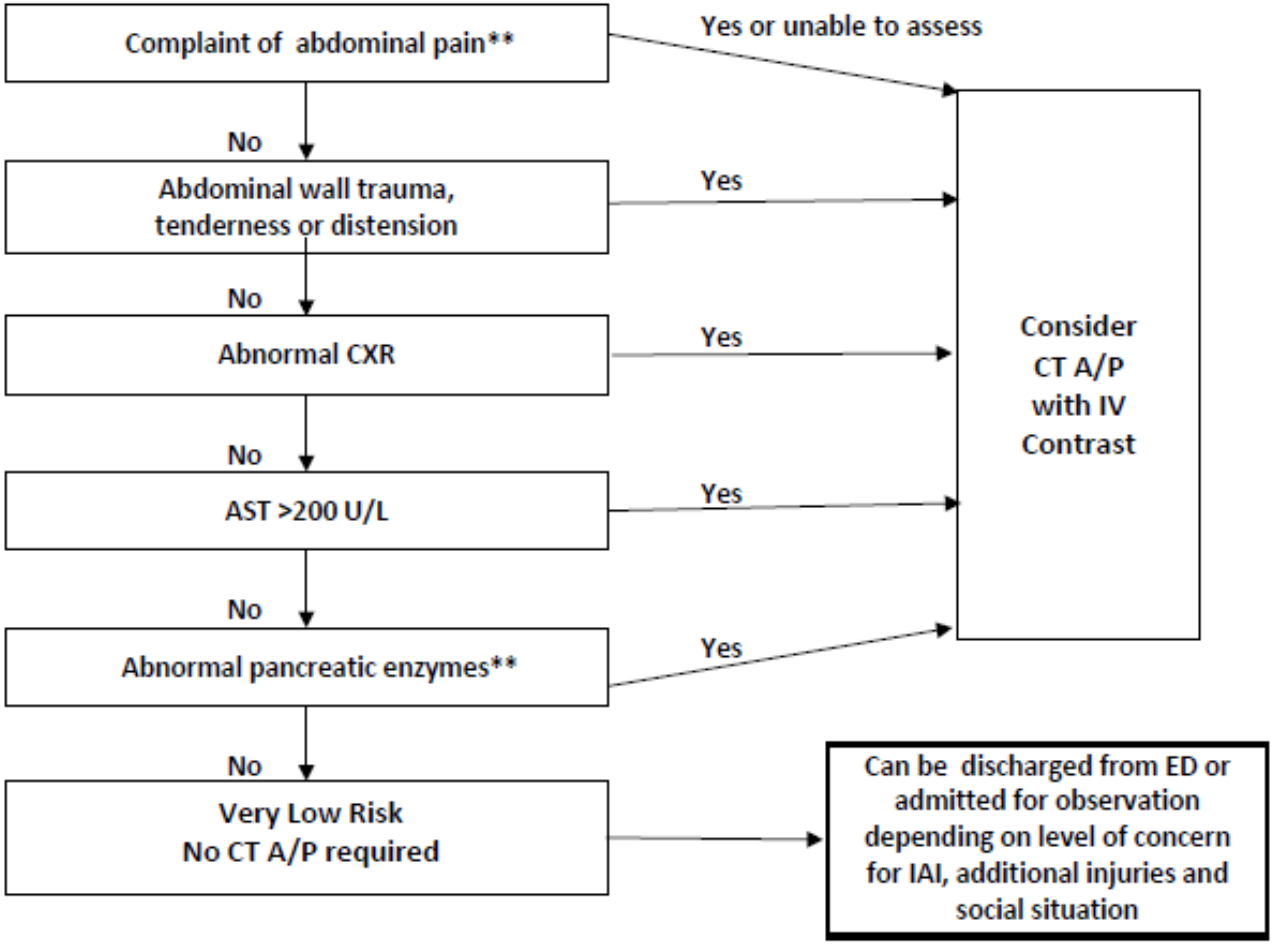
> J Trauma Acute Care Surg. 2018 Jul;85(1):71-77. doi: 10.1097/TA.0000000000001933.

External validation of a five-variable clinical prediction rule for identifying children at very low risk for intra-abdominal injury after blunt abdominal trauma

Chase A Arbra [1], Adam M Vogel, Leah Plumblee, Jingwen Zhang, Patrick D Mauldin, Melvin S Dassinger, Robert T Russell, Martin L Blakely, Christian J Streck



**If only abnormal risk factor present is complaint of abdominal pain or abnormal pancreatic enzymes, consider observation with serial abdominal exams over CT A/P

Risk of Intraabdominal Injury based on number of positive variables

Number positive variables	IAI	IAI requiring intervention
1	4.5%	0.6%
2	16.8%	4.8%
3	37.8%	8.9%
4+	62.6%	15.2%

Interventions – surgery, angioembolization, transfusion, death from IAI

Summary points

- Hemodynamically stable patients
  - 97% of activations have normal BP for age
  - <3% pediatric trauma patients needed acute intervention
  - Majority of IAI needing intervention have an abnormal abdominal exam
  - There is time to get labs and plain films
- Unnecessary abdominal CT scans can be reduced
  - 25% of “very low risk” population scanned
  - Significant variability in CT use between PTCs
  - >90% of patients initially seen at adult centers
  - Scanning based on “significant blunt mechanism” alone will result in 1/3 to ½ of all abdominal CTs being negative

Can the Rule be applied: Preverbal or low GCS?

Group	Sensitivity IAI	Sensitivity IAI-I	Specificity IAI	Specificity IAI-I	NPV IAI	NPV IAI-I
Whole Pop. (n=2,435)	97.5%	100.0%	36.9%	34.5%	99.4%	**100.0%**
Preverbal (15.5%) (n= 293)	100.0%	100.0%	47.5%	45.9%	100.0%	**100.0%**
GCS 14-15 (88.9%) (n= 2,165)	98.4%	100.0%	36.0%	33.6%	99.6%	**100.0%**
GCS 9-13 (6.2%) (n= 150)	94.1%	100.0%	47.4%	44.4%	**98.4%**	**100.0%**
GCS 3-8 (4.9%) (n=120)	92.0%	100.0%	42.1%	38.9%	**95.2%**	**100.0%**

Preverbal: Age 0-2 years, GCS 14-15

Abrasions and Seat Belt Signs

Sub-population	%IAI	%IAI-I	%Admitted
Seat Belt Signs (n=166)	**n = 38** **22.9%**	**n = 18** **10.8%**	75.3%
Abrasion as only abdominal exam finding (n=73)	7 of 73 = 9.6%	N =2, 2.7%	79.5%
Abrasions, no other +rule variables present (n=45)	0 of 45 = 0%	N =0, 0.0%	73.0%

Missed Injuries

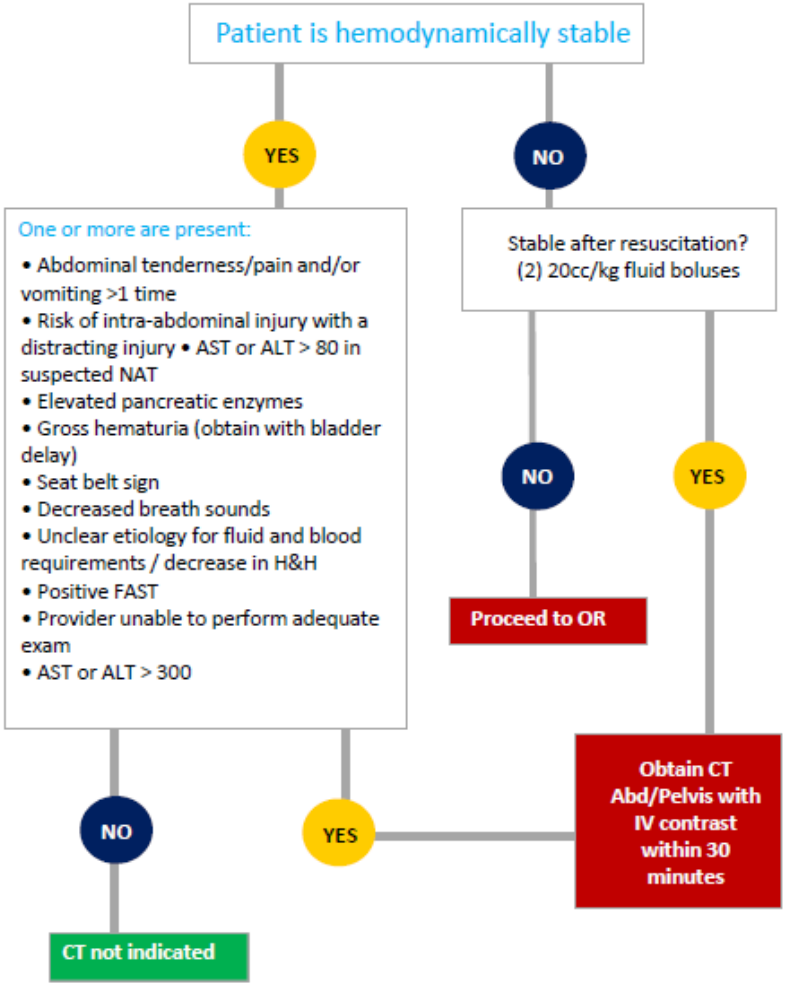
Missed by PEDSRC rule

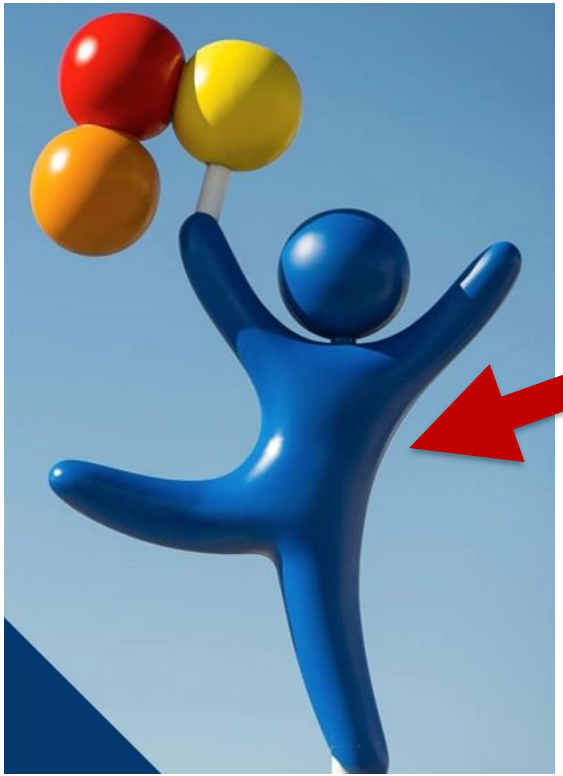
- Grade 1 Kidney x2
- Grade 2 liver x2
- Grade 2 spleen x1
- All admitted with other injuries

Missed by PECARN rule

- 20 liver injuries
  - 16 with AST >200
- 5 kidney injuries
  - All with lab or plain film finding
- 4 spleen injuries
  - 3 with lab or plain film finding

ABDOMEN AND PELVIS





T/L/S Spine

NO GUIDELINES

- Any neurologic deficit following trauma:
  - Spine consult
- If pain but normal exam:
  - Start with plain films
- If pain and normal plain films:
  - Trauma/Spine consult vs CT vs MR…no right answer

Remember:

- Kids are not adults: don’t image them the same but teenagers +/-
- PECARN for head imaging
- AAP guide for C-Spine
- Multiple options for BCVI
- CXR, very few pts need a chest CT
- Abdomen/pelvic CT based on clinical picture (NOT mechanism)
- Follow ATLS: do not delay transfer for imaging