



פורום טראומה שניידר

התוויות להדמיה בחבלות צוואר קהות בילדים ונוער

ד"ר יניב לקובסקי, רופא בכיר במכון הדימות
ד"ר ניר סמואל, רופא בכיר, טראומה ורפואה דחופה
מרכז שניידר לרפואת ילדים.

Pediatric Neck Trauma: Same-Same or Different?



INTRODUCTION



- **8 million children/year are evaluated for potential cervical injury (USA)**
- **Pediatric C-spine injuries: 0.6-2% Pediatric BCVI: 0.01-1.5%**
- **Dataset variation: Baseline incidence, age distribution, rate of imaging, level of CSI as outcomes**
- **Iatrogenic induced malignancy: +24% overall +78% for thyroid Ca. ~NNH 1:5,000**

Low frequency – High risk

October 17, 2001

The Canadian C-Spine Rule for Radiography in Alert and Stable Trauma Patients

Ian G. Stiell, MD, MSc, FRCPC; George A. Wells, PhD; Katherine L. Vandemheen, BScN; et al

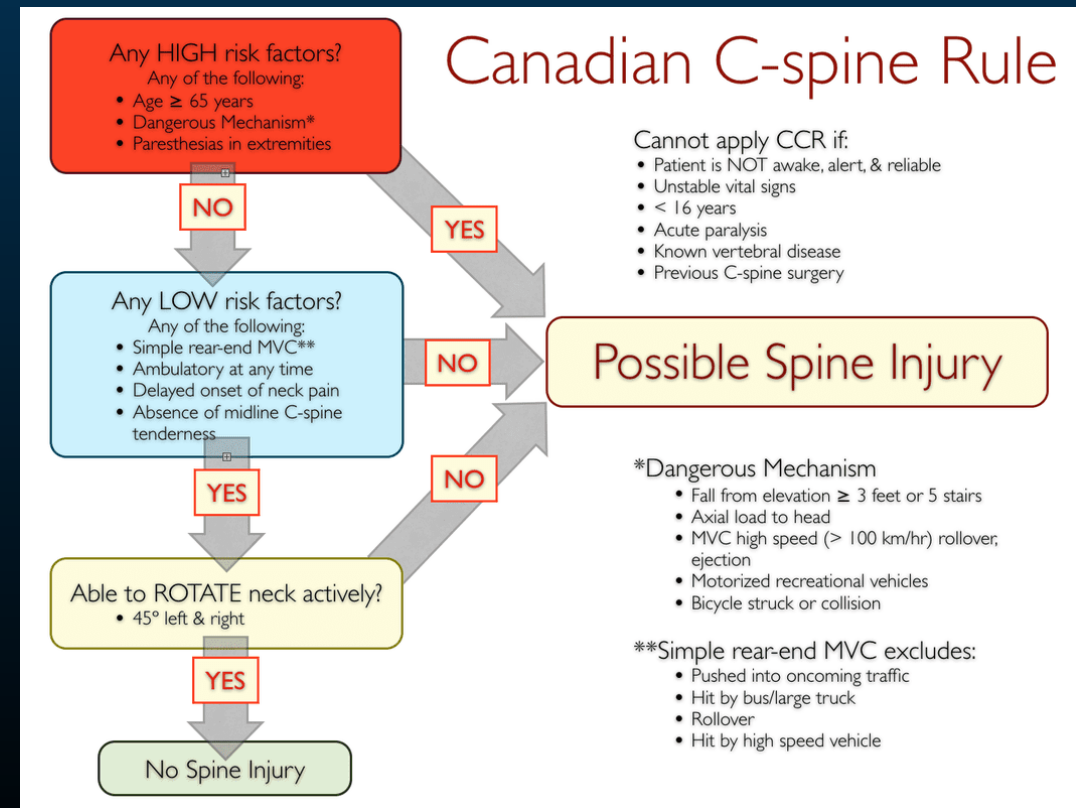
» Author Affiliations

JAMA. 2001;286(15):1841-1848. doi:10.1001/jama.286.15.1841

- Prospective cohort, 10 EDs
- 8924 Adults > 16 years (mean age 37), Baseline CSI incidence 1.7%
- Primary outcome: Clinically important C-spine injury. (fracture, dislocation, or ligamentous instability)
- Sens 100% NPV 99.8% Spec 42.5%



CCR





ORIGINAL ARTICLE



Validity of a Set of Clinical Criteria to Rule Out Injury to the Cervical Spine in Patients with Blunt Trauma

This article has been corrected. [VIEW THE CORRECTION](#)

Authors: Jerome R. Hoffman, M.D., William R. Mower, M.D., Ph.D., Allan B. Wolfson, M.D., Knox H. Todd, M.D., M.P.H., and Michael I. Zucker, M.D., for the National Emergency X-Radiography Utilization Study Group* [Author Info & Affiliations](#)

Published July 13, 2000 | N Engl J Med 2000;343:94-99 | DOI: 10.1056/NEJM200007133430203 | [VOL. 343 NO. 2](#)

- **Prospective cohort, 21 EDs**
- **34,069 Adults & Children 1-101 years (mean age 37), 2.5% < 8 years, Baseline CSI incidence 2.4% (any)**
- **Primary outcome: Any, Clinically significant C-spine injury. (fracture, dislocation, or ligamentous instability)**
- **Sens 99.0% NPV 99.8% percent Spec 12.9% PPV 2.7%**

NEXUS



מרכז שניידר לרפואת ילדים בישראל
מרכז שניידר לילדים - الإطفال في إسرائيل
Schneider Children's Medical Center of Israel

Nexus Criteria

In the NEXUS study, a clinical clearance protocol consisting of five criteria was validated with a 100% sensitivity for the exclusion of cervical spinal injury.

Protocol:

- 1st - assess signs of intoxication in the patient.
- 2nd - assess for the presence of focal neurologic deficits.
- 3rd - assessment for the presence of painful distracting injuries.
- 4th - assess whether the patient has a normal level of alertness.
- 5th - presence of posterior midline tenderness to palpation.

If no painful response is elicited and the patient has met all prior criteria, the C-collar can be removed and C-spine imaging is not needed.

Hoffman JR, Mower WR, Wolfson AB, et al. Validity of a set of clinical criteria to rule out injury to the cervical spine in patients with blunt trauma. N Engl J Med. 2000; 343:94-99.



PEDSPINE

ORIGINAL ARTICLE

Clinical Clearance of the Cervical Spine in Blunt Trauma Patients Younger Than 3 Years: A Multi-Center Study of the American Association for the Surgery of Trauma

Pieretti-Vanmarcke, Rafael MD; Velmahos, George C. MD; Nance, Michael L. MD; Islam, Saleem MD; Falcone, Richard A. Jr MD, MPH; Wales, Paul W. MD, MPH; Brown, Rebecca L. MD; Gaines, Barbara A. MD; McKenna, Christine MSN, RN, CRNP; Moore, Forrest O. MD; Goslar, Pamela W. PhD; Inaba, Kenji MD; Barmparas, Galinos MD; Scaife, Eric R. MD; Metzger, Ryan R. PhD; Brockmeyer, Douglas L. MD; Upperman, Jeffrey S. MD; Estrada, Joaquin MD; Lanning, David A. MD, PhD; Rasmussen, Sara K. MD, PhD; Danielson, Paul D. MD; Hirsh, Michael P. MD; Consani, Heitor F. X. MD; Stylianos, Steven MD; Pineda, Candace RN; Norwood, Scott H. MD; Bruch, Steven W. MD; Drongowski, Robert MA; Barraco, Robert D. MD, MPH; Pasquale, Michael D. MD; Hussain, Farheen MD; Hirsch, Erwin F. MD; McNeely, P Daniel MD; Fallat, Mary E. MD; Foley, David S. MD; Iocono, Joseph A. MD; Bennett, Heather M. MD; Waxman, Kenneth MD; Kam, Kelly RN; Bakhos, Lisa MD; Petrovick, Laurie CSTR, MHA; Chang, Yuchiao PhD; Masiakos, Peter T. MS, MD

Author Information

The Journal of Trauma: Injury, Infection, and Critical Care 67(3):p 543-550, September 2009. | DOI: 10.1097/TA.0b013e3181b57aa1

- Outline
- Images
- Download
- Cite
- Share
- Favorites

- Retrospective cohort, 21 EDs
- 12537 Children < 3years, Baseline CSI incidence 0.66%
- Primary outcome: C-spine injury.
- Sens 92.2% NPV 99.3% Spec 69.9%

score = 3 × II (GCS score <14) + 2 × II (GCS eye score = 1) + 2 × II (injury type = MVC) + 1 × II (patient age >2 years).

TABLE 3. Independent Predictors of Cervical Spine Injury

Variable	Odds Ratio	95% CI	p
GCS ≥14	12.5	5.0–31.6	<0.001
MVC	5.1	2.8–9.0	<0.001
GCS _{EYE} = 1	6.9	3.4–14.2	<0.001
Age >2 yr	2.2	1.2–4.0	<0.001

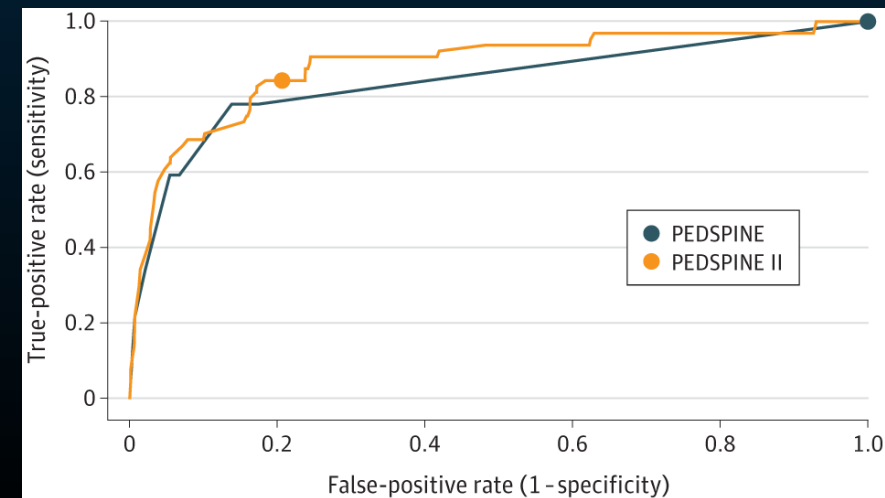
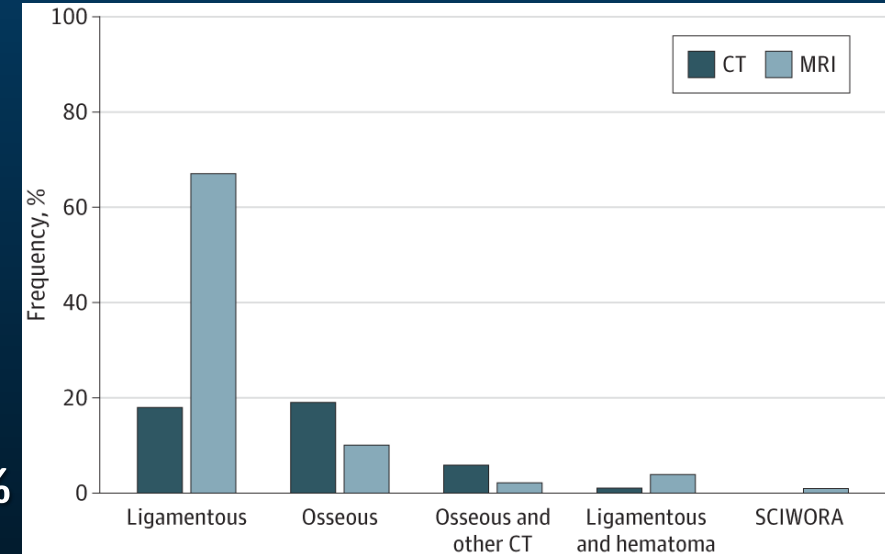
Pediatric Cervical Spine Injury Following Blunt Trauma in Children Younger Than 3 Years

The PEDSPINE II Study

Casey M. Luckhurst, MD; Holly M. Wiberg, PhD; Rebecca L. Brown, MD; Steven W. Bruch, MD; Nicole M. Chandler, MD; Paul D. Danielson, MD; John M. Draus, MD; Mary E. Fallat, MD; Barbara A. Gaines, MD; Jeffrey H. Haynes, MD; Kenji Inaba, MD; Saleem Islam, MD, MPH; Stephen S. Kaminski, MD; Hae Sung Kang, MD; Vashisht V. Madabhushi, MD; Jason Murray, MD; Michael L. Nance, MD; Faisal G. Qureshi, MD; Jeanne Rubsam, RN, PNP; Steven Stylianos, MD; Dimitris J. Bertsimas, PhD; Peter T. Masiakos, MD

- Retrospective cohort, 15 EDs
- 9,389 Children < 3years (mean 1.3years), Baseline CSI incidence 1.3%
- Primary outcome: C-spine injury.
- Sens 75.9% AUC 0.88

PEDSPINE II



PECARN prediction rule for cervical spine imaging of children presenting to the emergency department with blunt trauma: a multicentre prospective observational study



Julie C Leonard, Monica Harding, Lawrence J Cook, Jeffrey R Leonard, Kathleen M Adalgais, Fahd A Ahmad, Lorin R Browne, Rebecca K Burger, Pradip P Chaudhari, Daniel J Corwin, Nicolaus W Glomb, Lois K Lee, Sylvia Owusu-Ansah, Lauren C Riney, Alexander J Rogers, Daniel M Rubalcava, Robert E Sapien, Matthew A Szadkowski, Leah Tzimenatos, Caleb E Ward, Kenneth Yen, Nathan Kuppermann

PECARN!

- **Prospective cohort, 18 PECARN EDs**
- **22,430 children (11,857 derivation, 10,573 validation) 51.9% <8 years, Baseline CSI incidence 1.9%**
- **Primary outcome: Injury warranting inpatient observation or surgical intervention.**
- **Sens 94.3%, Spec 60.4%, NPV 99.9%**



	Enrolment status		Cohort	
	Enrolled (n=22 430)	Missed eligible (n=9837)	Derivation (n=11 857)	Validation (n=10 573)
Age, years				
0-8	11 633 (51.9%)	5347 (54.4%)	5982 (50.5%)	5651 (53.4%)
9-17	10797 (48.1%)	4478 (45.5%)	5875 (49.5%)	4922 (46.6%)
Sex				
Female	9362 (41.7%)	4126 (41.9%)	5002 (42.2%)	4360 (41.2%)
Male or undifferentiated	13 068 (58.3%)	5711 (58.1%)	6855 (57.8%)	6213 (58.8%)
Race				
White	10 906 (48.6%)	4769 (48.5%)	6471 (54.6%)	4435 (41.9%)
Black or African American	6793 (30.3%)	2840 (28.9%)	2693 (22.7%)	4100 (38.8%)
Other	3539 (15.8%)	1627 (16.5%)	1887 (15.9%)	1652 (15.6%)
Ethnicity				
Hispanic or Latino	4330 (19.3%)	2154 (21.9%)	1712 (14.4%)	2618 (24.8%)
Other	18 100 (80.7%)	7683 (78.1%)	10 145 (85.6%)	7955 (75.2%)
Mechanism of injury				
Motor vehicle crash (driver or passenger)	6358 (28.3%)	2680 (27.2%)	3129 (26.4%)	3229 (30.5%)
Motorcycle, all-terrain vehicle, or motorised scooter crash, etc.	1250 (5.6%)	512 (5.2%)	662 (5.6%)	588 (5.6%)
Hit by car or other motor vehicle (pedestrian, cyclist, or other)	1455 (6.5%)	408 (4.1%)	667 (5.6%)	788 (7.5%)
Fall	7444 (33.2%)	3371 (34.3%)	3897 (32.9%)	3547 (33.5%)
Diving	38 (0.2%)	15 (0.2%)	25 (0.2%)	13 (0.1%)
Sports or recreation related	2219 (9.9%)	1047 (10.6%)	1348 (11.4%)	871 (8.2%)
Suspected child abuse	1327 (5.9%)	912 (9.3%)	954 (8.0%)	373 (3.5%)
Assault or altercation	535 (2.4%)	87 (0.9%)	235 (2.0%)	300 (2.8%)
Emergency medical service scene response	13 453 (60.0%)	537 (5.5%)	6863 (57.9%)	6590 (62.3%)
Emergency department disposition				
Discharged home	14 948 (66.6%)	5717 (58.1%)	7531 (63.5%)	7417 (70.2%)
Admitted to intensive care unit	1614 (7.2%)	709 (7.2%)	1078 (9.1%)	536 (5.1%)
Admitted to hospital floor	5038 (22.5%)	2831 (28.8%)	2742 (23.1%)	2296 (21.7%)
Admitted to operating room	618 (2.8%)	277 (2.8%)	384 (3.2%)	234 (2.2%)
Death in the emergency department	43 (0.2%)	35 (0.4%)	23 (0.2%)	20 (0.2%)
Other	169 (0.8%)	256 (2.6%)	99 (0.8%)	70 (0.7%)
Cervical spine injury	433 (1.9%)	147 (1.5%)	274 (2.3%)	159 (1.5%)

Data are n (%). Percentages might not sum to 100 as a result of rounding.

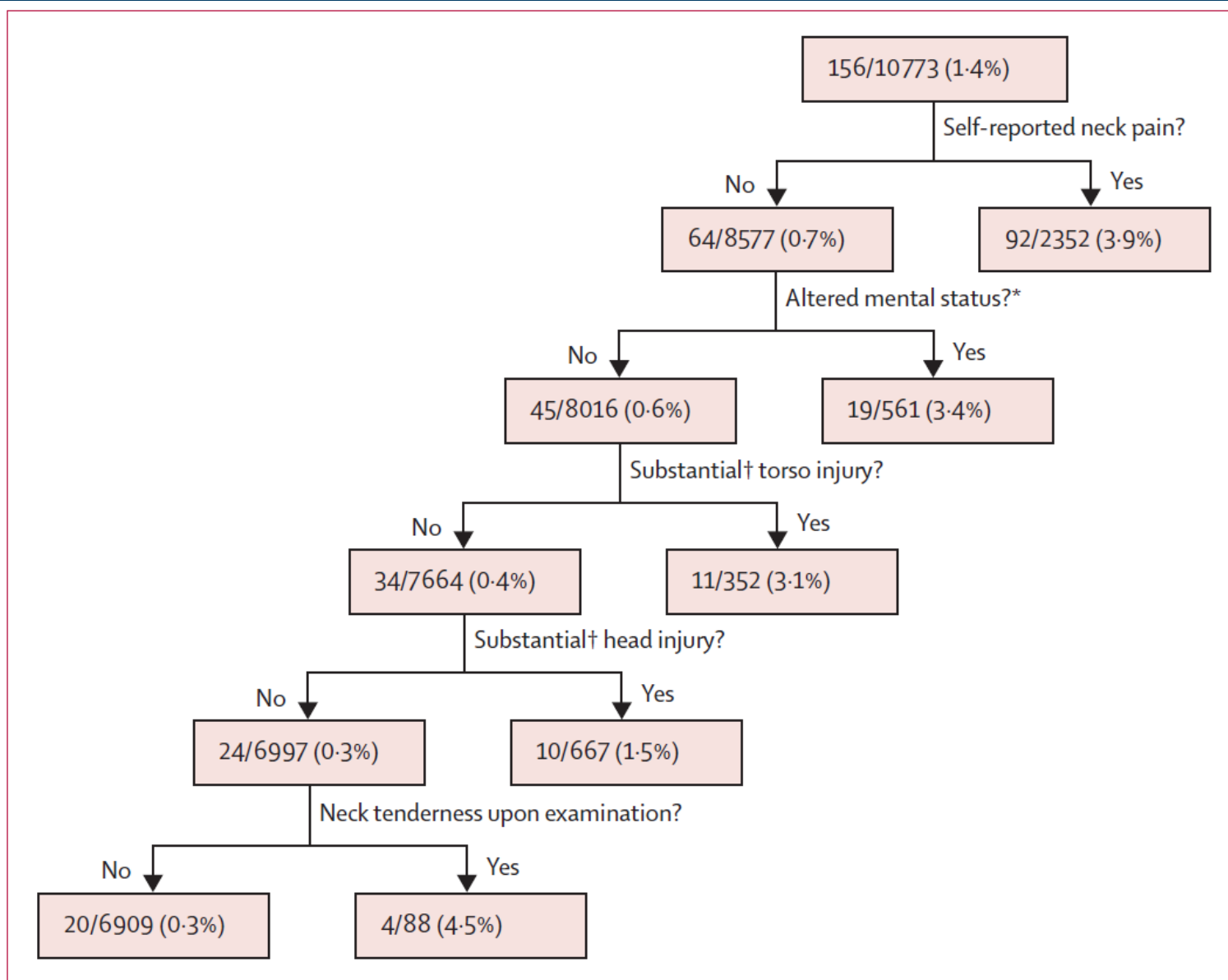
Table 1: Participant characteristics by enrolment status and cohort



	Cervical spine injury (n=274)	No cervical spine injury (n=11583)	Risk ratio (95% CI)	p value
Glasgow Coma Scale score: 3–8	72 (26.3%)	227 (2.0%)	13.8 (10.8–17.6)	<0.0001
Alert, Verbal, Pain, Unresponsive scale: unresponsive	49 (17.9%)	139 (1.2%)	13.5 (10.3–17.8)	<0.0001
Abnormal airway, breathing or circulation	92 (33.6%)	500 (4.3%)	9.6 (7.6–12.2)	<0.0001
Focal neurological deficit on examination (paresthesia, numbness, or weakness)	35 (12.8%)	324 (2.8%)	4.7 (3.3–6.6)	<0.0001
Any of the above	118 (43.1%)	810 (7.0%)	8.9 (7.1–11.2)	<0.0001

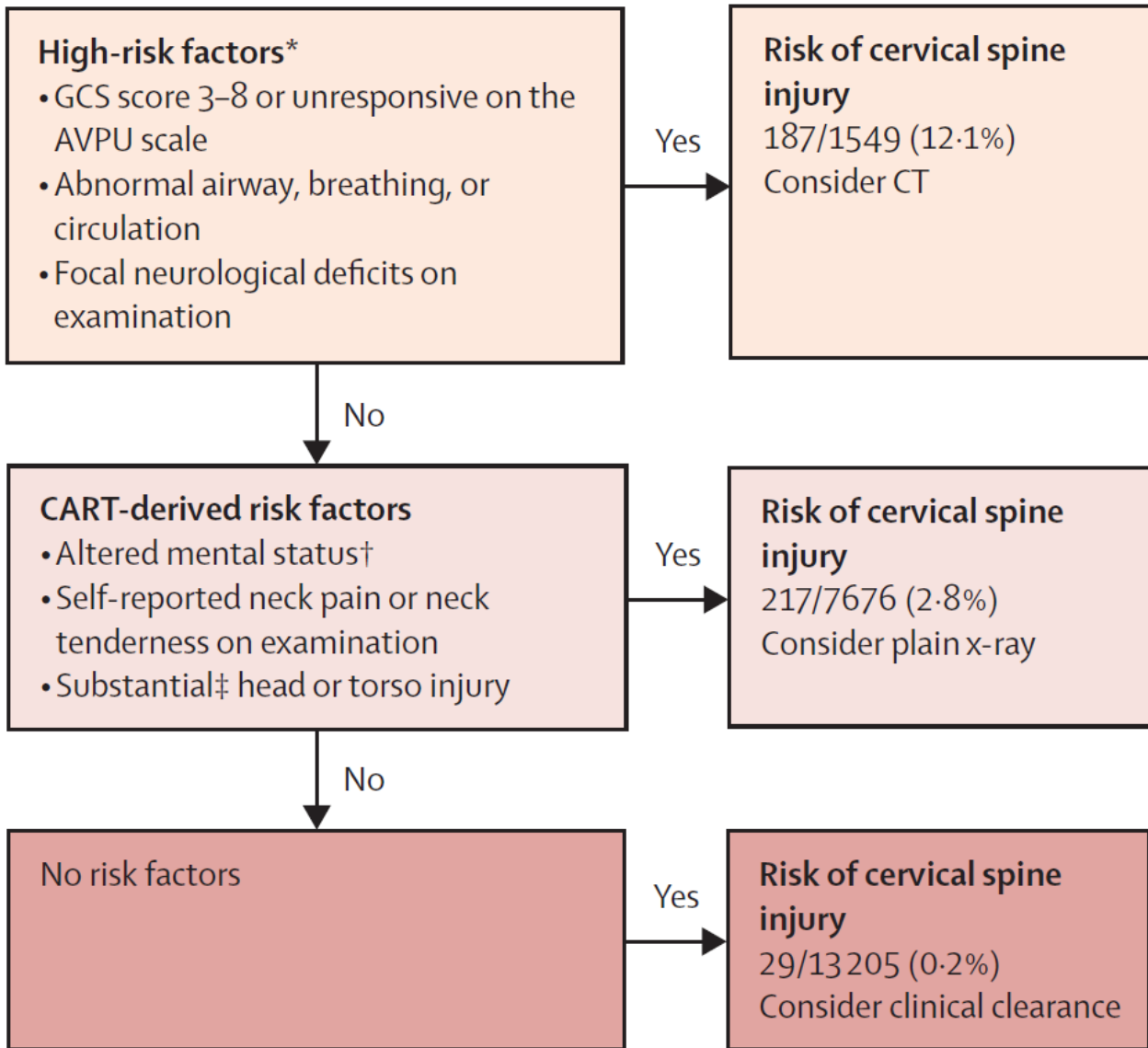
Data are n (%) unless indicated otherwise. Risk ratio (95% CI) were derived from unadjusted Poisson regression with robust error estimates.

Table 2: Cervical spine injury risk factors and risk ratio for high-risk variables in the derivation cohort



Notable variables not meeting threshold: hanging, strangulation mechanisms, history of cervical spine injury, intoxication.

Figure 1: Cervical spine injury classification and regression tree



	Derivation cohort (n=11 857)	Validation cohort (n=10 573)
Children with no cervical spine injury	11 583	10 414
Any factor observed		
No	6889	6287
Yes	4694	4127
Children with cervical spine injury	274	159
Any factor observed		
No	20	9
Yes	254	150
Sensitivity	254/274 (92.7%; 89.6–95.8)	150/159 (94.3%; 90.7–97.9)
Specificity	6889/11583 (59.5%; 58.6–60.4)	6287/10414 (60.4%; 59.4–61.3)
Positive predictive value	254/4948 (5.1%; 4.5–5.7)	150/ 4277 (3.5%; 3.0–4.1)
Negative predictive value	6889/6909 (99.7%; 99.6–99.8)	6287/6296 (99.9%; 99.8–100.0)

Data are n or n/N (%; 95% CI). Risk factors were obtained from the electronic questionnaires that were completed by the attending emergency department clinician before viewing the results of neck imaging. In the derived prediction rule, the presence of a risk factor was considered to render the prediction rule positive for cervical spine injury. Sensitivity is the proportion of children with cervical spine injuries who had at least one of the rule's risk factors. Specificity is the proportion of children without cervical spine injuries who did not have any of the rule's risk factors. Positive predictive value is the proportion of children with at least one of the rule's risk factors who have cervical spine injuries. Negative predictive value is the proportion of children who did not have any of the rule's risk factors that do not have a cervical spine injury.

Table 3: Clinical performance of the cervical spine injury prediction rule



	Derivation cohort (n=11 857)	Validation cohort (n=10 573)
Children with no cervical spine injury	11 583	10 414
Any factor observed		
No	6889	6287
Yes	4694	4127
Children with cervical spine injury	274	159
Any factor observed		
No	20	9
Yes	254	150
Sensitivity	254/274 (92.7%; 89.6–95.8)	150/159 (94.3%; 90.7–97.9)
Specificity	6889/11583 (59.5%; 58.6–60.4)	6287/10414 (60.4%; 59.4–61.3)
Positive predictive value	254/4948 (5.1%; 4.5–5.7)	150/4277 (3.5%; 3.0–4.1)
Negative predictive value	6889/6909 (99.7%; 99.6–99.8)	6287/6296 (99.9%; 99.8–100.0)

Data are n or n/N (%; 95% CI). Risk factors were obtained from the electronic questionnaires that were completed by the attending emergency department clinician before viewing the results of neck imaging. In the derived prediction rule, the presence of a risk factor was considered to render the prediction rule positive for cervical spine injury. Sensitivity is the proportion of children with cervical spine injuries who had at least one of the rule's risk factors. Specificity is the proportion of children without cervical spine injuries who did not have any of the rule's risk factors. Positive predictive value is the proportion of children with at least one of the rule's risk factors who have cervical spine injuries. Negative predictive value is the proportion of children who did not have any of the rule's risk factors that do not have a cervical spine injury.

Table 3: Clinical performance of the cervical spine injury prediction rule

	Overall (n=22 430)	Derivation cohort (n=11 857)	Validation cohort (n=10 573)
Observed imaging rates			
Clinically cleared (no imaging)	9662 (43.1%)	4682 (39.5%)	4980 (47.1%)
Plain x-ray	8912 (39.7%)	4639 (39.1%)	4273 (40.4%)
CT	3856 (17.2%)	2536 (21.4%)	1320 (12.5%)
Imaging rates with clinical prediction rule applied			
Clinically cleared (no imaging)	13 205 (58.9%)	6909 (58.3%)	6296 (59.5%)
Plain x-ray	7676 (34.2%)	4020 (33.9%)	3656 (34.6%)
CT	1549 (6.9%)	928 (7.8%)	621 (5.9%)

Data are n (%). Participants were grouped into three mutually exclusive categories: those who received no imaging (clinically cleared), those who received cervical spine plain x-rays only, and those who receive cervical spine CT with or without plain x-rays. Projected imaging categories were determined by applying the PECARN cervical spine injury prediction rule imaging algorithm (figure 3) to the study population. PECARN=Pediatric Emergency Care Applied Research Network.

Table 4: Actual imaging use in children presenting to an emergency department with known or suspected blunt injury versus projected use when applying the PECARN cervical spine injury prediction rule imaging algorithm

PECARN prediction rule for cervical spine imaging of children presenting to the emergency department with blunt trauma: a multicentre prospective observational study



Julie C Leonard, Monica Harding, Lawrence J Cook, Jeffrey R Leonard, Kathleen M Adalgais, Fahd A Ahmad, Lorin R Browne, Rebecca K Burger, Pradip P Chaudhari, Daniel J Corwin, Nicolaus W Glomb, Lois K Lee, Sylvia Owusu-Ansah, Lauren C Riney, Alexander J Rogers, Daniel M Rubalcava, Robert E Sapien, Matthew A Szadkowski, Leah Tzimenatos, Caleb E Ward, Kenneth Yen, Nathan Kuppermann



PROs

- Data + methodology
- Does not rely on mechanism
- Limited exclusion (Includes ETOH, NAI, T21)
- Simple

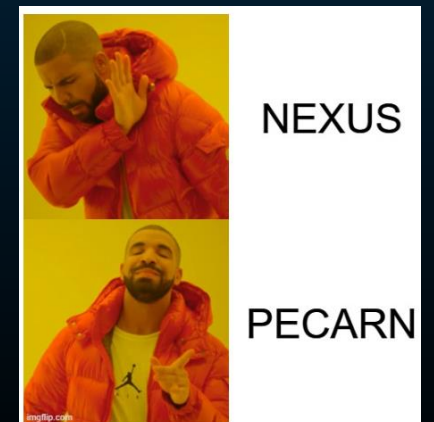
CONs

- Academic L1 Ped Trauma Centers
- Does not confirm previous evidence in some cases (axial load, NAI, ETOH) – caution

High baseline incidence of C-spine injury

IN SUM:

- Large, prospective multicentre study
- Accurate clinical prediction rule for cervical spine injury in children
- High sensitivity and near-perfect NPV. 0 missed spine injuries requiring intervention.
- The rule can potentially reduce CT use.
- Implementation



'A goal without a plan is just a wish.' Antoine de Saint-Exupéry



Trauma@SCMCI: Preparing For Today, and the Day After



samuelnir@gmail.com p: 0542041623

