


# PEDIATRIC CONCUSSION



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## Objectives:

By the End of This LECTURE, Learners Should be able to:

- Identify symptoms and exam findings consistent with a concussion, as well as 'red flag' symptoms that warrant immediate further evaluation
- Discuss initial management strategies for patients diagnosed with concussion



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1- Incidence

# 3,800,000

Sport-related traumatic brain injuries occur annually

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1- Incidence: SPORTS

|  |  |
|--|--|
|  |  |
| <b>BOYS</b>  | <b>GIRLS</b>   |
| Rugby<br>American Football<br>Ice Hockey<br>Lacrosse                               | Soccer<br>Lacrosse<br>Field Hockey   |

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## 2-definition

DIRECT OR INDIRECT blow that causes a force to be transmitted to the head.

With resulting short-lived impairment of neurologic function.

THIS IMPAIRMENT IS functional and, as such, no abnormality is seen on standard structural neuroimaging studies.

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**3-DIAGNOSIS**

### Sport-Related Concussion in Children and Adolescents

Mark E. Halstead, MD, FAAP; Kevin D. Walter, MD, FAAP; Eddy Moffat, MD, FAAP; COUNCIL ON SPORTS MEDICINE AND FITNESS

- Concussion diagnosis remains clinical
  - No objective diagnostic tests available
  - Especially true for adolescents and children

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**3-DIAGNOSIS**

### Sport-Related Concussion in Children and Adolescents

Mark E. Halstead, MD, FAAP; Kevin D. Walter, MD, FAAP; Eddy Moffat, MD, FAAP; COUNCIL ON SPORTS MEDICINE AND FITNESS

- 2018 Expert Panel:
  - Disorientation/confusion immediately after the event
  - Impaired balance within 1 day of injury
  - Slowed reaction times within 2 days of injury
  - Impaired verbal learning/memory within 2 days of injury

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**3-DIAGNOSIS**

I. Subjective Symptoms

- Post-concussion symptom scale
- Acute Concussion Evaluation

II. Objective Exam

- CHOP Visio-vestibular exam

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| Symptom Recorded                    | Percentage of concussions reporting symptom |
|-------------------------------------|---|
| Headache                            | 93  |
| Dizziness/unsteadiness              | 75  |
| Difficulty concentration            | 57  |
| Confusion/disorientation            | 46  |
| Vision changes/sensitivity to light | 38  |
| Nausea                              | 29  |
| Drowsiness                          | 27  |
| Amnesia                             | 24  |

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Subjective Symptoms: 3-DIAGNOSIS

TABLE 3 Postconcussion Symptom Scale (Ages 15 and Older)

| Symptoms                  | No Symptoms | Mild | Moderate | Severe  |
|---------------------------|-------------|------|----------|---------|
| Headache                  | 0           | 1    | 2        | 3 4 5 6 |
| "Pressure" in head        | 0           | 1    | 2        | 3 4 5 6 |
| Head pain                 | 0           | 1    | 2        | 3 4 5 6 |
| Nausea or vomiting        | 0           | 1    | 2        | 3 4 5 6 |
| Dizziness                 | 0           | 1    | 2        | 3 4 5 6 |
| Blurred vision            | 0           | 1    | 2        | 3 4 5 6 |
| Balance problems          | 0           | 1    | 2        | 3 4 5 6 |
| Sensitivity to light      | 0           | 1    | 2        | 3 4 5 6 |
| Sensitivity to noise      | 0           | 1    | 2        | 3 4 5 6 |
| Feeling slowed down       | 0           | 1    | 2        | 3 4 5 6 |
| Feeling "in a fog"        | 0           | 1    | 2        | 3 4 5 6 |
| "Don't feel right"        | 0           | 1    | 2        | 3 4 5 6 |
| Difficulty concentrating  | 0           | 1    | 2        | 3 4 5 6 |
| Difficulty remembering    | 0           | 1    | 2        | 3 4 5 6 |
| Fatigue and/or low energy | 0           | 1    | 2        | 3 4 5 6 |
| Cold/flu                  | 0           | 1    | 2        | 3 4 5 6 |
| Drowsiness                | 0           | 1    | 2        | 3 4 5 6 |
| More emotional            | 0           | 1    | 2        | 3 4 5 6 |
| Irritability              | 0           | 1    | 2        | 3 4 5 6 |
| Headaches                 | 0           | 1    | 2        | 3 4 5 6 |
| Numbness or tingling      | 0           | 1    | 2        | 3 4 5 6 |
| Headache lasting longer   | 0           | 1    | 2        | 3 4 5 6 |

TABLE 4 Postconcussion Symptom Scale (Ages 5–12 Years)

| Symptoms  | Not at All or Never | A Little or Often | Disturbed or Significant | A Lot or Often |
|---|---------------------|-------------------|--------------------------|----------------|
| I have headaches                                | 0                   | 1                 | 2                        | 3              |
| I feel dizzy                                    | 0                   | 1                 | 2                        | 3              |
| I feel like the room is spinning                | 0                   | 1                 | 2                        | 3              |
| I feel like I'm going to faint                  | 0                   | 1                 | 2                        | 3              |
| Things are blurry when I look at them           | 0                   | 1                 | 2                        | 3              |
| I have double vision                            | 0                   | 1                 | 2                        | 3              |
| I feel sick to my stomach                       | 0                   | 1                 | 2                        | 3              |
| My neck hurts                                   | 0                   | 1                 | 2                        | 3              |
| I get tired a lot                               | 0                   | 1                 | 2                        | 3              |
| I get tired easily                              | 0                   | 1                 | 2                        | 3              |
| I have trouble paying attention                 | 0                   | 1                 | 2                        | 3              |
| I have a hard time concentrating                | 0                   | 1                 | 2                        | 3              |
| I get confused easily                           | 0                   | 1                 | 2                        | 3              |
| I have problems remembering what people tell me | 0                   | 1                 | 2                        | 3              |
| I have problems following directions            | 0                   | 1                 | 2                        | 3              |
| I sleep more too much                           | 0                   | 1                 | 2                        | 3              |
| I get confused                                  | 0                   | 1                 | 2                        | 3              |
| I forget things                                 | 0                   | 1                 | 2                        | 3              |
| I have problems knowing things                  | 0                   | 1                 | 2                        | 3              |
| I have trouble figuring things out              | 0                   | 1                 | 2                        | 3              |
| It's hard for me to learn new things            | 0                   | 1                 | 2                        | 3              |

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Post-concussion Symptom SCALE

Symptom Monitoring: checklists

Player's Name: \_\_\_\_\_ Team: \_\_\_\_\_ Position: \_\_\_\_\_

| SYMPTOM                  | RATING (None, Mild, Severe) | BASELINE DATE | TESTING 2 DATE | TESTING 3 DATE | TESTING 4 DATE | TESTING 5 DATE |
|--------------------------|-----------------------------|---------------|----------------|----------------|----------------|----------------|
| Headache                 | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Dizziness                | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Vision                   | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Balance                  | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Distraction              | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Fatigue                  | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Trouble falling asleep   | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Trouble staying asleep   | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Concentration            | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Sensitivity to light     | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Sensitivity to noise     | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Headaches                | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Loss of memory           | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Difficulty concentrating | 0 1 2 3 4 5 6               |               |                |                |                |                |
| Difficulty remembering   | 0 1 2 3 4 5 6               |               |                |                |                |                |
| TOTAL SCORE              |                             |               |                |                |                |                |

-Self-reported Likert Scale  
 -Validated in > 11 years old  
 -Moderate test-retest reliability  
 -Able to detect reliable change

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Graded SYMPTOM CHECKLIST


**3-DIAGNOSIS**

I. Subjective Symptoms

- Post-concussion symptom scale
- Acute Concussion Evaluation**

II. Objective Exam

- CHOP Visio-vestibular exam



"You'd better sit out the rest of the game. You might have a concussion."

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**Acute Concussion Evaluation (ACE)**



"I think it's a concussion... although the snake has one a little concussed."

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**3-DIAGNOSIS**

I. Subjective Symptoms

- Post-concussion symptom scale
- Acute Concussion Evaluation

II. Objective Exam

- CHOP Visio-vestibular exam**



"You'd better sit out the rest of the game. You might have a concussion."

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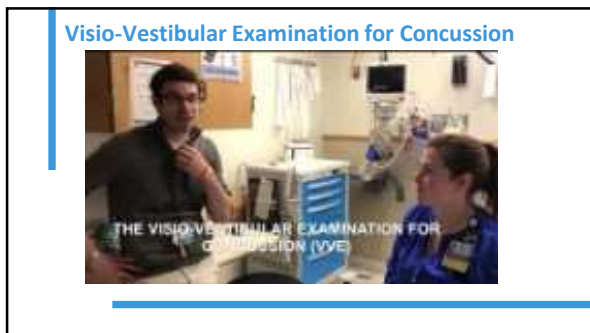
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**Visio-Vestibular Examination for Concussion**

| Physical Exam Element                | How to Perform Examination  | Abnormal Findings   |
|--------------------------------------|---|---|
| <b>Nystagmus:<br/>Smooth Pursuit</b> | Examiner's finger moving horizontally, progressively more slowly, stops at center. 5 repetitions  | jerky/jumpy eye movements<br>> 1 beat of nystagmus at center of visual field  |
| <b>Fast Saccades</b>                 | Examiner's finger shoulder width apart (horizontal) and forehead-head distance (vertical). 20 repetitions   | Symptom provocation<br>Dizziness, disorientation<br>Nausea, vomiting, redness/tearing eyes                                |
| <b>Gaze Stability</b>                | Patient fixes gaze on examiner's thumb while rotating eye and then rotating head to side to side. 20 repetitions                                      | Symptom provocation<br>Headache, dizziness, eye fatigue, vomiting, redness/tearing eyes                                   |
| <b>Near point<br/>Convergence</b>    | Patient holds object with letters at arm's length, bring toward face until becomes double   | Letters become double at < 4 cm from forehead (near point)  |
| <b>Monocular<br/>Accommodation</b>   | Patient looks object with letters at arm's length with 1 eye covered, bring toward face until becomes double<br>Repeat with contralateral eye covered | Letters become blurry at (near point)<br>For children age 12 and younger < 10 cm<br>For children age 13 and older < 12 cm |
| <b>Gait/Balance Testing</b>          | Tandem heel-toe gait<br>Forward eyes open<br>Forward eyes closed<br>Backward eyes open<br>Backward eyes closed  | Steps off straight line, raises arms for stability or violent gait, loses balance or vomiting                             |

Children's Hospital of Philadelphia

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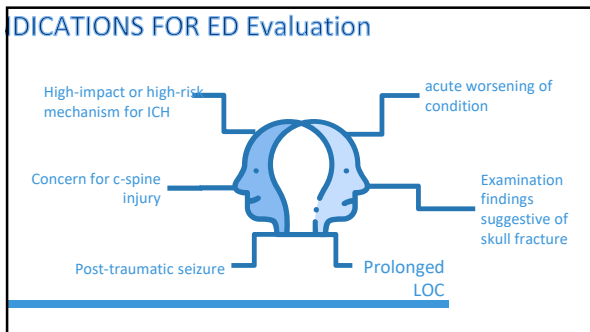
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### PECARN RULES FOR HEAD IMAGING

**Choosing Wisely** Pediatric Head Trauma CT Decision Guide  
Children younger than 2 years

**High Risk - 4.4% risk of crTBI\***

- GCS < 15
- Palpable skull fracture
- AMS (agitation, anisocoria, unequal pupillary reactivity, vomiting)

**YES TO ANY** → CT

**NO** → Intermediate Risk - 8.9%

**Intermediate Risk - 8.9%**

- Scalp hematoma (excluding frontal)
- LOC > 5 seconds
- Not acting normally per parent
- Severe mechanism of injury
- Fall > 5 ft
- MVA w/injection, rollover, or fatality
- Bike/w/ vs. vehicle w/o helmet
- Struck by high-impact object

**YES TO ANY** → Observation vs. CT using shared decision-making

**NO** → CT not indicated, Observe  
**Low Risk - < 0.02%**

**Clinical factors used to guide decision-making:**

- Multiple vs. isolated factors
- Worsening findings during observation (AMS, headache, vomiting)
- Physician experience
- Parental preference
- < 3 months old

\*1% TB risk of clinically important TB needing acute intervention, based on PECARN validated prediction rules

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### PECARN RULES FOR HEAD IMAGING

**Choosing Wisely** Pediatric Head Trauma CT Decision Guide  
Children 2 years and older

**High Risk - 4.1% risk of crTBI\***

- GCS < 15
- Signs of basilar skull fracture
- AMS (agitation, anisocoria, unequal pupillary reactivity, vomiting)

**YES TO ANY** → CT

**NO** → Intermediate Risk - 8.8%

**Intermediate Risk - 8.8%**

- Vomiting
- LOC
- Severe headache
- Severe mechanism of injury
- Fall > 5 ft
- MVA w/injection, rollover, or fatality
- Bike/w/ vs. vehicle w/o helmet
- Struck by high-impact object

**YES TO ANY** → Observation vs. CT using shared decision-making

**NO** → CT not indicated, Observe  
**Low Risk - < 0.05%**

**Clinical factors used to guide decision-making:**

- Multiple vs. isolated factors
- Worsening findings during observation (AMS, headache, vomiting)
- Physician experience
- Parental preference

\*1% TB risk of clinically important TB needing acute intervention, based on PECARN validated prediction rules

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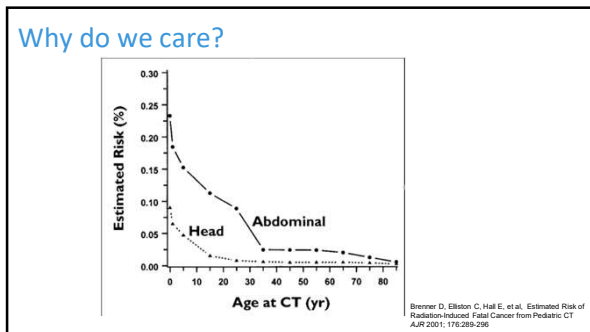
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### 5-MANAGEMENT:

-  Remove from play; no return to play
-  Relative Rest
-  Management of Somatic Symptoms
-  Observation after injury

Treatment Treatment

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### 5-MANAGEMENT:

#### Sport-Related Concussion in Children and Adolescents

Mark E. Robinson, MD, FAAP; Kevin D. Walter, MD, FAAP; Kelly Mattioli, MD, FAAP; COUNCIL ON SPORTS MEDICINE AND FITNESS

- Counseling/setting expectations
- Remove athlete from same-day play
  - Athletes who continued to play were 8.8 times more likely to have a recovery period of more than 21 days.
- Allow for sub-symptomatic activity
- When returning to school, allow for academic adjustments
  - Discourage prolonged removal/absence

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#### Risks of Prolonged Rest

- Delay concussion recovery
- Secondary fatigue, depression, anxiety
- Physical deconditioning

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**The Role of Rest:**  
 JAMA Pediatrics | Original Investigation  
**Early Subthreshold Aerobic Exercise for Sport-Related Concussion**  
 A Randomized Clinical Trial

John J. Leary, MD, Mohammad N. Nader, MD, Michael J. Ellis, MD, Rebekah Mannix, MD, Scott R. Darling, MD, Michael S. Franks, MD, Heidi R. Sulzberger, MD, Jeff Larson, PhD, David M. Cantelmo, MD, Berry Yellon, PhD

**-Type:** Multicenter, prospective RCT  
**-Population:** Ages 13-18  
**-Intervention:**  
 -Progressive sub-symptom threshold aerobic exercise program  
 -vs. Placebo-like stretching program  
**-Result: Median Time to Recovery (days)**  
 -Aerobic Exercise: 13 (IQR: 10-18.5)  
 -Stretching: 17 (IQR: 13-23)

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**Sport-Related Concussion in Children and Adolescents**

David J. Hassler, MD, MPH, David R. Martin, MD, MPH, Tracy Martin, MD, MPH, Connor M. O'Connell, MD, MPH

**Electronics**

"Young athletes are highly socially connected through their electronics ... blanket recommendations to have *athletes* completely avoid the use of electronics... is discouraged."

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JAMA Pediatrics | Original Investigation  
**Effect of Screen Time on Recovery From Concussion**  
 A Randomized Clinical Trial

Theodore Macnow, MD, Tess Curran, MD, MPH, Courtney Tolliday, MD, Kindi Martin, MD, Madeline McCarthy, MD, MS, Didem Ayurk, MS, Kavita M. Babu, MD, Rebekah Mannix, MD, MPH

**Electronics**

**-Type:** Single Center, Parallel-Design RCT  
**-Population:** 12-25yo; within 24 hours of sustaining a concussion  
**-Intervention:** over first 48 hours:  
 -Screen time  
 -vs. No screen time  
**-Median recovery: (days)**  
 -Screen time: 8.0 (IQR: 3-10)  
 -No screen time 3.5 (IQR: 2.0-10)

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**Poll 1:** All of the Following tools can help diagnose a concussion **except:**

- 1- CT scan of the head
- 2- Post-Concussive Symptom Scale/Graded Symptom Checklist
- 3- Acute Concussion Evaluation (ACE)
- 4- Visio-Vestibular Examination

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**Poll 2:** Which of the following recommendations for return to activity is best supported by the 2018 AAP Clinical Report: "Sport-Related Concussion in Children & Adolescents"?

- 1- Complete rest from all activities for 7 days
- 2- Immediate return to school, but no physical activity until cleared by a physician
- 3- Rest until complete symptom resolution
- 4- Brief rest, followed by supervised graduated return to activity, including light physical activity
- 5- Complete rest until evaluation by a specialty concussion clinic

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**Objectives:**  
By the End of This LECTURE, Learners Should be able to:

- Know when to provide C-spine immobilization for the injured athlete
- Know how to safely remove helmets/padding
- Know indications for and the benefits of splinting in the field



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Approximately **60 million** United States youth aged 6 through 18 years participate in organized sports each year. Analysis of sports and recreation related injury episodes in the United States has shown an average annual estimate of **8.6 million injury episodes** with an age-adjusted rate of **34.1 per 1000 population** .”

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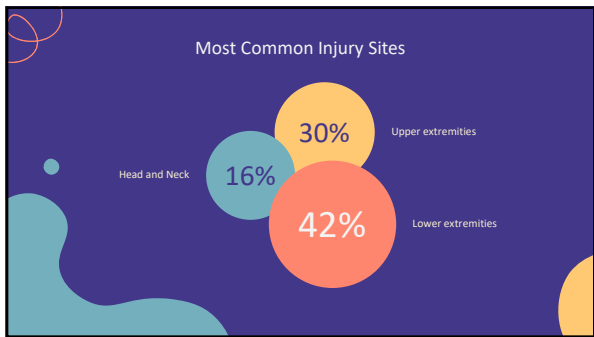
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- 02 Equipment Removal
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### C-Spine Injuries

- Sports account for 10% of all reported spine injuries
- UNC Study from 2016

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### Primary Survey

- Assess ABC's  
Not Breathing vs. Stable
- Remove Mouthpiece
- Call 911

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### Secondary Survey

- Inspection
- Palpate
- Neuro exam
- ROM
- Axial Compression and Spurling Test
- Concussion Assessment

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### Red Flags

- 01 Persistent Neck Pain or Stiffness
- 02 Point Tenderness
- 03 Spinal Deformity
- 04 Fear of Moving Head
- 05 B/L U or LE Symptoms

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### Action Plan

- Stabilize head AND neck
- Log roll-push if lying prone
- Maintain control of the head during spine board process
- Secure helmet to spine board with tape or EMS straps

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### Helmet/Pad Removal

"All or nothing"  
Remove poorly fitted or dislodged helmets w/ pads



Figure 1. Sample supine lateral radiographs taken of a 12-year-old child wearing helmet and shoulder pads (A), shoulder pads only (B), and no equipment (C).

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### Football Helmet Removal



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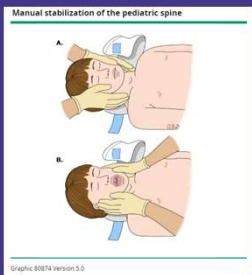
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1.) Stabilize c-spine



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2.) Remove Facemask

- Most facemasks have 4 anchoring points



Images from Youtube Video: St. Rita's: How to Spine Board and Athlete

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3.) Cut away jersey, chinstrap, & shoulder pad laces



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4.) Remove cheek pads +/- deflate bladder



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4.) Stabilize c-spine

- From below



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5.) Remove helmet & pads TOGETHER

- Holding c-spine from below



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### 6.) Apply Cervical Collar

- Use number of fingers from clavicle to jaw line to approximate size
- Avoid flexion/extension



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### What About A Backboard?

• Backboards: National Association of EMS Physicians and ACS Committee on Trauma position statement:

- Benefit of long backboards is largely unproven and use should be judicious.
- Backboards can cause pain, pressure ulcers, and respiratory compromise.

• **Useful in:**

- Obvious/high suspicion for thoracic or lumbar fractures

• **Consider in:**

- Blunt trauma AND altered level of consciousness
- High-energy mechanism of injury AND any one of:
  - Drug or alcohol intoxication
  - Inability to communicate
  - Distracting injury
  - Spinal pain or tenderness
  - Neurologic complaint (e.g., numbness or motor weakness)
  - Anatomic deformity of the spine



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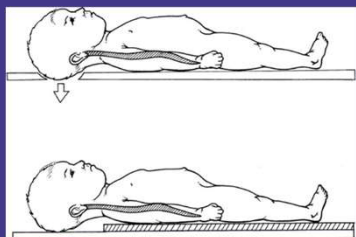
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### Pediatric Backboard Modifications



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**Case:**

16 yo male evaluated on scene at a football game.  
-Began noticing increased neck "discomfort" with each tackle.  
-Then, after a "spear" tackle, remained on the ground dazed/confused.



**ROS:** No LOC, vomiting, headache. No neck pain currently.  
**PE:** GCS: 15, no intoxication, no distracting injury, no focal neurologic defect, no midline neck tenderness

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Poll 3: Would you image this patient's C-spine?

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**NEXUS Criteria for C-Spine Imaging** ☆

Clears patients from cervical spine fracture clinically, without imaging.

|  |  |                                 |
|--|--|---------------------------------|
| Focal neurologic deficit present       | <input checked="" type="checkbox"/> No 0 | <input type="checkbox"/> Yes +1 |
| Midline spinal tenderness present      | <input checked="" type="checkbox"/> No 0 | <input type="checkbox"/> Yes +1 |
| Altered level of consciousness present | <input checked="" type="checkbox"/> No 0 | <input type="checkbox"/> Yes +1 |
| Intoxication present                   | <input checked="" type="checkbox"/> No 0 | <input type="checkbox"/> Yes +1 |
| Distracting injury present             | <input checked="" type="checkbox"/> No 0 | <input type="checkbox"/> Yes +1 |

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**Pediatric Cervical Spine Fractures**

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**A Prospective Multicenter Study of Cervical Spine Injury in Children**

Peter Vecellio, MD; Harold Sirova, MD; Barry D. Freeman, MD; Manish N. Shah, MD; William R. Mower, MD, PhD; and Jerome R. Hoffman, MA, MD, for the NEXUS Group

- Population: 3065 patients < 18 years
- Intervention: Applied NEXUS criteria to eligible patients
- Results:
  - 30/3065 had clinically significant c-spine injury
    - 0 fractures in 0-2 years (88 patients)
    - 4 fractures in 2-8 years (817 patients)
    - 0 cases of SCIWORA

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**Pediatric Risk Factors**

**> 3 yo: (540 injuries)**

**Risk Factors:**

- AMS
- Midline neck pain
- Focal Neurologic Defect
- Torticollis
- Predisposing risk factors:
  - High-risk MVA
  - Diving/clothes-line mechanism
  - Trisomy 21/Ankylosing Spondylitis

**< 3 yo (83/12,537 with injuries)**

**Risk Factors:**

- GCS < 14
- GCS EYE =1
- MVC
- Age > 2 years

Leonard JC, et al. Factors Associated with cervical spine injury in children after blunt trauma. Ann Emerg Med 1982;1:143-55

Parvizi Samir et al. 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. J Trauma. 2008 Sept; 65(3): 585-94

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**Pediatric Cervical Spine**

*< 8yo*

**GCS 14 or 15**

**History\*\***

- Child/parent reports persistent neck pain, abnormal head posture, or difficulty with neck movement
- History of focal sensory abnormality or motor deficit

**Physical Exam**

- Torticollis/abnormal head position
- Posterior midline neck tenderness
- Limited cervical range of motion
- Not able to focus due to other injuries
- Visible known substantial injury to chest, abdomen, pelvis\*\*

Answer "No" to all of the above → **Clear c-spine**

Answer "Yes" to any of the above → **Plain radiograph# (lateral view minimum)**

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

**Special Consideration:**

- Predisposing conditions
- Mechanism:
  - MVA
  - Diving/axial load
  - Clothes line

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**Case:**

16 yo male evaluated on scene at a football game.  
-Began noticing increased neck "discomfort" with each tackle.  
-Then, after a "spear" tackle, remained on the ground dazed/confused.



**ROS:** No LOC, vomiting, headache. No neck pain currently.  
**PE:** GCS: 15, no intoxication, no distracting injury, no focal neurologic defect, no midline neck tenderness

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**Poll 4:** Would you image this patient's C-spine?

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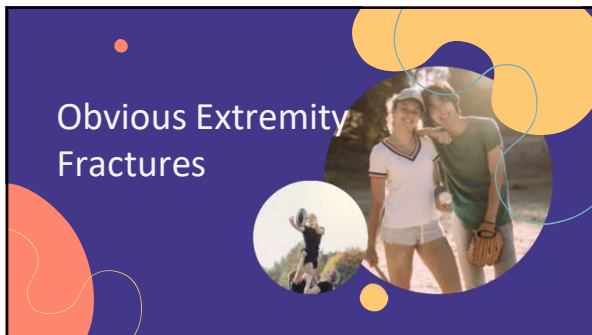
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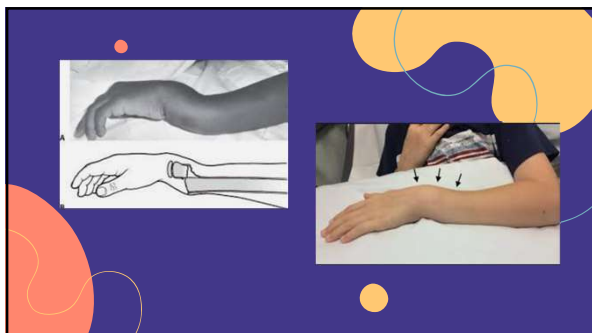
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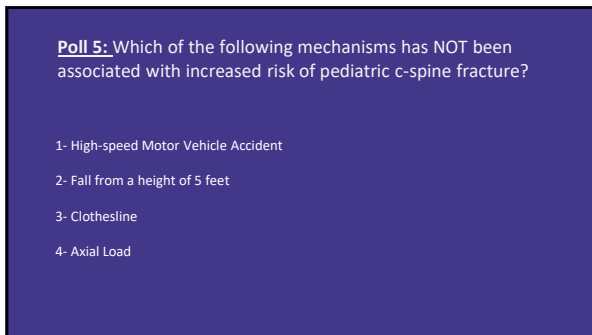
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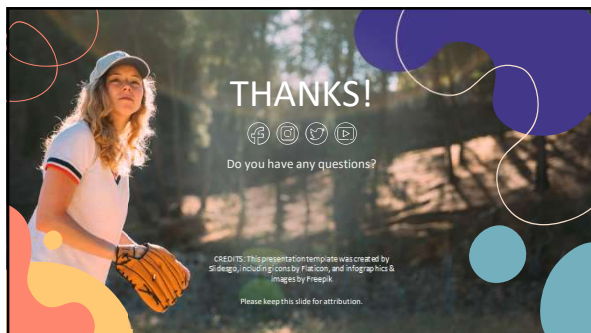
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**Resources**

Concussions:

- 1.) Halstead M, Walter K, Moffatt K, et al. Sport-Related Concussion in Children and Adolescents. *Pediatrics* (2018) 142(6):e20183074
- 2.) Iverson G, Karr J, Maxwell B, et al. Examining Criteria for Defining Persistent Post-concussion Symptoms in Children and Adolescents. *Front Neurol* (2021) 12: 614648
- 3.) Master C, Podolak, Cluffreda K, et al. Utility of Pupillary Light Reflex Metrics as a Physiologic Biomarker for Adolescent Sport-Related Concussion. *JAMA Ophthalmol*. 2020;138(11):1135-1141.

Concussion Resources:

- 4.) CHOP Visio-Vestibular Examination for Concussion: [Visio-Vestibular Examination for Concussion - YouTube](#)
- 5.) CDC ACE Concussion Checklist: [Acute Concussion Evaluation \(cdc.gov\)](#)
- 6.) Graded Symptom Scale Checklist: [Graded Symptom Scale Checklist \(ne.gov\)](#)
- 7.) Graham R, Rivara FP, Ford MA, et al. Committee on Sports-Related Concussions in Youth; Board on Children, Youth, and Families; Institute of Medicine; National Research Council. Appendix C: Clinical Evaluation Tools. [Clinical Evaluation Tools - Sports-Related Concussions in Youth - NCBI Bookshelf \(nih.gov\)](#)

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**Resources**

Cervical Spine Management:

- 1.) Brenner D, Elliston C, Hall E, et al, Estimated Risk of Radiation-Induced Fatal Cancer from Pediatric CT *AJR* 2001; 176:289-296
- 2.) Leonard JC, et al. Factors Associated with cervical spine injury in children after blunt trauma. *Ann Emerg Med* 58(2):145-55
- 3.) Pieretti-Vanmarcke et al. 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. *J Trauma*. 2009 Sept 67(3): 543-549
- 4.) Viccellio P, Simon H, Pressman B D, et al. A Prospective-multicenter study of cervical spine injury in children. *Pediatrics*. 2001 Aug;108(2):E20.
- 5.) Herman M, Brown K, Sponseller P, et al. Pediatric Cervical Spine Clearance: A Consensus Statement and Algorithm from the Pediatric Cervical Spine Clearance Working Group. *J Bone Joint Surg Am*. (2019) 101(1)
- 6.) Ferderber J, and Wolfson A. The Dangers of Spear Tackling: A Case Report of a NEXUS-negative High School Football Player. *J EMERG Med*. (2019) 56(2): 185-190.
- 7.) St. Rita's: [How to Spine Board an Athlete](#)

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### Resources

**Splinting:**

1.) Straccolini, Andrea. (2021). Basic techniques for splinting of musculoskeletal injuries. Michael Ganetsky (Ed.), UpToDate. Retrieved April 17, 2022, from <https://www.uptodate.com/contents/basic-techniques-for-splinting-of-musculoskeletal-injuries>

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