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SPINE AND HEAD TRAUMA

SPINE TRAUMA — Kenneth C. Jackimczyk, MD, Attending Physician, Department of Emergency Medicine, Maricopa Medical Center, Phoenix

Introduction: when is prehospital immobilization necessary? which emergency department (ED) patients need cervical spine films? are there other imaging studies besides plain films that are useful?

Spine immobilization: 5 million immobilized patients annually; costs ≈$15/patient ($75 million annually), added time at scene, patient discomfort (100% uncomfortable after 30 min); majority of immobilizations not helpful; direct and indirect costs of finding abnormal film in nontender patient; one study showed patients who were not immobilized had slightly better outcomes

- Fresno algorithm: 5-yr retrospective study; immobilized only those patients with pain or tenderness, multiple system trauma, head/facial trauma, extremity numbness, loss of consciousness, or altered mental status; of 500 patients with spinal injury, 3 missed; concluded selective immobilization may be safely applied in prehospital setting; mechanism of injury not considered
- Domeier criteria: used altered mental status, neurologic deficit, spinal pain or tenderness, intoxication, and extremity fracture to determine need for immobilization; enrolled ≈9000 patients, almost 300 of whom had spinal injuries; of 15 injuries missed, only 2 unstable
- Conclusion: research going forward with protocols and looking at objective criteria for immobilization

Plain films

- National Emergency X-Radiography Utilization Study (NEXUS): *criteria for low probability for injury* — no midline cervical tenderness; no focal neurologic deficit; normal alertness; no intoxication; no painful distracting injuries; mechanism of injury not included in criteria; *study* — 34 000 patients; 800 had spinal cord injury; missed 8 fractures, of which 2 clinically significant (one patient treated with soft collar, one had transient loss of consciousness and paraspinous muscle tenderness [probably failure to apply rules correctly]); *NEXUS* — very sensitive; avoids ≈1 in 8 radiographs; speaker uses criteria to justify not getting x-rays in patients who do not need them
- Canadian cervical spine rules: 10 Canadian centers involved in study; 20 criteria; 9000 patients enrolled; clinically cleared one third; 151 patients had injuries
  - High risk: older patients; dangerous mechanism; paresthesias in extremities; obtain films on these patients
  - Low risk: do not need films
  - Moderate risk: obtain films in patients who do not fall under high or low risk; range neck side to side to check for neck tenderness
  - Conclusion: more difficult to remember than NEXUS criteria but more sensitive and specific and have better inter-rater reliability
- Key point: whichever rules used, must know them well

Imaging options

- Three-view cervical series: review of NEXUS data shows about one third of 3-view plain films inadequate when patients had cervical fractures
- Flexion-extension films: traditionally used in patients who have neck tenderness despite normal appearance on 3 views; problem with getting adequate films in patients experiencing neck tenderness; number of studies show no neurologic sequelae from neck movement; one third of films inconclusive; significant minority of films inadequate
- Computed tomography (CT): moving up on algorithm; best for bone; shows more than plain films
  - Indications: patients with normal plain films who are in severe pain; abnormal neurologic examination; inadequate visualization; abnormal plain films; obtunded patients
  - Reasons for screening CT: high-velocity accident; distracting injuries; patient >50 yr of age; efficiency (if head CT indicated, request neck CT at same time)
- Magnetic resonance imaging (MRI): good for soft tissues and ligaments; starting to be used for grading injuries; indicated for patients with neurologic findings or persistent neck pain on follow-up

Steroids: many criticisms of National Acute Spinal Cord Injury Studies (NASCIS), *eg*, question whether "significant improvements" clinically relevant, placebo subgroups dissimilar; did not focus on preplanned primary outcome measures; difficult to prove results because placebo-controlled studies no longer allowed in United States; speaker passes decision on steroid use to consultant

Trends: less immobilization in field; physicians becoming more selective in ordering cervical spine films; CT use increasing (must consider benefits and risks; one CT gives same radiation as 350 chest x-rays); use of MRI gradually increasing; use of methylprednisolone gradually decreasing

PEDIATRIC HEAD TRAUMA — Jeffrey R. Avner, MD, Professor of Clinical Pediatrics, Albert Einstein College of Medicine, and Chief, Children's Emergency Service, Children's Hospital at Montefiore, Bronx, New York

Pathophysiology of head injury: *primary injury* — happens at scene and can cause brain damage directly; can lead to reactive lesions in central nervous system (CNS), *eg*, cerebral swelling, autoregulatory dysfunction in brain that can cause secondary injury that may result in brain damage; severe systemic injury (*eg,* bleeding, hypotension) can also cause secondary injury leading to brain damage; prevention of secondary injury goal of emergency management

Case 1: 8-yr-old boy unrestrained front seat passenger in motor vehicle accident (car hit light post); child's head struck windshield; windshield intact; child dizzy but oriented at scene; pulse 110 beats/min, respiratory rate 24 breaths/min, blood pressure (BP) 110/70 mm Hg; 30 min after event, child presents to ED oriented times 3, Glasgow Coma Scale (GCS) score 13; has bruise to upper forehead and no other obvious injuries; neurologic examination nonfocal

- Discussion: simple bruise to head can involve number of forces to brain, *eg*, rotational, shearing, pressure

Low-risk injuries: most common; patients commonly present completely asymptomatic or have mild headache, may have vomited once or twice, dizzy at scene but now resolved, normal neurologic examination; vomiting normal mechanism in young children, even after minor head trauma, as long as it is not progressive and takes place within 6 hr of injury; can dis-

Estimated time to complete the educational process:

Review Educational Objectives on page 3	5 minutes	Listen to audio program	60 minutes
Take pretest	10 minutes	Review written summary and suggested readings	35 minutes
		Take posttest	10 minutes

charge if patient does not decompensate after 2 to 3 hr of observation in ED

Moderate-risk injuries: not uncommon in pediatrics; have history of loss of consciousness (difficult to get accurate duration); progressive headache; vomiting >6 hr after injury; seizures; amnesia; severe associated injuries; drug or alcohol intoxication; suspected child abuse; evidence of basal skull fracture; observe for 4 to 6 hr; obtain CT if available; consider neurosurgical consultation; consider admission, depending on nature of injury and ability of parents to follow patient at home

High-risk injuries: depressed level of consciousness; penetrating injury; depressed skull fracture; focal neurologic examination; positional tachycardia; obtain immediate neurosurgical consultation

Initial management: secure airway; immobilize cervical spine; breathing; circulation; disability (check pupils and perform quick neurologic examination); exposure

Case 1 progression: categorized as moderate-risk injury; intravenous (IV) access established and O_2 placed; child sent to CT; upon return to ED, child disoriented, became lethargic; developed irregular respirations; pulse oximetry dropped to low 90s; heart rate fell from 112 bpm to 80 bpm; blood pressure rising; GCS score <8 (sign of intracranial hypertension); neurologic examination otherwise nonfocal; edema seen on CT

Pathophysiology of case 1

Intracerebral buffering system: intracranial vault consists of ≈80% brain, ≈10% blood, ≈10% cerebrospinal fluid (CSF); as brain swells, buffering of blood and CSF exhausted, resulting in dramatic rise in pressure

Cerebral perfusion pressure (CPP): comprised of mean arterial pressure (MAP) minus intracranial pressure (ICP); in normal brain, cerebral blood flow constant at normal MAP; CPP should be >50 mm Hg

Emergency management of increased ICP: place head in neutral position; elevate head of bed to 30°; use euvolemic dehydration; hyperventilate; goal to maintain MAP between 65 and 70 mm Hg

How hyperventilation works: produces hypocapnia, causing constriction of carotids, which reduces ICP by reducing cerebral blood flow; good for initial management (≈2 hr) because it slows expansion of bleeding and buys time to get child to neurologic evaluation and possible neurosurgical intervention

Intubation: indications include intracranial hypertension, abnormal respiratory rate or pattern, loss of protective airway reflexes, respiratory muscle dysfunction, or chest wall dysfunction; speaker uses MSOAP, *ie*, monitor, suction, oxygen, airway equipment, pharmacy (drugs and personnel); apply suction via nasogastric (NG) tube, preoxygenate with 100% O_2, apply cricoid pressure, give rapid infusion of sedative and muscle relaxant; make sure patient in full relaxation before performing laryngoscopy and intubation; use vagolytic (depending on physician style and age of patient), then use sedative (*eg*, thiopental or fentanyl), followed by full muscle relaxation (*eg*, vecuronium 0.2 mg/kg); lidocaine controversial

Managing ICP: many options, most not very effective; mannitol not helpful routinely (causes electrolyte problems, especially in children); steroids no longer used acutely; barbiturate coma should be reserved for intensive care unit (ICU); many complications with hypothermia

Case conclusion: child had diffuse axonal injury; typical sites of injury include internal capsule, cerebellar peduncle, and brainstem; perform serial examinations and get child to ICU as soon as possible

Case 2: 16-yr-old hockey player checked into boards, hit his head and fell to ground; probable loss of consciousness for about 1 min; dizzy on awakening, groggy for 10 to 15 min; vomited 3 times shortly after event; in ED 6 hr later, patient awake, alert, feels fine, and has normal vital signs on examination; no memory of incident; no vomiting within last 2 hr

Indications for CT: penetrating injury; signs of intracranial hypertension; GCS score ≤13; GCS score of 15 with signs of depressed skull fracture, prolonged (≥5 min) loss of consciousness, distracting injury, short loss of consciousness with contact seizure

Concussion: common injury in children; immediate transient interruption of normal neurologic function (loss of consciousness means patient had concussion but loss of consciousness not required for concussion); disturbance of vigilance and heightened distractibility or inability to maintain coherent stream of thought, or inability to carry out sequence of goal-directed movements; can be graded into categories 1, 2, and 3; recommended that player's season over by third concussion

Case 3: 9-mo-old child fell off changing table this morning; cried immediately; seemed fine after event; seen by regular physician 4 hr after event; physical examination normal; child diagnosed with minor head trauma and sent home; 8 hr after event, child presents to ED crying, irritable, not acting right, tachycardic; has swelling of right parietotemporal scalp; neurologic examination otherwise nonfocal

Epidural hematoma: 4% of children evaluated with CT have epidural hematoma; skull films can show fracture but often normal (rarely performed now); usually due to interruption of middle meningeal artery; generally presents in 3 ways

Classic presentation ("talk and die"): patient has loss of consciousness, followed by lucid interval, followed by lapse into coma; occurs in 33% of cases; trauma results in concussion and loss of consciousness; patient sustains tear in middle meningeal artery; child awakens; middle meningeal artery goes into spasm (child can look fine at this point); spasm stops, blood starts pouring into epidural space, causing compression; surgical emergency (good outcome if skull decompressed in timely fashion)

Loss of consciousness from scene: 33% of cases

No loss of consciousness: 33% of cases

Subdural hematoma: worse than epidural hematoma because mechanism worse; usually associated with underlying brain injury; high morbidity and mortality, especially in young children; consider child abuse

Case 4: 10-mo-old child presents with boggy right parietal swelling that mother noted this morning; child has been acting normally; no known recent trauma, except child fell out of stroller 3 days ago, cried, then seemed fine

Discussion: boggy scalp mass is subgaleal hematoma overlying linear simple skull fracture

Linear skull fracture: accounts for 90% of skull fractures; subgaleal hematoma may occur immediately but often delayed 3 to 5 days after injury; at speaker's institution, patients sent for CT to document simple skull fracture; can occur from minor event; no therapy required

Depressed skull fracture: feels like dented ping-pong ball; often associated with dural or cortical laceration; some underlying brain injury; depth of depression determines need for surgical intervention

Educational Objectives

The goal of this program is to educate the listener about spine and head trauma. After hearing and assimilating this program, the clinician will be better able to:

1. Name and describe 2 prominent algorithms for spine immobilization.
2. Describe and explain the National Emergency X-Radiography Utilization Study (NEXUS) criteria and the Canadian cervical spine rules for obtaining plain films in patients with suspected spine injuries.
3. Discuss the current status of the use of steroids in spinal injury.
4. Describe low-, moderate-, and high-risk pediatric head trauma.
5. Explain the management of increased intracranial pressure (ICP) in the pediatric patient.

Notes

Discussed on This Program

Fentanyl citrate [Sublimaze]
Lidocaine HCl (many trade names)
Mannitol [Osmitrol, Resectisol]
Methylprednisolone [Medrol]
Thiopental sodium [Pentothal]
Vecuronium bromide [Norcuron]

Programs of Related Interest

Bernstein RM, Bernstein SM: Back problems. *Audio-Digest Pediatrics* 52:03(Feb 7), 2006; **Bovis GK et al:** Spinal trauma. *Audio-Digest Orthopaedics* 29:01(Jan 1), 2006; **Congeni JA:** Sports injuries. *Audio-Digest Pediatrics* 51:14(Jul 21), 2005; **Herbert M:** Head trauma. *Audio-Digest Emergency Medicine* 21:05(Mar 7), 2004.

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Suggested Reading

Barry TB et al: Clinical decision rules and cervical spine injury in an elderly patient: a word of caution. *J Emerg Med* 29:433, 2005; **Biasca N et al:** Review of typical ice hockey injuries. Survey of the North American NHL and Hockey Canada versus European leagues. *Unfallchirurg* 98:283, 1995; **Brown LH et al:** Can EMS providers adequately assess trauma patients for cervical spinal injury? *Prehosp Emerg Care* 2:33, 1998; Cervical spine immobilization before admission to the hospital. *Neurosurgery* 50:S7, 2002; **Coleman WP et al:** A critical appraisal of the reporting of the National Acute Spinal Cord Injury Studies (II and III) of methylprednisolone in acute spinal cord injury. *J Spinal Disord* 13:185, 2000; **Dias MS:** Traumatic brain and spinal cord injury. *Pediatr Clin North Am* 51:271, 2004; **Dickinson G et al:** Retrospective application of the NEXUS low-risk criteria for cervical spine radiography in Canadian emergency departments. *Ann Emerg Med* 43:507, 2004; **Genuardi FJ et al:** Inappropriate discharge instructions for youth athletes hospitalized for concussion. *Pediatrics* 95:216, 1995; **Hauswald M et al:** Confusing extrication with immobilization: the inappropriate use of hard spine boards for interhospital transfers. *Air Med J* 19:126, 2000; **Hauswald M et al:** Out-of-hospital spinal immobilization: its effect on neurologic injury. *Acad Emerg Med* 5:214, 1998; **Knopp R:** Comparing NEXUS and Canadian C-Spine decision rules for determining the need for cervical spine radiography. *Ann Emerg Med* 43:518, 2004; **Nesathurai S:** Steroids and spinal cord injury: revisiting the NASCIS 2 and NASCIS 3 trials. *J Trauma* 45:1088, 1998; **Russ SA et al:** Patterns and risks in spinal trauma: the emergency transport perspective. *Arch Dis Child* 90:985, 2005; **Stiell IG et al:** The Canadian C-spine rule versus the NEXUS low-risk criteria in patients with trauma. *N Engl J Med* 349:2510, 2003; **Viccellio P et al:** A prospective multicenter study of cervical spine injury in children. *Pediatrics* 108:E20, 2001.

Faculty Disclosure

In adherence to ACCME guidelines, the Audio-Digest Foundation requests all lecturers to disclose any significant financial relationship with the manufacturer or provider of any commercial product or service discussed. For this issue, the faculty reported no conflict.

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*On a Test and Evaluation form, complete Pretest section **before** listening and Posttest section **after** listening.*

1. According to the Fresno algorithm, selective spinal immobilization may be safely applied in the prehospital setting.
   (A) True (B) False

2. When compared to the National Emergency X-Radiography Utilization Study (NEXUS) criteria, the Canadian rules for obtaining cervical spine films:
   (A) Are more sensitive and specific
   (B) Have better inter-rater reliability
   (C) Are more difficult to remember
   (D) A, B, and C

3. For patients in whom the traditional 3-view cervical x-ray series is inadequate, or who have neck tenderness despite a normal 3-view series, _____ is(are) increasing in importance in the cervical spine algorithm while the importance of _____ is(are) decreasing.
   (A) Flexion-extension x-rays; computed tomography (CT)
   (B) CT; flexion-extension x-rays

4. The use of methylprednisolone in patients with spinal trauma is gradually decreasing.
   (A) True (B) False

5. In the child with head trauma, which of the following is a sign of intracranial hypertension?
   (A) Heart rate 80 beats/min
   (B) Rising blood pressure
   (C) Glasgow Coma Scale score <8
   (D) Oxygen saturation 92%

6. Identify the *incorrect* statement about hyperventilation in the emergency management of increased intracranial pressure (ICP).
   (A) Produces hypocapnia
   (B) Reduces ICP by reducing cerebral blood flow
   (C) Slows expansion of bleeding in brain
   (D) P_{CO_2} should be brought down to 30 mm Hg for 36 hr

7. Which of the following is *not* necessary for a diagnosis of concussion?
   (A) Loss of consciousness
   (B) Disturbance of vigilance and heightened distractibility
   (C) Inability to maintain coherent stream of thought
   (D) Inability to carry out a sequence of goal-directed movements

8. In the classic presentation of an epidural hematoma:
   (A) Loss of consciousness is followed by a lucid interval
   (B) There is no loss of consciousness
   (C) There is continuous loss of consciousness from the time of injury

9. All else being equal, the prognosis is worse for a(n) _____ hematoma than for a(n) _____ hematoma.
   (A) Epidural; subdural (B) Subdural; epidural

10. Simple linear skull fractures:
    1. Account for 90% of skull fractures
    2. Can be caused by minor head trauma
    3. Do not require therapy
    4. May result in a subgaleal hematoma
    5. May lead to a leptomeningeal cyst

    (A) 1,2,5 (B) 2,3,4 (C) 1,2 (D) 1,2,3,4,5

Answers to Audio-Digest Emergency Medicine Volume 23, Issue 06: 1-B, 2-D, 3-A, 4-B, 5-C, 6-A, 7-B, 8-C, 9-A, 10-D

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