To Backboard or Not To Backboard? – Spinal Clearance Protocols

Will Smith, MD, NREMT-P
Medical Director, Jackson Hole Fire/EMS, Grand Teton National Park
Wilderness and Emergency Medicine Consulting (WEMC), LLC
www.wildmedconsulting.com

Friday, January 11, 2008 – 3:30-4:15 p.m.

NAEMSP 2008 Annual Meeting
Pointe Hilton Squaw Peak Resort, Phoenix, AZ
January 10-12, 2008

Lecture Summary:
With evidence based medicine becoming a new standard in EMS, how do we change our protocols on things such as spinal immobilization that have been the standard of care without being proven as the best patient practice.

Objectives:
1) Review research on spine injuries and evaluation standards.
2) Discuss standard of care and protocols regarding spine injuries.
3) How to implement focused spinal assessment protocols in your system.

Objective 1 – Review Research on spine injuries and evaluation standards.

Reference Summaries:

Summary: Evaluation of Maine’s (primarily rural state) Prehospital selective spine assessment protocol instituted July 1, 2002. In the 12 month study period, only one patient with an unstable spine fracture, and 19 stable fractures, were found to have not been immobilized by the protocol in approximately 32,000 trauma encounters. This single unstable spine injured patient was a 86 y.o. female who moved furniture one week prior to calling EMS and had a T6/7 subluxation that required operative fusion without any spinal cord injury. The protocol effectively decreased the number of patients immobilized by more than half. Its Sensitivity was 94.1% (CI95 of 82.9-100), Negative Predictive value of 99.9% (CI95 of 99.8-100), Specificity 59.3% (95CI of 58.8-59.8), and Positive Predictive Value of 0.1% (95CI of 0.1-0.1) for unstable acute spine fractures (unstable=required surgery). This study applied the rule to whole spine(C, T, and L). The protocol was instituted in patients with a mechanism of injury:
   a) Axial loading (diving)
   b) Blunt trauma
   c) MVC – all motorized vehicles including automobile, motorcycle, snowmobile, etc.
   d) Adult fall from standing height
Then if they were reliable (calm, cooperative, sober, and alert) without intoxication, altered LOC, or Acute Stress reaction. Also no distracting injury (any injury that produces clinically apparent pain that might distract the pain from the pain of a spine injury).

If the patient was then found to have no abnormal sensory/motor exam and no spine pain/tenderness they didn’t need to be immobilized. Very similar to NEXUS criteria. Elderly patients > 65 y.o. seemed to be the largest number of stable spine fractures without neurologic compromise, but also higher risk of complications (pain, pressure sores, respiratory compromise, etc.) from spinal immobilization. Simple and safe application of a selective spine immobilization protocol that supports pre-hospital EMS use.

Same study population as above reference (Burton, Trauma 2006) but looked more the historic perspective of the Maine spine protocols and reasons why patients were immobilized (disqualified from non-immobilization). Immobilization decision was made for 1,301 (59%) of 2,220 patients in which spine assessment from was completed: 416 (32%) were unreliable, 358 (28%) were considered to have distracting injuries, 80(6%) had abnormal neurological exam, and 709 (54%) had spine pain or tenderness. Linked hospital data showed that of the 2,220 patients, only 7 acute spine fractures, which were all appropriately immobilized. This study concluded that the pre-hospital spine assessment protocol resulted in a non-immobilization decision in approximately 40% of their trauma patients without any adverse outcomes or misses.

Summary: Prospective ALS pre-hospital EMS system in two southeast Michigan counties (mixed suburban/rural) that implemented a spine injury assessment protocol in October 1997 and examined 4 years of outcome data. The protocol used the similar 5 NEXUS categories for spinal assessment.

a) altered mental status
b) evidence of intoxication
c) suspected extremity fracture
d) neurologic deficit
e) spine pain or tenderness

There were 18,594 trauma patients with evaluation by protocol in 13,483 patients. Complete data for 13,357 available for analysis. Spine injuries confirmed in 415 (3%) and 50 patients had cord injuries (12% - 50 of 415). Sensitivity of the protocol was 92% (CI95 of 89.4-94.6) resulting in the nonimmobilization of 8% of the patients with spine injuries (33 of 415), but none had spinal cord injury. Specificity was 40% (CI95 of 38.9-40.5). 39% of patients were appropriately cleared from spinal immobilization. Some deviation from the protocol occurred, but none had a spinal cord injury. The protocol resulted in immobilization or most patients without causing harm because of spine immobilization.

Great study that evaluated 5 years of retrospective chart reviews from 2 university hospitals, one in Malaysia without an organized EMS system, and thus no spinal immobilization, and then and modern EMS system in Albuquerque, NM. All patients with acute blunt traumatic spinal or spinal cord injuries transported directly from the injury site to the hospital were evaluated. None of the 120 patients seen at the University of Malaya had spinal immobilization and all 334 patients seen at the University of New Mexico did. Neurologic injuries were labeled as disabling or not. There was less neurologic disability in the unimmobilized Malaysian patients (OR 2.03, CI 95 of 1.03-3.99). This corresponds to a <2% chance that immobilization had any beneficial effect. This study evaluated the entire spine and then again to just c-spine injuries. It was concluded from the data that out-of-hospital immobilization has little or no effect on neurologic outcome in patients with blunt spinal injuries. This was a rare study to be able to find a location that did not do spinal immobilization as it is considered to be the standard of care in many locations.
Although this study was a retrospective chart review, it disproves many theories that are the basis of many justifications for spinal immobilization for all patients with blunt trauma.

(NEXUS – National Emergency X-radiography Utilization Study)

Landmark article to move to a standard of clinical spine clearance in selected emergency department patients with blunt trauma and minimal symptoms—prospective observational study. Estimated in US 800,000 cervical spine imaging per year. This study evaluated 34,069 blunt trauma patients in 21 centers—predicted avoidance of radiographic imaging in 4,309 pts (12.6%)—all patients did have films. C-Spine injuries found in 818 pts (18.9%), clinically significant injuries 578 (13.4%). Identified all but 8 of the 818 pts with c-spine injury (sens 99.0% - 95%CI 98.0-99.6%). Negative Predictive Value of 99.8% (95% CI 99.6-100%). Specificity was 12.9% and Positive Predictive Value of 2.7%. Only 2 pts classified as unlikely to have injury had a clinically significant injury—1 of which did require surgical treatment. Need to have ALL 5 criteria to have low probability of injury (no radiographic study required):

1. No midline cervical tenderness
2. No focal neurologic deficit
3. Normal alertness
4. No intoxication
5. No painful/disturbing injury

Practitioners should be free to make exceptions for individual patients on clinical grounds.


No randomized control trials (RCT) have been performed on trauma patients in regard to spinal immobilization to determine its efficacy, and what techniques are superior. This study reviewed 17 RCT’s on healthy subjects that showed collars, full spine boards, vacuum splints, and abdominal/torso strapping provided the most significant reduction in spinal movement. The studies also clearly demonstrated the adverse effects of spinal immobilization with increased respiratory effort, skin ischemia, pain, and discomfort.


The review study objective was to quantify the effect of different methods of spinal immobilization (including immobilization versus no immobilization) on mortality, neurological disability, spinal stability and adverse effects in trauma patients. Extensive database searches were performed (MEDLINE, EMBASE, etc) as well as contacting manufactures in spinal immobilization devices. No randomized controlled trials (RCT) of spinal immobilization strategies in trauma patients were found. Trials in healthy volunteers were excluded. They concluded that the effect of spinal immobilization on mortality, neurological injury, spine stability and adverse effecting trauma patients remains uncertain and needs RCT studies. Airway concerns, breathing problems, pain, increased ICP, and tissue pressure in trauma patients are valid concerns that may lead to worsened morbidity and mortality in spinal immobilized patients without evidence based justification of the procedure. “The current protocol for pre-hospital spinal immobilization has a strong historical rather than scientific precedent.” It is estimated that over 50% of trauma patients without neck/back pain are unnecessarily transported in full spinal immobilization.


This article was an attempt to evaluate the cases for litigated missed cervical spine injuries in 10 states over 5 years. Type I error (inadequate or improper tests ordered) and Type III error (adequate tests were ordered
and read accurately but were not sensitive enough to demonstrate injury) were the cases that sometimes could be successfully defended. Type II error (errors occurred when adequate tests were ordered, but were either misread, or not read at all) in all studied cases led to successful litigation against the defendants. Twenty cases were identified and averaged awards for $2.9 million. Eight cases resulted in verdicts in favor of the defendants, but none of these successfully defended cases were a Type II error. If CT scanning and flexion/extension plain films are ordered in patients with a high suspicion of cervical spinal injury, a marked decrease in missed injuries would be reported, and subsequently successful litigation.

Prospective observational study in 21 centers identifying demographics of patients requiring spine radiographs from blunt trauma. Cervical spine injury is relatively rare, occurring in only 2-3% of patients with blunt trauma who undergo imaging studies, this study found 2.4% of patients presenting with blunt trauma. Substudy under NEXUS. Relative risk for injuries is greatest with elderly (>64) at 2.09, adult 0.87, and ped (<18) 0.39. Male sex RR of 1.72.

Canadian version of NEXUS with some subtle differences, but similar outcomes and recommendations. Estimated 1 million blunt trauma patients with possible C-Spine injuries are treated in the US each year. Incidence of acute fracture or spinal injury is less than 1%. This study evaluated a convenience sample of 8,924 adults (12,782 pts examined, 577 not x-rayed and couldn’t have 14 day phone f/u – considered less severely injured, 3,281 not enrolled by primary physician for variable reasons – but similar characteristics) in 10 large Canadian community and university hospitals. Patients were alert (GCS>15) and had stable v.s. Exclusions were <16 yo, minor injuries or no significant mechanism, GCS <15, abnormal v.s., injured >48 hours prior, penetrating trauma, paralysis, known vertebral disease, return visits for same complaint, pregnant. Not all patients had radiographs, phone follow up used to confirm no injuries – 2779 (31.1%). C-spine radiography in 6,145 pts (68.9%), CT studies done in 436 pts (4.9%). Of all study patients on 151 (1.7%) found to have clinically important c-spine injury, 28 found to have insignificant injury 28 (0.3%). Using criteria to find the 151 clinically important cases the rule had a sensitivity (95% CI) of 100% (98-100%), specificity of 42.5% (40-44%). Potential decrease of radiography using these rules with a relative reduction of 15.5% (1,383 pts) from 68.9% (6,145 pts) of the total 8,924 pts in the study. The rule would have also had identified 27 or 28 patients with clinically unimportant C-spine injuries. Same study population with NEXUS criteria – missed 10 of 148 injuries that were important – giving a sensitivity of only 93%. Needs further prospective study to validate.
Canadian C-spine rule – if all are met than no radiography is needed
Patients must first be:
1. Alert (GCS 15)
2. Stable v.s. in trauma patient where C-Spine injury is a concern
Then:
1. <65 yo
2. No dangerous mechanism (fall >= 5m/5 stairs, axial load-diving, MVC >100km/h (62mph), rollover, ejection, motorized recreational vehicles, bicycle collision)
3. No paresthesias in extremities
Any low risk factor that will allow safe ROM:
1. Simple rear-end MVC (excluded are: pushed into oncoming traffic, hit by bus/large truck, rollover, hit by high-speed vehicle)
2. Sitting position in ED
3. Ambulatory at any time
4. Delayed onset of neck pain (not immediate)
5. Absence of midline c-spine tenderness
Then:
1. Ability to actively rotate head 45 degrees to left and right

This study set out to compare the US study NEXUS Low Risk Criteria (NLC) decision rule to guide the use of cervical spine radiography in trauma patients with the Canadian C-spine Rule (CCR). A prospective cohort study was performed in 9 Canadian emergency departments who utilized the 2 rules in stable, alert trauma patients. 394 physicians evaluated 8,283 patients, with an overall incidence of 169 (2%) had actual clinically important spine injuries. Each patient with the two rules before x-rays were obtained. The CCR was more sensitive than the NLC (99.4% vs. 90.7%, p <0.001) and more specific 45.1% vs. 36.8%, p<0.001) at detecting spine injuries. This was only done in a limited age range of 16-65 yo. The CCR is more complete and thus has better sensitivity and specificity, but more cumbersome for the treating clinician. There may have been some bias acknowledge by the authors, as this was a Canadian study and there may have been more research familiarity, thus leading to a better utilization rate for the CCR. The authors concluded that the CCR was superior to the NLC.


This study evaluated the selective spine immobilization protocol in EMS services in Fresno County, CA over a 6 year period by retrospective chart reviews at 5 local trauma hospitals. The patients with a diagnosis of cervical spinal injury were identified. 861 patients with significant injuries were transported and brought 504 patients by EMS with 495 arrived in spinal immobilization. Of the remaining 9 patients, 2 refused, 2 could not be immobilized, 3 injuries were missed by the protocol criteria, and 2 were missed because of protocol violations. The result was that the protocol was 99% (CI95 97.7-99.7) sensitive and safe, but should be used with caution at extremes of age (4 patients missed were older than 67 and one was 9 months old).
Objective 2 - Discuss standard of care and protocols regarding spine injuries

Spine immobilization for trauma based on mechanism of injury is one of the most frequently performed prehospital procedures. For some patients, effective spinal immobilization is prudent, yet for many the excessive use of this precaution may not be beneficial or necessary, and may do harm. It is estimated that over 50% of patients currently immobilized could be saved this procedure without untoward effects. The ‘old’ unproven standard of care for all patients with concern for spinal column/cord injury is based on historical rather than scientific precedent.

Several EMS systems have successfully implemented selective spine immobilization protocols that seem to be safe and effective. In other countries in the world where little or no EMS systems exist, data has shown that outcomes are no worse without spinal immobilization. It is thought that the massive trauma exerted to cause a injury occurs at the time of the accident, but limited motion during treatment is orders of magnitude less and thus unlikely to cause more injury. There are significant benefits of these protocols in Urban, Rural, and Wilderness EMS settings.

See appendices for protocols.

Objective 3 - How to implement focused spinal assessment protocols in your system.

Review Research (above articles are a start – but you need to do your own as well)
Medical Director and Medical Control support
Review Established Protocols
Develop Protocol that works for your system
Good QA/QI system in place to assure compliance with protocol
Education of EMS providers
Review outcomes and decisions on an ongoing basis
The Canadian C-Spine Rule

For alert (GCS=15) and stable trauma patients where cervical spine injury is a concern

1. Any High-Risk Factor Which Mandates Radiography?
   - Age > 65 years
   - Dangerous mechanism*
   - Paresthesias in extremities

   **No**

2. Any Low-Risk Factor Which Allows Safe Assessment of Range of Motion?
   - Simple rear-end MVC **
   - Sitting position in ED
   - Ambulatory at any time
   - Delayed onset of neck pain ***
   - Absence of midline c-spine tenderness

   **Yes**

3. Able to Actively Rotate Neck?
   - 45° left and right

   **Able**

   **No Radiography**

**Dangerous Mechanism:**
- fall from elevation > 3 feet / 5 stairs
- axial load to head, e.g. diving
- MVC high speed (> 100km/hr), rollover, ejection
- motorized recreational vehicles
- bicycle collision

**Simple Rearend MVC Excludes:**
- pushed into oncoming traffic
- hit by bus / large truck
- rollover
- hit by high speed vehicle

**Delayed:**
- i.e. not immediate onset of neck pain

**Radiography**

**Unable**
Appendix B – Nexus Low-Risk Criteria, Stiel, NEJM, Dec 25, 2003
(full reference above)

<table>
<thead>
<tr>
<th>Table 1. The NEXUS Low-Risk Criteria.⁹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervical-spine radiography is indicated for patients with trauma unless they</td>
</tr>
<tr>
<td>meet all of the following criteria:</td>
</tr>
<tr>
<td>No posterior midline cervical-spine tenderness, †</td>
</tr>
<tr>
<td>No evidence of intoxication, §</td>
</tr>
<tr>
<td>A normal level of alertness, ¶</td>
</tr>
<tr>
<td>No focal neurologic deficit, ¶ and</td>
</tr>
<tr>
<td>No painful distracting injuries. ‡</td>
</tr>
</tbody>
</table>

* Criteria are from Hoffman and colleagues. ⁺
† Midline posterior bony cervical-spine tenderness is present if the patient reports |
  pain on palpation of the posterior midline neck from the nuchal ridge to the |
  prominence of the first thoracic vertebra, or if the patient evinces pain with |
  direct palpation of any cervical spinous process.
§ Patients should be considered intoxicated if they have either of the following: |
  a recent history provided by the patient or an observer of intoxication or intoxi- |
  cating ingestion, or evidence of intoxication on physical examination such as |
  an odor of alcohol, slurred speech, ataxia, dysmetria, or other cerebellar find- |
  ings, or any behavior consistent with intoxication. Patients may also be con- |
  sidered to be intoxicated if tests of bodily secretions are positive for alcohol or |
  drugs that affect the level of alertness.
¶ An altered level of alertness can include any of the following: a Glasgow Coma |
  Scale score of 14 or less; disorientation to person, place, time, or events; an in- |
  ability to remember three objects at five minutes; a delayed or inappropriate |
  response to external stimuli; or other findings.
‡ A focal neurologic deficit is any focal neurologic finding on motor or sensory |
  examination.
| No precise definition of a painful distracting injury is possible. This category |
| includes any condition thought by the clinician to be producing pain sufficient |
| to distract the patient from a second (neck) injury. Such injuries may include, |
| but are not limited to, any long-bone fracture; a visceral injury requiring surgic- |
| al consultation; a large laceration, degloving injury, or crush injury; large |
| burns; or any other injury causing acute functional impairment. Physicians |
| may also classify any injury as distracting if it is thought to have the potential |
| to impair the patient’s ability to appreciate other injuries. |
Spine Immobilization

Scope of practice: EMT, Parkmedic

Indications: Spinal immobilization is indicated for any patient with a history of trauma or found in the setting of potential trauma (including near-drowning) who meets any of the following criteria:

1. **Unstable Patient:** See Adult and Pediatric Major Trauma Protocols
2. **Pain:** Complaining of neck or back pain (without language barrier)
3. **Tenderness:** Midline posterior neck or back tenderness
4. **Altered mental status:** either GCS less than 15 or evidence of intoxication (drugs or alcohol)
5. **Distracting injury:** Any injuries which appear to be distracting patient from identifying neck or back pain (ex major fractures)
6. **Neuro deficit:** Any numbness, tingling or weakness not obviously explained by a co-existing extremity fracture
7. **Restricted or painful range of motion:** if a patient meets none of the above 5 criteria then they should be asked to move their head slowly from side to side and forward and backwards. If they are unable/unwilling to do so or describe pain or numbness/tingling in their arms or legs they should be immobilized.

Equipment: Backboard, rigid cervical collar, tape, straps, head supports

Procedure:
Complete spinal immobilization should ideally include backboard, rigid cervical collar, head support, taping of head to board and strapping of torso/extremities which permits patient to be turned on their side in case of vomiting, without movement of the spine. In the event that such equipment is not immediately available, immobilization can be maintained manually, using a blanket roll or other improvised bilateral head supports that prevent rotation and flexion. Specific attempts at improvising a collar need not be made.

Notes:
1. Children injured in motor vehicle collisions shall be immobilized and transported in their car seats whenever possible. Small children immobilized on a board will often require padding behind their torso to maintain neutral position because of their relatively large head.
2. C-spine: splint head-to-pelvis, no lateral movement of pelvis/legs, limited bending at hips OK for comfort.
   T-spine: splint head-to-pelvis, immobilize legs at hip (may pad pelvis for comfort)
   L-spine/pelvis: splint t-spine, pelvis, hips. Neck and head may be free for patient comfort.
3. When any doubt exists, err on the side of immobilization. This is especially true in the elderly.

Cross Reference:
Major Trauma – Adult and Pediatric
All other protocols when a potential spinal injury may exist:
Altered Mental Status
Near Drowning
Hypothermia/Hyperthermia
www.maine.gov/dps/ems/docs/Spinal%20QI%20Form.pdf

**SPINE ASSESSMENT PROTOCOL**

Suspected Spinal Injury

- Don’t Immobilize
- Immobilize

**MVC** applies to crashes of all motorized vehicles, e.g., automobile, motorcycle, snowmobile, etc.

**Clearence of the spine requires the patient to be calm, cooperative, sober, and alert.

**Distracting injury includes any injury that produces clinically apparent pain that might distract the patient from the pain of a spine injury.**

This protocol may be used by MEMS licensees, at the EMT Basic level or above, who have successfully completed the MEMS Spine Injury Management Course.

Graetz
PROTOCOL 4: SPINE INJURIES

Spinal assessment criteria allow rescuers to determine the need and justification for spine stabilization in the presence of an uncertain or positive mechanism of injury. This evaluation focuses on patient reliability, spinal column stability and neurologic function. Adequate time must be allowed for the evaluation. A clear assessment means that there is no significant spine injury and no need for spine stabilization.

1. Assess the mechanism. If a positive or uncertain mechanism exists, protect the spine by whatever method is feasible and available. This could include (but is not limited to) manual stabilization in the in-line position.

2. Do a thorough evaluation including a history and physical examination. To rule out a significant spine injury the patient must meet all of the following criteria:
   a. Patient must be reliable. The patient must be cooperative, sober, and alert, and must be free of other distracting injuries significant enough to mask the pain and tenderness of the spine injury.
   b. Patient must be free of spine pain and tenderness.
   c. Patient must have normal motor/sensory function in all four extremities:
      - Finger abduction/adduction or wrist extension (check both hands)
      - Foot plantar flexion/extension or great toe dorsiflexion (check both feet)
      - No complaint of numbness and sensation intact to sharp and dull stimuli in all four extremities
      - If reduced function in one particular extremity can be attributed with certainty to a specific extremity injury (e.g., unstable wrist injury), that deficit alone will not preclude ruling out a spine injury.

3. If a significant spine injury cannot be ruled out, the patient should be stabilized in a safe and comfortable position on a board, litter or other appropriate carrying device. Arrange for transport to hospital.

NB: There are situations in wilderness and technical rescue where the risk of spine stabilization exceeds the presumed benefit. In these circumstances spinal stabilization may be deferred or modified until risk can be mitigated. In unstable scenes or with unstable patients the remote possibility of exacerbating a spine injury may not justify the additional risk associated with stabilization.

The above specified protocol has been authorized for use by Wilderness Medical Associates WALS®, WRM, WEMT, WFR, and WAFA trained employees of the employer named on page one provided that they meet the requirements of the authorization criteria listed on page one.

________________________________________________________________________
Organization Date

________________________________________________________________________
Authorized Representative Position

________________________________________________________________________
Physician Advisor

Field Protocols for Staff Manual
©2007, Wilderness Medical Associates ©

rev. 02.09.07