

# To C-Spine or Not to C-Spine....

Kevin Parkes, M.D.





# Disclosures:

- None!



# Warning!

- This one is tough...
- Get ready to rethink your training!!
- “Mechanism of Injury” .....
- Remember CPR
  - ABC



# Pediatric issues

- General spinal precaution lecture
  - Discussion important here
- Peds differences
  - Age
  - Anatomy
  - Studies



**KEEP  
CALM  
AND  
DEMAND  
EVIDENCE**



# Two Different Questions

- Spinal precautions
  - Things have changed
  - Lots to consider
- Spinal clearance
  - We will touch on this first



# Spinal Clearance

- In selected patients:
  - Allows us to eliminate ANY spinal precautions
  - Safe
  - Validated
  - Just have to follow the rules
  - We use daily in the ED
  - Valuable tool



# Spinal Clearance

- Good evidence for this.
- **NEXUS (National Emergency X-Radiography Utilization Study)**
- **CCR (Canadian C-Spine Rules)**





# Canadian C-spine Rules

- No patients under 16
- Good for adults
- Not applicable to pediatric patients



# NEXUS (2000)

- There is no posterior midline cervical tenderness
- There is no evidence of intoxication
- The patient is alert and oriented to person, place, time, and event
- There is no focal neurological deficit
- There are no painful distracting injuries (e.g., long bone fracture)



# What About Peds?

- Can we use NEXUS?
  - Pediatric Subset: Viccellio et al 2001
- A few numbers: 34,069 – total patients in NEXUS
  - 3065 children < 18yrs
    - 603 “low risk”
      - 100% negative x-rays
    - 30 with CSI
      - 100% detected by NEXUS
      - Only 4 CSI < 9 yrs old
- Number of young kids is too small
  - Would take 80,000 children in a study to reach acceptable CI



# What About Peds?

- Go to the experts:
  - American Association Of Neurological Surgeons
    - recommend application of NEXUS criteria for children >9yrs
  - Viccellio:
    - Use NEXUS 12 or older
  - NEXUS Pediatric Study:
    - OK to use with younger kids
  - Pediatric Emergency Care Applied Research Network (PECARN)



# Enhanced Pediatric Clearance

- Pediatric Emergency Care Applied Research Network (PECARN)
- 540 children with trauma/ total 1774 controls
- Eight factors identified
  - altered mental status
  - focal neurologic findings
  - neck pain
  - torticollis
  - substantial torso injury
  - conditions predisposing to cervical injury ie Down Syndrome
  - diving
  - high risk MVA

# Enhanced Peds Clearance

- Conclusion : would have detected 98% CSI ;
- Reduced exposure to spinal immobilization
- Reduce ionizing radiation for non CSI children by more than 20%





# What should we do?

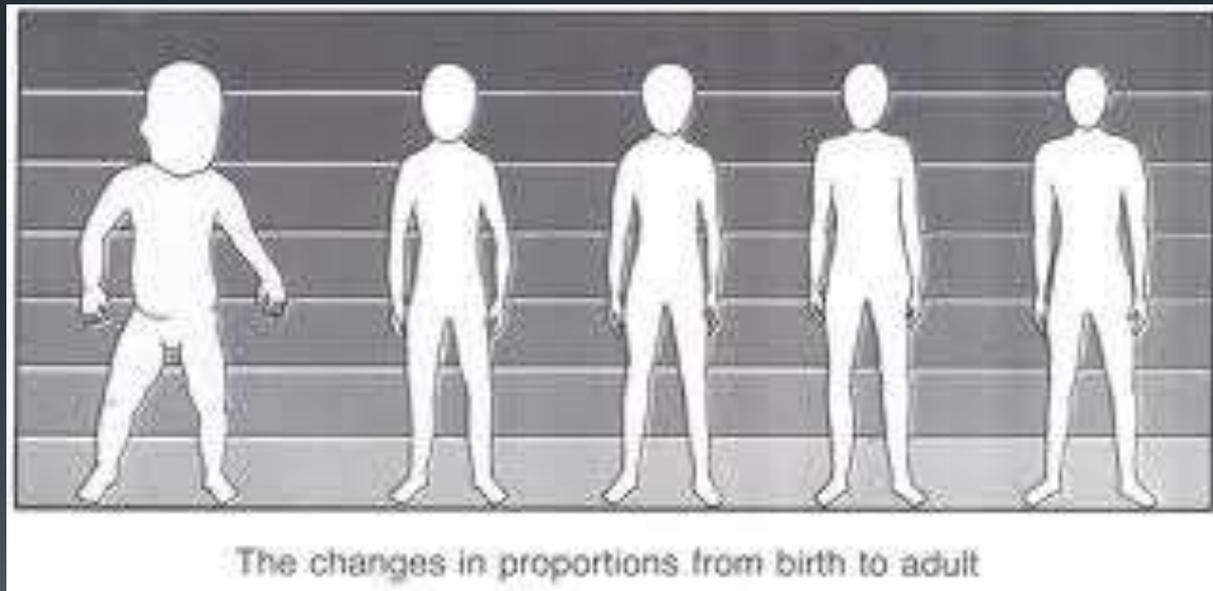
- Let's stop for a second
- Why does age matter?



# Pediatric Spinal Injuries

- Low incidence
  - National Trauma Registry avg 100 new cases per year
  - 1.5% blunt trauma patients
  - 35% with cord injury
- Higher mortality
- < 8 years
  - 2/3 above C3

# Pediatric C-spine injuries





# Pediatric C-spine injuries

- Young children's:
  - Heads are relatively
    - Bigger
    - Heavier
  - Necks are weaker
  - Spinal canals are smaller
  - Facets are flatter
  - Ligaments are more lax



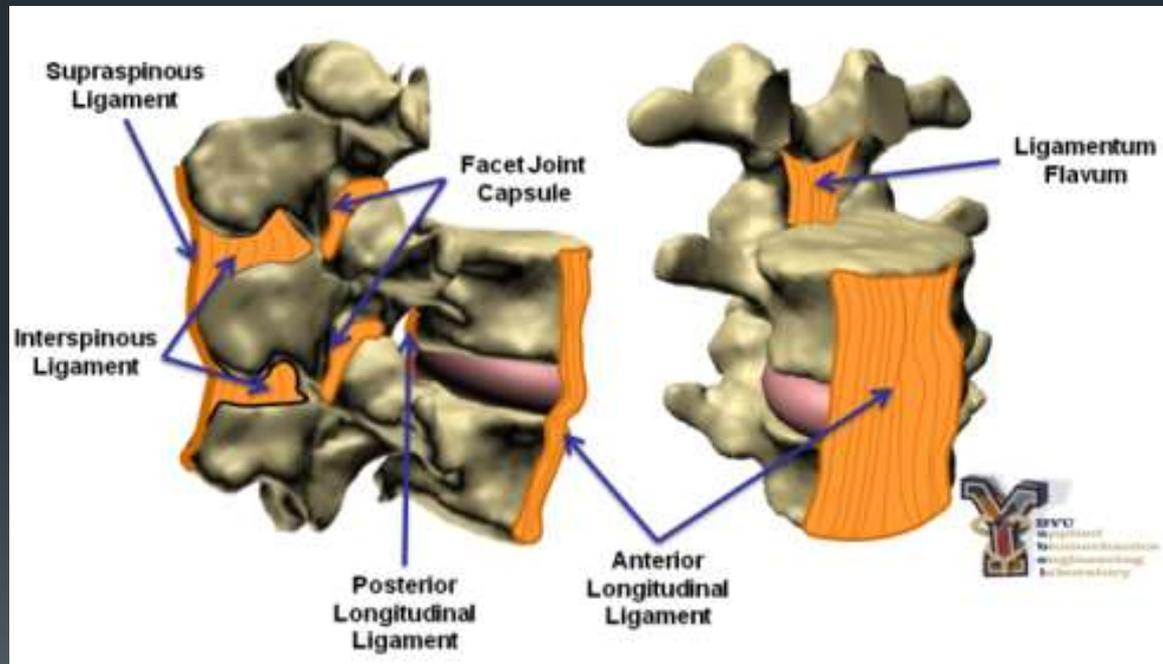
# Pediatric C-spine injuries

- Bigger, heavier head = higher “fulcrum”
  - Area where greatest force is applied
  - Explains more common C2C3 injuries
  - Craniocervical junction is more vulnerable
- Weaker muscles = less ability to protect
- Smaller canal = easier to shear
- Facets are flatter = easier for vertebra to move
- Ligamentous laxity = less boney stability
  - SCIWORA

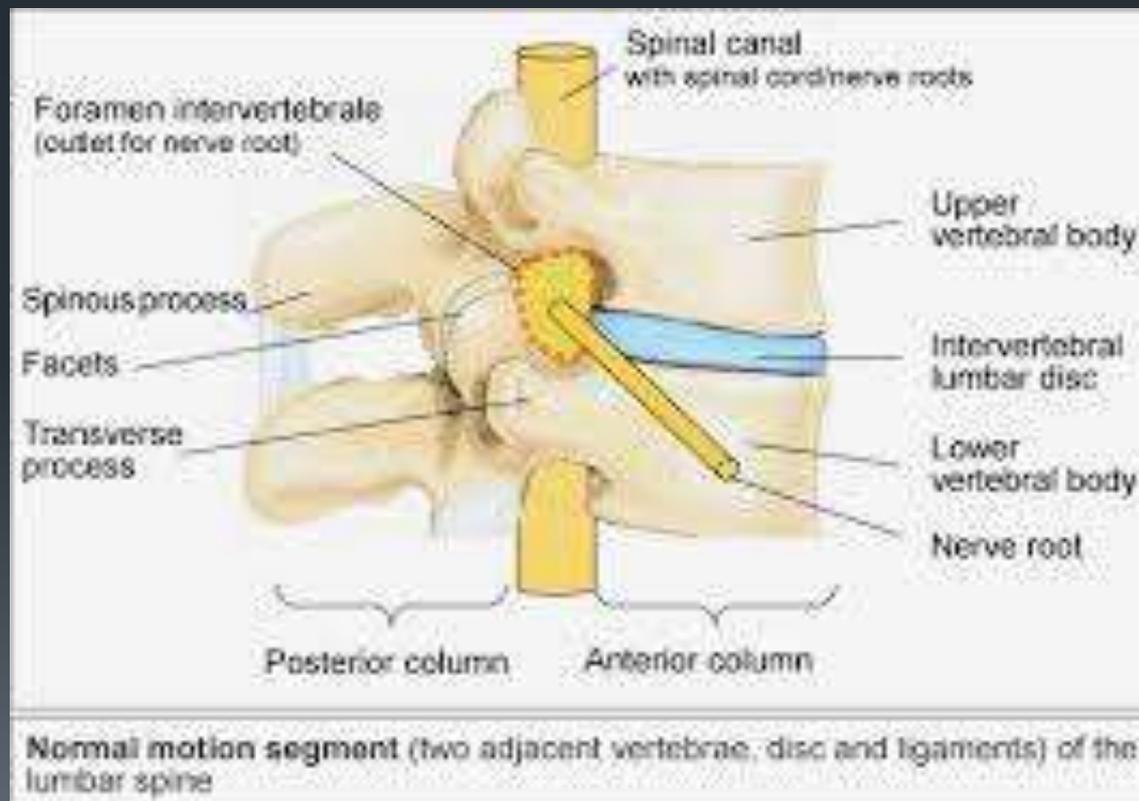
# Vertebra



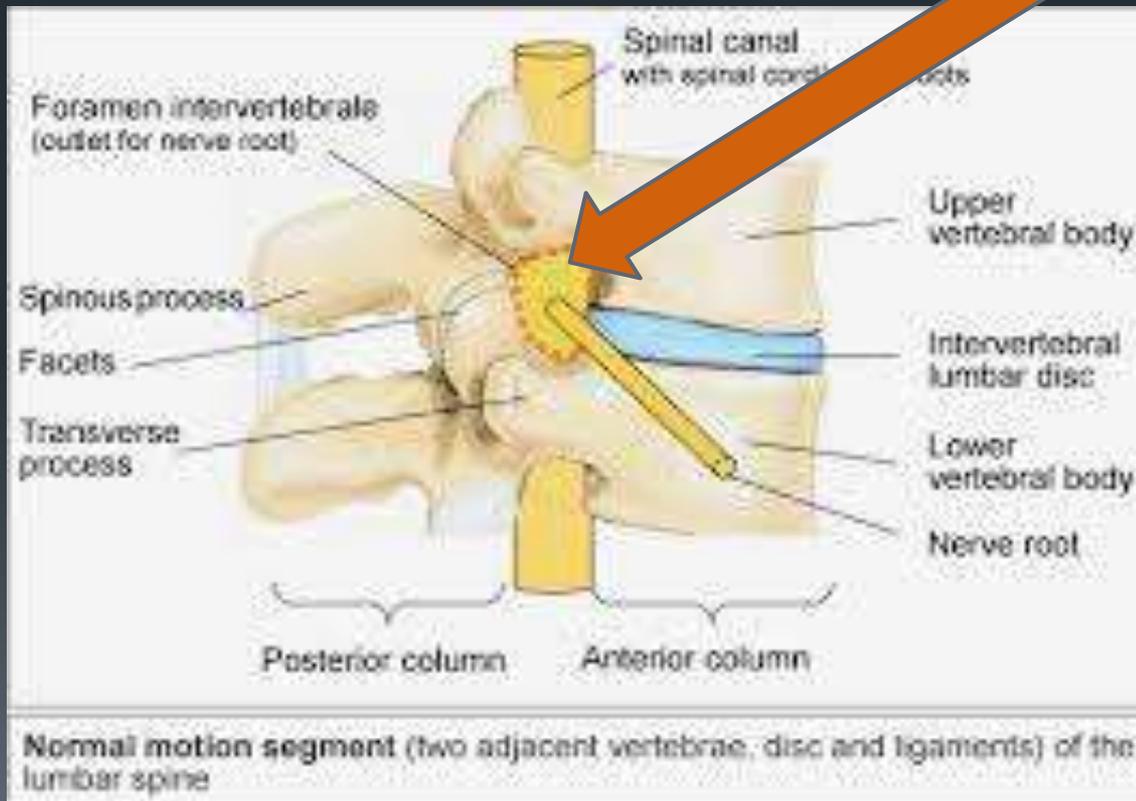
# Spinal ligaments



# Spinal column



# Spinal column





# SCIWORA

- Bones look OK
- Neck “flexed” enough to cause cord injury without bone injury
  - +/- ligamentous disruption
- Neuro deficit
  - Can be transient
  - Can return with later swelling
- Happens in adults too but usually considered with kids



# What should we do?

- Room for debate, but:
  - NEXUS criteria can cautiously be applied to patients older than 8
  - Younger children cannot be cleared based on NEXUS alone.
  - Enhanced clearance can be considered

C-spine

C-Collar

LONG BOARD

Immobilization

SPINAL PRECAUTIONS





# What are Spinal Precautions?

- C-collars
- Long board
- Straps
- Head Bed or blocks
- Tape
- Maybe a KED or short board



# What are our goals:

- Questions to answer:
  - What is best for our patients?
    - What method of extrication causes the least spinal movement?
    - What method of transport is most appropriate for potential spinal?
    - Do current treatments cause any harm?
    - Does age matter?
  - Does what we do work?
  - Is there a better way?



# Remember!

- I am NOT saying that protecting the spine is not important
- I AM saying we need to look at the best way to treat each patient
- One size won't fit all



# Dogma

Mechanism = Injury = Instability so...  
Movement = Paralysis = Bad

Full c-spine precautions prevent this =  
Protect the patient (and us...)

# Where did this come from:

- Initially, longboard was used to transport people
  - WW2
  - It was practical and made sense
  - Immobilization was not the goal





# Where did this come from:

- 60's
  - Farrington
    - Boards good because patients “don't sag.”
    - Movement device, not long term immobilization
  - Geisler
    - Surgeon
    - Delayed paralysis in skull fx patient
    - “faulty handling”



# Where did this come from:

- 70's
  - Longboards were adopted as useful devices
  - Idea of “underappreciated” injuries led to longboards for ANY mechanism
    - Regardless of symptoms...
- 80's
  - The idea of occult injury leads to full precautions on everyone based on mechanism



# Where did this come from:

- Studies showing benefit
  - Before? Since?
  - No randomized, controlled trials have shown longboards and “full spinal immobilization” to be beneficial
  - No studies show that patients do better because of long boards
  - Hmm...

# What DO the studies show?

- Younger kids
- Older kids and adults



# Younger Kids

## Variability of Prehospital Spinal Immobilization in Children at Risk for Cervical Spine Injury

*Emily G. Kim, MPH,\* Kathleen M. Brown, MD,† Julie C. Leonard, MD, MPH,‡  
David M. Jaffe, MD,‡ Cody S. Olsen, MS,§ and Nathan Kuppermann, MD, MPH,\*||  
for the C-Spine Study Group of the Pediatric Emergency Care  
Applied Research Network (PECARN)*

# Younger Kids

## **CONCLUSIONS**

Prehospital spinal immobilization is applied inconsistently to children at risk for CSI, particularly those younger than 2 years. It is imperative that we investigate why spinal immobilization is inconsistently applied in the prehospital setting among children at risk for CSI. In addition, further research is needed to identify the superior screening criteria and techniques for spinal immobilization of young children after blunt trauma.

# Younger Kids

## CONCLUSIONS

Prehospital spinal immobilization is applied inconsistently to children at risk for CSI, particularly those younger than 2 years. It is imperative that we investigate why spinal immobilization is inconsistently applied in the prehospital setting among children at risk for CSI. In addition, further research is needed to identify the superior screening criteria and techniques for spinal immobilization of young children after blunt trauma.

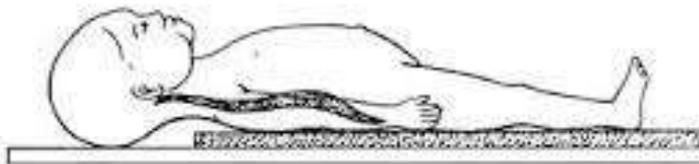


# Younger Kids

- Cannot adequately be cleared
- There is not enough research yet
- Peds boards

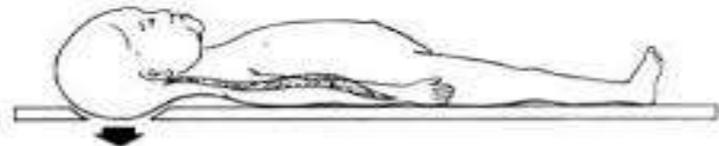
# Peds Boards

**Figure 2b. Young Child Positioned On A Standard Adult Backboard With Padding**



Young child positioned on a backboard with a double thickness mattress pad that raises the chest relative to the head allowing for neutral positioning of the cervical spine.

**Figure 2c. Young Child Positioned On A Modified Backboard**



Young child positioned on a modified backboard with a recessed area for the occiput that again allows for neutral positioning of the cervical spine. Reprinted with permission from Herzenberg JE, Hensinger RN, Dedrick DK, et al. *Emergency transport and positioning of young children who have an injury of the cervical spine. J Bone Joint Surg.* 1989; 71:15-22.

# Peds Boards





# Younger kids

- Cannot adequately be cleared
- There is not enough research yet
- Peds boards
  - Soft
  - Anatomically appropriate



# Younger kids

- Cannot adequately be cleared
- There is not enough research yet
- Peds boards
  - Soft
  - Anatomically appropriate
- Car seats



# Younger kids

- Cannot adequately be cleared
- There is not enough research yet
- Peds boards
  - Soft
  - Anatomically appropriate
- Car seats
- Appropriate c-collars...



# Younger kids

- Cannot adequately be cleared
- There is not enough research yet
- Peds boards
  - Soft
  - Anatomically appropriate
- Car seats
- Appropriate c-collars...
- Keep in mind the principles we are going to discuss

# Spinal Precautions

- Older kids
- Adults





# What DO the studies show?

- Lets ask some specific questions:
  - Do long boards work?
    - Do they stabilize the spine?
    - Do they help with extrication?
  - Do long board cause damage?
- How do we answer our questions?
  - Evidence based
  - Lets look at the literature...
  - What do the experts say?

# Lets start with EMS Journals

- Growing trend across the country to critically evaluate backboards and spinal immobilization
- More and more publications are supporting paradigm change
- Most quote studies and position papers





# What do the Societies say

- NAEMSP
- ATLS/PHTLS
- Cochran Review
- The Eagles
- And Hauswald...

# NAEMSP

- “Although early emergency medical literature identified mishandling of patients as a common cause of iatrogenic injury, these instances have not been identified anywhere in the peer-reviewed literature and probably represent anecdote rather than science.”



# PHTLS Position

There is no data to support spine immobilization in patients with penetrating trauma to the neck or torso

There are no data to support routine spinal immobilization in patients with isolated penetrating trauma to the cranium



# Cochrane Review

“Unwarranted spinal immobilization can expose patients to risk of iatrogenic pain, skin ulceration, aspiration and respiratory compromise”

“The potential risks of aspiration and respiratory compromise are of concern because death from asphyxiation is one of the major causes of preventable death in trauma patients.”

# US Consortium of Metropolitan Medical Directors “The Eagles”

“Current best practices reflect that there are no randomized controlled trials to evaluate the benefits of spinal immobilization in out-of-hospital trauma patients.”

“current EMS protocols are based principally on historical precedent, dogma and medico-legal concerns, and not on scientific evidence

There is, however, a growing body of literature that points to the potential deleterious effects of spinal immobilization.



# The Literature

- Hauswald
  - Compared spinal injury patients in New Mexico vs. Malaysia
  - Huh??

# Out-of-hospital Spinal Immobilization: Its Effect on Neurologic Injury<sup>2</sup>

*Mark Hauswald, MD, Gracie Ong, MBBS, Dan Tandberg, MD, Zaliha Omal; MBBS 1998*

**Objective:** To examine the effect of emergency immobilization on neurologic outcome of patients who have blunt traumatic spinal injuries.

**Methods:** A 5-year retrospective chart review was carried out at 2 university hospitals. All patients with acute blunt traumatic spinal or spinal cord injuries transported directly from the injury site to the hospital were entered. None of the 120 patients seen at the University of Malaya had spinal immobilization during transport, whereas all 334 patients seen at the University of New Mexico did. The 2 hospitals were comparable in physician training and clinical resources. Neurologic injuries were assigned to 2 categories, disabling or not disabling, by 2 physicians acting independently and blinded to the hospital of origin. Data were analyzed using multivariate logistic regression, with hospital location, patient age, gender, anatomic level of injury, and injury mechanism serving as explanatory variables.

**Results:** There was less neurologic disability in the unimmobilized Malaysian patients (OR 2.03; 95% CI 1.03-3.99;  $p = 0.04$ ). This corresponds to a ~ 2% chance that immobilization has any beneficial effect. Results were similar when the analysis was limited to patients with cervical injuries (OR 1.52; 95% CI 0.64-3.62;  $p = 0.34$ ).



# The Literature

- Hauswald
  - Compared spinal injury patients in New Mexico vs. Malaysia
    - New Mexico = all patients c-spined
    - Malaysia = no patients c-spined
  - So?
    - 334 pts immobilized, 120 pts not immobilized
      - Immobilized – 21% significant morbidity
      - Non-immobilized – 11% significant morbidity
  - At best:
    - Not helping...
  - At Worst:
    - Doing harm?



# The Literature

- What about peds?
  - Leonard 2012
  - Longboards assoc. with:
    - Increased pain
    - Increased xray usage
    - Increased admissions
  - EMS has impact on hospital behavior...



# The Literature

- Penetrating trauma
  - There are a number of studies that demonstrate spinal immobilization in penetrating trauma **doubles** mortality
  - Who agrees?



# The Literature

- Penetrating trauma
  - There are a number of studies that demonstrate spinal immobilization in penetrating trauma **doubles** mortality
    - AANS, ACS COT, NAEMSP, ATLS/PHTLS
  - Should we pay attention?

# A re-conceptualization of acute spinal care.



[Hauswald M.](#)

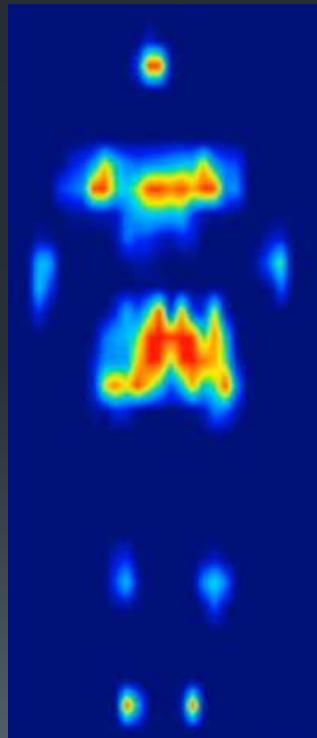
[Emerg Med J.](#)

2013 Sep;30(9):720-3. doi: 10.1136/emered-2012-201847. Epub 2012 Sep 8.

## Abstract

The emergency care of patients who may have spinal injuries has become highly ritualized. There is little scientific support for many of the recommended interventions and there is evidence that at least some methods now used in the field and emergency department are harmful. Since prospective clinical trials are not likely to resolve these issues I propose a reconceptualization of spinal trauma to allow a more rational approach to treatment. To do this I analyze the basic physics, biomechanics and physiology involved. I then develop a list of recommended treatment variations that are more in keeping with the actual causes of post impact neurological deterioration than are current methods. Discarding the fundamentally flawed emphasis on decreasing post injury motion and concentrating on efforts to minimize energy deposition to the injured site, while minimizing treatment delays, can simplify and streamline care without subjecting patients to procedures that are not useful and potentially harmful. **Specific treatments that are irrational and which can be safely discarded include the use of backboards for transportation, cervical collar use except in specific injury types, immobilization of ambulatory patients on backboards, prolonged attempts to stabilize the spine during extrication, mechanical immobilization of uncooperative or seizing patients and forceful in line stabilization during airway management.**

Lots of people lined up against backboards...





# Physics – very briefly...

- The spine can absorb large amounts of energy
- The spinal will fail at a certain energy level
- Trauma applies energy to the spine
- The amount of energy applied by standing, moving, etc. are extremely small
- Lets say someone fell 5 stories onto their head...
  - If they are paralyzed, then what?
  - What is done, is done...



# Physics – very briefly...

- What if they aren't paralyzed?
  - If the spinal cord wasn't injured in the event, we are not going to injure the spinal with controlled movement within the normal range of motion.
  - Energy is the culprit...
- If it hurts, patients don't move it.
  - This is a key point!



# Physics – very briefly...

- Penetrating trauma
  - Extremely high energy injuries
  - If they are paralyzed, it is final
    - 2006 – 57,000 patient study. No patient with penetrating cord injury regained function
  - If they are not paralyzed, your controlled movement will not hurt them
- However
  - Delay in transport, difficulty managing airway, aspiration, respiratory compromise may kill the patient...

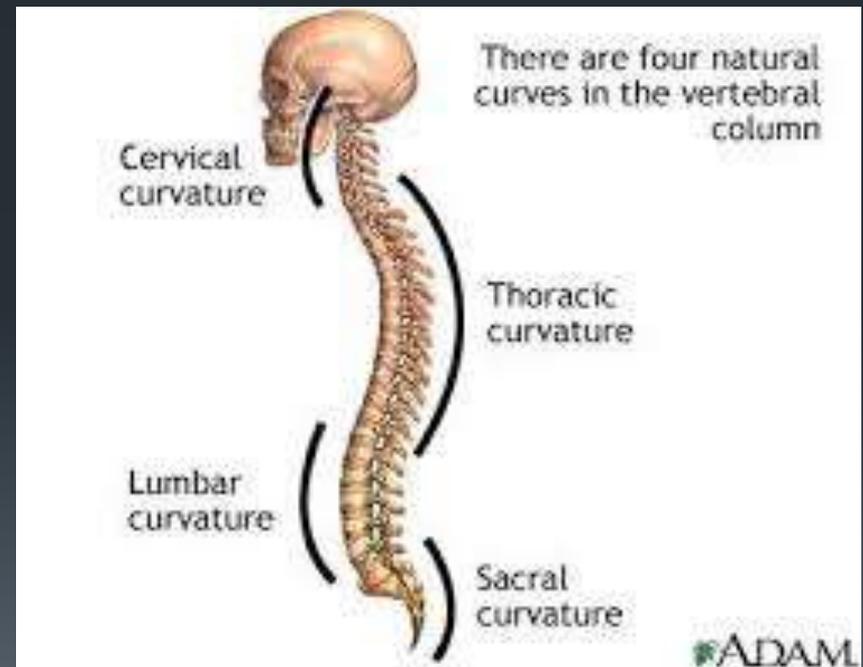


# So what is wrong with a backboard?

- Do they work??
  - Does it stabilize?
  - Is anything better
  - KED? Short board?
- Does it cause harm?
  - Respiratory
  - Skin
  - Time
  - Downstream

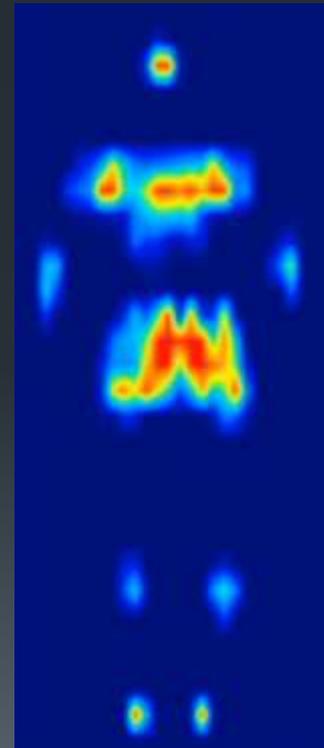
# Does it stabilize?

- Is the spine straight?
- How would a hard, flat board help?
  - Low friction
  - Hard

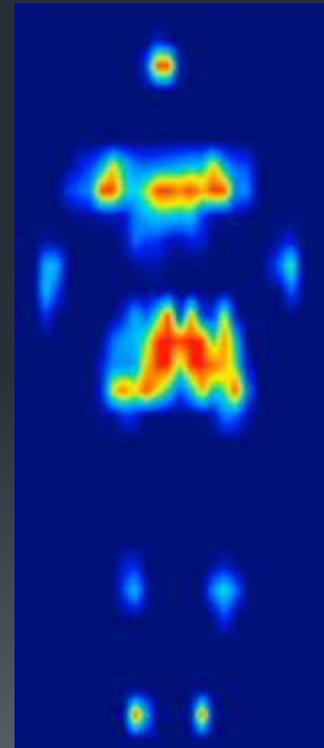
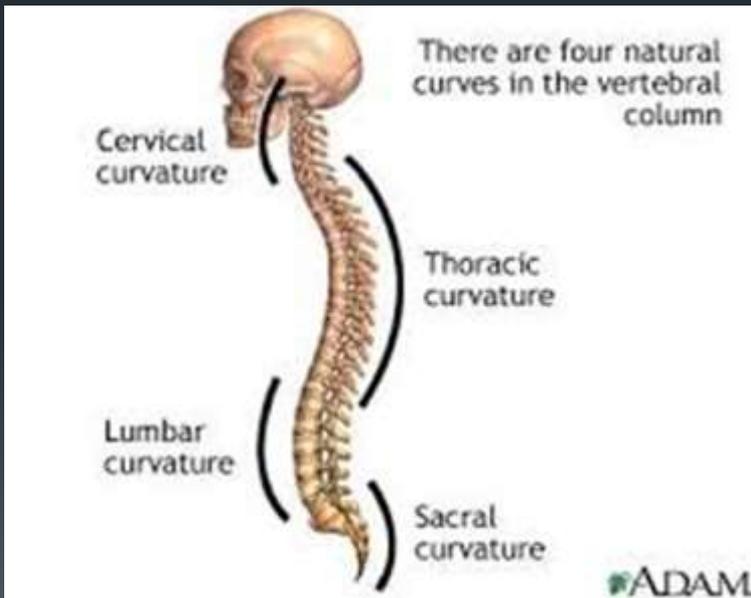


# Does it stabilize?

- Is the spine straight?
- How would a hard, flat board help?
  - Low friction
  - Hard



# Does it stabilize?





# What about lateral movement?

- Strap them down
  - Mazolewski, 1994
    - All patients placed on board and strapped down could move.
  - What happens when you are uncomfortable?
    - You wiggle...



# Straps

- The tighter the better...
  - Decrease FVC and FEV1 (measures of respiratory function) by 15%
  - This is in healthy subjects...
  - What about the sick or injured ones??



# Patient Harm

- Respiratory compromise
- Ischemic damage to tissue
  - 20 minutes in elderly
  - What about paralyzed patient
    - What was the benefit that outweighed the risk?
- Excess xrays
  - Especially a problem in peds
    - Brain
    - Thyroid
- Increased admission rate



# What is wrong with a backboard?

- Seems as though there are a number of issues...
- If it helps during extrication, though...



# What about extrication?

- Four techniques:
  - The patient exits the vehicle on their own and lies down on the back board
  - The patient exits the vehicle with a c-collar on and lies down on the board
  - The patient is extricated head first using standard technique by two paramedics with a c-collar alone
  - The patient is extricated head first using standard technique by two paramedics with a c-collar and a KED

Results??





# Results??

- “Ultimately, we documented the least movement of the cervical spine in subjects who had a c-collar applied and were allowed to simply get out of the car and lie down on a stretcher.”

# Extrication 2

• *Emerg Med J* doi:10.1136/emmermed-2013-202500

## • **Biomechanical analysis of spinal immobilization during prehospital extrication: a proof of concept study**

• [Mark Dixon](#)<sup>1,2</sup>,

• [Joseph O'Halloran](#)<sup>3</sup>,

• [Niamh M Cummins](#)<sup>1</sup>

• [+Author Affiliations](#)

• <sup>1</sup>Centre for Prehospital Research, Graduate Entry Medical School, University of Limerick, Limerick, Ireland

• <sup>2</sup>Centre for Emergency Medical Science, School of Medicine & Medical Sciences, University College Dublin, Dublin, Ireland

• <sup>3</sup>Department of Physical Education and Sport Sciences, University of Limerick, Limerick, Ireland

• Correspondence to Mark Dixon, Centre for Emergency Medical Science, School of Medicine and Medical Sciences, University College Dublin, Belfield, Dublin, Ireland; [mark.dixon@ucd.ie](mailto:mark.dixon@ucd.ie)

• **Received** 12 February 2013

• **Revised** 4 June 2013

• **Accepted** 6 June 2013

• **Published Online First** 28 June 2013

• **Abstract**

• **Background** In most countries, road traffic collisions (RTCs) are the main cause of cervical spine injuries. There are several techniques in use for spinal immobilisation during prehospital extrication; however, the evidence for these is currently poor.

• **Objective** The objective of this study is to establish which technique provides the minimal deviation of the cervical spine from the neutral inline position during the extrication of the RTC patient using biomechanical analysis techniques.

• **Methods** A crew of two paramedics and four fire-fighter first responders extricated a simulated patient from a prepared motor vehicle using nine different extrication techniques. The patient was marked with biomechanical sensors and relative movement between the sensors was captured via high speed infrared motion analysis cameras. A 3D mathematical model was developed from the recorded movement.

• **Results** Control measurements were taken from the patient during self-extrication and movement was recorded of 4.194° left of midline (LOM) to 2.408° right of midline (ROM) resulting in a total movement of 6.602°. The least deviation recorded during equipment aided extrication was movement of 3.365° LOM and 8.352° ROM resulting in a total movement of 11.717°. The most deviation recorded during equipment aided extrication was movement of 1.588° LOM and 24.498° ROM resulting in a total movement of 26.086°.

• **Conclusions** Conventional extrication techniques record up to four times more cervical spine movement during extrication than controlled self-extrication. This proof of concept study demonstrates the need for further evaluation of current rescue techniques and the requirement to investigate the clinical and operational significance of such movement.



# Extrication

- **Methods:** A crew of two paramedics and four fire-fighter first responders extricated a simulated patient from a prepared motor vehicle using nine different extrication techniques. The patient was marked with biomechanical sensors and relative movement between the sensors was captured via high speed infrared motion analysis cameras. A 3D mathematical model was developed from the recorded movement.



# Extrication

- **Conclusions:** Conventional extrication techniques record up to four times more cervical spine movement during extrication than controlled self-extrication.



# Uncooperative Patient

- Uncooperative patient
  - Forcefully holding head down while the patient resists
  - Physics...
    - Rescuer and patient head vs. body
    - Where is the fulcrum??
- Hauswald again
  - 2012 forced immobilization worse than none
- Reasonable for crew safety, though



# So what have we seen?

- There is no proven benefit to long board use for spinal stabilization
- Long boards:
  - Do not conform to the spine
  - Lateral stability is poor
  - In conjunction with straps, attempting to limit lateral motion negatively impacts respiratory function
  - Cause pain and discomfort
  - Can cause ischemic damage and ulceration



# So what have we seen?

- Spinal precautions as currently practiced:
  - INCREASE movement during extrication
  - Worsen outcome in penetrating trauma. Period
  - May cause more harm to uncooperative patients



What should we do?

?



# Disclosure!

- This is a discussion about the current, evidence-based patient care
- I am not advocating you disregard you local protocols
- I do want you to be aware of the direction emergency care is moving and why



# What should we do?

- First, this is what I am NOT saying:
  - I am not suggesting vigorous movement of patients with potential spinal injuries
  - I am not saying to ignore spinal injuries
  - I am not saying never to use a board
    - Transportation device
    - Scoop stretchers!
  - I am not saying “one size fits all”



# What should we do?

- Younger kids
  - Minimize movement
  - Use age and size appropriate immobilization devices
  - Consider general principles we have discussed
  - Agreement at local level
  - Anxiously look forward to new data



# What should we do?

- The rest?



# What should we do?

- Allow ambulatory patients to perform controlled self-extrication
  - There are good studies that show this decreases patient spinal movement
  - There are also good studies that show more equipment and intervention = more movement
  - No more standing take-down



# What should we do?

- Place patients on a gurney and secure with the gurney straps
  - The mattress is softer, conforms to the spine better and allows raising the head
  - Higher friction than a backboard
  - There is no downside to using the gurney mattress for transport
  - What do we do in the hospital?



# What should we do?

- For now, use a c-collar, but
  - **Not** in penetrating trauma to neck
  - Not if airway is difficult to manage
  - If they are alert, just ask them not to move their head
    - Don't need to tape



# What should we do?

- Agitated patients
  - Strapping for EMS personnel safety makes sense
  - Any attempt to restrain a struggling patient with hands, tape, straps will result in maximal force being applied to neck
  - Asleep on their side is better...



# What should we do?

- Penetrating trauma
  - Spinal precautions are of no benefit
  - NEVER delay patient treatment for spinal precautions

Thank you!

