Learning Outcome

EMS providers need to use appropriate clinical decision making to apply spinal immobilization to the patients who need it based on MOI, physical findings, and patient history.
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EMS providers need to use appropriate clinical decision making to apply spinal immobilization to the patients who need it based on MOI, physical findings, and patient history.
Objectives

- Describe the history and rationale for Spinal Immobilization
- Review anatomy & pathophysiology of the spine
- Explain the new NYS DOH and MLREMS protocols for Suspected Spinal Injury
- Give EMS providers the tools to make an appropriate decision on spinal immobilization
Suspected Spinal Injuries
(Not Meeting Major Trauma Criteria)

This protocol is for awake and stable adult and pediatric patients
NOT meeting the Major Trauma Criteria (Protocol T – 6).

Spine injury should be suspected if blunt mechanism of injury is present
and should be treated if one or more of the following criteria is present:

IMMOBILIZATION CRITERIA
1. Altered Mental Status for any reason, including possible
   intoxication from alcohol or drugs (GCS <15 or AVPU other
   than A).
2. Complaint of neck and/or spine pain or tenderness.
3. Weakness, tingling, or numbness of the trunk or extremities at
   any time since the injury.
4. Deformity of the spine not present prior to this incident.
5. Distracting injury or circumstances (i.e. anything producing an
   unreliable physical exam or history).

High risk mechanisms of injury associated with unstable spinal
injuries include, but are not limited to:

- Axial load (i.e. diving injury, spearing tackle)
- High speed motorized vehicle crashes or rollover
- Falls greater than standing height

IF THERE IS ANY DOUBT, SUSPECT THAT A
SPINE INJURY IS PRESENT!
Note:
Once spinal immobilization has been initiated (i.e. extrication collar placed on patient), spinal immobilization must be completed and may not be removed in the prehospital setting.

Note:
Standing Takedown with Spinal Immobilization should only be performed if a patient is found in a standing position.

Use a short board immobilization device for patients who are found in the sitting position.
Flow Chart

Meet Major Trauma or other Mechanism of Injury

Physical Findings

High Risk Patient

Any Doubt

Extrication Collar Applied

Routine Medical Care

IMMOBILIZE

YES

YES

YES

YES

YES

YES

DOCUMENTATION

MLREMS Version -090308
Cervical Spine Injuries in Perspective

- 2.4% of blunt trauma patients experience some degree of musculoskeletal injury to the spine
- Approximately 20,000 spinal cord injuries a year in United States
- $1.25 million to care for a single patient with permanent SCI
- 15,000 – 20,000 SCI per year
- Higher in men between ages of 16 – 30
- Common causes:
  - Motor vehicle crashes – 2.1 million per year (48%)
  - Falls (21%)
  - Penetrating injuries (15%)
  - Sports injuries (14%)
- Education in proper handling and transportation can decrease SCI
Historically

- Immobilization based on MOI – even if there were no signs and symptoms
- Lack of clear clinical guidelines
- EMS providers did poorly with full spinal immobilization
- Motor vehicles had fewer safety features
- Patients spent extended amounts of time in immobilization devices at E.D.
Why not board/collar and Xray everybody?

- Immobilization is uncomfortable: increased time immobilized = increased pain, risk of aspiration, vulnerable position, etc...
- >800,000 U.S. Patients receive cervical radiography each year
- Patient exposure to radiation
- >97% of x-rays are negative
- Cost exceeds $175,000,000 each year
Secondary Injury versus Primary Injury

- **Primary Injury**
  - Spinal Injury that occurred at time of trauma

- **Secondary Injury**
  - Spinal Injury that occurs after the trauma
  - possibly secondary to mishandling of unstable fractures
Review of Anatomy & Physiology

- **Spinal Column**
  - 32 - 34 separate, irregular bones
  - Head (15-22 lbs) Balances on Top C-Spine
  - Supported by Pelvis
  - Ligaments and Muscles connect head to pelvis
  - Injury to Ligaments may cause excess movement of vertebrae
  - Vertebral Foramen - canal formed for cord
Spinous process

Vertebral foramen

Body
Anatomy & Physiology, cont.

- **Cervical**
  - 7 Vertebrae
  - Considered “Joint Above” when splinting
  - Atlas (C1) and Axis (C2)

- **Thoracic**
  - 12 Vertebrae
  - Ribs connected forming rigid framework of thorax
Anatomy & Physiology, cont.

- **Lumbar**
  - 5 Vertebrae (largest vertebral bodies)
  - Flexible and Carries majority of body weight

- **Sacrum**
  - 5 fused bones
  - Considered “Joint Below” with pelvis when splinting
Anatomy & Physiology, cont.

- **Coccyx**
  - 2-4 fused bones
  - “Tailbone”

- **Vertebral Structures**
  - Body
  - Transverse Process
  - Spinous Process
  - Intervertebral Disks - fibrocartilage “shock absorber”
- Cervical (7)
- Thoracic (12)
- Lumbar (5)
- Sacrum (5)
- Coccyx (4)
Anatomy & Physiology, cont.

Central Nervous System (CNS)

- Brain
  - Largest most complicated portion of CNS
  - Continuous with spinal cord
  - Responsible for all sensory and motor functions

- Spinal Cord
  - Within the Vertebral Column
  - Begins at Foramen Magnum and ends near L2 (cauda equina)
  - Dural Sheath
Anatomy & Physiology, cont.

- CNS Cont.
  - Ascending Nerve Tracts
    - Carries impulses and sensory information from the body to the brain (i.e. touch, pressure, pain, tenderness, body movements, etc.)
  - Descending Nerve Tracts
    - Carries motor impulses from brain to body (e.g. muscle tone, sweat glands, muscle contraction, control of posture)
Anatomy & Physiology, cont.

- **CNS Cont.**
  - **Spinal Nerves**
    - 31 pairs originating from spinal cord
    - Mixed Nerves - carry both sensory and motor functions
  - **Dermatones**
    - Topographical region of body surface innervated by one spinal nerve
    - Example: C-7/T-1 motor = finger abduction and adduction, sensory = little finger
Pathophysiology of Spinal Injuries

Mechanisms and Associated Injuries

- **Hyperextension**
  - Cervical & Lumbar Spine
  - Disk disruption
  - Compression of ligaments
  - Fx with potential instability and bone displacement

- **Hyperflexion**
  - Cervical & Lumbar Spine
  - Wedge Fx
  - Stretching of ligaments
  - Compression Injury of cord
  - Disk disruption with potential vertebrae dislocation
Pathophysiology, cont.  
(Mechanisms and Common Injuries)

- **Rotational**
  - Most commonly Cervical Spine but potentially in Lumbar Spine
  - Stretching and tearing of ligaments
  - Rotational subluxation and dislocation
  - Fx

- **Compression**
  - Most likely between T12 and L2
  - Compression fx
  - Ruptured disk
Example of Wedge Fracture
Pathophysiology, cont.
(Mechanisms and Common Injuries)

- Distraction
  - Most common in upper Cervical Spine
  - Stretching of cord without damage to spinal column

- Penetrating
  - Forces directly to spinal column
  - Disruption of ligaments
  - Fx
  - Direct damage to cord
Pathophysiology, cont.

- Specific Injuries
  - Fractures to vertebrae
  - Tearing of Ligaments, Tendons and/or Muscles
  - Dislocation or Subluxation of vertebrae
  - Disk herniation / rupture
Pathophysiology, cont. (Specific Injuries)

- **Cord Injuries**
  - Concussion - temporary or transient disruption of cord function
  - Contusion - Bruising of the cord with associated tissue damage, swelling and vascular leaking
  - Compression - Pressure on cord secondary to vertebrae displacement, disk herniation and/or associated swelling
Pathophysiology, cont. (Specific Injuries)

- Cord Injuries cont.
  - Laceration - Direct damage to cord with associated bleeding, swelling and potential disruption of cord
  - Hemorrhage - Often associated with a contusion, laceration or stretching injury that disrupts blood flow, applies pressure secondary to blood accumulation, and/or irritation due to blood crossing blood-brain barrier.
  - Transection - Partial or complete severing of cord
Pathophysiology, cont. (Specific Injuries)

- Spinal Shock
  - Temporary insult affecting body below level of the injury
    - Flaccidity and decreased sensation
    - Hypotension
    - Loss of bladder and/or bowel control
    - Priapism
    - Loss of temperature control
    - Often transient if no significant damage to cord
Pathophysiology, cont.  
(Specific Injuries)

- **Neurogenic Shock**
  - Injury disrupts brain’s control over body
    - lack of sympathetic tone
    - Arterial and vein dilation causing relative hypovolemia
    - Decreased cardiac output
    - Decrease release of epinephrine
      - Decreased BP
      - Decreased HR
      - Decreased Vasoconstriction
Signs and Symptoms of Spinal Cord Injury

- Pain
- Tenderness
- Painful Movement
- Deformity
- Soft Tissue Injury in area of spine (Bruise, Laceration, etc.)
- Paralysis
- Paresthesias
- Paresis (weakness)
- Shock
- Priapism
Flowchart:

Meet Major Trauma or other Mechanism of Injury

- NO
  - Physical Findings
    - NO
    - High Risk Patient
      - NO
      - Any Doubt
        - NO
        - Extrication Collar Applied
          - NO
          - Routine Medical Care
            - YES
            - DOCUMENTATION
  - YES
  - IMMOBILIZE

- YES
General Assessment

- Scene Size Up
- Initial Assessment
  - Including manual stabilization/immobilization of the c-spine
- Focused History and Physical Exam - Trauma
  - Reevaluate Mechanism of Injury (MOI)
  - Suspected Spinal Injury Protocol
High Risk MOI - Forces or impact suggest a potential spinal injury

- High Speed MVC
- Falls Greater than 3x pt.’s body height
- Axial Loading
- Violent situations near the spine
  - Stabbing
  - Gun shots
  - etc.
- Sports Injuries
- Other High Impact Situations
- Consideration to special pt. Population
  - pediatrics
  - geriatrics
  - history of Down’s
  - spina bifida
  - etc.
High Risk MOI's

The presence of a High Risk MOI's does not always require treatment, but providers should be more suspicious of spinal injury, and immobilize if they are at all worried about the possibility of spinal injury.
Special Patient Risk Factors
Associated with Spinal Injury

- **Trisomy 21 (Down Syndrome, mongolism)**
  - Risk of Atlanto-Axial Instability (AAI)

- **Age Greater than 55**
  - Risk of degenerative arthritis of cervical spine

- **Degenerative Bone Disease (including osteogenesis imperfecta, or “fragile bones”)**
  - Risk of “pathological” (disease-related) fractures

- **Spinal Tumors**
  - Risk of “pathological” (disease-related) fractures
Negative MOI

- Forces or impact involved does not suggest a potential spinal injury
  - Dropping rock on foot
  - Twisting ankle while running
  - Isolated soft tissue injury
Uncertain MOI

- Unclear or uncertainty regarding the impact or forces
  - Trip and fall hitting head
  - Fall from 2-4 feet
  - Low speed MVC with minor damage
MOI, cont.

When using the Suspected Spinal Injury protocol, a positive mechanism of injury is not considered means to necessitate full immobilization …

**BUT…**

should be used as a historical component that may heighten a provider’s suspicion for a spinal cord injury.
Current Practice

Widespread spinal immobilization of all adult and pediatric trauma patients.
Spinal Immobilization Education

- Identify All Patients at Risk for Spinal Injury based on Mechanism of Injury and Patient Assessment

- Shift from current thinking of immobilization based on mechanism of injury alone.
History of Spinal Immobilization

- Maine Selective Spinal Immobilization
  - Early Leaders in Out-of-Hospital Selective Spinal Immobilization

- National Emergency X-Radiography Utilization Study (NEXUS)
Spinal Immobilization Protocols in New York State

The following groups of patients should be immobilized!
Major Trauma Protocol

- *All Adult and Pediatric Trauma Patients who meet the Major Trauma Protocols (T 6–7)*
Flow Chart

Meet Major Trauma or other Mechanism of Injury

NO

Physical Findings

NO

High Risk Patient

NO

Any Doubt

NO

Extrication Collar Applied

NO

Routine Medical Care

YES

IMMOBILIZE

DOCUMENTATION

MLREMS Version -090308
Signs and Symptoms of Spinal Cord Injury

- Pain
- Tenderness
- Painful Movement
- Deformity
- Soft Tissue Injury in area of spine (Bruise, Laceration, etc.)
- Paralysis
- Paresthesias
- Paresis (weakness)
- Shock
- Priapism
Consider Spinal Immobilization (1 of 2)

Not Meeting Major Trauma Protocol but patient has one or more:

- Altered Mental Status
- Patient Complaint of Neck Pain
- Weakness, Tingling or Numbness
- Pain on Palpation of Posterior Midline Neck
Meet Major Trauma or other Mechanism of Injury

Physical Findings

High Risk Patient

Any Doubt

Extrication Collar Applied

Routine Medical Care

DOCUMENTATION
Consider Spinal Immobilization (2 of 2)

High Risk Patients

- Not Meeting Major Trauma Protocol but patient has one or more:
  - Altered Mental Status
  - Evidence of Intoxication
  - Distracting Injury
  - Inability to Communicate
    - Acute Stress Reaction
  - Elderly
    - Age Greater than 65 years
What is an Altered Level of Consciousness?

- Verbal or less on the AVPU Scale
- Glasgow Coma Scale of 14 or Less
- Short Term Memory Deficit
What is Intoxication?

- Patients who have either
  - A History of Recent Alcohol Ingestion or Ingestion of Other Intoxicants
  - Evidence of Intoxication on Physical Examination
What is a Distracting Painful Injury??

- Painful Injury or Serious Illness that would Mask the Symptoms Associated with Spinal Cord Injury
Distracting Injury or Circumstances

- Painful Injury
  - Obvious Deformity
  - Significant Bleeding
  - Impaled Object
  - Any painful injury that may distract the patient’s attention from another, potentially more serious (cervical spine) injury

- Inability to Communicate Clearly (small child, confused or intoxicated adult)

- Emotional Distress

- Presence or Exacerbation of Existing Medical Conditions
Fundamental Principle

- Patient Communication
  - Patients with Communication Difficulties
  - Acute Stress Reaction
What is Acute Stress Reaction?

- A “fight or flight” response that can override any pain from an injury.
Flow Chart

Meet Major Trauma or other Mechanism of Injury

- NO

Physical Findings

- NO

High Risk Patient

- NO

Any Doubt

- NO

Extrication Collar Applied

- NO

Routine Medical Care

- YES

Documentation

- IMMOBILIZE
Key Point

- If there is ANY DOUBT, then SUSPECT that a SPINE INJURY is Present and Treat Accordingly.
Termination of Immobilization

Once spinal immobilization has been initiated, it **must** be completed.

An extrication/cervical collar *starts* the immobilization process

Manual Stabilization does **NOT** start the immobilization process
Negligence

- Either an omission or a commission of an act
  - Documentation of rationale to
    - Immobilize
    - Not Immobilize
Routine Prehospital Care Documentation

- Mechanism Of Injury
- Patient Chief Complaint
- Physical Examination Finding
  - Initial Assessment
  - Rapid Trauma Examination
  - Detailed Trauma Examination
Documentation of Rationale to Not Immobilize

- Mechanism Of Injury is Minor
  - Physical Examination (Positives)
  - Physical Examination (Negatives)
    - Absence of signs of spine injury
    - Absence of distracting injury
  - Patient was not one of the identified high risk patients
New NYS BLS Protocol

Suspected Spinal Injury
(not meeting major trauma criteria)
Suspected Spinal Injuries
(Not Meeting Major Trauma Criteria)

This protocol is for awake and stable adult and pediatric patients NOT meeting the Major Trauma Criteria (Protocol T – 6).

Spine injury should be suspected if blunt mechanism of injury is present and should be treated if one or more of the following criteria is present:

**IMMOBILIZATION CRITERIA**

1. Altered Mental Status for any reason, including possible intoxication from alcohol or drugs (GCS <15 or AVPU other than A).
2. Complaint of neck and/or spine pain or tenderness.
3. Weakness, tingling, or numbness of the trunk or extremities at any time since the injury.
4. Deformity of the spine not present prior to this incident.
5. Distracting injury or circumstances (i.e. anything producing an unreliable physical exam or history).

*High risk mechanisms of injury associated with unstable spinal injuries include, but are not limited to:*

- Axial load (i.e. diving injury, spearing tackle)
- High speed motorized vehicle crashes or rollover
- Falls greater than standing height

**IF THERE IS ANY DOUBT, SUSPECT THAT A SPINE INJURY IS PRESENT!**
Note:

Once spinal immobilization has been initiated (i.e. extrication collar placed on patient), spinal immobilization must be completed and may not be removed in the prehospital setting.

Note:

Standing Takedown with Spinal Immobilization should only be performed if a patient is found in a standing position.

Use a short board immobilization device for patients who are found in the sitting position.
2.33 SUSPECTED SPINAL INJURIES

CRITERIA

- For patients with a traumatic injury, physical complaint, or mechanism of injury suggestive of a spinal injury.

ALL LEVELS

1. Patients meeting any of the following criteria must immediately receive spinal immobilization appropriate to their presentation. (eg. unstable patients: rapid extrication, seated patients: short spine device, standing patients: standing take down.):

<table>
<thead>
<tr>
<th>Mechanism of Injury</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death of passenger in same compartment</td>
<td>Patients $\leq 8$ or $\geq 65$ years old</td>
</tr>
<tr>
<td>Falls greater than standing height</td>
<td></td>
</tr>
<tr>
<td>Vehicle-pedestrian collision</td>
<td></td>
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<tr>
<td>Patient ejection</td>
<td></td>
</tr>
<tr>
<td>Collision $&gt;20$ mph with $12$ inches deformity to vehicle</td>
<td></td>
</tr>
</tbody>
</table>

   | Motorcycle crash                            |                                          |
   | Vehicle versus bicycle $>5$ mph             |                                          |
   | Axial load (diving injury, spearing tackle) |                                          |
   | Vehicle rollover                            |                                          |
Physical Findings
- HR <50 or >120 bpm
- RR <10 or >28 bpm
- Penetrating injuries to trunk, head, neck, chest, abdomen or groin
- Burns ≥15% BSA or facial/airway burns
- Amputation (except digits)
- SBP <90 mmHg
- GCS <15
- Two or more proximal long bone fractures
- Flail Chest
- Trauma of two or more body systems

Medical History
- Patient’s with Down Syndrome
- History of degenerative bone disorders
- History of spinal tumors
- History of spina bifida

2. Patients not meeting any of the above criteria should be assessed for the following. If any are present, the patient must receive spinal immobilization.

- Altered Mental Status for any reason, including possible intoxication from alcohol or drugs (GCS <15 or AVPU other than A).
- Complaint of neck and/or spine pain or tenderness.
- Weakness, tingling, or numbness of the trunk or extremities at any time since the injury.
- Deformity of the spine not present prior to this incident.
- Distracting injury or circumstances (i.e. anything producing an unreliable physical exam or history).

3. Provide routine care per relevant MLREMS Protocol.

NOTE:
- Once spinal immobilization has been initiated (i.e. extrication collar placed on patient) spinal immobilization MUST be completed and may not be removed in the prehospital setting.
- If there is any doubt about the possibility of spinal injury, the patient should be immobilized.
Meet Major Trauma or other Mechanism of Injury
  NO
Physical Findings
  NO
High Risk Patient
  NO
Any Doubt
  NO
Extrication Collar Applied
  NO
Routine Medical Care

IMMOBILIZE

YES

YES

YES

YES

YES

DOCUMENTATION
Friday Night Lights

- 16 year old male football player
- Made a spear tackle during the game and remains down
- Assessment finds tenderness to the posterior of the neck

Should the patient be immobilized?
Why or Why not?
Motorcycle Accident

- 35 year old female
- Single vehicle accident in the rain
- Laid the motorcycle down to avoid striking another car
- Pain to left elbow & shoulder
- No other unusual findings

Should the patient be immobilized?
Why or Why not?
Two Cars, Two Drivers

- **Driver # 1**
  - Ambulatory, Agitated, 50 year old male
  - Rear ended by driver # 2 at a stoplight

- **Driver # 2**
  - Belted and still in vehicle 19 year old female
  - Couldn’t stop in time, struck other vehicle

Should either patient be immobilized? Why or Why not?
QA/QI

- Regional review of PCRs.
- Agency increased review of all PCRs where spinal immobilization was not used.
- On-going education of providers
What are the MOIs that should lead to spinal immobilization?

What other factors should also lead directly to immobilization?

What physical findings are common indicators of spinal injury?

What aspects of patient history may make a patient at higher risk for injury or masking an injury?
First, do no harm

- Good Medical Care requires good clinical judgment; this cannot be defined or legislated, but must be employed.

- When in doubt, decide in favor of the patient and immobilize the spine.