


# Sanders: Mosby's Paramedic Textbook, Revised 3<sup>rd</sup> Edition

## PowerPoint Lecture Notes

### Chapter 25: Spinal Trauma

**Chapter 25**  
**Spinal Trauma**



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**Objectives**

- Describe incidence, morbidity, mortality related to spinal injury
- Predict mechanisms of injury likely to cause spinal injury
- Describe anatomy and physiology of spine and spinal cord
- Outline assessment of a patient with suspected spine injury
- Distinguish between types of spine injury

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**Objectives**

- Describe prehospital assessment of spinal cord injury
- Identify prehospital management of the patient with spinal injuries
- Distinguish between spinal shock, neurogenic shock, and autonomic hyperreflexia syndrome
- Describe selected nontraumatic spinal conditions and the prehospital assessment and treatment of them

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## Scenario

It is 0300 and pouring rain when you reach the crumpled car in the ditch. It appears to have rolled several times. It is upright—and empty. Your flashlight beam glances over your patient, a 20-year-old man who is lying in the nearby brush moaning. He is prone, smells strongly of sour beer, and repeats, “My neck, my neck.” There is severe tenderness over his lower C-spine area. You quickly determine that he has rapid, shallow respirations; a weak, slow radial pulse; and no movement of his arms or legs.

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## Discussion

- What is your first challenge in the management of this patient?
- What concerns do you have about his respiratory status?
- Why is his pulse slow and weak?
- What drugs would be indicated on this call?
- How will you answer when he asks, “Why can’t I move my legs?”

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## Spinal Trauma

- Causes
  - MVC (48%)
  - Falls (21%)
  - Penetrating injuries (15%)
  - Sports injury (14%)
- 40% of victims with neurological deficit will have permanent injury

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## Spinal Assessment Criteria

- Altered level of consciousness
- Spinal pain or tenderness
- Neurological deficit or complaint
- Anatomical deformity of the spine
- Alcohol or drugs
- Distracting injury
- Inability to communicate

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## Mechanism of Injury

- Classify mechanism of injury as:
  - Positive
  - Negative
  - Uncertain
- Combine with clinical criteria for spinal injury to help identify situations in which spinal immobilization is appropriate

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## Positive MOI

- Forces highly suggestive of spinal cord injury
- Requires full spinal immobilization
- Examples
  - High-speed motor vehicle crashes
  - Falls >3x patient's height
  - Violent injuries occurring near patient's spine
  - Sports injuries
  - Other high-impact situations

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## Positive MOI

- In absence of signs and symptoms of SCI, some medical direction agencies may recommend that a patient with a positive MOI not be immobilized
- Based on assessment when:
  - Patient history is reliable
  - There are no distraction injuries

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## Negative MOI

- Force or impact suggests no potential for spinal injury
  - If no SCI signs and symptoms, does not require spinal immobilization
- Examples:
  - Dropping an object on the foot
  - Twisting an ankle while running
  - Isolated soft tissue injury

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## Uncertain MOI

- Impact or force involved in injury is unknown or uncertain
- Clinical criteria used to determine need for spinal immobilization
- Examples
  - Tripping or falling and hitting head
  - Falls 2-4 ft
  - Low-speed motor vehicle crashes (“fender benders”)

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## Assessment of Uncertain MOI

- Ensure patient is reliable
  - Calm, cooperative, sober, alert, and oriented
- Unreliable patients
  - Acute stress reactions
  - Brain injury
  - Intoxicated
  - Abnormal mental status
  - Distracting injuries
  - Problems communicating

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## Spinal Column

- 33 vertebrae
  - 7 cervical
  - 12 thoracic
  - 5 lumbar
  - 5 sacrum (fused)
  - 4 coccyx (fused)



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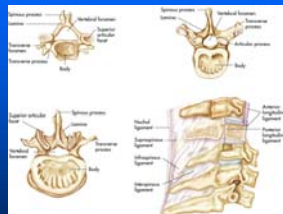
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## Spinal Column

- Anterior spine
  - Vertebral bodies
  - Intervertebral disks
  - Anterior and posterior longitudinal ligaments
    - Connect vertebral bodies anteriorly and inside canal



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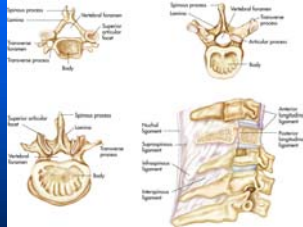
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## Spinal Column

- Vertebra
  - Solid body
    - Bears weight of vertebral column
  - Posterior and anterior arch
  - Posterior spinous process
  - Transverse process (in some vertebrae)



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## Spinal Column

- Spinal cord lies in spinal canal
- Spinal nerve roots pass out through vertebral foramen



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## Adult Skull

- Sits first cervical vertebra (C1) (atlas)
- Second cervical vertebra (C2) (axis) and its odontoid process allow head to move with about 180-degree range of motion

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## Adult Skull

- Cervical spine susceptible to injury due to:
  - Weight and position of head in relation to
  - Thin neck and cervical vertebrae

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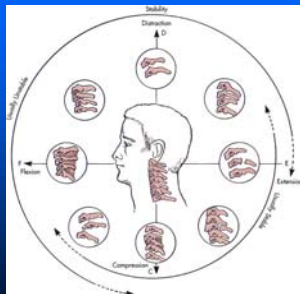
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## Cervical Spine Injury



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## Spinal Injury

- Causes
  - Axial loading
  - Flexion, hyperextension, hyperrotation
  - Excessive lateral bending
  - Distraction
- Stable and unstable injuries based on:
  - Extent of disruption to spinal structures
  - Relative strength of structures remaining intact

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## Axial Loading

- Direct forces transmitted along length of spinal column
- May produce compression fracture or a crushed vertebral body without SCI
  - Commonly occur at T12 to L2

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## Flexion, Hyperextension, Hyperrotation

- Extremes may result in:
  - Fracture
  - Ligamentous injury
  - Muscle injury
- Spinal cord injury when impingement into spinal canal by subluxation of one or more cervical vertebrae

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## Lateral Bending

- Excessive lateral bending
  - Dislocations and bony fractures of cervical and thoracic spine
  - Sudden lateral impact moves torso sideways
- Head remains in place until pulled along by cervical attachments

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## Distraction

- Cervical spine suddenly stops while weight and momentum of body pull away from it
  - May result in tearing and laceration of spinal cord

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## Less Common Mechanisms

- Other mechanisms of spine injury
  - Blunt trauma
  - Electrical injury
  - Penetrating trauma

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## Classifications of Spinal Injury

- Sprains
- Strains
- Fractures
- Dislocations
- Sacral fractures
- Coccygeal fractures
- Cord injuries

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## Spinal Injuries

- Immobilize patients with:
  - Suspected spinal trauma
  - OR
  - Signs and symptoms of SCI
    - Avoid unnecessary movement
- Unstable spine can be ruled out only by radiography or lack of any mechanism for injury

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## Assume Spinal Injury

- Significant trauma and use of intoxicating substances
- Seizure activity
- Pain or paresthesia in neck or arms
- Neck tenderness
- Unconsciousness because of head injury
- Significant injury above clavicle
- Fall more than three times patient's height
- Fall and fracture of both heels
- Injury from a high-speed motor vehicle crash

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## Spinal Injury

- Damage further complicated by:
  - Patient's age
  - Preexisting bone diseases
  - Congenital spinal cord anomalies
- Spinal cord neurons do not regenerate to any great extent

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## Hyperflexion Sprains and Strains

- Hyperflexion sprains
  - Posterior ligamentous complex tears
- Hyperextension strains (whiplash)
  - Low-velocity, rear-end automobile collisions
- Local pain
- Spasms of neck muscles
- Nonradiating, aching soreness of neck or back
- Treat as cord injury until cleared by x-ray

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## Fractures and Dislocations

- Most frequently injured spinal regions
  - C5-C7
  - C1-C2
  - T12-L2
- Wedge-shaped compression fractures and "teardrop" fractures or dislocations common

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## Wedge-Shaped Fractures

- Hyperflexion injury
- Compressive force to anterior vertebral body stretches posterior ligament complex
  - Industrial accidents, falls
  - Middle or lower cervical segments or at T12 and L1
- Generally stable



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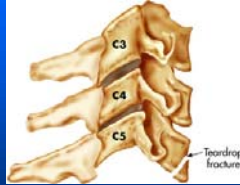
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## Teardrop Fractures and Dislocations

- Extremely unstable
- Severe hyperflexion and compression forces
- Motor vehicle crashes



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## Sacral and Coccygeal Fractures

- Most serious spinal injuries in cervical, thoracic, and lumbar regions
- Patient may say, "I broke my tailbone"
  - Moderate pain from mobile coccyx

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## Sacral and Coccygeal Fractures

- Fractures of S1 and S2 fairly common
  - May compromise sacral nerves
  - May result in loss of perianal sensory motor function and in bladder and sphincter disturbances
- Sacrococcygeal joint may be injured from direct blows and falls

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## Classification of Cord Injuries

- Primary injuries
  - Occur at time of impact
- Secondary injuries
  - Occur later due to:
    - Swelling
    - Ischemia
    - Movement of bony fragments

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## Cord Injuries

- Concussed
- Contused
- Compressed
- Lacerated
- Severity of injuries depends on:
  - Amount and type of force
  - Duration of injury

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## Cord Lesions

- Lesions (transections) of spinal cord are classified as:
  - Complete
  - Incomplete

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## Complete Cord Lesions

- Usually spinal fracture or dislocation
- Absence of pain, pressure, and joint sensation
- Complete motor paralysis below injury
- Quadriplegia
  - Injury at cervical level
  - Loss of all function below injury site
- Paraplegia
  - Thoracic or lumbar level injury
  - Loss of lower trunk function

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## Complete Cord Lesions

- Autonomic dysfunction may occur with complete cord lesions
- Manifestations of autonomic dysfunction
  - Bradycardia
  - Hypotension
  - Priapism
  - Loss of sweating and shivering
  - Poikilothermy
  - Loss of bowel and bladder control

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## Incomplete Lesions

- Central cord syndrome
  - Seen with hyperextension or flexion cervical injuries
  - Greater motor impairment of upper than lower extremities
- Signs and symptoms
  - Paralysis of arms
  - Sacral sparing

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## Incomplete Lesions

- Anterior cord syndrome
  - Usually flexion injuries
  - Pressure on anterior spinal cord by ruptured intervertebral disk
    - Fragments of vertebral body extruded into spinal canal
- Signs and symptoms
  - Decreased sensation of pain and temperature below lesion
  - Intact light touch and position sensation
  - Paralysis

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## Incomplete Lesions

- Brown-Séquard syndrome
  - Hemitransection of spinal cord
    - Ruptured intervertebral disk
    - Encroachment on spinal cord by a fragment of vertebral body
  - Pressure on half spinal cord results in:
    - Weakness of upper and lower extremities on ipsilateral side
    - Loss of pain and temperature on contralateral side

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## Pharmacological Therapy

- Use in incomplete cord injury is very controversial
  - Glucocorticoids
  - Naloxone
  - Calcium channel blockers
  - Methylprednisolone (Solu-Medrol)

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## Assessment of Spinal Cord Injury

- After life-threatening injuries have been assessed and treated
- Priorities:
  - Scene survey
  - Assess airway, breathing, and circulation
  - Preserve spinal cord function
  - Avoid secondary injury to spinal cord

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## Assessment of Spinal Cord Injury

- Prevent secondary injury from:
  - Unnecessary movement
  - Hypoxemia
  - Edema
  - Shock

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## Prehospital Goals

- Suspect spinal injury:
  - Scene survey
  - Kinematics
  - History of event
- Early spinal immobilization
- Oxygen
- Correct volume deficits

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## Neurological Examination

- Neurological exam
  - At scene or en route
  - Document findings
  - Motor and sensory findings
  - Reflex responses

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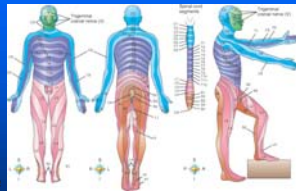
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## Dermatomes

- Spinal nerves (except C1) have specific cutaneous sensory distribution
- *Dermatome* is skin surface area supplied by a single spinal nerve



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## Dermatomes

- Landmarks for sensory evaluation
  - C2 to C4: Around the neck and over anterior chest to below clavicles
  - T4: Nipple line
  - T10: Umbilicus
  - S1: Soles of feet



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## Reflex Responses

- Seldom evaluated prehospital
- Some indicate autonomic injury
- Babinski's sign
  - Plantar reflex
  - Dorsiflexion of great toe with or without fanning of toes



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## Other Methods of Evaluation

- Visual inspection
  - Cord transection above C3 often results in respiratory arrest
  - C4 lesions may cause paralysis of diaphragm
  - Transections at C5-C6 spare diaphragm
    - Permit diaphragmatic breathing

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## Spinal Injury

- Absence of neurological deficits **does not** rule out spinal injury
- Ability to walk should **not** be a factor in determining need for spinal precautions

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## Spinal Immobilization

- Primary goal
  - Prevent further injury
- Treat spine as a long bone with a joint at either end (the head and pelvis)
- Use complete spinal immobilization
- Begins at initial assessment
- Maintain until spine is immobilized on a long backboard

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## Spinal Immobilization Techniques

- When a possible or potential spine injury recognized, manually protect head and neck
  - Maintain in line with long axis of body



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## Manual In-Line Immobilization from the Front



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## Log Roll—Prone Patient

In one move, patient is rotated away from prone position.



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## Manual In-Line Immobilization from the Front



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## Log Roll—Supine Patient

Rescuer 1 at head, rescuers 2 and 3 at midthorax and knees



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## Log Roll—Supine Patient

Rescuer 4 manages spine board



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## Log Roll—Supine Patient

Maintain immobilization and roll in one move



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## Log Roll—Supine Patient

In one move, rescuers log-roll and center patient on spine board



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## Log Roll—Prone Patient

Rescuer 1 provides in-line stabilization; prepares for rotation



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## Log Roll—Prone Patient

In one move, rescuers log-roll and center patient on spine board



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## Rigid Cervical Collar

- Protects cervical spine from compression
  - Reduces movement and some range of motion of head
  - Does not provide adequate spinal immobilization
- Use with manual in-line stabilization or immobilization by a suitable device

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## Rigid Cervical Collars

- Many sizes (or are adjustable)
- Appropriate size reduces flexion or hyperextension
- Must not:
  - Inhibit ability to open mouth or clear airway
  - Obstruct airway or ventilations
- Apply after head is in neutral in-line position

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## Cervical Collar Application

- Rescuer 1 maintains in-line stabilization
- Rescuer 2 positions and secures collar
- Rescuer 1 maintains support until patient has been secured to board



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## Short Spine Boards

- Splint cervical and thoracic spine
- Vary in design
- Spinal immobilization for patient in a sitting position or a confined space
- After short spine board has been applied, patient is transferred to a long spine board

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## KED Application



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## Rapid Extrication

- Steps vary depending on:
  - Size and make of vehicle
  - Patient's location inside vehicle

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## Rapid Extrication

- Rescuer 1 maintains in-line stabilization



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## Rapid Extrication

- Rescuer 2 supports midthorax as rescuer 3 frees lower extremities



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## Rapid Extrication

- Patient lowered onto long spine board



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## Rapid Extrication

- Patient centered and secured on spine board



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## Rapid Extrication—2 Rescuers



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## Rapid Extrication—2 Rescuers



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## Long Spine Board

- Available in a variety of types:
  - Plastic and synthetic spine boards
  - Metal alloy spine boards
  - Vacuum mattress splints
  - Split litters (scoop stretchers) that must be used with a long spine board

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## Long Spine Board—Supine Patient

- Immobilize torso to a long spine board before immobilization of head
- Torso must not be allowed to move up, down, or to either side

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## Long Spine Board—Supine Patient

- Place straps at:
  - Shoulders or chest
  - Around midtorso
  - Across iliac crests to prevent movement of lower torso
- After immobilization of torso, immobilize head and neck

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## Long Spine Board—Supine Patient

- Padding added as needed before securing head
- Padding (if needed) should be firm and extend full length and width of the torso from the buttocks to the top of the shoulders



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## Long Spine Board—Supine Patient

- Children have proportionally larger heads
  - May require padding under the torso to allow head to lie in a neutral position



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## Long Spine Board—Supine Patient

Secure head to device



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## Long Spine Board—Supine Patient

- Secure forehead across supraorbital ridge
- Secure lower head across front of cervical collar
- Secure legs with two or more straps above and below knees



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## Long Spine Board—Standing Patient

- Rescuer 1 maintains manual in-line stabilization; rescuers 2 and 3 support patient;
  - Patient is lowered onto long spine board for further immobilization.



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## Immobilizing Pediatric Patients

- Prehospital care
  - Manual in-line immobilization
  - Rigid cervical collar
  - Spinal immobilization device
- Adult long spine boards may be used



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## Manual In-Line Immobilization

- Apply without traction
- Use only enough tension to relieve weight of head from cervical spine

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## Manual In-Line Immobilization

- **Do not** move head to in-line position if:
  - Resistance to movement
  - Neck muscle spasm
  - Increased pain
  - Presence or increase in neurological deficits during movement
  - Compromise of airway or ventilation
  - Severe misalignment of head

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## Helmets

- Helmets protect head and brain, not neck
  - Leaves cervical spine vulnerable to injury

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## Types of Helmets

- Full-face or open-face designs
  - Motorcycling, bicycling, rollerblading, and other activities
- Helmets designed for sports such as football and motocross

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## Helmet Removal

- If helmet removal is needed:
  - Athletic trainers may have special equipment to remove face-pieces
  - Easier access to airway
  - Sports gear (shoulder pads) could compromise spine if helmet is

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## Helmet Removal

- Helmet removal is controversial
  - Guided by medical direction
- Full-face helmets are removed in the field
  - Permits access to airway
  - Allows assessment for hidden bleeding or injuries

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## Helmet Removal

- Immobilize helmet and head in in-line position



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## Helmet Removal

- Spread side of helmet away from head and ears



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## Helmet Removal

- Rotate helmet to clear nose and remove from head in straight line



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## Helmet Removal

- After removal of helmet, apply in-line immobilization and rigid cervical collar



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## Spinal Immobilization in Diving Accidents

- Most diving accidents cause injury to head, neck, and spine
- Patient in water:
  - Ensure scene and personal safety
  - Rescuers trained in water rescue should enter water

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## Spinal Immobilization in Diving Accidents

- Float supine patient to shallow area:
  - No unnecessary movement of spine
- Approach prone patient from top of head:
  - Carefully turn supine and assess airway and breathing
  - Rescue breathing may be initiated in water

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## Spinal Immobilization in Diving Accidents

- Rescuer 2 slides long spine board or rigid device under patient
  - Rescuer 1 supports head and neck without flexion or extension
  - Rigid cervical collar is applied
  - Maintain manual in-line immobilization
- Float immobilization device to edge of water and lift out
- Immobilize patient on long spine board

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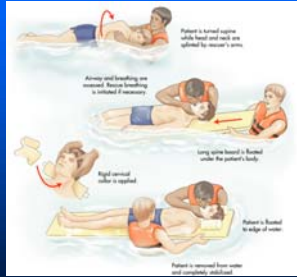
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## Extrication of a Diving Accident Victim



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## Spinal Shock

- Temporary loss of spinal cord function distal to injury
  - Flaccid paralysis
  - Loss of autonomic function
- Avoid secondary injury
  - Oxygen
  - Trendelenburg
  - IV crystalloids

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## Neurogenic Hypotension

- Blockade of vasoregulatory fibers, motor fibers, and sensory fibers
- Rare
- Hypotension
- Bradycardia
- Warm, dry skin

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### Autonomic Hyperreflexia Syndrome

- Chronic SCI with injuries at T6 or above
- Distended bladder or rectum initiates
  - Hypertension
  - HA
  - Blurred vision
  - Sweating
  - Nausea
  - Bradycardia

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### Low Back Pain (LBP)

- Affected area
  - Between lower rib cage and gluteal muscles
  - May radiate to thighs
- Risk factors
  - Repetitive lifting
  - Vibrations from machinery
  - Osteoporosis

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### Low Back Pain—Causes

● Tumors	● Abnormal joint disease
● Disk prolapse	● Inflammation from infection
● Bursitis	● Fractures
● Synovitis	● Ligament strains
● Degenerative joint disease	

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## Degenerative Disk Disease

- Common >50 y/o
- Causes
  - Alterations in tissue of intervertebral disks that occur with aging
  - Narrowing of disk results in variable segmental instability and occasional low back pain

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## Spondylosis

- Defect of lamina or vertebral arch
  - Usually lumbar spine between superior and inferior articulating facets
  - Rotational stress fractures common at affected site
  - Heredity significant factor

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## Herniated Intervertebral Disk

- Tear in posterior rim of capsule encloses gelatinous center of disk
- Rupture of disk by:
  - Trauma
  - Degenerative disk disease
  - Improper lifting (most common)
- Disks commonly affected:
  - L5-S1 and L4-L5
  - Occasionally C5-C6 and C6-C7

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## Spinal Cord Tumors

- May develop from:
  - Cord compression
  - Degenerative changes in bones and joints
  - Interruption in cord's blood supply
- Classified by cell type, growth rate, and structure of origin

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## Spinal Cord Tumors

- Signs and symptoms depend on tumor type and location
- May include:
  - Temperature dysfunction
  - Sensory changes
  - Other abnormalities
  - Paresis
  - Spasticity
  - Pain
  - Bilateral or asymmetric motor dysfunction

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## Nontraumatic Spinal Conditions

- Assessment and management are based on:
  - Patient's chief complaint
  - Physical examination
  - Evaluation of associated risk factors
- Common signs and symptoms
- Care must be taken to decrease pain and discomfort
  - Full spinal immobilization is not required unless condition is the result of trauma

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## Conclusion

Education in injury prevention, prehospital assessment, and proper handling and transportation of patients with spinal injury can decrease mortality and morbidity.

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## Questions ?

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