Updated Curriculum Module Trauma

Suspected Spinal Injury Protocol Update

OBJECTIVES

OBJECTIVES LEGEND
C = Cognitive P = Psychomotor A = Affective
1 = Knowledge level
2 = Application level
3 = Problem-solving level

UNIT TERMINAL OBJECTIVE

1-1 At the completion of this unit, the EMT-Basic or Advanced EMT student will be able to integrate pathophysiological principles and the assessment findings to formulate a field impression and implement a treatment plan for the patient with a suspected spinal injury.

COGNITIVE OBJECTIVES

At the completion of this unit, the student will be able to:

1-1.1 Describe the incidence, morbidity, and mortality of spinal injuries in the trauma patient. (C-1)
1-1.2 Describe the anatomy and physiology of structures related to spinal injuries. (C-1)
a. Cervical
b. Thoracic
c. Lumbar
d. Sacrum
e. Coccyx
f. Head
g. Brain
h. Spinal cord
i. Nerve tract(s)
j. Dermatomes
1-1.4 Describe the pathophysiology of spinal injuries. (C-1)
1-1.5 Relate mechanism of injury to potential traumatic spinal injuries. (C-1)
1-1.6 Describe the assessment findings associated with spinal injuries. (C-1)
1-1.7 Describe the management of spinal injuries through the use of the protocol. (C-1)
1-1.8 Develop a patient management plan for possible spinal injury based on assessment findings. (C-3)

AFFECTIVE OBJECTIVES

At the completion of this unit, the student will be able to:

1-1.27 Advocate the use of a thorough assessment when determining the proper management

options for potential spine injuries. (A-3)

1-1.28 Advocate the implications of failing to properly immobilize a spine injured patient. (A-2)

PSYCHOMOTOR OBJECTIVES

At the completion of this unit if practical skills sessions are utilized, the student will be able to:

1-1.29 Demonstrate a clinical assessment to determine the proper management modality for a patient with a suspected spinal injury. (P-1)

1-1.31 Demonstrate immobilization of the urgent and non-urgent patient with assessment findings of spinal injury from the following presentations: (P-1)

a. Supine
b. Prone
c. Semi-prone
d. Sitting
e. Standing

1-1.32 Demonstrate documentation of suspected spinal cord injury to include: (P-1)

a. General area of spinal cord involved
b Sensation
c. Dermatomes
d. Motor function
e. Area(s) of weakness

1-1.33 Demonstrate preferred methods for stabilization of a helmet from a potentially spine injured patient. (P-1)

1-1.34 Demonstrate helmet removal techniques. (P-1)

1-1.35 Demonstrate alternative methods for stabilization of a helmet from a potentially spine injured patient. (P-1)

1-1.36 Demonstrate documentation of assessment before spinal immobilization. (P-1)

1-1.37 Demonstrate documentation of assessment during spinal immobilization. (P-1)

1-1.38 Demonstrate documentation of assessment after spinal immobilization. (P-1)

PREPARATION

Motivation: Injuries to the head and spine are extremely serious and may result in severe permanent disability or death if improperly treated or missed in the assessment.

Prerequisites: BLS, Preparatory, Airway and Patient Assessment.

MATERIALS

AV Equipment:	Utilize various audio-visual materials relating to injuries of the head and spine. The continuous design and development of new audio-visual materials relating to EMS requires careful review to determine which best meet the needs of the program. Materials should be edited to assure meeting the objectives of the curriculum.
EMS Equipment:	Practical session is not mandatory, but is encouraged. Long spine board, short spine immobilization device, cervical immobilization devices, helmet, head immobilization device, blanket roll, two inch tape.

PERSONNEL

Primary Instructor:	One EMT-Basic instructor knowledgeable in head and spinal injuries.
Assistant Instructor:	The instructor-to-student ratio should be 1:6 for psychomotor skill practice. Individuals used as assistant instructors should be knowledgeable in head and spinal emergencies and treatment.
Recommended Minimum Time to Complete:	Two hours Three hours if practical skills session is utilized

PRESENTATION

DECLARATIVE

I. Introduction
   A. Spinal cord injury (SCI) impacts
      1. Human physiology
      2. Lifestyle
      3. Financial
      4. 1.25 million to care for a single victim with permanent SCI (overall life span)
   B. Treatment and management of suspected or probable SCI has historically emphasized full spinal immobilization based on MOI.
   C. Studies such as NEXUS 2000 have shown that a stepped clinical decision rule for suspected SCI is effective in the prehospital setting.

II. Incidences
   A. 15,000 - 20,000 SCI per year
   B. Higher in men between ages 16 - 30 years
   C. Common causes
      1. Motor vehicle crashes - 2.1 million per year (48%)
      2. Falls (21%)
      3. Penetrating injuries (15%)
      4. Sports injuries (14%)

III. Morbidity and mortality
   A. 40% of trauma patients with neurological deficit will have temporary or permanent SCI
   B. 25% of SCI may be caused by improper handling
   C. Education in proper handling and transportation can decrease SCI

IV. Traditional spinal assessments/ criteria
   A. Based upon mechanism of injury (MOI)
   B. Past emphasis for spinal immobilization considerations
      1. Unconscious accident victims
      2. Conscious accident victims checked for SCI prior to movement
      3. Any patient with a “motion” injury
   C. Lack of clear clinical guidelines or specific criteria to evaluate for SCI
   D. Signs which may indicate SCI
      1. Pain
      2. Tenderness
      3. Painful movement
      4. Deformity

5. Cuts/ bruises (over spinal area)
6. Paralysis
7. Paresthesias
8. Paresis (weakness)
9. Shock
10. Priapism

E. Not always practical to immobilize every “motion” injury

F. Potential complications of full spinal immobilization:
1. Increased pain and discomfort
2. Increased risk of aspiration
3. Increased risk of skin ulcerations and other injuries to geriatric and other high risk patients
4. Psychological affects
5. Nausea/vomiting
6. Complicates treatment of patient when it may not be necessary

G. Need to have clear criteria to assess for the presence of SCI

V. General spinal anatomy and physiology review

A. Spinal column
1. Irregular bone
2. 33 vertebrae
3. Head balances at top of spine
4. Spine supported by pelvis
5. Ligaments and muscles connect head to pelvis
a. Anterior longitudinal ligament
(1) Runs on anterior portion of the body
(2) Major source of stability
(3) Protects against hyperextension
b. Posterior longitudinal ligament
(1) Runs along posterior body within the vertebral canal
(2) Prevents hyperflexion
(3) Can be a major source of injury
6. Injury to ligaments may cause excess movement of vertebrae

B. Cervical spine
1. 7 vertebrae
2. Supports head (16 - 25 lbs)
3. Considered “joint above” in splinting
4. Very flexible
5. C1 (atlas)
6. C2 (axis)

C. Thoracic spine
1. 12 vertebrae
2. Ribs connected
3. Provides rigid framework of thorax

D. Lumbar spine
    1. 5 vertebrae
    2. Largest vertebral body
    3. Flexible
    4. Carries most of body weight
    5. Torso balances on sacrum
E. Sacrum
    1. 5 fused vertebrae
    2. Common to spine and pelvis
    3. Forms “joint below” with pelvis for splinting
F. Coccyx
    1. 4 fused vertebrae
    2. Tailbone
G. Vertebral structure
    1. Body
        a. Constructed of cancellous bone
        b. Posterior portion forms part of the vertebral foramen
        c. Increase in size when moving from cervical to sacral region for support of the trunk
H. Vertebral foramen
    1. When all vertebrae are in place forms opening for spinal cord (vertebral canal)
I. Transverse process
    1. Projects laterally and posteriorly
    2. Attachment site for various muscles and ligaments
J. Spinous process
    1. Posterior aspect
    2. Attachment site for muscles and ligaments
K. Intervertebral foramen
    1. Formed by the lower surfaces of the vertebrae
    2. Creates a “notch” for spinal nerves
        a. Allows nerves to connect to the spinal cord
L. Intervertebral disk
    1. Mass of fibrocartilage separating each vertebrae
    2. Connecting together by ligaments
    3. Acts as a shock absorber
        a. Reducing bone wear
        b. Compression protection
M. Brain and spinal cord (central nervous system)
    1. Brain
        a. Largest and most complex portion of the nervous system
        b. Continuous with spinal cord
        c. Responsible for all sensory and motor functions
    2. Spinal cord

a. Located within the vertebral canal
    (1) Begins at foramen magnum
    (2) Ending near L-2
b. Dural sheath
    (1) Sheathed, tube-like sac
    (2) Filled with cerebrospinal fluid (CSF)

3. Blood supplied by
    a. Vertebral arteries
    b. Spinal arteries
4. Ascending nerve tracts
    a. Carries impulses from body parts and sensory information to the brain
    b. Conduct sensory impulse from skin, muscle tendons, and joints to the brain for interpretation as sensations of touch, pressure, and body movement
    c. Cross over at the medulla oblongata from one side to the other, therefore impulses originating from the left side ascend to the right side of the brain and vice versa
5. Descending nerve tracts
    a. Carries motor impulses from the brain to the body
    b. Motor impulses originate in the brain to control muscle tone, sweat gland activity, coordination and control of posture
6. Spinal nerves
    a. 31 pairs
        (1) Originates from the spinal cord
    b. Mixed nerves
        (1) Carries both sensation and motor function
        (2) Provides two-way communication between spinal cord and body parts
    c. Named according to level of spine from which they arise
        (1) Cervical 1-8
        (2) Thoracic 1-12
        (3) Lumbar 1-5
        (4) Sacral 1-5
        (5) Coccygeal 1 set of nerves
    d. Spinal nerve
        (1) Emerges from the cord
        (2) Two short branches or roots
        (3) Dorsal root
            (a) Carries sensory impulses to the cord
        (4) Ventral root
            (a) Carries motor impulses from the cord to the body
7. Motor and sensory dermatomes
    a. Dermatome is the particular area controlled by a specific spinal

nerve

b. Mapped out by level of the spinal nerve

c. Useful for assessment for a specific level of SCI

d. Table for common nerve root and motor/ sensory correlation

Nerve Root	Motor	Sensory
C-3,4	Trapezius (shoulder shrug)	Top of shoulder
C-3,4,5	Diaphragm	Top of shoulder
C-5,6	Biceps (elbow flexion)	Thumb
C-7	Triceps (elbow extension) wrist/ finger extension	Middle finger
C-8/ T-1	Finger abduction/adductio	Little finger
T-4	Nipple	
T-10	Umbilicus	
L-1,2	Hip flexion	Inguinal crease
L-3,4	Quadriceps	Medial thigh/ calf
L-5	Great toe/ foot dorsiflexion	Lateral calf
S-1	Knee flexion	Lateral foot
S-1,2	Foot plantar flexion	
S-2,3,4	Anal sphincter tone	Perianal

VI. Pathophysiology of Spinal Injuries:

A. Mechanisms and Associated Injuries

1. Hyperextension
   a. Most commonly in the cervical and/or lumbar area
   b. Potential disk disruption, compression of ligaments, fractures
   c. Torn ligament and/or fractures may lead to instability
2. Hyperflexion
   a. Most commonly in the cervical and/or lumbar area
   b. Potential anterior vertebral body wedge fractures, stretch/torn ligaments, cord compression, disk disruption with potential vertebrae dislocation
3. Rotational
   a. Most commonly in the cervical area but possibly in lumbar region as well
   b. Potential stretching/tearing of ligaments, rotational subluxation or dislocation, fractures
4. Compression
   a. Most commonly between T12 and L2
   b. Potential compression fractures, herniated/ruptured disk
5. Distraction
   a. Most commonly in upper c-spine
   b. Stretching/pulling of the cord
   c. Potential damage to cord without damage to spinal column,

potential torn ligaments

6. Penetrating
    a. Forces directed to spinal column
    b. Potential fractures, damage to cord, disruption of ligaments

B. Specific Injuries
1. Fracture
    a. Cause potential instability
    b. Loose bone fragments
    c. Disruption of cord
2. Ligament, Tendons and/or Muscles
    a. Potentially stretched, compressed or torn/disrupted
    b. Potential instability of spinal column
3. Dislocations / Subluxation
    a. Displacement of Vertebrae potential disrupting the cord
    b. Potential instability to spinal column
4. Disk Herniation / Rupture
    a. Displacement or rupture of disk
    b. Potential disruption of cord
5. Cord Injuries
    a. Concussion
        (1) Temporary or transient disruption of cord function
        (2) Similar to cerebral concussion
        (3) Generally does not produce residual deficits
    b. Contusion
        (1) Bruising of the cord with associated tissue damage, swelling, vascular leakage.
        (2) Blood crossing blood-brain barrier may increase swelling significantly.
        (3) Likely to recover from with limit or no deficit.
    c. Compression
        (1) Pressure on cord secondary to swelling, vertebrae displacement, disk herniation, etc.
        (2) Causes potential restricted circulation, ischemia or physical damage to cord
    d. Laceration
        (1) Direct damage to cord
        (2) Likely to involve hemorrhage into cord tissue, associated swelling, and possible disruption of cord
        (3) Potential disruption of cord "communication" pathways
        (4) Minor laceration may have some recovery. Severe laceration usually result in permanent damage.
    e. Hemorrhage
        (1) Often associate with other injury such as laceration, contusion, stretching, etc.
        (2) Causes potential disruption of blood flow, pressure to cord, and/or irritation secondary to blood crossing

blood-brain barrier
(3) Potential ischemic injuries secondary to decreased blood flow

f. Transection
(1) Partial or complete disruption of cord
(2) Causes partial or complete loss of sensory and motor function below injury site

6. Spinal Shock
a. Temporary insult to cord that affect the body below the level of the injury
b. Affected areas are flaccid, loss of sensation, loss of motor control
c. Potential priapism, loss of bowel/bladder control, loss of temperature regulation
d. Potential hypotension
e. Generally transient problem if no significant injury to cord

7. Neurogenic Shock
a. Injury to cord that affects the brain's ability to control body
b. Disruption can affect vasoconstriction below level of injury
c. Decreased sympathetic tone causes expansion of arteries and veins creating a relative hypovolemia
d. Decreased cardiac output secondary to decreased preload
e. Decreased epinephrine release resulting in decreased heart rate, decreased blood pressure and decreased vasoconstriction

VII. Review signs and symptoms which may indicate SCI:
A. Pain
B. Tenderness
C. Painful movement
D. Deformity
E. Cuts/ bruises (over spinal area)
F. Paralysis
G. Paresthesias
H. Paresis (weakness)
I. Shock
J. Priapism

VIII. General assessment of spinal injuries
A. Determine mechanism of injury/ nature or injury
1. Positive MOI – forces of impact suggest a potential for SCI
a. Examples
(1) High speed motor vehicle crash(es)
(2) Falls greater than three times patient's height
(3) Violent situations occurring near the spine
(a) Stabbings
(b) Gun shots

(c) Others
(4) Sports injuries
(5) Axial Loading
(6) Other high impact situations
(7) Consideration to special and high risk patients (i.e. pediatrics, geriatrics, history of Down's, etc.)

2. Negative MOI
   a. Forces or impact involved does not suggest a potential spinal injury
   b. Does not require spinal immobilization
      (1) Examples
         (a) Dropping a rock on foot
         (b) Twisted ankle while running
         (c) Isolated soft tissue injury
3. Uncertain MOI
   a. Unclear or uncertainty regarding the impact or forces
   b. Clinical criteria used for a basis of whether to employ spinal immobilization
      (1) Examples
         (a) Person trips over garden hose, falling to the ground and hitting their head
         (b) Fall from 2-4 feet
         (c) Low speed motor vehicle crash (fender bender)
4. High risk factors associated with SCI
   a. Trisomy 21 (Down Syndrome, mongolism) – risk of Atlanto-Axial Instability (AAI)
   b. Age greater than 55 – risk of degenerative arthritis of cervical spine
   c. Degenerative bone disease (osteogenesis imperfecta or "fragile bones"
   d. Spinal tumors – risk of pathological (disease related) fractures

5. When using the NYS BLS protocol for Suspected Spinal Injuries, positive mechanism of injury is not considered means to necessitate full immobilization of a patient, but should be used as a historical component that may heighten suspicion of spine injury.

IX. Assessment of uncertain MOIs
   A. Specific clinical criteria
      1. Necessary to assess when electing not to immobilize a trauma patient
      2. Begins with patient reliability
         a. Continually reassessed during specific exam
      3. If specific criteria cannot be clearly satisfied; complete spine immobilization undertaken
   B. Specific criteria
      1. Prevent motion of the spine by assistant maintaining stabilization

throughout the exam

2. Reliable patients/ exam
    a. In order for assessments of pain, tenderness, motor, and sensory function to be accurate the patient must be reliable
    b. Patient must be
        (1) Calm
        (2) Cooperative
        (3) Sober
            (a) Alcohol
            (b) Drugs
        (4) Alert and oriented
    c. Unreliable patient defined
        (1) Acute stress reaction
            (a) Sudden stress of any type
        (2) Brain injury
            (a) Any temporary change in consciousness or altered level of consciousness
            (b) Uncooperative or belligerent behavior
        (3) Intoxication
        (4) Abnormal mental status
        (5) Distracting injuries
        (6) Communication problems
    d. Unreliable indicators present
        (1) Full spinal immobilization indicated
3. Assess for spinal pain
    a. Patient is asked about
        (1) Any related spinal pain
        (2) Signs
        (3) Symptoms
    b. May be poorly localized
    c. Might not feel directly over the spinous process
4. Assess for spine tenderness
    a. Palpate over each of the spinous processes of the vertebra
    b. Begin at the neck and work towards the pelvis
    c. May be beneficial to palpate back up from the pelvis to the neck
5. Upper extremity neurological function assessment
    a. Motor function
        (1) Finger abduction/ adduction
            (a) Test interosseous muscle function controlled by T-1 nerve roots
            (b) Have patient spread fingers of both hands and keep them apart while you squeeze the 2nd and 4th fingers
            (c) Normal resistance should be spring-like and equal on both sides

(2) Finger/ hand extension
(a) Test the extensors of the hand and fingers controlled by C-7 nerve roots
(b) Have patient hold wrist or fingers straight out and keep them out while you press down on their fingers
(c) Support the arm at the wrist to avoid testing arm function and other nerve roots

(d) Normal resistance should be felt to moderate pressure
(e) Both right and left sides should be checked
(f) Can still check if isolated, e.g., finger fracture, push on hand only not fingers; if wrist injury support MP joints and push on fingers only

b. Sensory function
(1) Pain sensation

(a) Abnormal sensation - ask patient about weakness, numbness, paresthesia, or radicular pain
(b) Pain or pinprick
(c) Need to separate from light touch (remember light touch carried by more than one tract)
(d) Use end of pen or broken Q-tip (avoid sharp objects which may damage or cause bleeding)
(e) Have patient close eyes and hold out hands; ask the patient to compare between sharp and dull pain
(f) Compare on both sides of the body; equal on both sides

6. Lower extremity neurological function assessment
a. Motor function
(1) Foot plantar flexion
(a) Place your hands at the sole of each foot and have the patient push against your hands
(b) Both sides should feel equal and strong
(2) Foot/ great toe dorsiflexion
(a) Hold foot with fingers on toes and instruct patient to pull foot back or towards their nose

b. Sensory function
(1) Pain sensation
(a) Abnormal sensation - ask patient about weakness, numbness, paresthesia, or radicular pain
(b) Pain or pinprick controlled by spinothalamic tracts
(c) Need to separate from light touch (remember light touch carried by more than one tract)
(d) Use end of pen or broken Q-tip (avoid sharp objects

which may damage or cause bleeding)

(e) Have patient close eyes and hold out hands; ask the patient to compare between sharp and dull pain

(f) Compare on both sides of the body; equal on both sides

X. Review principles of spinal immobilization

A. Principles of spinal immobilization

1. Primary goal is to prevent further injury
2. Treat spine as a long bone with a joint at either end (head and pelvis)
3. 15% of secondary spinal injuries are preventable with proper immobilization
4. Always use “complete” spine immobilization
   a. Impossible to isolate and splint specific injury site
5. Spine stabilization begins in the initial assessment
   a. Continues until the spine is completely immobilized on a long backboard
6. Head and neck should be placed in a neutral, in-line position unless contraindicated
   a. Neutral positioning allows for the most space for the cord
      (1) Reducing cord hypoxia
      (2) Reducing excess pressure
   b. Most stable position for the spinal column
      (1) Reduces instability

XI. Patient Transfer and Documentation

A. Verbal Report:

1. Other EMS personnel who will be taking over patient care
2. Assessment findings before and after immobilization
3. Treatments
4. Results of treatments
5. Personnel at receiving Emergency Department

B. Document:

1. Assessment findings before and after immobilization
2. Treatments
3. Results of treatments
4. State why patient was or was not immobilized according to the protocol

REFERENCES

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