

# Stabilization and Interfacility Management of Spinal Cord Injuries

## Guidelines from the Alaska Trauma Systems Review Committee

Spinal fractures, spinal ligamentous injuries, and spinal cord injuries (SCI) represent a small proportion of traumatic injuries in Alaska and yet have immense impact on the injured as well as upon state resources due to associated long-term disability, health care costs and transfer needs. The Alaska Trauma Registry has documented an average of 51 spinal cord injuries per year during the years of 2016 through 2020. While this represents only 1.3% of total trauma patients, approximately 40% will require out of state transfer for specialty care evaluation, continued management and rehabilitation. The goal of early management of spinal cord injuries is to limit secondary injury. Rural and remote hospitals in Alaska need to be prepared to stabilize patients with suspected or confirmed spinal cord injury.

This document is intended to guide initial management and stabilization of patients at acute care centers prior to transfer to higher-level trauma centers with capability for definitive care of spinal cord injuries. Prehospital providers seeking guidance on the management of spine injury are referred to “Spinal Care” in the 2022 NASEMSO Model EMS Clinical Guidelines (<https://tinyurl.com/23rt8mw5>). These guidelines address the management of SCI and is not inclusive of spinal column fractures.

SCI is frequently associated with other severe injuries. The most common mechanism for spinal cord injury is vehicular trauma. Other mechanisms include unintentional falls, firearm injuries, and sports-related injuries. Polytrauma is common in high-mechanism injuries. Older adults are at increased risk of spinal injuries due to comorbidities, including osteoporosis and osteopenia. Multi-system trauma injuries should be addressed according to principles of Advanced Trauma Life Support®. Level 1 and level 2 trauma centers are best resourced for the optimal care of patients with SCI and early consultation and transfer is recommended.

### INITIAL MANAGEMENT

- 1) Initial management of all trauma patients includes an organized primary and secondary survey with stabilization of immediate life threats. Identify and treat life-threatening injuries within the capabilities of the sending facility.
  - a) SCI above the level of T6 may predispose the patient to ventilatory compromise. The maintenance of the supine position may further impair ventilation and oxygenation: carefully consider the need for ventilatory support prior to transfer. If intubation is required, secondary injury associated with peri-intubation hypoxemia, hypotension, hyper/hypocarbica and excess spinal movement must be strictly avoided.
  - b) Hemorrhage remains the leading cause of shock in trauma patients. Neurogenic shock may be present in association of high-level spinal cord injury. However, occult

hemorrhage must be assumed in SCI with associated serious trauma and must be excluded clinically. Cardiovascular compromise in the setting of neurogenic shock will be unexplained by hypovolemic/hemorrhagic shock and is often associated with bradycardia.

- c) Disability exam may be suggestive of spinal cord injury when the following is present:
  - i) Absence of equal movement in the upper and/or lower extremities combined with gross sensory deficit.
  - ii) Loss of bladder or bowel function.
  - iii) Priapism.

## **SPINAL MOTION RESTRICTION**

- 1) SCI patients should be maintained with spinal motion restriction (SMR).
  - a. Maintain neutral spine alignment.
    - i. Consider full body lift (“forklift lift”) or logroll as needed for transfers and turns. Ensure that sufficient people are available to assist with patient transfers. A slider board or air mattress (e.g. HoverMatt®) may be helpful adjuncts.
    - ii. Children have disproportionately large heads and may require padding to elevate the torso to prevent head flexion.
    - iii. SMR should be maintained during transport, with preference for vacuum mattress. Do not use a long spine board other than for extrication.
    - iv. Removal of long spine board, scoop stretcher, or vacuum mattress should be accomplished in a timely fashion once in an acute care setting. The use of hard boards during long transfers is explicitly discouraged, given the risk of pressure injury.
  - b. If indicated by injury, a cervical collar.
    - i. The neck should be in a neutral position without undue flexion, extension, or lengthening. Care must be taken to assure cervical collars are applied so they do not impede jugular venous return or create undue pressure on submandibular area, anterior neck, and other soft tissues. Padding may be necessary to accommodate anatomy.
    - ii. Prior to interfacility transfer, if a cervical collar is indicated, extrication collars should be replaced with a collar designed for treatment (i.e., Miami J or Aspen) when available.
    - iii. Certain patients with pre-injury conditions, such as severe kyphosis, may not tolerate a cervical collar. An alternative means of cervical SMR should be used if application of the collar increases pain or requires significantly altering the position of comfort assumed by the patient.
    - iv. Use of cervical collars with SCI from penetrating mechanisms has been shown to be harmful and should be avoided.
  - c. Alternatives for cervical spinal restriction include head blocks, “horse collar” (a blanket roll or similar that frames the head and neck and is secured) or other commercial or improvised methods.

- d. When the cervical spine has motion restriction it is mandatory that the rest of the torso is also restricted to avoid it becoming a lever against the cervical restraint.
- e. Special considerations for the helmeted patient, including timing and technique of removal are addressed in Appendix A.

## **HEMODYNAMICS**

- 1) Prevention of hypotension is critical to reduce the risk of secondary spinal cord injury. Reverse treatable causes of shock. Sources of hemorrhage should be identified and controlled. Maintain a systolic BP of at least 90mm/hg or MAP > 65 during initial resuscitation. Limited evidence and international treatment guidelines suggest increased circulatory support may be beneficial during the acute and subacute phase of spinal cord injury.
  - a) In consultation with a trauma/spine specialist, consider augmentation of the MAP >85 mmHg to improve spinal cord perfusion.
  - b) Initial treatment of hypotension due to neurogenic shock will include volume resuscitation. Vasopressor use once initial resuscitation is achieved may be preferred to avoid volume overload.

## **REEXAMINE AND DOCUMENT**

- 1) Perform repeat neurological examinations prior to and during transfer to definitive care.
  - a) A standardized motor and sensory exam improves interrater reliability. If time allows, clinical documentation using a standardized tool published by the American Spinal Injury Association (ASIA) should be used. Please see Appendix B.
  - b) Neurochecks should be performed by a health care provider, at least hourly until patient is transferred to a definitive care center.

## **TRANSFER**

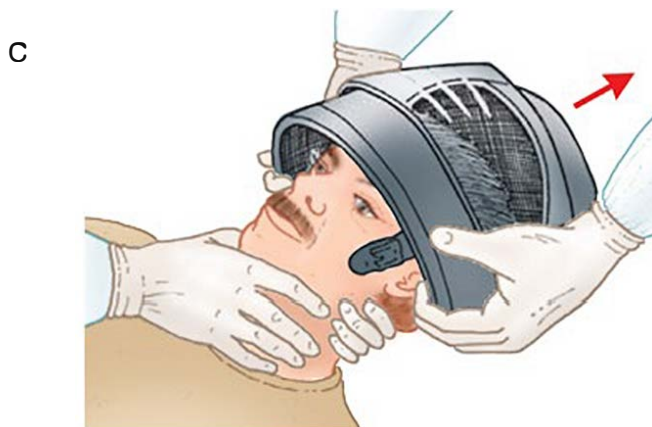
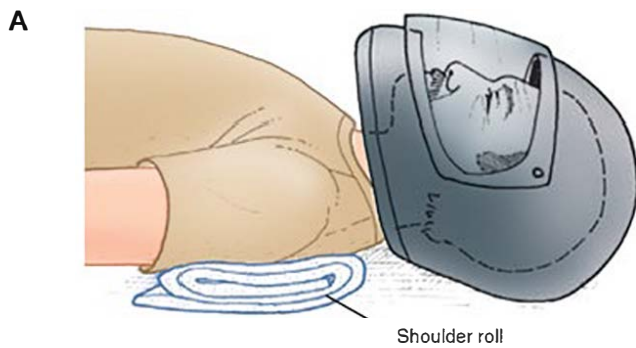
- 1) Early decision to transfer, within 2 hours, is strongly encouraged. Transfer should be to a higher-level trauma center.
  - a. Obtain early consultation with a spine specialist, with use of telemedicine as appropriate.
  - b. Use of methylprednisolone for early treatment of spinal cord injury cannot be definitively recommended. Steroid therapy should not be initiated without the guided direction of an accepting facility's spine specialist.
  - c. Blunt cerebrovascular injury is a common complication of cervical SCI and radiographic screening with CT angiography of the neck should be included in the diagnostic workup if it does not delay transfer.

## References:

1. Fischer PE, Perina DG, Delbridge TR, et al. Spinal Motion Restriction in the Trauma Patient - A Joint Position Statement. *Prehosp Emerg Care*. 2018;22(6):659-661.
2. Ryken TC, Hurlbert RJ, Hadley MN, et al. The acute cardiopulmonary management of patients with cervical spinal cord injuries. *Neurosurgery*. 2013;72 Suppl 2:84-92.
3. Spine Injury Guidelines. American College of Surgeons Trauma Quality Programs Best Practices Guidelines. Updated March 2022. Accessed March 7, 2022.  
[https://www.facs.org/-/media/files/quality-programs/trauma/tqip/spine\\_injury\\_guidelines.ashx](https://www.facs.org/-/media/files/quality-programs/trauma/tqip/spine_injury_guidelines.ashx)
4. Walters BC, Hadley MN, Hurlbert RJ, et al. Guidelines for the management of acute cervical spine and spinal cord injuries: 2013 update. *Neurosurgery*. 2013;60(CN\_suppl\_1):82-91.
5. Chapter 192. Helmet Removal. In: Reichman EF. eds. *Emergency Medicine Procedures*, 2e. McGraw Hill; 2013. Accessed December 01, 2022. <https://accessemergencymedicine.mhmedical.com/content.aspx?bookid=683&sectionid=45343843>



**Appendix A(2):** The two-person helmet removal technique. **A.** Patient positioning. **B.** An assistant provides in-line stabilization. The base of the helmet is spread open. **C.** Remove the helmet to clear the nose. **D.** The helmet is removed while the assistant continues in-line stabilization. **E.** The second rescuer provides in-line stabilization, in addition to the assistant. **F.** The assistant has removed their hands and the second rescuer maintains in-line stabilization.



Appendix B: ASIA Reference Form (Page 1 of 2)

Patient Name \_\_\_\_\_ Date/Time of Exam \_\_\_\_\_  
 Examiner Name \_\_\_\_\_ Signature \_\_\_\_\_

**RIGHT**

**MOTOR KEY MUSCLES**

**Upper Extremity Right**

Elbow flexors	C5
Wrist extensors	C6
Elbow extensors	C7
Finger flexors	C8
Finger abductors (little finger)	T1

Comments (Non-key Muscle? Reason for NT? Pair? Non-SCI condition?):

C2	
C3	
C4	
T2	
T3	
T4	
T5	
T6	
T7	
T8	
T9	
T10	
T11	
T12	
L1	
L2	
L3	
L4	
L5	
S1	
S2	
S3	
S4-5	

**LER (Lower Extremity Right)**

Hip flexors	L2
Knee extensors	L3
Ankle dorsiflexors	L4
Long toe extensors	L5
Ankle plantar flexors	S1

(VA) Voluntary Anal Contraction (Yes/No)  S4-5  S3

**RIGHT TOTALS (MAXIMUM)**

Light Touch (LTR) Pin-Pick (PPR)   (50)

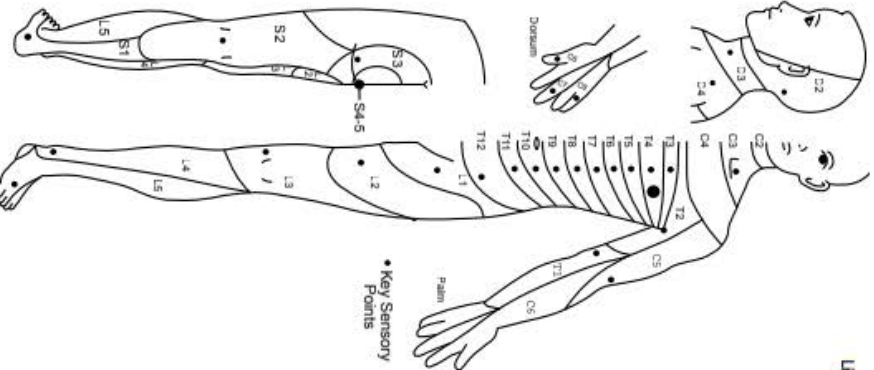
**MOTOR SUBSCORES**

UER  + UEL  = UEMS TOTAL  (50)

MAX (25) (25)

**SENSORY KEY SENSORY POINTS**

C2	
C3	
C4	
T2	
T3	
T4	
T5	
T6	
T7	
T8	
T9	
T10	
T11	
T12	
L1	
L2	
L3	
L4	
L5	
S1	
S2	
S3	
S4-5	



**MOTOR KEY MUSCLES**

**Upper Extremity Left**

Elbow flexors	C5
Wrist extensors	C6
Elbow extensors	C7
Finger flexors	C8
Finger abductors (little finger)	T1

(SCORING ON REVERSE SIDE)

**SENSORY (SCORING ON REVERSE SIDE)**

0 = Absent  
 1 = Not testable  
 2 = Normal

0 = Total paralysis  
 1 = Palpable or visible contraction  
 2 = Active movement, gravity eliminated  
 3 = Active movement, against gravity  
 4 = Active movement, against some resistance  
 5 = Active movement, against full resistance

NT = Not testable  
 0 = '1', '2', '3', '4', 'NT' = Non-SCI condition present

**LER (Lower Extremity Left)**

Hip flexors	L2
Knee extensors	L3
Ankle dorsiflexors	L4
Long toe extensors	L5
Ankle plantar flexors	S1

(DAP) Deep Anal Pressure (Yes/No)  S4-5  S3

**LEFT TOTALS (MAXIMUM)**

Light Touch (LTR) Pin-Pick (PPR)   (50)

**SENSORY SUBSCORES**

LTR  + LTL  = LT TOTAL  (56)

MAX (56) (56)

**NEUROLOGICAL LEVELS**

1. SENSORY MOTOR

2. MOTOR

3. NEUROLOGICAL LEVEL OF INJURY (NLI)

4. COMPLETE OR INCOMPLETE?

5. ASIA IMPAIRMENT SCALE (AIS)

6. ZONE OF PARTIAL PRESERVATION SENSORY MOTOR

## Appendix B: ASIA Reference Form (Page 2 of 2)

### Muscle Function Grading

- 0 = Total paralysis
  - 1 = Palpable or visible contraction
  - 2 = Active movement, full range of motion (ROM) with gravity eliminated
  - 3 = Active movement, full ROM against gravity
  - 4 = Active movement, full ROM against gravity and moderate resistance in a muscle specific position
  - 5 = (Normal) active movement, full ROM against gravity and full resistance in a functional muscle position expected from an otherwise unimpaired person
- NT = Not testable (i.e. due to immobilization, severe pain such that the patient cannot be graded, amputation of limb, or contracture of > 50% of the normal ROM)
- 0\*, 1\*, 2\*, 3\*, 4\*, NT\* = Non-SCI condition present \*

### Sensory Grading

- 0 = Absent
  - 1 = Altered, either decreased/impaired sensation or hypersensitivity
  - 2 = Normal
  - NT = Not testable
  - 0\*, 1\*, NT\* = Non-SCI condition present \*
- \* Note: Abnormal motor and sensory scores should be tagged with a "\*" to indicate an impairment due to a non-SCI condition. The non-SCI condition should be explained in the comments box together with information about how the score is rated for classification purposes (at least normal / not normal for classification).

### When to Test Non-Key Muscles:

In a patient with an apparent AIS B classification, non-key muscle functions more than 3 levels below the motor level on each side should be tested to most accurately classify the injury (differentiate between AIS B and C).

Movement	Root level
<b>Shoulder:</b> Flexion, extension, adduction, abduction, internal and external rotation	C5
<b>Elbow:</b> Supination	C5
<b>Elbow:</b> Pronation	C6
<b>Wrist:</b> Flexion	C6
<b>Finger:</b> Flexion at proximal joint, extension	C7
<b>Thumb:</b> Flexion, extension and abduction in plane of thumb	C7
<b>Finger:</b> Flexion at MCP joint	C8
<b>Thumb:</b> Opposition, adduction and abduction perpendicular to palm	C8
<b>Finger:</b> Abduction of the index finger	T1
<b>Hip:</b> Adduction	L2
<b>Hip:</b> External rotation	L3
<b>Hip:</b> Extension, abduction, internal rotation	L4
<b>Knee:</b> Flexion	L4
<b>Ankle:</b> Inversion and eversion	L4
<b>Toe:</b> MP and IP extension	L5
<b>Hallux and Toe:</b> DIP and PIP flexion and abduction	L5
<b>Hallux:</b> Adduction	S1

### ASIA Impairment Scale (AIS)

- A = Complete.** No sensory or motor function is preserved in the sacral segments S4-5.
- B = Sensory Incomplete.** Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-5 (light touch or pin prick at S4-5 or deep anal pressure) AND no motor function is preserved more than three levels below the motor level on either side of the body.
- C = Motor Incomplete.** Motor function is preserved at the most caudal sacral segments for voluntary anal contraction (VAC) OR the patient meets the criteria for sensory incomplete status (sensory function preserved at the most caudal sacral segments S4-5 by LT, PP or DAP), and has some sparing of motor function more than three levels below the ipsilateral motor level on either side of the body. (This includes key or non-key muscle functions to determine motor incomplete status.) For AIS C – less than half of key muscle functions below the single NLL have a muscle grade  $\geq 3$ .
- D = Motor Incomplete.** Motor incomplete status as defined above, with at least half (half or more) of key muscle functions below the single NLL having a muscle grade  $\geq 3$ .
- E = Normal.** If sensation and motor function as tested with the ISNCSCI are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E. Someone without an initial SCI does not receive an AIS grade.

**Using ND:** To document the sensory, motor and NLL levels, the ASIA Impairment Scale grade, and/or the zone of partial preservation (ZPP) when they are unable to be determined based on the examination results.

### Steps in Classification

- The following order is recommended for determining the classification of individuals with SCI.
1. **Determine sensory levels for right and left sides.**  
The sensory level is the most caudal, intact dermatome for both pin prick and light touch sensation.
  2. **Determine motor levels for right and left sides.**  
Defined by the lowest key muscle function that has a grade of at least 3 (on square testing), providing the key muscle functions represented by segments above that level are judged to be intact (graded as a 5).  
Note: In regions where there is no myotome to test, the motor level is presumed to be the same as the sensory level, if testable motor function above that level is also normal.
  3. **Determine the neurological level of injury (NLL).**  
This refers to the most caudal segment of the cord with intact sensation and antigravity (3 or more) muscle function strength, provided that there is normal (intact) sensory and motor function rostrally, respectively.  
The NLL is the most cephalad of the sensory and motor levels determined in steps 1 and 2.
  4. **Determine whether the injury is Complete or Incomplete.**  
(i.e. absence or presence of sacral sparing)  
If voluntary anal contraction = No AND all S4-5 sensory scores = 0 AND deep anal pressure = No, then injury is Complete.  
Otherwise, injury is Incomplete.
  5. **Determine ASIA Impairment Scale (AIS) Grade.**  
Is Injury Complete? If YES, AIS=A  
NO ↓  
Is Injury Motor Complete? If YES, AIS=B  
NO ↓ (No=voluntary anal contraction OR motor function more than three levels below the motor level on a given side, if the patient has sensory incomplete classification)  
Are at least half (half or more) of the key muscles below the neurological level of injury graded 3 or better?  
NO ↓ AIS=C      YES ↓ AIS=D
- Note: AIS E is used in follow-up testing when an individual with a documented SCI has recovered normal function. If at initial testing no deficits are found, the individual is neurologically intact and the ASIA Impairment Scale does not apply.
6. **Determine the zone of partial preservation (ZPP).**  
The ZPP is used only in injuries with absent motor (no VAC) OR sensory function (no DAP, no LT and no PP sensation) in the lowest sacral segments S4-5, and refers to those dermatomes and myotomes caudal to the sensory and motor levels that remain partially innervated. With sacral sparing of sensory function, the sensory ZPP is not applicable and therefore "NA" is recorded in the block of the worksheet. Accordingly, if VAC is present, the motor ZPP is not applicable and is noted as "NA".

