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# Prognosis after SCI

SCI Education Day 2022

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LEADING WITH PURPOSE.

# Objectives

- To review the current knowledge on prognosis after traumatic spinal cord injury (SCI)
  - To understand how prognostication after SCI can be determined by clinicians
    - To discuss how rehabilitation goals can be based on accurate prognostication



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## **Outline:**

- Neurologic evaluations for prognostication
- Current literature on prognosis after traumatic SCI
- Functional goal setting for rehabilitation



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# Neurologic Evaluations



## **Neurologic Evaluations:**

- **Why are neurologic evaluations important after SCI?**
  - To objectively determine neurologic status, rather than just anatomic status
  - To prognosticate after acute SCI
  - To set functional goals for both the patients/families and the rehabilitation professionals
  - Serial neurologic evaluations will detect any improvement or deterioration of neurologic status



## **Neurologic Evaluations:**

- Clinical examination
  - International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) (“ASIA classification”) is widely accepted as the standard neurologic evaluation after SCI (for both clinical and research) (Steeves, 2007)
  - Developed in 1982, first reference manual published in 1994; multiple revisions since



## Neurologic Evaluations:

- Components of ISNCSCI
  - Motor exam:
    - 10 key muscle groups on each side (UE + LE)
    - Anal sphincter volitional contraction
  - Sensory exam:
    - 28 dermatomes on each side + deep anal pressure
    - Light touch, pin prick





**ASIA** INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY (ISNCSCI) **ISCOS** INTERNATIONAL SPINAL CORD SOCIETY

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

**RIGHT**

**UER** (Upper Extremity Right)

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

**LER** (Lower Extremity Right)

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

(VAC) Voluntary Anal Contraction (Yes/No)

**RIGHT TOTALS** (MAXIMUM)  (50)  (50)  (50)

**MOTOR SUBSCORES**  
 UER  + UEL  = UEMS TOTAL  (50)  
 LER  + LEL  = LEMS TOTAL  (50)

• Key Sensory Points

**LEFT**

**UEL** (Upper Extremity Left)

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

**LEL** (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)

**LEFT TOTALS** (MAXIMUM)  (50)  (50)  (50)

**MOTOR SUBSCORES**  
 UEL  + UER  = UEMS TOTAL  (50)  
 LEL  + LER  = LEMS TOTAL  (50)

**SENSORY KEY SENSORY POINTS**

	Light Touch (LTR)	Pin Prick (PPR)	Light Touch (LTL)	Pin Prick (PPL)
C2				
C3				
C4				
C5				
C6				
C7				
C8				
T1				
T2				
T3				
T4				
T5				
T6				
T7				
T8				
T9				
T10				
T11				
T12				
L1				
L2				
L3				
L4				
L5				
S1				
S2				
S3				
S4-5				

**SENSORY SUBSCORES**  
 LTR  + LTL  = LT TOTAL  (50)  
 PPR  + PPL  = PP TOTAL  (112)

**NEUROLOGICAL LEVELS**  
 1. SENSORY: R  L   
 2. MOTOR: R  L   
 3. NEUROLOGICAL LEVEL OF INJURY (NLJ):   
 4. COMPLETE OR INCOMPLETE?   
 5. ASIA IMPAIRMENT SCALE (AIS):

**ZONE OF PARTIAL PRESERVATION** (In complete injuries only)  
 Most caudal level with any innervation  
 SENSORY: R  L   
 MOTOR: R  L

*This form may be copied freely but should not be altered without permission from the American Spinal Injury Association.* REV 11/15

## ISNCSCI Worksheet





## Output of ISNCSCI:

- “NLI” = Neurologic level of injury
- “AIS” = ASIA Impairment Scale:
  - AIS A: “complete” – no sensory or motor function is preserved in S4/5
  - AIS B: “sensory incomplete” – sensory preservation in S4/5
  - AIS C: “motor incomplete” – some motor function preserved
  - AIS D: “motor incomplete” – more motor function preserved
  - AIS E: “normal”



## **Neurologic Evaluations:**

- Clinical examination
  - Simple and available but needs training
  - Correlates well with neurologic status and prognostication (Ditunno, 2005)
  - ISNCSCI useful for specific functional prognostication, e.g. independent ambulation (van Middendorp 2011)



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# ISNCSCI for prognostication

*“Prognosticate” definition: “to foretell (future events) according to present signs or indications; prophecy” (Collins English Dictionary)*



## **ISNCSCI for Prognostication:**

- Motor and sensory (light touch + pin prick) exams form the basis of the ISNCSCI exam, providing information on level of injury and impairment severity
- Both exams yield useful information for prognostication of functional recovery after SCI
- It is the standard examination for clinical trials studying recovery after SCI
- Most studies used initial exam at 48h/72h/<30d
- Rick Hansen SCI Registry uses 72h



## **Motor Examination:**

- Studies have shown that motor level can be predictive of functional outcomes (Burns, 2005)
- Motor exam at 1 week post-injury may predict functional outcomes (Ditunno, 2000)
- High % of C4, C5, C6 injuries (incomplete and complete) gain 1 motor level by 24 months



## **Motor Examination:**

- Recovery of quadriceps muscles (>3/5 strength) by 2 months is a good predictor of ambulation by 6 months in persons with incomplete paraplegia (Crozier, 1993)
- Presence of combination of acute voluntary anal contraction, light touch and pin prick sensation in S4,5 is a good predictor of ambulation potential at 1 year (van Middendorp, 2010)



## **Motor Examination:**

- Initial ASIA motor score >50 on admission + less severe AIS classification is a good predictor of FIM motor outcomes at 1 year (compared to AMS <50) (Wilson et al, 2012)





## **Sensory Examination:**

- Pin prick and sacral sensory exams have been studied
- Baseline lower-extremity pinprick preservation and sacral pinprick preservation at 4 weeks post-injury are associated with an improved prognosis for ambulation in persons with motor complete, sensory incomplete injuries (Oleson, 2005)



## **Sensory Examination:**

- Presence of pin prick sensation (<7 days post-injury) at lateral antecubital fossa (C5) predicts motor recovery of extensor carpi radialis (C6) in C4,5 injuries (Browne,1993)
- Preserved pin prick sensation at levels below injury in motor complete injuries predicts functional ambulation (Crozier,1991)
- Presence of pin prick sensation (<7 days post-injury) at AIS (ASIA Impairment Scale) also has prognostic values (Marino et al 1999)



## **Sensory Examination:**

- Preserved S1 sensation a good predictor of S4,5 sensation and voluntary anal contraction (Zariffa et al, 2012)
- Light touch before surgery has the best predictive value for SCIM at 1 year, when compared to AIS, ISS (Injury Severity Score), AMS (ASIA Motor Score) (Kaminski et al, 2017)

# Let's take a poll!

“What % of persons with new traumatic SCI that is classified as AIS A (complete injury) initially will convert to AIS B/C/D in one year?”

- a. 0%
- b. 5%
- c. 15%
- d. 28%
- e. 35%



## Prognostication by AIS:

- Recent studies showed much better conversion rates than previous studies in 1990s
- Overall conversion rates (Kirshblum et al 2016):
  - AIS A: 27.8% converts to incomplete status at 1 year (about half to AIS B, half to AIS C/D)
  - AIS B: 53.6% changes to motor incomplete at 1 year
  - AIS C: initial voluntary anal contraction + other sacral sparing – AIS D on discharge



## Prognostication by AIS:

Initial AIS Classification	AIS at one year
AIS A tetraplegia	~30% (half to AIS B, half to AIS C/D)
AIS A paraplegia	~15-20% Lower thoracic and lumbar levels much higher rates of conversion than upper thoracic levels
AIS B tetraplegia	50-65% to AIS C/D
AIS B paraplegia	60-70% to AIS C/D
AIS C	85% to AIS D/E



## **Prognostication by neurological level of injury:**

- L>C/TL>T
- Lumbar level highest recovery rate
- Thoracic level lowest recovery rate
- Thoracic level + penetrating injury – likely to result in complete injury  
(Khorasanizadeh et al, 2019)





## **UMN vs LMN injury:**

- Sacral exam (sensory, motor, reflex – anal wink, bulbocavernosus) can help differentiate between UMN and LMN injuries for bowel/bladder/sexual function
- Very different management between UMN and LMN bowel/bladder/sexual functions



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# Functional Goal Setting



## **Functional Goal Setting:**

- Functional goals may be set by determination of prognosis through ISNCSCI exam:
  - Level of injury
  - Severity of impairment
  - Specific findings in motor and sensory exam (e.g. pin prick, sacral exam findings)



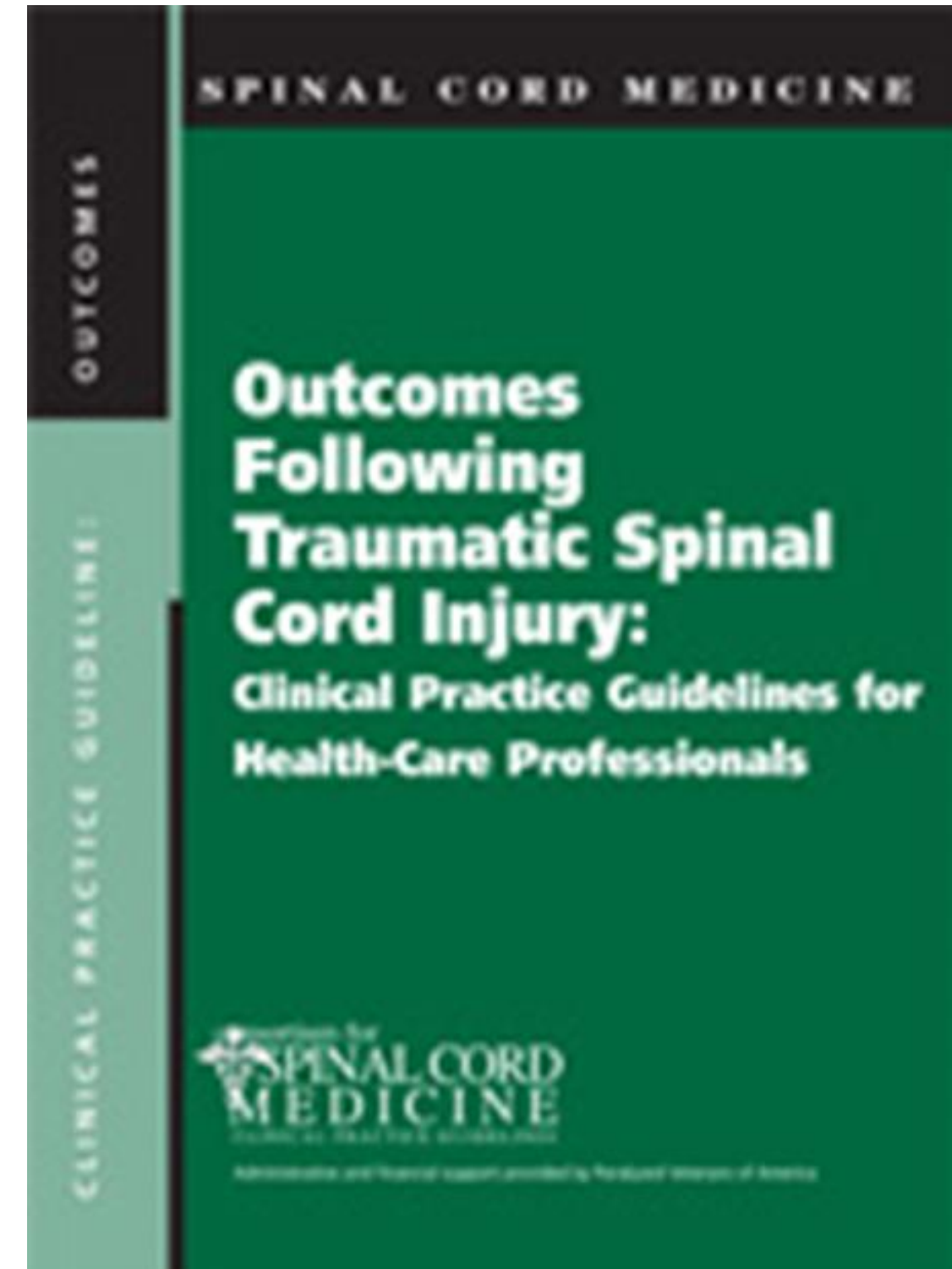
## **Functional Goal Setting:**

- ISNCSCI exam provides objective and clear basis for functional goal setting
  - Initial exam on admission to rehab provides objective data to support rehab and discharge planning
  - Subsequent exams provide objective basis for change in goals



## Functional Goal Setting:

- Consortium for Spinal Cord Injury  
Medicine Clinical Practice Guideline for  
Outcomes Following Traumatic Spinal Cord  
Injury has an expected functional  
outcomes table by level of injury
- [www.pva.org](http://www.pva.org)





## **Functional Goal Setting:**

- Case study:
  - 52 yo man with an acute paraplegia after a helicopter accident
  - No motor movement the legs when evaluated 1 week after accident in the ICU



## Functional Goal Setting:

- ISNCSCI exam 1 week after injury showed:
  - Neurologic level of injury: T12
  - Deep anal pressure present
  - No volitional anal contraction
  - No motor contraction in legs
  - Present pin prick sensation in most of the lower extremity dermatomes





## **Functional Goal Setting:**

- What is his ISNCSCI classification?
- How do you prognosticate:
  - Motor recovery?
  - Bowel and bladder function?
  - Ambulation potential?



## **Summary:**

1. ISNCSCI exam is a commonly accepted tool for neurologic evaluation following SCI – useful for prognostication.
2. Clinicians can prognosticate SCI recovery in their assessment of patients, hence setting appropriate rehab goals.
3. Recent research shows that neurologic improvement after SCI is better than what was previously thought, even for those with initial motor complete injuries.