Special article

International Standards for Neurological Classification of Spinal Cord Injury: Cases with classification challenges

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The International Standards for the Neurological Classification of Spinal Cord Injury (ISNCSCI) is routinely used to determine the levels of injury and to classify the severity of the injury. Questions are often posed to the International Standards Committee of the American Spinal Injury Association regarding the classification. The committee felt that disseminating some of the challenging questions posed, as well as the responses, would be of benefit for professionals utilizing the ISNCSCI. Case scenarios that were submitted to the committee are presented with the responses as well as the thought processes considered by the committee members. The importance of this documentation is to clarify some points as well as update the SCI community regarding possible revisions that will be needed in the future based upon some rules that require clarification.

Keywords: Spinal cord injury, International Standards, Classification, Neurological level

Introduction

The International Standards for the Neurological Classification of Spinal Cord Injury (ISNCSCI) were initially developed as the American Spinal Injury Association (ASIA) Standards for the Classification of Spinal Cord Injuries in 1982 for the National SCI Statistical Center Database.¹ While the ISNCSCI has undergone multiple revisions since then, the goal has remained the same: to provide precision in the definition of neurological levels and the extent of a spinal cord

injury (SCI), and to achieve more consistent and reliable data among the centers that may ultimately benefit patient care and research activities. The most recent revisions of the International Standards were published in 2011^{2,3} along with a reference article to clarify some of the changes.⁴ Most recently the worksheet was updated, along with the description of non-key muscle functions for the upper and lower extremities that may be used to differentiate an ASIA Impairment Scale (AIS) B versus C.⁵

The International Standards Committee often receives questions regarding the ISNCSCI. If these questions are not strictly a misunderstanding of what has been previously described in print, the question is disseminated to the committee members to develop a

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This manuscript is being jointly published by *Topics in Spinal Cord Injury Rehabilitation* and the *Journal of Spinal Cord Medicine*.

consensus response. As it is important that these responses be documented as well as brought to the attention of the field as a whole, the committee felt that sharing the most common questions in a peer reviewed reference, available for healthcare professionals to consult, would be beneficial. In this paper, we describe a number of case scenarios that have come from recent questions and the responses from the committee. The questions include (1) Can the AIS be determined in cases when not testable (NT) is documented?; (2) Can the AIS be determined when a non-SCI-related weakness is present?; (3) How do you classify a non-contiguous SCI (i.e. two distinct SCI lesions)?; and (4) Is the *motor level* or the *neurological level* used to differentiate AIS B from AIS C?

Questions and responses

Question 1: If “NT” muscles have been recorded, can one determine the AIS classification?

Response: While the rule of the ISNCSCI is “in such cases (where NT is recorded) sensory and motor scores for the affected side of the body, as well as total sensory and motor scores, cannot be generated at that point in treatment” (page 12 of the ISNCSCI booklet 2011),³ one may still determine whether an injury is neurologically complete or incomplete based upon sacral

sparing, unless it is the lowest sacral segments that are listed as NT or it occurs within segments that may make a difference in determining the AIS grade. This is an important concept as NT may occur in up to 9% of cases.⁶

A few examples will help illustrate how to score the worksheet when NT has been recorded.

Case 1a: (see Fig. 1A).

The summary of the levels and the AIS classification in this case:

Sensory level: C6 bilaterally.

Motor level: Right C7; Left – “Unable to determine” (UTD) as NT is documented at C6.

Neurological level of injury (NLI): “Unable to determine” (UTD).

AIS: A

ZPP: Sensory C6 bilaterally; C7 motor bilaterally.

Comment: Motor level and NLI cannot be determined because NT has been documented in areas that impact the determination of the levels.

In this case, the NT is not in the sacral segments and does not impact the AIS classification and therefore the AIS can be determined as noted above. The left motor level cannot be specifically determined in this case. With C5 grading as normal (5/5) and C7 being less than normal (grade 2), the motor level would be

A

RIGHT		MOTOR KEY MUSCLES		SENSORY KEY SENSORY POINTS		SENSORY KEY SENSORY POINTS		MOTOR KEY MUSCLES		LEFT	
				Light Touch (LT)		Pin Prick (PP)					
		C2	2	2	2	2	2	C2	2	2	2
		C3	2	2	2	2	2	C3	2	2	2
		C4	2	2	2	2	2	C4	2	2	2
		C5	5	2	2	2	2	C5	5	2	2
		C6	5	2	2	2	2	C6	NT	2	2
		C7	3	0	0	0	0	C7	2	0	0
		C8	0	0	0	0	0	C8	0	0	0
		T1	0	0	0	0	0	T1	0	0	0
		T2	0	0	0	0	0	T2	0	0	0
		T3	0	0	0	0	0	T3	0	0	0
		T4	0	0	0	0	0	T4	0	0	0
		T5	0	0	0	0	0	T5	0	0	0
		T6	0	0	0	0	0	T6	0	0	0
		T7	0	0	0	0	0	T7	0	0	0
		T8	0	0	0	0	0	T8	0	0	0
		T9	0	0	0	0	0	T9	0	0	0
		T10	0	0	0	0	0	T10	0	0	0
		T11	0	0	0	0	0	T11	0	0	0
		T12	0	0	0	0	0	T12	0	0	0
		L1	0	0	0	0	0	L1	0	0	0
		L2	0	0	0	0	0	L2	0	0	0
		L3	0	0	0	0	0	L3	0	0	0
		L4	0	0	0	0	0	L4	0	0	0
		L5	0	0	0	0	0	L5	0	0	0
		S1	0	0	0	0	0	S1	0	0	0
		S2	0	0	0	0	0	S2	0	0	0
		S3	0	0	0	0	0	S3	0	0	0
		S4-5	0	0	0	0	0	S4-5	0	0	0

Comments (Non-key Muscle? Reason for NT? Pain?):

NT – Severe left wrist pain

Key Sensory Points

Motor (SCORING ON REVERSE SIDE)

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
5+ = normal corrected for pain/disuse
NT = not testable

Sensory (SCORING ON REVERSE SIDE)

0 = absent
1 = altered
2 = normal
NT = not testable

(VAC) Voluntary anal contraction (Yes/No) **No**

(DAP) Deep anal pressure (Yes/No) **No**

Figure 1 (A–C) Sample worksheet for question 1.

B RIGHT

MOTOR KEY MUSCLES

SENSOR KEY SENSORY POINTS
Light Touch (LT) Pin Prick (PP)

C2	2	2
C3	2	2
C4	2	2
C5	5	2
C6	1	1
C7	1	1
C8	1	1
T1	0	1
T2	1	1
T3	1	1
T4	1	1
T5	1	1
T6	1	1
T7	1	1
T8	1	1
T9	1	1
T10	1	1
T11	1	1
T12	1	1
L1	1	1
L2	0	1
L3	0	1
L4	0	1
L5	0	1
S1	0	1
S2	1	1
S3	1	1
S4-5	1	1

Comments (Non-key Muscle? Reason for NT? Pain?)

NT – Splint in place on left hand and unable to test T1 motor.

LER (Lower Extremity Right)

UER (Upper Extremity Right)

Motor level: C5 bilaterally

Sensory level: C5 bilaterally

NLI: C5

AIS: UTD.

(VAC) Voluntary anal contraction (Yes/No) ☐ No

LEFT

MOTOR KEY MUSCLES

SENSOR KEY SENSORY POINTS
Light Touch (LT) Pin Prick (PP)

C2	2	2
C3	2	2
C4	2	2
C5	5	2
C6	2	1
C7	2	1
C8	2	1
T1	2	1
T2	1	1
T3	1	1
T4	1	1
T5	1	1
T6	1	1
T7	1	1
T8	1	1
T9	1	1
T10	1	1
T11	1	1
T12	1	1
L1	1	1
L2	1	1
L3	1	1
L4	1	1
L5	1	1
S1	1	1
S2	1	1
S3	1	1
S4-5	1	1

Motor level: C8 right; C7 left

Sensory level: C7 bilaterally

NLI: C7

AIS: UTD.

(DAP) Deep anal pressure (Yes/No) ☐ Yes

Key Sensory Points

Scoring Legend:

MOTOR (SCORING ON REVERSE SIDE)

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
5* = normal corrected for pain/disease
NT = not testable

SENSOR (SCORING ON REVERSE SIDE)

0 = absent
1 = altered
2 = normal
NT = not testable

Figure 1 Continued

classified as C6 if the NT muscle function grade is $\geq 3/5$ or C5 if the grade is $< 3/5$. The zone of partial preservation (ZPP) can be determined in this case because there is a neurologically complete (AIS A) injury and the NT muscle function is cephalad to the most caudal key level with some function.

As a contrast, case 1b (Fig. 1B) illustrates where the NT does impact the AIS classification. Please note the use of the comment box.

A summary of the levels and AIS classification in this case:

Sensory level: C5 bilaterally

Motor level: C5 bilaterally

NLI: C5

AIS: UTD.

If the T1 myotome had any muscle strength, this case would be classified as an AIS C, since there is sensory sacral sparing and there would be motor sparing in more than three levels below the motor level of C5. If the T1 myotome strength was recorded as 0, then this case would be classified as an AIS B, since motor sparing would only be at three levels (C6, C7, and C8) below the motor level and not more than three levels. In this case the motor level was able to be determined since the NT muscle function is below the last normal motor level. The ZPP is not applicable in this case

because this is only referred to in neurologically complete (AIS A) cases.

A last case will further illustrate this point (Fig. 1C). Again, please note the use of the comment box to highlight the issue.

A summary of the levels and AIS classification in this case:

Sensory level: C7 bilaterally

Motor level: C8 right; C7 left

NLI: C7

AIS: UTD.

One can determine the motor level in this case since regardless of what the muscle function grade would be at the left C8 myotome, the motor level would remain at C7, even if the left C8 myotome scored a 5/5. This is because the left C7 myotome grades a 3/5 and the motor level is defined as the

lowest key muscle function that has a grade of at least 3, providing the key muscle functions represented by segments above that level are judged to be intact.^{2,3} (Booklet – page 24)

The AIS classification, however, cannot be determined because if any of the motor levels where NT has been documented (at C8 or T1) were to have scored a strength of $\geq 3/5$, then this case would be classified as an AIS D –

C

RIGHT

MOTOR KEY MUSCLES

SENSORY KEY SENSORY POINTS
Light Touch (LT) Pin Prick (PP)

C2	2	2
C3	2	2
C4	2	2
C5	5	2
C6	5	2
C7	5	2
C8	3	1
T1	3	1
T2	1	1
T3	1	1
T4	1	1
T5	1	1
T6	1	1
T7	1	1
T8	1	1
T9	1	1
T10	1	1
T11	1	1
T12	1	1
L1	1	1
L2	3	1
L3	3	1
L4	3	1
L5	1	1
S1	1	1
S2	1	1
S3	1	1
S4-5	1	1

NERVE ROOTS

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

LOWER EXTREMITY (LER)
Hip flexors L2
Knee extensors L3
Ankle dorsiflexors L4
Long toe extensors L5
Ankle plantar flexors S1

(VAC) Voluntary anal contraction (Yes/No) **Yes**

• Key Sensory Points

LEFT

MOTOR KEY MUSCLES

SENSORY KEY SENSORY POINTS
Light Touch (LT) Pin Prick (PP)

C2	2	2
C3	2	2
C4	2	2
C5	5	2
C6	5	2
C7	3	1
C8	NT	1
T1	NT	1
T2	1	1
T3	1	1
T4	1	1
T5	1	1
T6	1	1
T7	1	1
T8	1	1
T9	1	1
T10	1	1
T11	1	1
T12	1	1
L1	1	1
L2	1	1
L3	1	1
L4	3	1
L5	2	1
S1	2	1
S2	1	1
S3	1	1
S4-5	1	1

NERVE ROOTS

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

LOWER EXTREMITY (LER)
Hip flexors L2
Knee extensors L3
Ankle dorsiflexors L4
Long toe extensors L5
Ankle plantar flexors S1

(VAC) Voluntary anal contraction (Yes/No) **Yes**

Comments (Non-key Muscle? Reason for NT? Pain?)

NT – Splint in place on left hand and unable to test C8 and T1 motor.

MOTOR (SCORING ON REVERSE SIDE)

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
5* = normal corrected for pain/disuse
NT = not testable

SENSORY (SCORING ON REVERSE SIDE)

0 = absent
1 = altered
2 = normal
NT = not testable

Figure 1 Continued

since there would then be $\geq 50\%$ of the segmental motor scores below the NLI with a muscle strength of $>3/5$. If both of these levels where NT is scored had instead a strength of $<3/5$, then this case would be classified as an AIS C.

Question 2: In a case scenario where there is a mid-thoracic injury but there is also a peripheral nerve injury (e.g. a radial nerve injury or a brachial plexus injury) how should this be reflected in the classification of the motor and sensory level?

Case scenario 2: (Fig. 2).

A summary of the levels and AIS classification in this case:

Response: Sensory level: T6 bilaterally

Motor level: T6 bilaterally

NLI: T6

AIS: A

ZPP: Sensory and motor T6 bilaterally.

Comment: There is a concomitant (distal) radial nerve injury accounting for the impaired sensation at the C6 and C7 dermatomes on the left and the absent strength at the left C6 myotome.

Without taking into account the extenuating circumstance of the concomitant radial nerve injury as the cause of the muscle function grade at the left C6 myotome, and sensory loss at the left C6 and C7 dermatomes, one might normally score the left motor and

sensory level as C5. However, it is important to recognize and document whether the neurological injury is unrelated to a SCI as depicted in this case with a thoracic spinal cord level injury along with a concomitant radial nerve injury. A note should be made in the comment box on the worksheet to correctly classify the patient's spinal cord level of injury (thoracic level in this case), rather than assigning a higher level due to a non-SCI-related injury.

The ISNCSCI booklet reinforces this with the paragraph that reads:

It is important to indicate on the worksheet, any weakness due to neurological conditions unrelated to SCI. For example, in a patient with a T8 fracture who also has a left brachial plexus injury, it should be noted that sensory and motor deficits in the left arm are due to the brachial plexus injury, not the SCI. This will be necessary to classify the patient correctly. (Booklet – page 29)³

Fortunately, this is a relatively simple case with a single-level non-SCI-related weak muscle that is above the NLI. The committee is working on possible notations for the worksheet to designate non-SCI-related weakness above the NLI.

The upper extremity motor scores, lower extremity motor scores, as well as the sensory scores for light

RIGHT

	MOTOR KEY MUSCLES	SENSORY KEY SENSORY POINTS Light Touch (LT) Pin Prick (PP)	
		LT	PP
C2		2	2
C3		2	2
C4		2	2
C5	Elbow flexors	5	2
C6	Wrist extensors	5	2
C7	Elbow extensors	5	2
C8	Finger flexors	5	2
T1	Finger abductors (little finger)	5	2
T2		2	2
T3		2	2
T4		2	2
T5		2	2
T6		2	2
T7		0	0
T8		0	0
T9		0	0
T10		0	0
T11		0	0
T12		0	0
L1		0	0
L2	Hip flexors	0	0
L3	Knee extensors	0	0
L4	Ankle dorsiflexors	0	0
L5	Long toe extensors	0	0
S1	Ankle plantar flexors	0	0
S2		0	0
S3		0	0
S4-5		0	0

UER (Upper Extremity Right)

LER (Lower Extremity Right)

(VAC) Voluntary anal contraction (Yes/No) ☐ No

• Key Sensory Points

LEFT

	MOTOR KEY MUSCLES	SENSORY KEY SENSORY POINTS Light Touch (LT) Pin Prick (PP)	
		LT	PP
C2		2	2
C3		2	2
C4		2	2
C5	Elbow flexors	5	0
C6	Wrist extensors	0	0
C7	Elbow extensors	5	0
C8	Finger flexors	5	0
T1	Finger abductors (little finger)	5	0
T2		2	2
T3		2	2
T4		2	2
T5		2	2
T6		2	2
T7		0	0
T8		0	0
T9		0	0
T10		0	0
T11		0	0
T12		0	0
L1		0	0
L2	Hip flexors	0	0
L3	Knee extensors	0	0
L4	Ankle dorsiflexors	0	0
L5	Long toe extensors	0	0
S1	Ankle plantar flexors	0	0
S2		0	0
S3		0	0
S4-5		0	0

UEL (Upper Extremity Left)

LEL (Lower Extremity Left)

(DAP) Deep anal pressure (Yes/No) ☐ No

Comments (Non-key Muscle? Reason for NT? Pain?)

Note – Radial nerve palsy on the left side affecting the left C6 motor and left C6 and C7 sensory testing.

MOTOR (SCORING ON REVERSE SIDE)

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
5* = normal corrected for pain/disuse
NT = not testable

SENSORY (SCORING ON REVERSE SIDE)

0 = absent
1 = altered
2 = normal
NT = not testable

Figure 2 Sample worksheet for question 2.

RIGHT

	MOTOR KEY MUSCLES	SENSORY KEY SENSORY POINTS Light Touch (LT) Pin Prick (PP)	
		LT	PP
C2		2	2
C3		2	2
C4		2	2
C5	Elbow flexors	3	1
C6	Wrist extensors	4	2
C7	Elbow extensors	4	2
C8	Finger flexors	5	2
T1	Finger abductors (little finger)	5	2
T2		2	2
T3		2	2
T4		2	2
T5		2	2
T6		2	2
T7		0	0
T8		0	0
T9		0	0
T10		0	0
T11		0	0
T12		0	0
L1		0	0
L2	Hip flexors	0	0
L3	Knee extensors	0	0
L4	Ankle dorsiflexors	0	0
L5	Long toe extensors	0	0
S1	Ankle plantar flexors	0	0
S2		0	0
S3		0	0
S4-5		0	0

UER (Upper Extremity Right)

LER (Lower Extremity Right)

(VAC) Voluntary anal contraction (Yes/No) ☐ No

• Key Sensory Points

LEFT

	MOTOR KEY MUSCLES	SENSORY KEY SENSORY POINTS Light Touch (LT) Pin Prick (PP)	
		LT	PP
C2		2	2
C3		2	2
C4		2	2
C5	Elbow flexors	2	1
C6	Wrist extensors	1	1
C7	Elbow extensors	2	2
C8	Finger flexors	2	2
T1	Finger abductors (little finger)	2	2
T2		2	2
T3		2	2
T4		2	2
T5		2	2
T6		2	2
T7		0	0
T8		0	0
T9		0	0
T10		0	0
T11		0	0
T12		0	0
L1		0	0
L2	Hip flexors	0	0
L3	Knee extensors	0	0
L4	Ankle dorsiflexors	0	0
L5	Long toe extensors	0	0
S1	Ankle plantar flexors	0	0
S2		0	0
S3		0	0
S4-5		0	0

UEL (Upper Extremity Left)

LEL (Lower Extremity Left)

(DAP) Deep anal pressure (Yes/No) ☐ No

Comments (Non-key Muscle? Reason for NT? Pain?)

Note: Two spinal fractures are present (at cervical and thoracic levels)

MOTOR (SCORING ON REVERSE SIDE)

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
5* = normal corrected for pain/disuse
NT = not testable

SENSORY (SCORING ON REVERSE SIDE)

0 = absent
1 = altered
2 = normal
NT = not testable

Figure 3 Sample worksheet for question 3.

touch and pin prick can still be calculated even though the left upper extremity impairments are not due to SCI. The scores do provide a clinical picture of the patients total motor/sensory impairment, but should not be considered an accurate measure of spinal cord impairment, for example in a clinical trial.

Question 3: In a case where there are two non-contiguous SCIs, one seemingly an incomplete injury and a more distal lesion resulting in a neurologically complete injury, how is this best documented and classified? For example, take the case of a C4 spinal fracture with deficits in strength and sensation at the upper cervical spinal cord segments, but otherwise sparing through the upper to mid-thoracic level with a concomitant T6 fracture (and a T6 SCI), with no sparing below (Fig. 3).

Response: A summary of the levels and AIS classification in this case:

Sensory level: C4 bilaterally

Motor level: C5 right; C4 left

NLI: C4

AIS: Unable to be determined.

ZPP: Unable to be determined.

Comment: AIS is not able to be determined due to multiple levels of SCI. This includes a C5 right, C4 left, motor level, with a C4 sensory level, most likely cervical motor incomplete injury and a T6 neurologically complete injury.

Case scenarios where there are multiple distinct levels of SCI pose a challenge to give an appropriate single classification. As such, this is a very difficult case in which to utilize the AIS and the associated levels of injury including the zone of partial preservation.

The motor level is C4 on the left and C5 on the right because the motor level is the lowest level whose key muscle function tests at least a 3 with all the myotomes above it being normal.^{2,3} By definition, when the myotome cannot be determined by direct examination of a key muscle function, it is presumed normal if the corresponding dermatome is normal. Since the dermatome for C4 right is normal, the myotome for C4 right is presumed normal. Since the right C5 key muscle function tests as grade 3/5 (and sensation is intact at C4 and above), the motor level for that side is C5.

The committee spent a great deal of time discussing the options in classifying this case. Even though there is no motor or sensory function at S4/5, which makes the AIS classification – an A, the thoracic lesion prevents one from knowing what the AIS for the cervical lesion injury might have been. Consideration was given to classify this case as a C4 motor incomplete (possibly AIS C or D) injury with a concomitant T6 complete (AIS A) injury. There was further discussion

regarding how to document the motor ZPP, some suggesting T1 while others at T6. The recommendation of the committee is to not document any single AIS classification for this case scenario, but rather to use the comment box to explain more fully what is seen (see the above comments).

It should be noted that non-contiguous levels of spinal fracture is not uncommon as there is an estimated 10–40% incidence in the setting of trauma,^{7–10} and as such careful inspection of the entire spinal column is necessary once a single fracture is identified. The importance of this scenario is the potential impact on the preservation of autonomic function and as such careful evaluation of the patient in this regard should be undertaken.¹¹

Question 4: In the revised booklet and worksheet for the ISNCSCI published in 2011, it seems unclear

ASIA Impairment (AIS) Scale	
☐	A = Complete. No sensory or motor function is preserved in the sacral segments S4-S5.
☐	B = Sensory Incomplete. Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5 (light touch, pin prick at S4-S5; or deep anal pressure (DAP)), 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 below the neurological level**, and more than half of key muscle functions below the single neurological level of injury (NLI) have a muscle grade less than 3 (Grades 0-2).
☐	D = Motor Incomplete. Motor function is preserved below the neurological level**, and <u>at least half</u> (half or more) of key muscle functions below the NLI have a muscle grade ≥ 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.
<p>**For an individual to receive a grade of C or D, i.e. motor incomplete status, they must have either (1) voluntary anal sphincter contraction or (2) sacral sensory sparing <u>with</u> sparing of motor function more than three levels below the motor level for that side of the body. The Standards at this time allows even non-key muscle function more than 3 levels below the motor level to be used in determining motor incomplete status (AIS B versus C).</p>	
<p>NOTE: When assessing the extent of motor sparing below the level for distinguishing between AIS B and C, the motor level on each side is used; whereas to differentiate between AIS C and D (based on proportion of key muscle functions with strength grade 3 or greater) the single neurological level is used.</p>	

Figure 4 ASIA impairment scale

RIGHT

MOTOR KEY MUSCLES

SENSORY KEY SENSORY POINTS
Light Touch (LT) Pin Prick (PP)

UER (Upper Extremity Right)

Elbow flexors C5 5 2 2
Wrist extensors C6 4 0 0
Elbow extensors C7 2 0 0
Finger flexors C8 1 0 0
Finger abductors (little finger) T1 1 0 0

LER (Lower Extremity Right)

Hip flexors L2 0 0 0
Knee extensors L3 0 0 0
Ankle dorsiflexors L4 0 0 0
Long toe extensors L5 0 0 0
Ankle plantar flexors S1 0 0 0

Comments (Non-key Muscle? Reason for NT? Pain?)

Key Sensory Points

Voluntary anal contraction (Yes/No) ☐ No

LEFT

MOTOR KEY MUSCLES

SENSORY KEY SENSORY POINTS
Light Touch (LT) Pin Prick (PP)

UEL (Upper Extremity Left)

Elbow flexors C5 5 2 2
Wrist extensors C6 4 0 0
Elbow extensors C7 2 0 0
Finger flexors C8 1 0 0
Finger abductors (little finger) T1 0 0 0

LEL (Lower Extremity Left)

Hip flexors L2 0 0 0
Knee extensors L3 0 0 0
Ankle dorsiflexors L4 0 0 0
Long toe extensors L5 0 0 0
Ankle plantar flexors S1 0 0 0

Motor (Scoring on Reverse Side)

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
5* = normal corrected for pain/disuse
NT = not testable

Sensory (Scoring on Reverse Side)

0 = absent 2 = normal
1 = altered NT = not testable

Voluntary anal contraction (Yes/No) ☒ Yes (DAP) Deep anal pressure (Yes/No)

Figure 5 Sample worksheet for question 4.

whether the motor level or NLI is used to differentiate the classification of AIS B versus C. Specifically, on the ISNCSCI worksheet summary on the back of page 2, in the middle column (Fig. 4), it states the following:

*C = Motor Incomplete. Motor function is preserved below the neurological level**, and more than half of key muscle functions below the single neurological level of injury (NLI) have a muscle grade less than 3 (Grades 0–2).*

In a case as presented in Fig. 5 (above), there is sacral sparing (DAP) and there is sparing of motor function more than three levels below the NLI (of C4) and <50% the muscles functions below the NLI have a score of $\geq 3/5$. Therefore, should this case be classified as an AIS C?

Response:

A summary of the levels and AIS in this case should be documented as follows:

Sensory level: C5 bilaterally

Motor level: C6 bilaterally

NLI: C5

AIS: B

ZPP: Not applicable

It is important to recognize that the guidelines in the ISNCSCI booklet, as well as on the back of the International Standards worksheet, state that to differentiate an AIS B versus C, you use the *motor level* (booklet – page 31) 3.⁴ At the bottom of Fig. 4, this is noted where it states the following:

Note: When assessing the extent of motor sparing below the level for distinguishing between AIS B and C, the motor level on each side is used...

In this case as presented, since the motor level is at C6, there is sparing of exactly three levels below the motor level on the right and two levels on the left, which therefore, does not meet the definition of having sparing *more than three levels below the motor level* on either side (or having voluntary anal contraction).

It should be clear how to differentiate a sensory from motor incomplete injury (AIS B versus C) and between motor incomplete injuries (AIS C versus D). Fig. 4 represents what is on the back of the standard worksheet and the double asterisk (**) is a notation to read further the paragraph on the bottom of the column on that page which states the following to make it clear:

Note: When assessing the extent of motor sparing below the level for distinguishing between AIS B

Table 1 Non-key muscle function

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

and C, the **motor level** on each side is used; whereas to differentiate between AIS C and D (based on proportion of key muscle functions with strength grade 3 or greater) the **single neurological level** is used.

****For an individual to receive a grade of C or D, i.e. motor incomplete status, they must have either (1) voluntary anal sphincter contraction or (2) sacral sensory sparing with sparing of motor function more than three levels below the motor level for that side of the body. The Standards at this time allows even non-key muscle function more than 3 levels below the motor level to be used in determining motor incomplete status (AIS B versus C).**

As described earlier, the International Standards Committee has designated non-key muscle functions with their associated myotomal levels so they can be used consistently by examiners (Table 1).⁵ A full explanation for the changes is described on the website.⁵

Discussion

Often when dealing with different case scenarios, questions arise regarding the classification of SCI utilizing the ISNCSCI assessment. In addition, as clinical trials in SCI are currently enrolling individuals based, in part, upon the AIS, it is important that the ISNCSCI be clearly defined and consistently interpreted and utilized. The International Standards Committee continues

to work to refine the classification, based upon the questions that arise as well as research performed in the field. A research subcommittee of international clinicians and researchers has been formed to consider possible revisions to the ISNCSCI to improve consistency.

It is hoped that our responses to the questions illustrated here will be of use to professionals in the classification of patients with SCI when such challenging cases present themselves. The International Standards Committee will continue to present questions and responses to keep the professional community up-to-date with current knowledge with publication in appropriate venues as well as available as part of InSTeP and the ASIA website. We encourage comments and feedback.

Conclusion

Sample cases presented here offer some answers to questions posed regarding the ISNCSCI. Recommendations for classification in these scenarios have been described and serve as a reference for professionals in SCI when faced with these situations.

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