



Clinical Case of the Month

Neurological issues

William H Donovan¹, Douglas J Brown², John F Ditunno Jr³, Paul Dollfus⁴, and Hans L Frankel⁵

¹Department of Physical Medicine and Rehabilitation, University of Texas–Houston Medical School, 1333 Moursund, Houston, Texas 77096, USA; ²Spinal Injuries Unit, Austin Hospital, Heideberg, Victoria, Australia; ³Thomas Jefferson University Hospital, Philadelphia, PA 19107, USA; ⁴72 rue des Carrières, 6810, Mulhouse, France; ⁵National Spinal Injuries Centre, Stoke Mandeville Hospital, Aylesbury, Bucks HP21 8AL, UK

The case histories of two patients who had had a spinal cord injury (SCI) were selected by the senior author and sent to four experts in the field of SCI. Based on the 1992 American Spinal Injury Association (ASIA) and International Medical Society of Paraplegia (IMSOP) standards, the four participants plus the senior author recorded the motor and sensory scores, the ASIA impairment scale (AIS), the neurological level (NL) and the zone of partial preservation (ZPP). Several minor scoring errors occurred among the participants, especially with motor scores when key muscles could not be tested due to pain, or external immobilization devices. Difficulties with interpretation occurred with the motor levels and the ZPP for the patient with a complete injury. This exercise points to the need for all examiners of SCI patients to thoroughly familiarize themselves with the standards and to use the motor and sensory scores to arrive at a NL and ZPP. They also indicate a need to revise the standards to clarify the determination of sensory levels and how to score muscles whose strength is inhibited by pain.

Keywords: spinal cord injury; neurological examination; standards for classification of spinal cord injury

Introduction

In 1982, the American Spinal Injury Association (ASIA) published a booklet entitled, *Standards for Neurological Classification of Spinal Cord Injured Patients*.¹ In 1989, the Standards were revised in response to concerns raised by clinicians and researchers, who were concerned about removing as much ambiguity as possible when collecting and recording data. The standards were next revised in 1992 and published in *Paraplegia*.² For the first time, the standards included a disability measure by incorporating the functional independence measures (FIM) as part of the standards.³ These standards were formally adopted by the International Medical Society of Paraplegia (IMSOP) at its 1992 annual meeting in Barcelona.² In response to ongoing feedback, the standards have again been revised in 1996 and will continue to be updated from time to time.

Despite the wide acceptance of the standards, little investigation has been done to test their reliability. Donovan⁴ reported significant problems existed with interrater reliability, particularly with the parameters

of neurologic level, what was then called the Frankel grade, and the zone of partial preservation (ZPP) for both physicians and therapists. Subsequently, Priebe⁵ found similar problems in a test, retest study especially with the determination of sensory levels at T12 and L1 and motor levels in incomplete patients. They supported the call for the revisions which followed in 1992. In a study aimed at assessing the efficacy of Omental Transposition in the treatment of chronic spinal cord injury, Clifton *et al*⁶ tested the intrarater reliability of the 1992 standards and found the motor score to be very reliable ($r=0.99$) and the sensory scores less so but still acceptable for their study. Cohen *et al*⁷ assessed the interrater and intrarater reliability of the 1992 standards in a test conducted at the 1994 American Spinal Injury Association (ASIA) annual meeting. She found that participants had the greatest difficulty with scoring an incomplete SCI patient, establishing a motor level, and determining the ZPP of a complete patient. These were areas that needed still further refinement.⁷

Since the interrater reliability still remains to be established, it seemed that this first exercise in the assessment of clinical cases, a series which appears for the first time in this issue of 'Spinal Cord', should

survey a group, recognized as experts in the field of spinal cord injury, provide them with the same two cases and determine how they would score and interpret them using the 1992 standards.⁸

Materials and methods

Two patients which the senior author personally examined, are described below. The case reports were then sent to four expert volunteers who agreed to read the cases, read the standards, interpret the narrative, complete the motor and sensory score chart following the diagram (Figure 1)⁸ and along with the author, interpret the findings to arrive at a neurological level, an ASIA Impairment Scale (AIS) and a ZPP, if applicable. The participants were not asked to comment on the treatment or prognosis, only to interpret the information as reported so that they could score and classify each patient. Two were from the United States, and one each was from Australia, Great Britain and France. All four volunteers and the author, speak fluent English.

Case 1

A 44 year-old computer programmer was involved in a motor vehicle accident and sustained a left C5/6

unifacetal dislocation and a right perched facet at the same level. Following rescue and transport to a trauma center, he underwent closed reduction by cervical traction, and 48 h later had an operation with internal fixation and fusion via a posterior approach. His post-operative course was uneventful. A follow-up examination 4 weeks following the injury revealed the following:

Sensation Pinprick: Right: From the occipital protuberance to the top of the acromioclavicular joint—normal. From the lateral side of the antecubital fossa to the perianal area—absent. *Left:* From the occipital protuberance to the top of the acromioclavicular joint—normal. From the lateral side of the antecubital fossa to the medial side of the antecubital fossa—absent. From the apex of the axilla to the perianal area, the sensation was described as sharp but not as sharp as the face but nevertheless was accompanied by an unpleasant hyperpathia. *Light Touch: Right:* From the occipital protuberance to the top of the acromioclavicular joint—normal. At the lateral side of the antecubital fossa—diminished. At the thumb and middle finger—absent. From the little finger to the perianal area—diminished. *Left:* From the occipital protuberance to the top of the acromioclavicular joint—normal. From the lateral side of the antecubital fossa to the perianal area—diminished. Deep anal sensation was present.

STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

MOTOR

KEY MUSCLES

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

Elbow flexors
Wrist extensors
Elbow extensors
Finger flexors (distal phalanx of middle finger)
Finger abductors (little finger)

Hip flexors
Knee extensors
Ankle dorsiflexors
Long toe extensors
Ankle plantar flexors

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

Voluntary anal contraction (Yes/No)

TOTALS: (MAXIMUM) (50) (50) (100) **MOTOR SCORE**

SENSORY

KEY SENSORY POINTS

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

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

Any anal sensation (Yes/No)

TOTALS: (MAXIMUM) (56) (56) (56) (56) **PIN PRICK SCORE** (max: 112)
LIGHT TOUCH SCORE (max: 112)

NEUROLOGICAL LEVELS
The most caudal segment with normal function

COMPLETE OR INCOMPLETE?
Incomplete - Any sensory or motor function in S4-S5

ASIA IMPAIRMENT SCALE

ZONE OF PARTIAL PRESERVATION
Partially innervated segments

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.

Version 4p
GHC 1996

Figure 1

Motor Muscle strength was graded from 0 to 5 as follows: Right/Left: Elbow Flexors 5/5, Wrist Extensors 4/4, Elbow Extensors 2/1, Finger Flexors 0/0, Small Finger Abductor 0/0, Hip Flexors 4/4, Quadriceps 5/5, Ankle Dorsiflexors 4/3, Long Toe Extensor 4/4, Ankle Plantarflexors 5/5. Voluntary Anal Contraction—present.

Request Using the accompanying ‘Standard Neurological Classification of Spinal Cord Injury’ chart, please complete the motor score, the pinprick score, the light touch score, the neurological levels (sensory and motor), left and right—the Impairment Scale, and the Zone of Partial Preservation. Please insert the ASIA impairment scale based upon the revised 1992 edition in the box which says complete or incomplete.

Case 2

A 32 year old bicyclist was struck by a car. Following rescue and transport to a trauma center, he was found to have a L1 compression fracture with retropulsion of the body into the neural canal. Two days later, he underwent L1 vertebrectomy, anterior interbody fusion from T12 to L2 using a left iliac crest strut graft and Z-plate instrumentation via a lateral approach. He also underwent posterior Cotrel-Dubousset instrumentation and fusion. He had also sustained a left Colles fracture which was treated with closed reduction and immobilization in a cast. His examination 24 h after the injury, and prior to the operation was as follows:

Sensation Pinprick: Right: From the occipital protuberance to the medial femoral condyle—normal. From the medial malleolus to the lateral heel—diminished. From the popliteal fossa to the perianal area—absent. Left: From the occipital protuberance to the medial malleolus—normal. The dorsum of the foot and the lateral heel—diminished. From the popliteal fossa to the perianal area—absent.

Light Touch: Right: From the occipital protuberance to the lateral (sic) femoral condyle—normal. From the to (sic) the popliteal fossa—diminished. The ischial tuberosity and the perianal area—absent. Left: From the occipital protuberance to the medial malleolus—normal. The dorsum of the foot—diminished with accompanying sensation of hyperpathia. From the lateral heel to the perianal area—absent. Deep anal sensation—absent.

Motor All muscles in the upper extremities were normal, however, the left wrist extensors could not be tested. Lower extremities: **Hip flexors** Right: the patient was unable to lift the leg due to pain. When the right thigh was supported by the examiner and elevated 15 degrees, a strong isometric contraction was palpated. Left: The patient was able to lift the leg (flexed at the knee) to 90 degrees. A strong contraction was palpated but the patient could offer no resistance against extension due to pain. **Knee Extensors:** Right

and Left: Able to offer full resistance: **Ankle Dorsiflexors:** Right: Full range of motion is possible but only with gravity eliminated. Left: Able to offer moderate resistance. **Extensor Hallucis Longus:** Right: A minimal contraction is palpable. Left: Full range of motion against gravity is possible but no resistance can be provided. **Ankle Plantar Flexors:** Right: No contraction is palpated or seen. Left: A slight contraction is appreciated by palpating over the Achilles tendons. Voluntary anal contraction—absent.

Request Using the accompanying ‘Standard Neurological Classification of Spinal Cord Injury’ chart, please complete the motor score, the pinprick score, the light touch score, the neurological levels, the impairment scale, and the zone of partial preservation. Please insert the ASIA impairment scale based upon the revised 1992 edition in the box which says complete or incomplete.

Results

Case 1

The motor scores are shown in Table 1a. The sensory scores are shown in Table 1b and c while Table 1d displays the neurological level, impairment scale and zone of partial preservation for all five participants. As shown in Table 1a, there was complete agreement in the motor scoring. Scorer number 3, however, failed to indicate whether any anal contraction was present. Table 1b shows the complete agreement for light touch among all participants. Number 3 omitted the anal sensation also. Table 1c reveals that the pinprick scores were identical with regard to totals despite the fact that scorer number 4 scored T1 on the left as a 1 instead of a 0. As shown in Table 1d, scorer number 5 did not submit a sensory or motor level. Scorers 1 and 3 stated that the motor level was C6 bilaterally while scorers 2 and 4 stated that the motor level was C5 bilaterally. All scorers stated that the ASIA impairment scale was ‘D’ except scorer number 2 who left this out. Likewise all scorers except scorer number 5 who left it out, reported the zone of partial preservation as non-applicable because the lesion was incomplete.

Case 2

As shown in Table 2a, all scorers recognized that C6 on the left was not testable except scorer number 5 who reversed the scores left to right. Scorer number 2 declared the L2 muscle as not testable. Scorers 1 and 3 gave the hip flexors a grade 5 bilaterally while 4 and 5 gave them grade 4 bilaterally. There was complete agreement for L3. For L4, all scorers gave the right ankle dorsiflexors a grade 2 except scorer 4 who gave it a grade 3. For the extensor hallucis and the ankle plantarflexors, the scorers were in complete agreement. Scorers 1 and 2 treated the total as not scorable. Scorer 3’s total was 81, scorer 4 put down 75 over 95 and

Table 1 Case 1

	1		2		3		4		5	
	R	L	R	L	R	L	R	L	R	L
<i>a Motor</i>										
C5	5	5	5	5	5	5	5	5	5	5
C6	4	4	4	4	4	4	4	4	4	4
C7	2	1	2	1	2	1	2	1	2	1
C8	0	0	0	0	0	0	0	0	0	0
T1	0	0	0	0	0	0	0	0	0	0
L2	4	4	4	4	4	4	4	4	4	4
L3	5	5	5	5	5	5	5	5	5	5
L4	4	3	4	3	4	3	4	3	4	3
L5	4	4	4	4	4	4	4	4	4	4
S1	5	5	5	5	5	5	5	5	5	5
T	64		64		64		64		64	
ANAL	Y		Y		-		Y		Y	
CONT										

b Sensory light touch

C2	2	2	2	2	2	2	2	2	2	2
C3	2	2	2	2	2	2	2	2	2	2
C4	2	2	2	2	2	2	2	2	2	2
C5	1	1	1	1	1	1	1	1	1	1
C6	0	1	0	1	0	1	0	1	0	1
C7	0	1	0	1	0	1	0	1	0	1
C8	1	1	1	1	1	1	1	1	1	1
T1	1	1	1	1	1	1	1	1	1	1
T2	1	1	1	1	1	1	1	1	1	1
T3	1	1	1	1	1	1	1	1	1	1
T4	1	1	1	1	1	1	1	1	1	1
T5	1	1	1	1	1	1	1	1	1	1
T6	1	1	1	1	1	1	1	1	1	1
T7	1	1	1	1	1	1	1	1	1	1
T8	1	1	1	1	1	1	1	1	1	1
T9	1	1	1	1	1	1	1	1	1	1
T10	1	1	1	1	1	1	1	1	1	1
T11	1	1	1	1	1	1	1	1	1	1
T12	1	1	1	1	1	1	1	1	1	1
L1	1	1	1	1	1	1	1	1	1	1
L2	1	1	1	1	1	1	1	1	1	1
L3	1	1	1	1	1	1	1	1	1	1
L4	1	1	1	1	1	1	1	1	1	1
L5	1	1	1	1	1	1	1	1	1	1
S1	1	1	1	1	1	1	1	1	1	1
S2	1	1	1	1	1	1	1	1	1	1
S3	1	1	1	1	1	1	1	1	1	1
S4/5	1	1	1	1	1	1	1	1	1	1
T	60		60		60		60		60	
ANAL	Y		Y		-		Y		Y	
SENS										

c Sensory pin prick

C2	2	2	2	2	2	2	2	2	2	2
C3	2	2	2	2	2	2	2	2	2	2
C4	2	2	2	2	2	2	2	2	2	2
C5	0	0	0	0	0	0	0	0	0	0
C6	0	0	0	0	0	0	0	0	0	0
C7	0	0	0	0	0	0	0	0	0	0
C8	0	0	0	0	0	0	0	0	0	0
T1	0	0	0	0	0	0	0	1	0	0
T2	0	1	0	1	0	1	0	1	0	1
T3	0	1	0	1	0	1	0	1	0	1
T4	0	1	0	1	0	1	0	1	0	1

cont.

Table 1 continued

	1		2		3		4		5	
	R	L	R	L	R	L	R	L	R	L
<i>c Sensory pin prick</i>										
T5	0	1	0	1	0	1	0	1	0	1
T6	0	1	0	1	0	1	0	1	0	1
T7	0	1	0	1	0	1	0	1	0	1
T8	0	1	0	1	0	1	0	1	0	1
T9	0	1	0	1	0	1	0	1	0	1
T10	0	1	0	1	0	1	0	1	0	1
T11	0	1	0	1	0	1	0	1	0	1
T12	0	1	0	1	0	1	0	1	0	1
L1	0	1	0	1	0	1	0	1	0	1
L2	0	1	0	1	0	1	0	1	0	1
L3	0	1	0	1	0	1	0	1	0	1
L4	0	1	0	1	0	1	0	1	0	1
L5	0	1	0	1	0	1	0	1	0	1
S1	0	1	0	1	0	1	0	1	0	1
S2	0	1	0	1	0	1	0	1	0	1
S3	0	1	0	1	0	1	0	1	0	1
S4/5	0	1	0	1	0	1	0	1	0	1
T	32		32		32		32		32	

d Neurological level

SENS	C4	C4	C4	C4	C4	C4	C4	C4	C4	-
MOT	C6	C6	C5	C5	C6	C6	C5	C5	C5	-

ASIA impairment scale

1	2	3	4	5
D	-	D	D	D

Zone of partial preservation

1	2	3	4	5
N/A	N/A	N/A	N/A	-

scorer 5 scored 75. All agreed on the absence of anal contraction.

As shown in Table 2b, there was total agreement from C2 through L3. Despite the typographical error in the light touch section of the case descriptions, scorers 1 through 4 were able to agree on the scoring from L4 to S2. Scorer 5 however did not interpret the information and left a question mark for L4, L5 and S1 on the right. S3 and S4/5 were uniformly scored. Scorers 1, 2, 4 and 5 placed 95 as the total. Scorer 3 reported 51. For pinprick (Table 2c) the scorers were in complete agreement except for the total where scorer number 3 again summed the values as 51 instead of 95.

As shown in Table 2d, there was agreement between scorers 1 and 3 as to the motor and sensory levels, ie L3 left and L4 right. Scorer 2 did not commit to a motor level but gave the sensory level as L3 bilaterally. Scorer 4 also gave the sensory level as L3 bilaterally and the motor level as L4 on right and L5 on the left. Scorer 5 simply gave an overall sensory level of L4 and a motor level of L5. All five scorers gave the ASIA impairment scale as A. Under zone of partial preservation, again Scorers 1 and 3 were in agreement, reporting the ZPP for sensory as S2 on the right

Table 2 Case 2

	1		2		3		4		5	
	R	L	R	L	R	L	R	L	R	L
<i>a Motor</i>										
C5	5	5	5	5	5	5	5	5	5	5
C6	5	NT	5	NT	5	NT	5	NT	NT	5
C7	5	5	5	5	5	5	5	5	5	5
C8	5	5	5	5	5	5	5	5	5	5
T1	5	5	5	5	5	5	5	5	5	5
L2	5	5	NT	NT	5	5	4	4	4	4
L3	5	5	5	5	5	5	5	5	5	5
L4	2	4	2	4	2	4	3	4	2	4
L5	1	3	1	3	1	3	1	3	1	3
S1	0	1	0	1	0	1	0	1	0	1
T	NT		NT		81		75/95		75	
ANAL	N		N		N		N		N	
CONT										
<i>b Sensory light touch</i>										
C2	2	2	2	2	2	2	2	2	2	2
C3	2	2	2	2	2	2	2	2	2	2
C4	2	2	2	2	2	2	2	2	2	2
C5	2	2	2	2	2	2	2	2	2	2
C6	2	2	2	2	2	2	2	2	2	2
C7	2	2	2	2	2	2	2	2	2	2
C8	2	2	2	2	2	2	2	2	2	2
T1	2	2	2	2	2	2	2	2	2	2
T2	2	2	2	2	2	2	2	2	2	2
T3	2	2	2	2	2	2	2	2	2	2
T4	2	2	2	2	2	2	2	2	2	2
T5	2	2	2	2	2	2	2	2	2	2
T6	2	2	2	2	2	2	2	2	2	2
T7	2	2	2	2	2	2	2	2	2	2
T8	2	2	2	2	2	2	2	2	2	2
T9	2	2	2	2	2	2	2	2	2	2
T10	2	2	2	2	2	2	2	2	2	2
T11	2	2	2	2	2	2	2	2	2	2
T12	2	2	2	2	2	2	2	2	2	2
L1	2	2	2	2	2	2	2	2	2	2
L2	2	2	2	2	2	2	2	2	2	2
L3	2	2	2	2	2	2	2	2	2	2
L4	1	2	1	2	1	2	1	2	?	2
L5	1	1	1	1	1	1	1	1	?	1
S1	1	0	1	0	1	0	1	0	?	0
S2	1	0	1	0	1	0	1	0	1	0
S3	0	0	0	0	0	0	0	0	0	0
S4/5	0	0	0	0	0	0	0	0	0	0
T	95		95		51		95		95	
ANAL	N		N		N		N		N	
SENS										
<i>c Sensory pin prick</i>										
C2	2	2	2	2	2	2	2	2	2	2
C3	2	2	2	2	2	2	2	2	2	2
C4	2	2	2	2	2	2	2	2	2	2
C5	2	2	2	2	2	2	2	2	2	2
C6	2	2	2	2	2	2	2	2	2	2
C7	2	2	2	2	2	2	2	2	2	2
C8	2	2	2	2	2	2	2	2	2	2
T1	2	2	2	2	2	2	2	2	2	2
T2	2	2	2	2	2	2	2	2	2	2
T3	2	2	2	2	2	2	2	2	2	2
T4	2	2	2	2	2	2	2	2	2	2

cont.

Table 2 continued

	1		2		3		4		5	
	R	L	R	L	R	L	R	L	R	L
<i>c Sensory pin prick</i>										
T5	2	2	2	2	2	2	2	2	2	2
T6	2	2	2	2	2	2	2	2	2	2
T7	2	2	2	2	2	2	2	2	2	2
T8	2	2	2	2	2	2	2	2	2	2
T9	2	2	2	2	2	2	2	2	2	2
T10	2	2	2	2	2	2	2	2	2	2
T11	2	2	2	2	2	2	2	2	2	2
T12	2	2	2	2	2	2	2	2	2	2
L1	2	2	2	2	2	2	2	2	2	2
L2	2	2	2	2	2	2	2	2	2	2
L3	2	2	2	2	2	2	2	2	2	2
L4	1	2	1	2	1	2	1	2	1	2
L5	1	1	1	1	1	1	1	1	1	1
S1	1	1	1	1	1	1	1	1	1	1
S2	0	0	0	0	0	0	0	0	0	0
S3	0	0	0	0	0	0	0	0	0	0
S4/5	0	0	0	0	0	0	0	0	0	0
T	95		95		51		95		95	
<i>d Neurological level</i>										
SENS	L3	L4	L3	L3	L3	L4	L3	L3		L4
MOT	L3	L4	-	-	L3	L4	L4	L5		L5
<i>ASIA impairment scale</i>										
	1		2		3		4		5	
	A		A		A		A		A	
<i>Zone of partial preservation</i>										
	1		2		3		4		5	
	R	L	R	L	R	L	R	L	R	L
SENS	S2	S1	S2	L5	S2	S1	S1	S1		S1
MOT	L5	S1	-	-	L5	S1	L5	S1	L5	S1

and S1 on the left and for motor L5 on the right and S1 on the left. Scorer number 2 again did not give a motor ZPP but reported sensory on the right as S2 and on the left as L5. Scorer 4 reported the sensory ZPP as S1 bilaterally and the motor ZPP as L5 on the right and S1 on the left. Scorer 5 gave the sensory ZPP as S1 (presumably bilaterally) and the motor ZPP as L5 on the right and S1 on the left just as Scorers 1, 3 and 4.

Discussion

It becomes apparent when analyzing the data from an exercise such as this, that scoring and interpreting are two different processes. Accuracy is necessary for the former and reliability is needed for the latter before an instrument like the *International Standards* can be optimally utilized in multicenter studies. This project was designed to examine the 1992 Standards' usefulness to seasoned students of the topic of spinal cord injury by allowing them to uniformly score and interpret two representative patients with a SCI. If such uniformity were not reached, then at least the study could point the way to further refinements and

the ASIA Neurological Standards Committee could see whether these had been made in the 1996 revision, which was not available at the time of this study.

Case 1

The following were regarded as scoring and recording problems: (a) examiner number 3 omitted the information regarding anal contraction and sensation (Table 1a,b); (b) examiner number 4 gave segment T1 on the pinprick score (Table 1c) a '1' on the left yet the total recorded was 32, not 33 as expected, if the sums had been correct. The text of Case 1 stated the patient had absent pinprick sensation at 'the medial side of the antecubital fossa'. This is the key area for T1 on the dermatome chart (Figure 1); (c) examiner number 5 took segments of the score sheet provided and had them enlarged but the enlargements did not contain the boxes for the neurological level (NL) nor the ZPP. These two pieces of information were missing from the results submitted; (d) examiner number 2 omitted the AIS; (e) as an aside, examiner number 4 expressed concern about the use of the lateral antecubital fossa representing C5. However, the key point for C5 is clearly shown on the dermatome chart as located in this area (Figure 1). All of the foregoing (a–d) were classified as scoring errors that would likely disappear with more practice.

The interpretation of the data for Case 1 is to be found in Table 1d. Even though this was a case of incomplete SCI, there was near unanimous agreement as to the sensory level, AIS and ZPP (exceptions as noted above). The motor level posed a problem, however. The 1992 standards state that '... the motor level (the lowest normal motor segment—which may differ by side of body) is defined by the lowest key muscle that has a grade of at least 3, providing the key muscles represented by segments above that level are judged to be normal ...'. Since the C5 muscles were Grade 5 (normal strength) and the C6 muscles were Grade 4, while the C7 muscles were less than Grade 3, the C6 muscles were the lowest ones that tested 'at least 3' (actually 4) while the muscles 'above that level' (C5) were Grade 5 (normal). Following the guidelines then, C6 is the motor level.

The ASIA standards committee has already recognized that further clarification of the standards regarding the determination of the motor level is needed and this has been addressed in the 1996 revised standards.

Case 2

The following were interpreted as scoring and recording problems: (a) while all examiners recognized the wrist extensors in this case were not testable (NT), examiner number 5 reversed the sides (Table 2a). Examiners 3, 4 and 5 gave a total score while numbers 1 and 2 did not. Number 3 gave the NT muscle a value

of 5 by summing the score as 81. Number 4 scored the total as 75 out of 95 while number 5 simply indicated 75; (b) examiner number 5 gave a sum of 75 but the actual sum should have been 74, if the scores were added correctly as reported (Table 2a). The ASIA standards say when a dermatome or myotome cannot be tested, NT should be recorded for that segment, for the affected side of the body and for the total sensory and/or motor scores (as applicable) since they 'cannot be generated with respect to the injury at that point in treatment'.

Other scoring and recording problems noted were: (c) number 4 graded the L4 muscle as Grade 3 even though the case text stated 'full range of motion is possible with gravity eliminated'. In Case 2 it was purposely decided to use the names of the muscles and words to describe the strength grades rather than numbers as were used in Case 1. This was the only error that appeared to result from that decision; (d) examiner number 3 summed the sensory scores for pinprick and light touch both as 51 (Tables 2b,c); (e) despite the typographic error in the case text describing the light touch findings on the right, examiners 1 through 4 assumed that *medial* rather than lateral femoral condyle was intended and that light touch was diminished from L4 to S2. Examiner 5 placed a '?' in L4, L5 and S1 but gave these three dermatomes a summed value of 3 to arrive at a total of 95 (Table 2b); (f) examiner number 5 recorded only one level and one sensory ZPP. This may also have resulted from enlarging the score sheets and separating their components (Figure 1).

Problems relating to interpretation are more evident in this case. The most significant is posed by the hip flexors. Case 2 had a significant injury to his upper lumbar spine. The psoas portion of the iliopsoas muscle originates from this area and the concomitant injury to the muscle makes testing it in the way described in the ASIA standards manual⁹ problematic. It could be argued that all five examiners were correct in the way they scored these muscles, even though they gave three different answers (Table 2a). Since so much depends upon the examiner's judgement and experience as to how to grade the iliopsoas under these conditions, the use of NT would likely result in a more uniform, albeit unscorable response. Examiner 2 gave no motor level (Table 2d) but this was consistent with the motor score (Table 2a). Numbers 1 and 3 also gave motor levels consistent with their assumption of Grade 5 iliopsoas muscles. They scored the left L4 muscle as 'less than Grade 3' (actually 2), while the right one was 'at least 3' (actually 4). Since they scored both the L2 and L3 muscles as Grade 5 bilaterally, they followed the standards by giving their motor levels as right L3 and left L4.

While the typographical error seemed to have created only minor problems with respect to sensory scoring, it may have affected the interpretation of a sensory level (Table 2d). Nevertheless, when studying

the sensory scores (Table 2b,c), all examiners recorded the lowest normal segments as being L3 on the right and L4 on the left. However, the sensory levels were not unanimous. The 1992 standards⁸ do not define the requisite conditions for arriving at the sensory level as explicitly as they do for the motor level. They say 'when the term sensory level is used, it refers to the most caudal segment of the spinal cord with normal sensory function on both sides of the body.' This is an area for the ASIA Neurological Standards Committee to address.

All examiners recognized the AIS as 'A' or complete. The clarity with which the NL is defined becomes critical when recording the ZPP. The segments included in the latter are calculated based upon the former. Nevertheless, despite the differences among the examiners for the sensory and motor levels, numbers 1, 3, 4 and 5 all agreed upon the most caudal level to which the motor ZPP extended ie, right L5, left S1 (number 2, consistently, did not give a motor ZPP as there was no motor NL recorded). The sensory ZPP was a problem area however. Examiners 1, 2 and 3 agreed on the right side (S2) while examiners 1, 3 and 4 agreed on the left side (S1). Yet, if Tables 2b and c are examined carefully, all agreed that the lowest segment with any sensation at all was S2 on the right and S1 on the left. The 1992 standards define the ZPP as '. . . those dermatomes and myotomes caudal to the neurological level that remain partially innervated. When some impaired sensory and/or motor function is found below the lowest normal segment, the exact number of segments so affected should be recorded for both sides as the ZPP. The term is used only with complete injuries.'

The discrepancies in the NL and ZPP interpretations seem to relate to inexact applications of the standards and lack of utilization of the scoring sheets by all examiners. When allowance for the difficulty related to the hip flexors, the current definition of a sensory level and the typographical error which appeared in the light touch section is made, overall, the standards contained most of the information needed to score and interpret these two cases.

It is recognized that asking multiple examiners to score and interpret a case report is not the same as

having them examine, score and interpret the examination of a real patient. The former was the only means of conducting this exercise. Comparing the results of a case report of a 'standardized patient' with the examination of that patient would be an interesting study.

The senior author has deliberately refrained from listing 'the right answer' for each case, allowing the reader to decide individually based upon the 1992 standards. Now that the 1996 standards have just been released, in 12 months, this exercise will be repeated to see if the difficult areas of interpretation have improved.

References

- 1 Standards for Neurological Classification of Spinal Cord Injured Patients. American Spinal Cord Injury Association 1982, Chicago.
- 2 Ditunno JF, Young W, Donovan WH, Creasey G. The International Standards Booklet for Neurological and Functional Classification of Spinal Cord Injury. *Paraplegia* 1994; **2**:70–80.
- 3 Hamilton BB, Devoe MJ. 1990 Functional Enhancement in Spinal Cord Injury. The Model. Proceedings of a National Consensus Conference on Catastrophic Illness and Injury, Georgia Regional Spinal Cord Injury Care System, Shepherd Center. Atlanta, GA.
- 4 Donovan WH, Wilkerson MA, Rossi D, Mechoulam F, Frankowski RF. A test of the ASIA Guidelines for Classification of Spinal Cord Injuries. *Journal of Neurologic Rehabilitation* 1990; **4**: 39–53.
- 5 Priebe MM, Waring WP. The Interobserver Reliability of the Revised American Spinal Injury Association Standards for Neurological Classification of Spinal Injury Patients. *Amer J PM&R* 1991; **70**: 286–70.
- 6 Clifton GL et al. Omental Transposition in Chronic Spinal Cord Injury. *Paraplegia* 1996; **4**: 193–203.
- 7 Cohen ME, Ditunno JF, Donovan WH, Maynard FM. A test of the International Standards for Neurological and Functional Classification of Spinal Cord Injury. *J Spinal Cord Med* 1996; **19**: 137.
- 8 Standards for Neurological Classification of Spinal Cord Injured Patients. American Spinal Cord Injury Association 1992, Chicago, IL.
- 9 Reference Manual for the International Standards for Neurological and Functional Classification of Spinal Cord Injury. American Spinal Injury Association/International Medical Society of Paraplegia 1994, Chicago, IL.