



2009 Review and Revisions of the International Standards for the Neurological Classification of Spinal Cord Injury

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Abstract

Summary: The International Standards for the Neurological Classification of Spinal Cord Injury (ISNCSCI) were recently reviewed by the ASIA's Education and Standards Committees, in collaboration with the International Spinal Cord Society's Education Committee. Available educational materials for the ISNCSCI were also reviewed. The last citable reference for the ISNCSCI's methodology is the ISNCSCI Reference Manual, published in 2003 by ASIA. The Standards Committee recommended that the numerous items that were revised should be published and a precedent established for a routine published review of the ISNCSCI. The Standards Committee also noted that, although the 2008 reprint pocket booklet is current, the reference manual should be revised after proposals to modify/revise the ASIA Impairment Scale (AIS as modified from Frankel) are considered. In addition, the Standards Committee adopted a process for thorough and transparent review of requests to revise the ISNCSCI.

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INTRODUCTION

The International Standards for the Neurological Classification of Spinal Cord Injury (ISNCSCI) were initially developed as the ASIA (American Spinal Injury Association) Standards for the Classification of Spinal Cord Injuries in 1982 for the National SCI Statistical Center Database. The impetus came from the need to develop greater precision in the definition of neurologic levels and the extent of incomplete injury and to achieve more

consistent and reliable data among the centers participating in the National Database. This led to adopting key muscles and key sensory points in the neurologic assessment. In 1989–1990 an ASIA committee further refined the precision in the determination of levels, the key muscles, and sensory points and clarified the zone of partial preservation and Frankel grades (1).

Major revisions of the standards were completed in 1992, 1996, and 2000 (2–4). At their annual meeting in Barcelona in September 1992, the International Medical Society of Paraplegia endorsed ISNCSCI-92 (International Standards for the Classification of Spinal Cord Injuries) for use by their members (5). In 1996 The International Spinal Cord Society (ISCoS, formerly known as the International Medical Society of Paraplegia) endorsed ISNCSCI-96, which was renamed the ISNCSCI (3).

A booklet for the ISNCSCI was first published in 1982 and a Reference Manual in 1994. Additional minor revisions and reprints have been made for the booklet,

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and the manual had a second revision in 2003 (6–8). In 2005, ASIA began plans to create a multimedia Internet teaching program for the ISNCSCI that would complement the booklet and Reference Manual. An extensive review of the ISNCSCI by the ASIA and ISCoS's Education Committees was performed during the content creation of the Web-based training course called the International Standards e-Learning Program (InSTeP). Creating InSTeP was a 3-year project spanning 2006 to 2009. This project resulted in a comprehensive 6-module eLearning course available at www.asialearningcenter.org. In collaboration with this project, ASIA's International Standards Committee also reviewed and approved the changes made in the ISNCSCI.

The changes in the ISNCSCI were extensive enough that ASIA's International Standards Committee decided the 2003 Reference Manual should no longer be sold or used. Recommendations were made to revise the 2003 Reference Manual, but the earliest that this will occur will be in 2013 after the next planned review and revision of InSTeP and the ISNCSCI occurs. In the interim, to provide a citable source for research and manuscript preparation the International Standards Committee requested *The Journal of Spinal Cord Medicine* to publish this summary of the revised ISNCSCI.

METHODS

The 2003 ISNCSCI Reference Manual accurately reflects the process used during this current review, except for the increased use of electronic communication: "The face validity of ISNCSCI is based on a process that included lengthy discussion within the {ASIA Standards} committee of definitions and procedures to develop consensus in several face-to-face meetings and phone conferences. The discussion was based on both clinical experience and research results. Input to the committee was broadened beyond the organizations and disciplines directly represented by its members through extensive organizational contacts and presentations of the standards at a wide variety of meetings and through journal publications. These efforts tapped into numerous health professional networks in addition to those of physicians, including physical therapists, occupational therapists, nurses and others. All written comments were circulated to members of the committee and are responded to in several of the chapters of this manual." (1).

RESULTS/REVISIONS

Purpose of the Standards

The International Standards Committee reviewed the purpose of the ISNCSCI in the 1994 and 2003 Reference Manuals (1–5). The 1994 Reference manual states "... the goal is to ensure that both the measurement technique and the use of the resulting data are consistent across practitioners and researchers." (5). The International Standards Committee, although aware the ISNCSCI can be used clinically, in research, and for

prognosis, felt it would be inappropriate that the ISNCSCI mandate their specific use. The 2003 Manual discussed that the ISNCSCI can measure the severity of the injury or impairment: "Motor and sensory losses are quantified in measures of impairment, while losses in daily life functioning are assessed using measures of disability. Together, these measures of impairment and disability can be used to predict clinical outcomes and to monitor gains following spinal cord injury." (1). The International Standards Committee felt it would be inappropriate to tie the ISNCSCI to disability because there is no one accepted measure for disability. Instead the purpose of the ISNCSCI was revised as "The International Standards' primary purpose remains unchanged: they are an internationally adopted standardized clinical neurological examination and classification for SCI."

T3 Sensory Exam Revisions

An alternate test was added for patients with pendulous breasts or when it is difficult to count ribs. The alternative is to locate the second rib at the sternomanubrial junction (angle of Louis) and then descend one rib to T3. Then the sensory testing can be performed at the T3-T4 intercostal space.

Motor Exam Revisions

Contractures. It was clarified that muscles/joints with contractures with at least 50% of the normal range can be tested. Previous directions were confusing regarding contractures of 25% to 50%.

Sequence of Muscle Functions. It was clarified that the sequence of muscle functions tested is at the discretion of the examiner while still recommending that examiners use a consistent pattern of motor and sensory examination.

Testing Position. The suggestion to start with a grade 3 testing position was added. The intent was to assist less experienced examiners, to minimize over grading muscle strength, and to make the exam more time efficient.

C5—Elbow Flexion. For grades 0, 1, and 2, the phrase "resting on abdomen" for the testing position was deleted and "support the forearm" was substituted to prevent the patient dragging the forearm across the trunk.

C6—Wrist Extension. For grades 4 and 5, 90 degrees was deleted for the testing position to full wrist extension. It was clarified that the resistance is given by grasping the hand and applying force in a diagonally down and out (flexion and ulnar deviation) motion (see Figure 1).

C7—Elbow Extension. For grades 4 and 5, support to the upper arm when testing was added to improve examiner's leverage. In addition for grade 2, support the forearm was added to prevent the patient dragging the forearm across the trunk.

C8—Finger Flexors (Distal Phalanx of Middle Finger). Specific directions were added on how to stabilize the proximal interphalangeal (PIP) and metacarpophalangeal joints to prevent substitution (see Figure 2).



Figure 1. C6—wrist extension, grades 4–5. Resistance is given by grasping the hand and applying force in a diagonally down and out (flexion and ulnar deviation) motion.

T1—Finger Abductors (Little Finger). For grade 3, directions were added to stabilize the metacarpophalangeal joint to prevent substitution of finger extension. In addition, for grades 4–5 it was clarified that the examiner should apply force on the distal lateral little finger.

L2—Hip Flexors. For grade 3, the hip and knee position was changed from neutral to 15 degrees of flexion. This allows the examiner to place his or her hand underneath the distal thigh to stabilize the hip in a neutral rotation and put a hand under the heel to prevent the foot from dragging on the exam surface. This change was also made to use the same 15 degrees of hip and knee flexion used in the grades 0–1 positioning in the 2003 Reference Manual (1).

L3—Knee Extensors. For Grade 3, knee flexion at 30 degrees was added instead of the previous direction that “the knee is partially flexed.” Thirty degrees of knee flexion allows the examiner to place one arm underneath the knee to be tested and on top of the opposite knee to

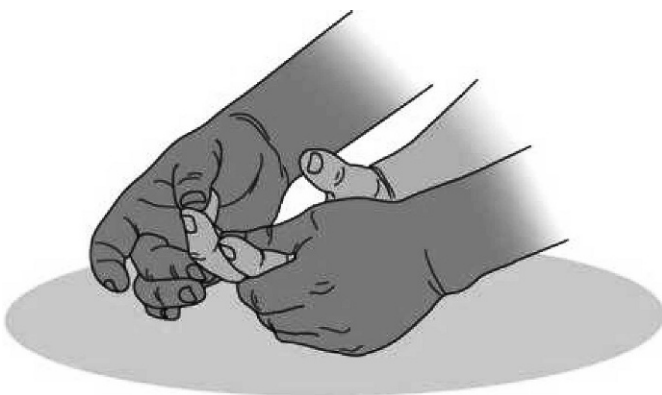


Figure 2. C8—finger flexors (distal phalanx of middle finger). Stabilize the proximal interphalangeal and metacarpophalangeal to prevent substitution.



Figure 3. L3—knee extensors, grades 4–5. 30 degrees of knee flexion allows the examiner to place one arm underneath the knee to be tested and on top of the opposite knee to allow better leverage for the examiner when testing for strength.

allow better leverage for the examiner when testing for grade strength (see Figure 3).

L4—Ankle Dorsiflexors. Grade 2 of the 2003 Reference Manual instructs the examiner to place the patient’s knee in 90 degrees of flexion (1). The intent of this instruction was to isolate the gastrocnemius muscle from the plantar flexion capacity of the soleus. The current instructions in InSTeP state only “to position the knee in flexion” (9). This change was not intentional but the Committee felt it is only a very minor deviation that can be corrected in a future version of InSTeP.

L5—Long Toe Extensors. Grades 4–5. The change clarified that the examiner pushes against the distal interphalangeal joint of the big toe as opposed to “push against the toe” (1).

S1—Ankle Plantar Flexors. For grade 3, instead of placing the foot flat against the examining surface, the examiner is instructed to position the foot in full dorsiflexion. The intent of this change is to accommodate cases in which the patient’s foot is in a mechanically disadvantaged position. This will occur if the plantar flexors are in a shortened length and unable to decrease their length (contract) due to soft examining surfaces, the patient’s body habitus, or altered range of motion of the hip or knee.

Anorectal Examination

Neither the 2003 ISNCSCI Reference Manual nor the ISNCSCI Booklet contained specific instructions for testing anorectal voluntary motor function or S4-S5 deep sensation. There was strong consensus that without clear instruction there would be a risk for inaccurate scoring and hence classification due to the impact of misinterpreting involuntary tone for voluntary tone, confusion for novice examiners from findings due to evolution of spinal

Determine the AIS grade

Patient Name _____ Date/Time of Exam _____

Examiner Name _____

ASIA **STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY** **ISCS**

MOTOR
KEY MUSCLES (writing on reverse side)

CS	R	L	Elbow flexors
C6	R	L	Wrist extensors
C7	R	L	Elbow extensors
C8	R	L	Finger flexors (antagonists of middle finger)
T1	R	L	Finger abductors (2nd digit)

UPPER LIMB TOTAL (MAXIMUM) (20) (20) (20)

Comments: _____

SENSORY
KEY SENSORY POINTS

C2	R	L	Light Touch	Pin Prick
C3	R	L	Light Touch	Pin Prick
C4	R	L	Light Touch	Pin Prick
C5	R	L	Light Touch	Pin Prick
C6	R	L	Light Touch	Pin Prick
C7	R	L	Light Touch	Pin Prick
C8	R	L	Light Touch	Pin Prick
T1	R	L	Light Touch	Pin Prick
T2	R	L	Light Touch	Pin Prick
T3	R	L	Light Touch	Pin Prick
T4	R	L	Light Touch	Pin Prick
T5	R	L	Light Touch	Pin Prick
T6	R	L	Light Touch	Pin Prick

Legend: (0) = absent, (1) = impaired, (2) = normal, NT = not testable

Voluntary anal contraction (Yes/No) S4-5 Any anal sensation (Yes/No)

LOWER LIMB
KEY MUSCLES (writing on reverse side)

L4	R	L	Ankle dorsiflexors
L5	R	L	Long toe extensors
S1	R	L	Ankle plantar flexors

LOWER LIMB TOTAL (MAXIMUM) (20) (20) (20)

Voluntary anal contraction (Yes/No) Any anal sensation (Yes/No)

TOTALS (MAXIMUM) (40) (40) (40)

PIN PRICK SCORE (max: 112)
LIGHT TOUCH SCORE (max: 112)

NEUROLOGICAL LEVEL: The most rostral segment with normal function. COMPLETE OR INCOMPLETE? COMPLETE INCOMPLETE (Impairment in the sensory or motor function of the sacral segments) ASIA IMPAIRMENT SCALE ZONE OF PARTIAL PRESERVATION (ZPP) (Zone of partial preservation of sacral sensory or motor function)

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Figure 4. ASIA Impairment Scale grade worksheet. Refer to bottom row of data for the N-O-O-O-O-N sign if the injury is complete.

shock on reflex function, and inadvertent scoring of visceral sensation mediated by the vagus nerve as somatic sensation. A separate teaching module was developed for the anorectal examination due to its importance in the ASIA Impairment Scale (AIS) and the definition of complete vs incomplete spinal cord injuries.

The Anorectal Exam Module for InSTeP content includes the anorectal anatomy, the concept of spinal shock, and a discussion on involuntary reflex function. The module adopted Vogel's recommendation for using the thumb and index finger to squeeze the anorectal junction to test for deep sensation (10) and added specific direction for the depth of digital rectal insertion. These specific guidelines were used to avoid moving viscera that might be innervated by autonomic nerves while testing for somatic sensation that might be innervated by autonomic nerves. These detailed instructions for the anorectal examination will be included in the next revised Reference Manual.

Scoring, Scaling, and Classification

There were no revisions made in the ISNCSCI scoring or scaling. Psychometric analysis of the imbedded scoring, scaling, and classification test questions in the initial version of InSTeP revealed poor test reliability and discrimination compared with anatomy, motor, and sensory questions. This led to rewriting the scoring, scaling, and classification content in InSTeP/ISNCSCI and creating tips for classification. This included rewriting the material on how to determine motor level in the

“transition zones” C4-C5 or L1-L2, pointing out a simple technique to identify complete injuries, and expanding the explanation of the zone of partial preservation (ZPP) and how to document it on the worksheet.

When evaluating the key muscle for C5 (elbow flexors) or L2 (hip flexors), the general rule for determining the motor level cannot be followed because there is no key muscle just rostral to C5 or L2. Assuming that the C5 or L2 muscle tests at least grade 3, the motor level determination depends on the status of sensory testing at C4 or L1. The revised instructions state that if the C4 (L1) light touch and pin prick are both normal on the right or left side, then this is equivalent to the C4 (L1) motor being grade 5. If either light touch or pin prick are abnormal, then this is equivalent to the C4 (L1) motor being grade 1. The motor level definition can be applied using the derived C4 (L1) grades.

To determine if an injury is complete from the worksheet, InSTeP recommends that the classifier look at the bottom row of data on the worksheet for the N-O-O-O-O-N sign (Figure 4). If the block for voluntary anal contraction is marked “N,” the S4-S5 light touch and pin prick scores are all “0,” and the block for any anal sensation is marked “N,” then the bottom row of the worksheet will read “N-O-O-O-O-N,” and the patient meets the sacral sparing definition of complete. If there is any value besides 0 or NO in this row of data, the injury is incomplete.

Since the last edition of the standards booklet, the International Standards Committee had been asked what to mark on the worksheet if there was no spared function

below the sensory or motor level in a person with a complete injury. The Committee decided that, rather than have a dash or blank space, the sensory or motor level should be listed in the ZPP block. InSTeP clarified these instructions and also indicated that in the case of spared function, the lowest level of sensory or motor function found below the sensory or motor level should be documented in the appropriate block. The length of the ZPP was then defined as the number of segments from the listed ZPP and the given sensory or motor level. If for example the right sensory level is C5 and the ZPP C7, then the right sensory ZPP is 2 segments long.

The most controversial issue when classification was reviewed was the use of non-key muscle function below the level of injury to determine a motor incomplete classification in the absence of key muscle function below the level of injury. There were very strong recommendations to either eliminate this concept or adopt it as a working part of the ISNCSCI specifically for determination of AIS C.

As the non-key muscle concept was discussed, it was found there was not a universal awareness of its existence. The non-key muscle concept is included in the 2003 Reference Manual (1) and the 2006 and 2008 Booklets (7,8), but it is not highlighted and requires a fair amount of extrapolation. A review completed on the existing Reference Manual (2003) (1) and the Booklet for the ISNCSCI (revised 2000 and reprinted 2006 and 2008) resulted in the following findings:

- (a) Neither reference uses the term “non-key muscle function” when discussing the AIS (page 54 in the Manual or page 19 in the Booklet) and both define AIS C as “C = Incomplete. Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3 (grades 0–2).”
- (b) Both references have the following note without mentioning the term “non key”: “For an individual to receive a grade of C or D...the individual must have either (1) voluntary anal sphincter contraction or (2) sparing of motor function more than three levels below the motor level.”
- (c) At the time that InSTeP was developed, the only published reference using the term non-key muscle was found in the 2003 Standards Reference Manual (and the prior 1994 version of the Reference Manual) in the form of a question (pages 58–59).

The Education Committee heard compelling arguments that the ISNCSCI needs to address non-key muscle functions as future research and clinical trials focus on motor recovery. This is of special interest with interventional recovery research both for measuring direct outcomes and screening potential research subjects for study inclusion.

As a compromise it was decided not to eliminate the previous reference to non-key muscle functions in the

Reference Manual (1) but to mention the concept in InSTeP. This will hopefully improve the awareness and understanding of non-key muscle function as well as be a starting point for studying this concept. Some important steps include identifying the incidence of isolated non-key muscle functions, acquiring consensus for which non-key muscle functions are important and their innervations levels, standardizing their testing, and producing the research on their validity and reproducibility. Then, if adopted, expanded teaching on the non-key muscle functions concept can be included in future revisions of the ISNCSCI and InSTeP.

The ISNCSCI were never intended to override the judgment of an experienced clinician in the face of atypical examination findings. At the same time it should be noted that any examiner regardless of experience should look for, or be attentive to, the possibility of volitional contraction of non-key muscles. Since the previous discussion on the use of non-key muscles with the ISNCSCI, there has been a publication on a classification program that includes non-key muscle function in the decision process (11). The Education and International Standards Committees look forward to input and research from our ASIA and ISCoS members to determine how the non-key muscle function components should be included in the teaching of the ISNCSCI.

Future Review and Revisions of the ISNCSCI

There has been no written policy or procedure on how the ISNCSCI are reviewed or revised and how a request can be made to the International Standards Committee for possible change. As the ISNCSCI are now being widely used internationally for clinical care, research, and experimental outcomes, their precision, validity, teachability, and interrater reliability are increasingly important. This led the International Standards Committee to adopt the following policy in September 2009 and the ISCoS Education Committee in October 2009.

Policies and Procedures for Revisions to the ISNCSCI

Purpose. To establish a formal policy for periodic review of the current ISNCSCI, review of newer research pertaining to the ISNCSCI, and submission and review of requests for revisions to the ISNCSCI.

Policies. When first established in 1982, the primary purpose of the standards was to reach agreement on a clinical classification of spinal cord injury (SCI) severity. Since that time, the examination has been standardized, and the international standards have undergone a number of revisions, based on research findings, to improve their reliability. Investigators have demonstrated that the classifications have predictive validity, both for neurologic and functional recovery, and they have been used as neurologic outcome measures in spinal cord injury clinical trials. However, their primary purpose remains unchanged: They are an internationally adopted

standardized clinical neurologic examination and classification for SCI and similar spinal cord disorders such as transverse myelitis and myelopathies with focal lesions. Therefore, revisions to the standards should support this primary purpose.

The International Standards Committee has the primary responsibility for revision of the ISNCSCI. Because modification to instructions will be required for any revisions, the ASIA Education Committee and the ISCoS Council will review proposed revisions and provide recommendations to the International Standards Committee and the ASIA Board. The ASIA Board has the final authority to approve or deny proposed revisions to the ISNCSCI.

Procedures. Requests for revisions to the ISNCSCI may be submitted by any ISCoS or ASIA member, using a form to be developed by the International Standards Committee. The form will request the following:

- (a) A detailed description of all proposed revisions, including suggested additions, deletions, or modifications to the examination and classification
- (b) The rationale for the proposed revisions, such as poor reliability of a current component of the standards or research that supports use of a different exam or classification component

Requests for revisions will be reviewed by the International Standards Committee no less frequently than annually. The committee will consider the rationale for the proposed revisions and make a determination based primarily on whether there is scientific support for the change. Additional considerations will include the following:

- (a) The complexity of the proposed revision (eg, time required to complete the examination, or number of individual rules to derive a classification)
- (b) The potential impact on use of previously published research
- (c) The clinical utility of the revised standards

The International Standards Committee will make 1 of 3 decisions for requested revisions: (a) approve, (b) deny, or (c) request more information. This could include a request to the individual submitting the request to provide additional data, such as the proportion of patients affected by the proposed revision as could be determined from a number of existing databases. The committee may also request consultation with other individuals (such as investigators or former committee members).

A majority vote of International Standards Committee members will be required to support any revisions. Ex-officio members are considered nonvoting members.

All formally submitted requests for revisions and decisions by the International Standards Committee will be documented in the annual minutes and will be posted on the ASIA Web site. When the Request for ISNCSCI

Revisions form is completed, it will also be available on the ASIA Web site.

Proposed revisions supported by the International Standards Committee will be forwarded to the Education Committee of ASIA and the ISCoS Council for review. These groups will provide any further recommendations to the International Standards Committee and the ASIA Board. The ASIA Board will approve or deny the recommended revision. Approved revisions will be forwarded to the ISCoS Council for endorsement. The International Standards Committee will update the ISNCSCI Booklet and Reference Manual as needed and will request that the Education Committee include the revisions in the next update of InSTeP or WeeSTeP (pediatric version of InSTeP) (9).

Every 3 years, the International Standards Committee will conduct a review of the ISNCSCI and all publications pertaining to their reliability or validity. Every 3 years the Education Committee will review InSTeP in coordination with the review of the ISNCSCI. A written report on these findings will be submitted to the ASIA Board. Depending on the volume of new research, the Reference Manual chapters on the motor, sensory, and anorectal examinations along with reliability and validity will be updated. If a modification to the standards is warranted based on the findings of this review, it will occur using the process described previously along with revisions of InSTeP and the booklet.

SUMMARY

A review of the educational material for the ISNCSCI was undertaken by the ASIA Education and International Standards Committees in collaboration with the ISCoS Education Committee for the development of InSTeP and recommended certain clarifications and revisions that have been explained in this article. The most recently reprinted pocket booklet is current (2008), but the 2003 Reference Manual requires updating. Further revisions may be considered in the future, but the earliest a revised Reference Manual will be available will be in 2013. ASIA's International Standards Committee has adopted a process for thorough and transparent review of requests to revise the ISNCSCI, or a regular periodic review of the entire standards, to keep them up-to-date with current knowledge.

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