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The Walking Index for Spinal Cord Injury (WISCI/WISCI II): nature, metric properties, use and misuse.

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The Walking Index for Spinal Cord Injury (WISCI/WISCI II): nature, metric properties, use and misuse.

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STRUCTURED ABSTRACT

Study design: Literature review

Objective: To critically review all publications/internet sites that have described/used the Walking Index for Spinal Cord Injury (WISCI II), as a measure of impairment of walking function after spinal cord injury (SCI), in order to identify its psychometric properties, clarify its nature, specify misuse, and incorporate the findings in an updated guide.

Method: A systematic literature search was done of Ovid MEDLINE, CINAHL, PsychINFO, Cochrane Central Register of Controlled Trials, Scopus, and electronic sites using key words: WISCI or WISCI II, SCI, paraplegia/ tetraplegia/ quadriplegia, ambulation/gait/walking. Among 1,235 citations retrieved, 154 relevant articles/sites were identified, classified and examined by the authors; recommendations were made based on findings.

Results and Discussion: The validity (face/concurrent/content/construct/convergent/criterion) and reliability of the WISCI II has been documented in clinical trials, clinical series, and considered adequate by systematic reviewers. In chronic SCI subjects, reliable determination of the maximum (as opposed to self-selected) WISCI II level requires more time and experience by the assessor. The correct use of WISCI II is clarified for testing acute/chronic phases of recovery after SCI, age of subjects, devices and settings. The WISCI II and walking speed measures may be performed simultaneously.

Conclusion: The increased use of the WISCI II is attributed to its unique characteristics as a capacity measure of walking function and its strong metric properties. Appropriate use of the WISCI II was clarified and incorporated into a new guide for its use. Combining it with a walking speed measure needs further study.

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Keywords: Walking Function, WISCI, Spinal Cord Injury**,** Outcome Measure, Functional Capacity Scale

INTRODUCTION

The Walking Index for Spinal Cord Injury (WISCI) is an ordinal scale that captures the extent and nature of assistance (combinations of orthoses, supporting equipment such as walkers, and human helpers) that persons with spinal cord injury (SCI) require to walk. The original 19 levels, from unable to walk in spite of all possible supports, to being able to walk without any, were rank-ordered by a panel of SCI experts to reflect gradations of impairment and their relationship to walking function.[1] The WISCI scale was modified the following year to the WISCI II with the addition of two levels.[2] Since its introduction, it has enjoyed increased popularity[3] and acceptance[4] as a capacity measure of walking function for use in clinical trials.

International SCI experts[5,6] have, however, recommended that the WISCI II,[2] be combined with the Ten Meter Walk Test (10MWT), another validated tool for quantifying walking function. Systematic reviews of the medical literature confirm the validity of the WISCI/WISCI II[7] and its use together with the 10 MWT for assessment of ambulatory function.[8]

It has been recommended by some, nonetheless, that the WISCI II undergo further evaluation.[6,7,9] Recent studies[10-12] have demonstrated reliability, and the relationship of WISCI II to both the severity of the injury and to walking speed. These studies also showed the need to progress subjects systematically[10,11] from their community (self selected) WISCI II level (performance, in the terminology of the International Classification of Functioning, Disability and Health (ICF)[13] to their maximum level (capacity, in ICF terms), which has not been clearly stated in existing instructions to clinical investigators[14-16] and does require additional time, and training for obtaining accurate assessments.

Our purpose here is to critically review all publications and internet sites that have described and/or used the WISCI/WISCI II, in order to identify and clarify the nature, psychometric properties, correct use and misuse of the WISCI II. Recommendations for proper use, stemming from this review,

are incorporated into an updated guide (Appendix 1: WISCI II Guide: Instructions for Use) suitable for use by clinical investigators and dissemination in the literature and appropriate websites.[17]

METHOD

A systematic search was performed of all papers as well as websites mentioning WISCI/WISCI II. The literature search was conducted with the assistance of a senior librarian from May to August, 2011 and identified papers published from 2000 to August 2011 that explicitly mentioned the WISCI/WISCI II, and/or articles that dealt with the measurement of walking capacity in patients with SCI. Databases included Ovid MEDLINE, Ovid MEDLINE In-Process & Other Non-Indexed Citations, CINAHL, PsychINFO, Cochrane Central Register of Controlled Trials, and Scopus, which includes Embase citations. All study designs, including case reports, were included, with no restrictions on the ages of participants. Non-English articles and animal studies were excluded. The following search terms were used: WISCI/WISCI II, SCI, paraplegia/tetraplegia/quadriplegia, ambulation/gait and walking/walking capacity. Citations were then imported into a RefWorks© database and duplicates removed, leaving 1,235. In addition, other data bases such as Google and a hand search of *Spinal Cord* yielded twelve citations not identified by the above strategy.

Two authors (GS & JFD) independently identified and classified the papers and (as applicable) their study design, which included both SCI and WISCI/WISCI II through a review of the abstracts, texts and references. A third author (PLD) reconciled differences and prepared results for circulation to the authors' panel and subsequently to external reviewers. This yielded 168 citations from all sources, of which 14 were subsequently excluded as non-English, involving diseases other than SCI or animal research, for a total of 154 relevant references.

The list of 154 citations with their assigned classification is published as supplementary material. Sixteen of the 154 study citations examined underlying mechanisms of physiological changes and referenced the WISCI II scale. Ten of these 16 studies correlated changes in WISCI II scores with neurophysiological parameters, whereas 6 cited the WISCI/WISCI II only in the bibliography or for purposes of classification of the subjects.

Relevant citations included six systematic reviews of outcome measures for SCI, which referenced WISCI/WISCI II. Two reviews [7,8] assessed the validity and other psychometric properties of outcome measures for ambulation, including the WISCI II. Other reviews targeted measures of disability,[18] general function or mobility[19] or merely reference the WISCI II in studies on body weight supported/robot-assisted gait training.[20,21] Articles[7, 9] that identified limitations of the WISCI/WISCI II were studied carefully for issues related to the WISCI/WISCI II requiring clarification. Afterwards, the guide for suggested future use of the WISCI II was edited by a coauthor (MSR) who has trained clinical investigators in previous clinical trials in Asia, Europe and USA. The final guide was reviewed by the panel of authors and by outside reviewers for comment and approval. The outside reviewers were chosen to provide balance and reduce bias; Tania Lam and Hubertus van Hedel, who had published most of criticisms[7,30] discussed in this manuscript.

A panel composed of authors of the WISCI/WISCI II identified the following issues for further analysis and discussion: the nature of the WISCI/WISCI II, the relationship of severity of injury to walking capacity, the validity, reliability and responsiveness of the scale and its correct use (see below).

RESULTS AND DISCUSSION

1. Nature of the WISCI II

The WISCI II is unique as a walking capacity scale for individuals with SCI who have the capacity "to stand and walk," for several reasons. First, it has standard criteria for the testing environment and subjects are progressed systematically through a validated sequence of capacity levels,[22] incorporating devices and personal assistance, to their **maximum** walking capacity. Second, WISCI II ranks levels according to the severity of underlying impairment rather than the need for physical assistance, walking aids, or braces (or their equivalent). The relationship between the severity of the impairment, reflected in the strength of leg muscles (lower extremity motor scores), and the WISCI II has been demonstrated in acute[23] and chronic[11] subjects with SCI. In fact, in subjects with acute SCI, the initial (baseline) lower extremity motor score (LEMS) is the best predictor of WISCI II score at 12 months post SCI onset, explains most of the variance in the WISCI II, and has high correlations with WISCI II improvement at 3, 6, 9 and 12 months.[23] The strength of these correlations differ based on whether subjects are paraplegic or tetraplegic, the demographics of the population studied, and whether subjects have acute or chronic injuries.[11,24] Factors other than LEMS such as pain, spasticity or balance also contribute to walking function. Training plays a major role in improvement in walking function for subjects with chronic SCI, in whom leg strength has been maximized and plateaued.[24]

The WISCI II's levels reflect the underlying impairment and should not be dichotomized into dependent and independent levels based on physical assistance, in an attempt to more closely mirror a disability scale. Its unique features differentiate the WISCI II from disability scales, which may fail to identify differences in devices when assigning scores. As an example, the Functional Independence Measure (FIM) assigns a 6 for locomotion to an individual capable of modified independent ambulation regardless of the device(s) used; while the Spinal Cord Independence Measure (SCIM) progresses the ranking of devices from walking frame to one cane without addressing personal assistance at each level as discussed by Patrick.[25]

The WISCI II scale is an impairment related capacity scale and the lower extremity motor score explains most of the variance (R2 = 0.85) of the WISCI score at 12 months in a multicenter randomized trial of 146 subjects.[23] Capacity measures of walking function such as the WISCI II and walking speed utilized in research studies require standardized measurements of devices, distance and the environment. However, global disability scales (performance) such as the FIM reflect burden of care and describes what a person routinely does in their environment,[13] which "may differ from individual to individual and from one time to another".[26] Curt[27] reported significant functional improvement in activities of daily living at 12 months in 246 ASIA A and B subjects assessed by the SCIM (a global disability scale) with no change in WISCI scores. This improvement is most likely due to training alone (i.e. compensation)[27] since a subject with complete paraplegia may achieve wheelchair independence with no recovery in lower extremity strength. Thus, papers[19,28] that identify the WISCI II as a disability scale place it in the incorrect domain (ICF classification) and are in error.

Systematic progression justifies all WISCI II levels

In the original publications[1, 2], the ranking of the 21 levels was determined and validated by SCI specialists from 8 countries. Order was determined by the severity of the underlying motor impairment which resulted in some WISCI II levels which require physical assistance but few devices (i.e. reflecting less impairment) being placed higher than other levels where subjects ambulate without physical assistance but more devices. This is one of the characteristics that distinguish the WISCI II as a capacity scale from disability scales which always rank individuals who do not require human assistance higher, regardless of the use of devices. Some publications[29,30] noted that the observed frequency of some WISCI II levels (14 and 17) was low and therefore they might not be needed. It was also noted that the WISCI II

instructions require clarification as to how to assess subjects' walking capacity at follow-up after discharge from the hospital.

While prior guides[1,14] stated that during the acute period SCI subjects should be assessed at the highest possible level without compromising safety, as determined by a trained therapist; the precise method of systematic progression in chronic subjects has not been stated. Determining the maximum WISCI II level requires that subjects be progressed systematically through each level; as several studies[10,11] have shown that the maximal level may be 3 to 6 levels higher than the patient's self-selected one. Marino's study[10] provides insight into how frequently WISCI II levels 14 and 17 are used during the progression of subjects from their self selected to maximum WISCI II level. Over half (14/26) of subjects progressed to or beyond level 14 during the determination of their maximal WISCI II level and almost a quarter (6/26) progressed to 17 or above. However, only 2 of 26 ended their progress at levels 14 or 17. In chronic subjects the challenge is ensuring that the maximum level has been accurately evaluated. This method of progression for chronic subjects has been described in recent papers[10, 11] and has been incorporated into the updated guide.[17]

2. Psychometric qualities of the WISCI II

Validity

One of the strongest features of the WISCI II, which has likely contributed to its broad acceptance, is high validity across multiple dimensions. The hierarchical ranking agreed on by the 24 experts in SCI walking function established content and face validity.[1, 2] A subsequent prospective study[22] of 170 subjects in four countries confirmed that progression through the levels followed a monotonic pattern in more than 80% of subjects, and the correlation of walking capacity (WISCI II) with impairment (LEMS) was 0.91 ($p < 0.001$) at final assessment, supporting content and construct validity. Subsequent studies by

136 our group and others have demonstrated criterion-related, predictive and concurrent validity, as well as
137 both convergent and divergent construct validity.[11,22,27,29,31,32] The outcomes of the Spinal Cord Injury
138 Locomotor Trial (SCILT)[23] reported predictive, criterion and concurrent validity: the WISCI II was
139 correlated with LEMS (impairment), balance, walking speed, 6 minute walk (capacity), locomotor FIM (7
140 items) and the total motor FIM (13 items). Others studies have shown a correlation between the WISCI II
141 and mobility measures such as the 10MWT, Timed up and Go (TUG) test,[31,33] 6 minute walk test
142 (6MWT),[32,34] Berg Balance Scale, SCIM and Spinal Cord Injury-Functional Ambulation Profile (SCI-
143 FAP).[33]
144
145 *Reliability and responsiveness*
146 Although the validity of the WISCI/WISCI II has been well established, it has been suggested that
147 further evidence of reliability and responsiveness is needed.[6, 7,18,30] During the development of the WISCI
148 II, a videotape was created of representative patients functioning at each level (40 randomized clips) and
149 circulated to SCI experts. The data collected included 24 individual independent scorings and team
150 scorings. The inter-rater reliability (IRR) was 1.00 for individual participants and the 8 participating
151 teams.[1] However, reliability here involved agreement on the nature and types of physical assistance and
152 aides the person used with walking.
153 A more crucial test for a capacity scale is whether two appropriately trained individuals agree on
154 the same level of maximum capacity after assessing and progressing the same patient independently. In a
155 study of subjects with chronic SCI, Marino and colleagues[10] reported that inter-and intra-rater reliability
156 were both 1.00 for self selected WISCI II level. The intra-rater reliability for maximal level WISCI II was
157 1.00; inter-rater reliability was 0.98. The progression from self selected to maximal WISCI II level also

158 showed good agreement between and within therapists. Recently, Scivoletto[12] reported that inter-rater
159 reliability was 0.98 for 19 acute patients.

160 The WISCI II was initially reported[9] to have limited responsiveness in the period of 0-3 months
161 post SCI onset and poor responsiveness in subsequent periods, however, the study cohort was small (n =
162 22) and consisted of good walkers (70 % with LEMS ≥30). In a more representative sample of 886
163 persons with American Spinal Injury Association Impairment Scale (AIS) A, B, C and D injuries, the
164 same group reported several years later[4] that responsiveness was good in AIS C (N=137) and D (N=223)
165 subjects, and equal to that of the 10MWT at 3, 6 and 12 months after injury.

166 In a study[11] of 76 subjects with chronic SCI, WISCI II reproducibility was excellent, with an
167 intraclass correlation coefficient (ICC) of 0.99 for both the self-selected and maximum WISCI II level.
168 The resulting smallest real differences (SRDs) of 0.79 (self-selected) and 0.60 (maximum) suggest that "a
169 change of one WISCI II level can be interpreted as real in a chronic patient".

170 The study of the psychometric properties of the WISCI II in chronic subjects has been limited to
171 an assessment of reliability, reproducibility and validity in two studies.[10,11] Further validation in chronic
172 subjects is warranted.

173

174 **3. Use and misuse of the WISCI II**

175 Past criticisms of the WISCI II include ceiling effects,[7, 23, 30] floor effects,[7] lack of responsiveness
176 beyond 3 months,[30] lack of clarity regarding the scoring of equivalents of short leg braces (e.g., Alpine
177 boots),[3,30] broad range of physical assistance,[30] redundant categories,[30] and cultural differences in use of
178 walking devices. Several of these, such as responsiveness and low frequency (unneeded) categories, have
179 been addressed above.

The ceiling effect and other limitations of walking function were addressed in the original publication[1] by the statement "different distances (household and community), velocity and energy requirements will need to be added". Two studies demonstrating the ceiling effect were reported in 2006; one with 22 subjects[9] who were primarily AIS D, and the SCILT randomized controlled trial (RCT)[23] of 144 patients, which included AIS B, C and D subjects. In both studies, the subjects who reached the maximum WISCI II level of 20 were able to show improvement in the speed of walking in subsequent evaluations. Ceiling effects were one of the reasons that studies examining subjects at different distances and speeds were planned.[10,11,35] Most authorities recommend combining the WISCI II with a measure of walking speed to compensate for this shortcoming. The floor effect has been mentioned in one systematic review,[7] based on one study[29] which included a large proportion (84/284) of AIS A SCI subjects. While this study has value for demonstrating validity and providing normative data, the WISCI II was not designed for AIS A subjects, as it was developed for subjects "who can stand and walk".

Cultural issues

Cultural differences are an important consideration in planning a clinical trial and our group has shown differences across cultures for both clinical approaches to walking training, and consumer preferences for walking with SCI.[25,36] For example, parallel bars are used far more frequently in Europe than the USA,[22] which reflects the therapists' preference for equipment. This would change WISCI II baseline scores if this equipment was unavailable or at least not tried. In the context of an international trial, however, the effects of cultural differences are not limited to the types of walking aids and braces used, but also result from differences in methods/intensities of therapy and dissimilar lengths of stay, which may affect maximum WISCI II scores. Future multi-center studies across cultures (USA, Europe, Asia) must consider this in the design and protocol.

Braces

The "grouping" of both short and long leg braces into one category "braces"[3] and the variety of alternatives to short leg braces such as "alpine boots" [30] has been raised as a problem when assigning WISCI II levels.

Our prospective study[22] showed that the "descriptors" for the different types of braces (short leg; long leg, unilateral, bilateral), as listed in prior WISCI II publications[1,2] and updated on the website,[14,17] may be used to record the types of braces used as subjects progress to their maximum WISCI II Level. The information on the type of brace does not alter the scoring of the WISCI II level. However, recording the use of aids is extremely important information in the design of a trial, because of potential cultural differences. Thus the use of descriptors is recommended in planning cross cultural trials (Appendix 1 – WISCI II Guide: Instructions for Use).

This study revealed that the use of one (9%) or two (5%) long leg braces is far less common than the use of short leg braces (28%).[22] Therefore, adding separate WISCI II levels to reflect all the possible brace combinations would result in a large increase in the number of levels, and does not seem warranted.

The criticism[3] that advance reciprocating gait orthosis (ARGO) braces are not included needs clarification. ARGO braces and other devices enable subjects with complete injuries to ambulate with a spring loaded assist. Such mechanical devices could impact the correlation between an underlying motor impairment and demonstrated walking capacity, and were never intended to be part of the WISCI II assessment of SCI subjects who can "stand and walk".

The descriptors (Appendix 1: WISCI II Guide: Instructions for Use) mentioned above are rarely reported by those who study and utilize the WISCI II other than the WISCI/WISCI II authors themselves.[22] Based on these reports, several modifications of protocol language regarding walkers and

braces have been adopted[14] since the original publication. Some of the web site descriptions[15,16] of the WISCI/WISCI II do not make mention of the expanded list of descriptors.

Physical Assistance

For the WISCI II levels that incorporate physical assistance, there is the potential for variability in the extent of assistance provided. To provide additional clarification, the descriptors for specific amounts of physical assistance have been provided on the WISCI II scoring sheet. Descriptors A1 (Max Assist x 2 people) and A2 (Min/Mod assist x 2 people) apply only to WISCI II levels 1 and 2, both of which require maximal assistance. Descriptor A3 (Min/Mod assist x 1 person) applies to WISCI levels 3, 4, 6, 7, 8, 10, 11, 14 and 17. The Instructions for Use also clarify that any physical contact with the subject, including "contact guarding" is considered physical assistance.

Use in Children

Although two of the web sites[15, 16] are kept current and can be updated through communication with the authors of the sites, there are several omissions/ inaccuracies, which have not been previously addressed by the WISCI/WISCI II authors. The first has to do with the use of the WISCI II for children. The psychometric properties (validity and reliability) of the WISCI II have not been evaluated for children ages 13 to 21, as implied by Rehab Measures.[16] A study will be reported in 2012 that examines reliability in children.[37]

Qualifications of staff and time needed to administer the WISCI II

Another issue relates to the time required to perform the WISCI II test, where one site[16] states "5 minutes" while the other[15] has "a minimal time". While this is accurate for the acute and sub-acute phases

of SCI, where therapists tend to know the capacity of their patients very well; recent studies in chronic subjects, who were not known to their assessors,[10,11,35] describe the need for progressive testing of WISCI II levels from self selected (SS) to maximum (Max), which may require fifteen minutes. Since there often is a difference of 3 to 6 levels between SS and Max, testing cannot be performed in five minutes (Appendix 1 – WISCI II Guide: Instructions for Use).

Perhaps the issue that requires the greatest emphasis is the need for trained clinicians to perform the WISCI II assessments. In the acute and sub-acute phases, the therapist must determine the maximum WISCI II level and this requires a clinical judgment based on experience, because the subjects/patients are not capable of making a reliable judgment on what the minimum support needed for walking is as they begin to recover ambulatory function. After the patient is discharged to the community and returns for assessment 3 to 12 months post injury, the preferred WISCI II level is by definition self-selected. At times subjects have developed habits of walking without braces and with an unstable ankle; testing by a trained clinician is required to determine the appropriate maximum WISCI II level, especially to make judgments on patient safety that limit the maximum WISCI II.

4. Future Directions: Combining WISCI II with a Walking Speed Measure

Rationale

In exploring the reasons for combining the WISCI II with a measure of walking speed, we briefly examine the characteristics of both, to demonstrate why each complements the other. The nature and limitations of the WISCI II, particularly its ceiling effect, have been discussed above. Subjects with a less severe initial injury may recover to the maximum WISCI II level of 20 within the first 3 months after SCI and will no longer see improvement on the WISCI II,[9, 23] therefore further improvement in walking capacity requires assessing speed. Walking speed, however, has the limitation of a floor effect in clinical

trials, as illustrated in the SCILT trial.[38] The baseline data[38] for walking speed, measured for 50 feet in the Dobkin trial, was assessed in less than 20% (20/142) of subjects; while all 142 subjects had baseline data for the WISCI II (median = 1.49 and range 0-17). The walking speed for the 10 meter walk test (10MWT) showed a floor effect[30] in a large sample of 917 subjects, in which only 6 subjects were able to complete the 10MWT and TUG at 2 weeks, compared to 74 at one month and 136 at 3 months. The "flying start" or dynamic start of the 10MWT, as reported by van Hedel,[30] requires subjects to walk a minimum of 14 meters in order to assess the speed for the 10 middle meters which are timed, and very few AIS C subjects are capable of this at 2 weeks. Upon examining the strengths and weaknesses of walking speed measures and WISCI II, it seems logical to combine the two. Since the 10MWT can demonstrate improvement in less severely paralyzed subjects at later stages of recovery when there is often a ceiling for the WISCI II (level 20), and the WISCI II has far less of a floor effect at baseline assessment, the two tests complement each other. This idea is shared in the literature,[7,8,39] and an international consensus conference on ambulation and gait[6] recommended use of both measures in clinical trials. Our systematic search of the literature reveals that a combination of the two measures is used not only in clinical trials[40] and case series,[4,31] but has been used to validate other measures.[33]

Is it possible to administer both tests at the same time?

If it is recommended to acquire the data at the same time (i.e. during the same observed/timed10 meter walk), the use of a dynamic start is not possible for standardized WISCI II testing. While some authors[41] recommend a dynamic start with 2 meters of acceleration before measurement of walking speed, others[42] state that the static start with no acceleration is adequate. In a systematic review of walking speed research in neurological diseases[42] it was concluded that the static start is the preferred method for the 10MWT. In addition, Scivoletto[43] has shown that in chronic incomplete SCI patients, walking speed

with a static start does not differ significantly (P = 0.092) from walking with a dynamic start. Subjects with the highest scores (WISCI II 18 – 20) and the lowest scores (WISCI II 9 – 12) showed no statistical difference between the two methods and inter/intra rater reliability was .98-.99. Furthermore, Marino,[10] Kim,[35] and Burns[11] have reported excellent correlations of walking speed measured using a static start with WISCI II levels. Based on these recent studies, it appears that WISCI II and 10MWT may be performed simultaneously, but this will need to be investigated in larger populations.

Is a combined scoring system for WISCI II and 10MWT possible?

A single score that encompasses the two most important agreed-upon elements of walking capacity has tremendous research potential. The statistical method of blending the two metrics would be the most challenging issue.

A recent study of walking function reported by Musselman et al.[33] attempted to validate a new measure which combines timed activities, use of devices and physical assistance into one metric. The authors employed both the 10MWT and the WISCI II to validate their instrument, which has many similarities to a combined 10MWT/WISCI II. The ordering of assistance, which combines walking aids (walkers, crutches and canes) and physical assistance from one person, however, does not take into account braces. It "encompasses the timed performance of 7 tasks, such as walking and negotiating obstacles, doors, and stairs." (p. 285), but not the walking capacity measured by the WISCI II or 10MWT, and may serve as a complement to these measures in a trial. However, the combining of the WISCI II and the 10MWT with timed activities would produce so many combinations and permutations that it is not feasible.

CONCLUSION

The increased use of the WISCI II may be attributed to its unique characteristics as a capacity measure of walking function, its strong metric properties, and recommendations by international panels.[5,6,39] A systematic review of the literature found over 150 WISCI/WISCI II citations, including clinical trials, cohort studies, case series, case reports, reviews and websites describing outcome measures. Recent studies using the WISCI II have addressed concerns regarding the reliability of data resulting from testing in chronic SCI subjects, where more time and experience by the assessor is required. Misunderstandings and inappropriate use of the WISCI II scale revealed in this review of the literature have required clarification and updating of the testing guide,[17] which is published as an Appendix and will be disseminated electronically. The major future challenge is enhancing the utility of the WISCI II by combining it with a walking speed measure, in a statistically valid way.

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CONFLICT OF INTEREST

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340 **REFERENCES**

341 1. Ditunno JF, Jr., Ditunno PL, Graziani V et al. Walking index for spinal cord injury (WISCI): an
342 international multicenter validity and reliability study. *Spinal Cord.* 2000;38:234-243.
343 2. Ditunno PL, Ditunno JF, Jr. Walking index for spinal cord injury (WISCI II): scale revision. *Spinal*
344 *Cord.* 2001;39:654-656.
345 3. Harvey L, Marino RJ. The walking index for spinal cord injury. *Australian journal of*
346 *physiotherapy.* 2009;55:66.
347 4. van Hedel HJ, Dietz V. Walking during daily life can be validly and responsively assessed in
348 subjects with a spinal cord injury. *Neurorehabil Neural Repair.* 2009;23:117-124.
349 5. Steeves JD, Lammertse D, Curt A et al. Guidelines for the conduct of clinical trials for spinal cord
350 injury (SCI) as developed by the ICCP panel: clinical trial outcome measures. *Spinal Cord.*
351 2007;45:206-221.
352 6. Jackson AB, Carnel CT, Ditunno JF et al. Outcome measures for gait and ambulation in the spinal
353 cord injury population. *J Spinal Cord Med.* 2008;31:487-499.
354 7. Lam T, Noonan VK, Eng JJ. A systematic review of functional ambulation outcome measures in
355 spinal cord injury. *Spinal Cord.* 2008;46:246-254.
356 8. Labruyere R, Agarwala A, Curt A. Rehabilitation in spine and spinal cord trauma. *Spine (Phila Pa*
357 *1976).* 2010;35:S259-S262.
358 9. van Hedel HJ, Wirz M, Curt A. Improving walking assessment in subjects with an incomplete
359 spinal cord injury: responsiveness. *Spinal Cord.* 2006;44:352-356.
360 10. Marino RJ, Scivoletto G, Patrick M et al. Walking index for spinal cord injury version 2 (WISCI-
361 II) with repeatability of the 10-m walk time: Inter- and intrarater reliabilities. *Am J Phys Med*
362 *Rehabil.* 2010;89:7-15.

11. Burns AS, Delparte JJ, Patrick M, Marino RJ, Ditunno JF. The reproducibility and convergent validity of the Walking Index for Spinal Cord Injury (WISCI) in chronic spinal cord injury. *Neurorehabil Neural Repair.* 2011;25:149-157.
12. Scivoletto, G., Tamburella, F., Calogere F, Molinari, M., and Ditunno, J. F. Walking Index for Spinal Cord Injury (WISCI) Reliability in Patients with Acute Spinal Cord Injury (SCI). International Congress on Spinal Cord Medicine and Rehabilitation 2011 Annual Meeting. Accessed 1/06/2012 at http://www.iscos.org.uk/page.php?content=64
13. World Health Organization. ICF: International Classification of Functioning, Disability and Health. Geneva, Switzerland 2001.
14. Patrick, M, Marino, R. J, Ditunno PL, and Ditunno, J. F., Jr. Instructions for the Use of the Walking Index for Spinal Cord Injury II (WISCI II). Regional Spinal Cord Injury Center of the Delaware Valley, Thomas Jefferson University, 2005. Accessed 1/06/2012 at http://www.spinalcordcenter.org/research/wisci_guide.pdf
15. Eng J. J. Walking Index for Spinal Cord Injury (WISCI) and WISCI II. Spinal Cord Evidence (SCIRE) project. Accessed 1/06/2012 at http://www.scireproject.com/outcome-measures/walking-index-spinal-cord-injury-wisci-and-wisci-ii
16. Raad, J and Moore, J. Rehab Measures: Walking Index for Spinal Cord Injury. Rehabilitation Measures Database. 5-25-2011. Accessed 1/06/2012. http://www.rehabmeasures.org/Lists/RehabMeasures/DispForm.aspx?ID=957
17. Patrick, M., Marino, R.J, Ditunno P.L., Ditunno, J. F., Jr., and Schmidt-Read, M. Walking Index for Spinal Cord Injury II (WISCI II) Guide: Instructions for Use. Regional Spinal Cord Injury Center of the Delaware Valley, Thomas Jefferson University, 2012. Accessed 10/18/2012 at http://www.spinalcordcenter.org/research/wisci_guide.pdf

18. Furlan JC, Noonan V, Singh A, Fehlings MG. Assessment of disability in patients with acute traumatic spinal cord injury: a systematic review of the literature. *J Neurotrauma.* 2011;28:1413-1430.

19. Dawson J, Shamley D, Jamous MA. A structured review of outcome measures used for the assessment of rehabilitation interventions for spinal cord injury. *Spinal Cord.* 2008;46:768-780.

20. Mehrholz J, Kugler J, Pohl M. Locomotor training for walking after spinal cord injury. Spine 2008, 33(21):E768-77

21. Swinnen E, Duerinck S, Baeyens J, Meeusen R, Kerckhofs E. Effectiveness of robot-assisted gait training in persons with Spinal cord injury: a systematic review. *J Rehabil Med.* 2010;42:520-526.

22. Ditunno JF, Scivoletto G, Patrick M, Biering-Sorensen F, Abel R, Marino R. Validation of the walking index for spinal cord injury in a US and European clinical population. Spinal Cord. 2007 Apr;45(4):275-91.

23. Ditunno JF, Jr., Barbeau H, Dobkin BH et al. Validity of the walking scale for spinal cord injury and other domains of function in a multicenter clinical trial. *Neurorehabil Neural Repair.* 2007;21:539-550.

24. Wirz M, van Hedel HJ, Rupp R, Curt A, Dietz V. Muscle force and gait performance:relationships after spinal cord injury. *Arch Phys Med Rehabil.* 2006;87:1218-1222.

25. Patrick M, Ditunno P, Ditunno JF, et al. Consumer preference in ranking walking function utilizing the walking index for spinal cord injury II. Spinal Cord. 2011 Dec;49(12):1164-72

26. Marino RJ. Domains of outcomes in spinal cord injury for clinical trials to improve neurological function. *J Rehabil Res Dev* 2007; 44(1):113-122

27. Curt A, van Hedel HJ, Klaus D, Dietz V. Recovery from a spinal cord injury: significance of compensation, neural plasticity, and repair. *J Neurotrauma.* 2008;25:677-685.

28. Winchester P, McColl R, Querry R et al. Changes in supraspinal activation patterns following robotic locomotor therapy in motor-incomplete spinal cord injury. *Neurorehabil Neural Repair.* 2005;19:313-324.

29. Morganti B, Scivoletto G, Ditunno P, Ditunno JF, Molinari M. Walking index for spinal cord injury (WISCI): criterion validation. *Spinal Cord.* 2005;43:27-33.

30. van Hedel HJ, Wirz M, Dietz V. Standardized assessment of walking capacity after spinal cord injury: the European network approach. *Neurol Res.* 2008;30:61-73. Z

31. van Hedel HJ, Dietz V, Curt A. Assessment of walking speed and distance in subjects with an incomplete spinal cord injury. Neurorehabil Neural Repair. 2007 Jul-Aug;21(4):295-301.

32. van Hedel HJ, Wirz M, Dietz V. Assessing walking ability in subjects with spinal cord injury: validity and reliability of 3 walking tests. *Arch Phys Med Rehabil.* 2005;86:190-196.

33. Musselman K, Brunton K, Lam T, Yang J. Spinal cord injury functional ambulation profile: a new measure of walking ability. *Neurorehabil Neural Repair.* 2011;25:285-293.

34. Lemay JF, Nadeau S. Standing balance assessment in ASIA D paraplegic and tetraplegic participants: concurrent validity of the Berg Balance Scale. *Spinal Cord.* 2010;48:245-250.

35. Kim MO, Burns AS, Ditunno JF, Jr., Marino RJ. The assessment of walking capacity using the walking index for spinal cord injury: self-selected versus maximal levels. *Arch Phys Med Rehabil.* 2007;88:762-767.

36. Ditunno PL, Patrick M, Stineman M, Morganti B, Townson AF, Ditunno JF. Cross-cultural differences in preference for recovery of mobility among spinal cord injury rehabilitation professionals. *Spinal Cord.* 2006;44:567-575.

37. Calhoun CL., Mulcahey MJ. Pilot Study of the Evaluation of the Validity and Reliability of the Walking Index for Spinal Cord Injury II in Young Children with Spinal Cord Injuries. J Pediatric Phys Med Rehab (In press).
38. Dobkin B, Apple D, Barbeau H et al. Weight-supported treadmill vs over-ground training for walking after acute incomplete SCI. *Neurology.* 2006;66:484-493.
39. Alexander MS, Anderson KD, Biering-Sorensen F et al. Outcome measures in spinal cord injury: recent assessments and recommendations for future directions. *Spinal Cord.* 2009;47:582-591.
40. Benito Penalva J., Opisso E., Medina J., CorronsM., Kumru H., Vidal J. Valls-Sole J. H reflex modulation by transcranial magnetic stimulation in spinal cord injury subjects after gait training with electromechanical systems. Spinal Cord (2010) 48, 400–406.
41. Salbach N., Mayo N., Higgins J., Ahmed S., Finch L., Richards C. Responsiveness and predictability of gait speed and other disability measures in acute stroke. Arch. Phys. Med. Rehab. 2001;82:1204–1212.
42. Graham JE, Ostir GV, Fisher SR, Ottenbacher KJ. Assessing walking speed in clinical research: a systematic review. *J Eval Clin Pract.* 2008;14:552-562.
43. Scivoletto G, Tamburella F, Laurenza L, Foti C, Ditunno JF, Molinari M. Validity and reliability of the 10-m walk test and the 6-min walk test in spinal cord injury patients. Spinal Cord. 2011 Jun;49(6):736-40.

APPENDIX 1

Walking Index for Spinal Cord Injury II (WISCI II) Guide: Instructions for Use

Purpose

The WISCI/WISCI II **scale** was developed **as a research tool in clinical trials** to measure improvements in walking in persons with acute and chronic spinal cord injury.

NOTE: In a recent review of the literature (2012), it was found that clinicians have misused the WISCI II scale by documenting WISCI II levels on patients clinically, to show a more accurate snapshot of a patient's walking ability. The scale was not validated for this purpose. However, if clinicians choose to assign a WISCI II level to a patient in a clinical setting, they should clearly state whether the level is baseline/self-selected or maximum (see below).

Subject Selection

The following outline describes subjects for whom the scale is most commonly utilized:

1. Spinal cord injury subjects who are capable of standing and walking in parallel bars will be eligible for assessment. Only a reciprocal gait (without the use of mechanical device ie ARGO) is to be considered in scoring the WISCI II. Additional inclusion/exclusion criteria may be necessary.
2. Most often ASIA Impairment Scale (AIS) grade A below T10 and AIS B, C, and D subjects qualify (Ditunno 2004). AIS A subjects with a higher injury level may be included in studies that use the WISCI II but typically they would function on initial assessment at the 0 level.
3. Individuals with tetraplegia generally require motor strength in triceps of at least grade 3 or better to be able to support their body weight[3,4]. (Ditunno 2004, Dobkin 2003). Individuals with tetraplegia and arm strength in triceps of less than grade 3 may not be easily classified by the WISCI II scale (Ditunno, 2005).
4. The WISCI II has not been assessed for validity and reliability in subjects under age 18.

Standardized Physical Environment and Distance

The WISCI II is a functional capacity scale, NOT a disability scale. It must be used in a standardized environment with standardized equipment and methods, which are observed and recorded by professionals that are trained in the use of the WISCI II. The following are necessary:

1. A flat, smooth, non-slippery surface of 10 meters length.
2. Individuals walk at their own speed.

Standardized Physical Assistance

1. Any physical contact with the subject, including "contact guarding" is considered physical assistance.
2. Supervision without actual touching should not be regarded as physical assistance.
3. For additional clarification, descriptors of specific levels of physical assistance are provided on the WISCI II scoring sheet.

Standardized Equipment

1. Walkers should be conventional, but if a rolling walker is used, it should be coded as a walker and identified in the descriptors. A rolling walker has commonly been used in the USA and several European centers.
2. A platform walker is equivalent to a walker.
3. ARGOs and other mechanical devices (e.g. use of treadmills) should be excluded.
4. Crutches can be Lofstrand (Canadian) or axillary.
5. "Braces" means one or two braces, either long or short, and should be identified in the descriptors. Other devices used for bracing such as ace wraps or splints should be coded as a brace and described under "other". Equivalents of short leg braces may include high top "sneakers"; alpine shoes, or other footwear that stabilizes the ankle.
6. Whether long leg braces are locked or unlocked at the knees should be identified in the descriptors.
7. Clothing should not cover braces to allow therapists and other professional staff to make a visual determination that the patient has a brace (Ditunno, 2005).

Standardized Method

WISCI II testing is performed by physical therapists trained in the use of the WISCI II, and baseline and maximum levels are determined according to a specific protocol.

In the acute (hospital) setting, the initial (baseline) WISCI II level (i.e., the first one determined after injury onset) is determined by the therapist alone, since the patient is newly injured and must be instructed in achieving the maximum level that is safe in the hospital setting under the supervision of the therapist

Standardized Method cont.

In follow-up assessments after the patient has been discharged to a community setting, the following steps are required to determine the maximum WISCI II level.

First, the therapist interviews the subject to determine the self-selected WISCI II level, which is defined as the level the subject is ambulating at in the community, or in the household if the subject is not a community ambulator. The therapist confirms that the participant can ambulate 10 meters at the reported level. This is the self-selected level, but may not be the maximum level.

To determine the maximum WISCI II level, the therapist advances the subject sequentially through WISCI II levels starting at the level one step above the self-selected level, until the subject fails a level or is deemed unsafe for the next level. If the therapist thinks the subject can ambulate three or more levels above the self-selected WISCI II level, then to avoid fatigue, the subject can skip to a higher level. However, if the subject fails to complete that level, the subject is tested at the first skipped level and advanced until failure. If the level tested requires a brace, an alternative method of ankle stabilization as described under standardized equipment is acceptable.

Scoring

In scoring the WISCI II, first check the descriptors that apply to the current walking performance, and then assign the level of walking performance (see pgs. 7-8). For example, a subject who walks with a rolling walker and assistance of one person and no braces would be scored at a WISCI II Level 8. In selecting a level, one should choose the level at which the patient is safe as judged by the therapist, with patient's comfort level described. If devices other than those stated in the standard definitions are used, they should be documented in the comment section. If there is a discrepancy between two observers (that is, one judges the patient to be safe, the other unsafe; there never should be disagreement as to whether the patient is or is not using particular equipment; the patient's comfort level is not of relevance in assigning scores, unless insofar it informs on safety), the higher level should be chosen.

Time to Administer

The time needed to administer the WISCI II may vary from 5 minutes in the acute phase to 15 minutes in a follow-up assessment. The duration of the assessment depends on the subject's self-selected WISCI II level in the follow-up or chronic phase. For example, a subject who's self-selected WISCI II is 19 may only take 5 minutes because he/she only needs to be tested at 1 more level to reach his/her maximum WISCI II level. Similarly, a subject whose self-selected WISCI II is at the lower end of the scale may not be able to progress to a higher level and the self-selected WISCI II and maximum WISCI II levels are the same. Testing time for these two scenarios would be minimal. However, those subjects who can progress through multiple WISCI II levels beyond their self-selected level or require donning of additional

equipment (such as braces), may take longer.

Additional Notes

In clinical trials initiated in the acute phase, the increase in score is calculated by subtracting the baseline level at the beginning of the trial from the maximum level at the end of the trial.

In performing the WISICI II, individuals walk at their own speed and the 10 meters should not be timed, unless the walking speed and the WISCI II assessments are combined (Scivoletto 2011).

The WISCI II's ranking of walking levels reflecting impairment should not be dichotomized into dependent and independent levels of physical assistance, in an attempt to more closely mirror a disability scale.

Descriptors may have value in reflecting cultural differences when planning a trial.

References

1. Ditunno JF, Ditunno PL, Graziani V, Scivoletto G, Bernardi M, Castellano V, Marchetti M, Brabeau H, Frankel HL, D'Andrea Greve JM, Ko HY, Marshall R, Nance P. Walking Index for spinal cord injury (WISCI): an international multicenter validity and reliability study. *Spinal Cord* 2000;38:234-243.

2. Ditunno PL, Ditunno JF. Walking index for spinal cord injury (WISCI II): scale revision. *Spinal Cord* 2001;39:654-656.

3. Doblin BH, Apple D, Barbeau H, Basso M, Behrman A, Deforge D, Ditunno JF, Dudley G, Elasoff R, Fugate L, Harkema S, Saulino M, Scott M. Methods for a randomized trial of weight-supported treadmill training versus conventional training for walking during inpatient rehabilitation after incomplete traumatic spinal cord injury. *Neurorehabil Neural Repair* 2003; 17(3):153-167.

4. Morganti B, Scivoletto G, Ditunno P, Ditunno JF, Molinari M. Walking index for spinal cord injury (WISCI): criterion validation. *Spinal Cord* 2005; 43(1): 27-33.

5. Dobkin B, Apple D, Barbeau H, Basso M, Behrman A, Deforge D, Ditunno JF, Dudley G, Elasoff R, Fugate L, Harkema S, Saulino M, Scott M. Weight-supported treadmill vs. over-ground training for walking after acute incomplete SCI. Neurology 2006; 66(4):484-93.
6. Ditunno JF, Jr., Barbeau H, Dobkin BH, Elashoff R, Harkema S, Marino RJ et al. Validity of the walking scale for spinal cord injury and other domains of function in a multicenter clinical trial. *Neurorehabil Neural Repair* 2007; 21(6):539-550.

7. Kim MO, Burns A, Ditunno JF, Marino RJ. The assessment of walking capacity using the walking index for spinal cord injury: self-

selected versus maximal levels. Arch Phys Med Rehabil 2007, 88(6):762-67.

8. Ditunno JF, Scivoletto G, Patrick M, Biering-Sorensen F, Abel R, Marino R. Validation of the walking index for spinal cord injury in a US and European clinical population. *Spinal Cord* 2008; 46(3):181-188.

9. Marino RJ, Scivoletto G, Patrick M, Tamburella F, Read MS, Burns AS et al. (2010). Walking Index for Spinal Cord Injury Version 2 (WISCI-II) with repeatability of the 10-m walk time: inter- and intrarater reliabilities. Am J Phys Med Rehabil, 89(1):7-15.

10. Burns AS, Delparte JJ, Patrick M, Marino RJ, Ditunno JF. (2011). The reproducibility and convergent validity of the Walking Index for Spinal Cord Injury (WISCI) in chronic spinal cord injury. Neurorehabil Neural Repair, 25(2):149-157.

11. Burns AS, Kim MO, Marino RJ, Ditunno JF. Correlation of Borg Rating to Physiologic Cost Index (PCI) and Total Heart Beat Index (THBI) for The Walking Index for Spinal Cord Injury (WISCI). J Spinal Cord Med 2006;29[3]:339.

12. 12. Scivoletto G, Tamburella F, Laurenza L, Foti C, Ditunno JF, Molinari M. Validity and reliability of the 10-m walk test and the 6-min walk test in spinal cord injury patients. Spinal Cord. 2011 Jun;49(6):736-40. Epub 2011 Jan 11.

Research Face Validity

Twenty-four spinal cord injury (SCI) experts in walking function from eight counties established and agreed on hierarchial ranking of 20 items. (Ditunno et al., 2000)

Results Kendall coefficient of concordance for the pilot data was significant (W=0.843, P< 0.001) indicating agreement among the experts in rank ordering of original items

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Concurrent/ Predictive/ Construct Validity

First use of WISCI II in a clinical trial of Body-Weight Supported Treadmill Training versus overground mobility training. Prospective study of 146 subjects with incomplete SCI (C4 to L3) confirmed concurrent validity of the WISCI by correlating with all measures at 3, 6, and 12 months. (FIM, 50-foot walking speed, 6-minute walk, LEMS, Berg Balance, FIM Locomotor Score). Correlation of LEMS change scores supports predictive validity (Ditunno et al., 2007).

Results - Correlations with WISCI at 6 months were significant with BBS (r = .90), LEMS (r = .85), LFIM (r = .89), FIM (r = .77), 50FW-S (r = .85), and 6MW-D (r = .79); similar correlations occurred at 3 and 12 months. Correlations of change scores from baseline WISCI were significant for change scores from baseline of LEMS/BBS/LFIM. Correlation of baseline LEMS and WISCI at 12 months were most significant (r = .73). The $R2$ of baseline LEMS explained

57% of variability of WISCI levels at 3 months.

Content/Construct Validity

Prospective study of 170 subjects in four countries confirmed that progression through the levels followed a monotonic pattern in more than 80% of subjects and the relationship of walking capacity (WISCI) to impairment (LEMS) was 91% ($p < 0.001$) at final assessment, supporting content and construct validity. (Ditunno et al., 2008).

Results – Eighty-five percent of motor complete (66/78) and 10% (7/72) of motor incomplete participants showed no progression (73/150). Of the remaining participants (77/150) who improved, 81% (62/77) showed MDI. However, the deviation from MDI occurred only at one timepoint in 10/15 participants. LEMS correlated with WISCI at initial and final assessment (0.47 and 0.91 $P<0.001$). Parallel bar use differed between the US and Europe possibly due to patterns of care. Use of braces also differed.

Convergent Validity/ Reproducibility

Prospective study of 76 subjects with chronic SCI confirmed convergent validity by correlating WISCI II levels to LEMS and walking speed. Reproducibility was assessed with the intraclass correlation coefficient (ICC) and the smallest real difference (SRD). (Burns et al., 2011)

Results – Convergent validity of the self-selected and maximum WISCI II with LEMS was moderate for paraplegia ($r = 0.479$ and $r = 0.533$) and strong for tetraplegia ($r = 0.852$ and $r = 0.816$). Tetraplegia, but not paraplegia, demonstrated convergent validity of walking speed at the self-selected and maximum WISCI levels with LEMS ($r = 0.752$ and $r = 0.813$). WISCI reproducibility was excellent (Intraclass correlation (ICC) for self-selected level 0.995). The resulting significant real differences (SRDs) of 0.785 (self-selected) and 0.597 (maximum), suggest that a change of one WISCI level can be interpreted as real (meaningful) in a chronic patient.

Inter/Intra-rater Reliability

Study of 26 subjects with chronic SCI from the United States and Italy tested by two blinded raters on two separate
days to determine self-selected and maximum WISCI II levels and the time to complete a 10-m walk confirmed inter.intra-rater reliability (Marino et al., 2010).

Results – Inter-and intra-rater reliability were 1.00 for self selected WISCI. The intra-rater reliability for maximal level WISCI was 1.0; inter-rater reliability was .98. The progression from self selected to maximal WISCI level also showed high agreement between and within raters, with no communication between therapists.

Walking Index for Spinal Cord Injury (WISCI II) Descriptors

Physical Limitation for walking secondary to impairment is defined at the person level and indicates the ability of a person to walk after spinal cord injury. The development of this assessment index required a rank ordering along a dimension of impairment, from the level of most severe impairment (0) to least severe impairment (20) based on the use of devices, braces and physical assistance of one or more persons. The order of the levels suggests each successive level is a less impaired level than the former. The ranking of severity is based on the severity or the impairment and not on functional independence in the environment. The following definitions standardize the terms used in each item:

Physical assistance: 'Physical assistance of two persons' is moderate to maximum assistance.
'Physical assistance of one person' is minimal to moderate assistance.
'Contact guarding' is minimal assistance

Braces: 'Braces' means one or two braces, either short or long leg.
(Splinting of lower extremities for standing is considered long leg bracing).
'No braces' means no braces on either leg.

Walker: 'Walker' is a conventional rigid walker without wheels.

Crutches: 'Crutches' can be Lofstrand (Canadian) or axillary.

Cane: 'Cane' is a conventional straight cane.

Level	Description
0	Unable to stand and/or participate in assisted walking.
1	Ambulates in parallel bars, with braces and physical assistance of two persons, but less than 10 meters
2	Ambulates in parallel bars, with braces and physical assistance of two persons, 10 meters.
3	Ambulates in parallel bars, with braces and physical assistance of one person, 10 meters.
4	Ambulates in parallel bars, no braces and physical assistance of one person, 10 meters
5	Ambulates in parallel bars, with no braces and no physical assistance, 10 meters.
6	Ambulates with walker, with braces and physical assistance of one person, 10 meters.
7	Ambulates with two crutches, with braces and physical assistance of one person, 10 meters.
8	Ambulates with walker, no braces and physical assistance of one person, 10 meters.
9	Ambulates with walker, with braces and no physical assistance, 10 meters.
10	Ambulates with one cane/crutch, with braces and physical assistance of one person, 10 meters.
11	Ambulates with two crutches, no braces and physical assistance of one person, 10 meters.
12	Ambulates with two crutches, with braces and no physical assistance, 10 meters.
13	Ambulates with walker, no braces and no physical assistance, 10 meters.
14	Ambulates with one cane/crutch, no braces and physical assistance of one person, 10 meters.
15	Ambulates with one cane/crutch, with braces and no physical assistance, 10 meters.
16	Ambulates with two crutches, no braces and no physical assistance, 10 meters.
17	Ambulates with no devices, no braces and physical assistance of one person, 10 meters.
18	Ambulates with no devices, with braces and no physical assistance, 10 meters.
19	Ambulates with one cane/crutch, no braces and no physical assistance, 10 meters.
20	Ambulates with no devices, no braces and no physical assistance, 10 meters.

Scoring Sheet for the Walking Index for Spinal Cord Injury II (WISCI II)

Name_____ Date_____

Check descriptors that apply to current walking performance, and then assign the highest level of walking performance. (In scoring a level, one should choose the level at which the patient is safe as judged by the therapist, with patient's comfort level described. If devices other than those stated in the standard definitions are used, they should be documented as descriptors. If there is a discrepancy between two observers, the higher level should be chosen.)

Descriptors: Make ONE selection only in each section

Devices		Comments	Braces		Comments
D1 Parallel bars < 10 meters			B1 Long Leg Braces - Uses 2 – Locked at knee		
D2 Parallel bars 10+ meters			B2 Long Leg Braces - Uses 1 - Locked at knee		
D3 Walker - Standard			B3 Short Leg Braces - Uses 2 – Unlocked		
D4 Walker - rolling platform			B4 Short Leg Braces - Uses 1 – Unlocked		
D5 Walker – other > describe >>>			B5 Alpine boots		
D6 Crutches - Uses 2			B6 Ace bandages		
D7 Crutches - Uses 1			B7 High tops		
D8 Canes- Quad - Uses 2			B8 Other braces / bracing methods > describe >		
D9 Canes- Quad - Uses 1			B9 No braces		
D10 No devices					
Assistance		**Comments**	**Patient reported comfort level**		**Comments**
A1 Max assist x 2 people*			C1 Very comfortable		
A2 Min/Mod assist x 2 people*			C2 Slightly comfortable		
A3 Min/Mod assist x 1 person[t]			C3 Neither comfortable nor uncomfortable		
A4 No assistance			C4 Slightly uncomfortable		
Patient safety comments					

*Applies only to WISCI II levels 1 and 2; [t]Applies to WISCI II levels 3,4,6,7,8,10,11,14,17

WISCI Levels

Level	Devices	Braces	Assistance	Distance
0				Unable
1	Parallel bars	Braces	2 persons	Less than 10 meters
2	Parallel bars	Braces	2 persons	10 meters
3	Parallel bars	Braces	1 person	10 meters
4	Parallel bars	No braces	1 person	10 meters
5	Parallel bars	Braces	No assistance	10 meters
6	Walker	Braces	1 person	10 meters
7	Two crutches	Braces	1 person	10 meters
8	Walker	No braces	1 person	10 meters
9	Walker	Braces	No assistance	10 meters
10	One cane/crutch	Braces	1 person	10 meters
11	Two crutches	No braces	1 person	10 meters
12	Two crutches	Braces	No assistance	10 meters
13	Walker	No braces	No assistance	10 meters
14	One cane/crutch	No braces	1 person	10 meters
15	One cane/crutch	Braces	No assistance	10 meters
16	Two crutches	No braces	No assistance	10 meters
17	No devices	No braces	1 person	10 meters
18	No devices	Braces	No assistance	10 meters
19	One cane/crutch	No braces	No assistance	10 meters
20	No devices	No braces	No assistance	10 meters

Baseline/Self-Selected Level assigned_____

Maximum WISCI Level assigned_____