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REVIEW

Classification and measurement of pain in the spinal cord-injured population

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Study Design: Comprehensive review and systematic analyses.
Objectives: The purpose of this review was to summarize studies reporting on the psychometric properties of measures commonly utilized in spinal cord injury (SCI) pain research to better inform clinicians and researchers on the selection of appropriate pain-related instruments.
Setting: Vancouver, British Columbia, Canada.
Methods: A detailed literature search was completed to extrapolate articles that described the psychometric properties of pain measures specifically used in SCI populations. Psychometric properties data of the identified measures such as reliability coefficients, type and magnitude of validity correlations, responsiveness as well as logistical factors (that is, interpretability, acceptability and feasibility) were extracted from manuscripts in accordance with similar projects designed to review outcome measures.
Results: Five different pain classification schemas, six self-report measures of pain, and two measures of pain impact on functioning were selected based on our inclusion criteria. The majority of the studies identified in these areas reported inter- and intra-rater reliability information. Of the little validity data found for pain screening measures, it was difficult to compare due to the variability of the descriptors used. No data on sensitivity was identified.
Conclusion: We propose a call to SCI researchers to consistently apply psychometric analyses to SCI pain data measures. Greater rigor for assessing psychometric information in SCI pain studies will better inform the SCI research community of the applicability of generic measures to SCI pain investigations.
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Keywords: pain; measurement; spinal cord injury; reliability; validity

Introduction

Although loss of function is considered the most significant consequence of spinal cord injury (SCI), pain is a debilitating accompaniment that imposes significant burden on individuals who have already suffered substantial emotional and physical trauma.[1,2] Pain in general is defined by the International Association for the Study of Pain (IASP) as 'an unpleasant sensory and emotional experience associated with actual or potential tissue damage'.[3] SCI-related pain is heterogeneous; several subtypes are presumed to exist, each with different pathophysiology and likely different treatment approaches.[4,5] The most common of these in SCI are neuropathic pain elements, defined as 'pain arising as a direct consequence of a lesion or disease of the somatosensory system'.[6]

Data concerning the prevalence, causes, characteristics and treatment of chronic pain in the SCI literature are accumulating but are not yet definitive.[7,8] Prevalence rates for SCI-related pain range between 48 and 94% of the SCI population, depending on population characteristics (for example, acute, chronic) and measurement factors (for example, pain intensity, interference).[9–11] However, regardless of prevalence, pain in SCI is remarkable for its chronicity, interference with functioning and resistance to medical treatment.[12,13]

A lack of standardization and agreement regarding both classification and description of pain elements hampers understanding of pain in SCI, especially for neuropathic pain elements.[14,15] Historically, clinical assessment of pain has generally followed a commonly utilized, but loosely applied format focused on subjective phenomena of pain.[16] However,

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pain is 'essentially a subjective experience described by person-specific symptoms and expressed with a certain intensity'.[17] Measurement must therefore be reliable, valid and responsive to pain phenomena;[18] a standardized and reliable classification is essential. Determination of pain type, prevalence and associated complications should lead to specific, circumscribed treatment approaches and permit meaningful comparisons across studies.[4]

Although a considerable volume of literature exists on pain in the SCI population, there is a notable lack of adequate documentation on the psychometric properties of instruments used specifically in SCI pain research.[19] Selection of appropriate pain-related instruments for clinical or research purposes is therefore uncertain.[4] To address this deficiency, this critical review assesses the psychometric properties (reliability, validity, purpose, utility and responsiveness) of measures commonly utilized in SCI pain research.

Three aspects of pain measurement were addressed: classification of SCI-related pain (pain description according to type, region and presumed mechanism), pain perception (intensity, sensory description) and pain interference (impact on daily life/activity).

Methods

PubMed, MEDLINE, CINAHL, EMBASE, HaPI, PsycINFO and SPORTDiscus electronic database searches were undertaken to identify peer-reviewed articles published between 1986 and 2006 that reported on pain measurement in SCI. Additional searches were conducted through archival of references in papers obtained by electronic search. The keyword 'spinal cord injury' was used in all database searches and then combined with other terms (that is, pain, pain measures, pain measurement, reliability, validity, psychometrics, reproducibility of results and data collection) depending on database parameters.

Approximately 1000 peer-reviewed publications that addressed SCI pain were identified. Article titles and abstracts were reviewed for initial retention of relevant articles on SCI pain. Sixty-seven articles specifically addressed measurement of SCI pain, describing various algorithms or measures for evaluation of a wide array of pain-related domains and the impact of pain on functioning. To be included, measures had to have psychometric properties assessed and reported in at least one peer-reviewed study using a SCI population. Selected papers were carefully reviewed and relevant psychometric information was extracted. (For the purpose of this review, RCT studies were not included since the primary focus of this review was methodological analyses of the tools. While reliability (and responsiveness—effect size can be calculated) and statistics can be calculated in these studies, the formulae used are often different.)

Evaluation procedure

A review team consisting of clinicians and scientists with established expertise in research areas relevant to SCI issues was established. The team reviewed each of the articles as part of a larger review of health care and rehabilitation strategies for persons with SCI.[20] Data about psychometric properties of the identified measures (that is, reliability coefficients, type and magnitude of validity correlations, responsiveness) and 'pragmatic' factors (that is, interpretability, acceptability and feasibility) were extracted from manuscripts in accordance with similar projects designed to review outcome measures.[21–23]

Selection criteria

Standards for quality of reliability, validity and responsiveness for each measure were adapted from a previously published overview of outcome measurement criteria.[24] Reporting format for rigor and quality replicated the approach adopted by McDowell and Newell[25] adapted for the SCI population. Definitions, cutoff ratings and criteria details for outcome ratings are briefly summarized in Table 1 and further explicated by the SCIRE authors.[20]

Results

Seventeen studies identified by this process reported psychometric properties of measures in studies of SCI pain. Five SCI pain classification systems were identified. Eleven studies were identified that evaluated seven self-report measures of pain perception. Four self-report measures of pain perception and two self-report measures of pain impact on functioning were subjected to review (Table 2).

Pain classification

Stated goals were similar across the five SCI pain classifications, namely to standardize terminology, provide direction for treatment, inform outcome evaluation and promote knowledge translation of basic science advances to clinical practice. Early constructions (Tunks,[26] Donovan[27] and Siddall[7] classifications) were instrumental in providing initial categorizations for SCI pain. These early constructs are superceded by three recent SCI pain classification systems. Siddall's initial construction, modified to a three-tier taxonomy, is most well known as the IASP Task Force on Pain following SCI.[28] This schema classifies SCI pain according to type (nociceptive and neuropathic), subtype (musculoskeletal, visceral at, below and above lesion level) and finally presumed mechanism (specific structure/pathology) (Table 3).

The most recent SCI pain categorization construction (Cardenas *et al.*[29]) is comprised of two major categories (neurologic and musculoskeletal pain) further divided into four neurologic pain subcategories (SCI, transition zone, radicular and visceral). SCI level of lesion, level of pain (at, below and above lesion level), pain laterality, responsiveness to pain stimuli/activity and SCI completeness are also used as criteria for categorization purposes in this multi-axial assessment protocol. Other classification systems have also been published, such as the Bryce/Ragnarsson-SCI-Pain Taxonomy (BR-SCI-PT),[30] a three-tier system aligned with Siddall's original classification by level of injury, pain type

Table 1 Criteria for rating outcome measures

	Excellent	*Adequate*	*Poor*
Study rigor and quality	Minimum two studies with inter-rater reliability >0.75.	Single study with adequate to excellent reliability, validity and/or responsiveness	Single study with less than adequate reliability, validity and/or responsiveness
Reliability: Reproducibility, stability	$\geqslant 0.80$	0.70–0.79	<0.70
Internal consistency ICC, κ values	$\geqslant 0.75$	0.40–0.75	<0.40
Validity: Extent to which the instrument measures pain construct (for example, face, content, construct and criterion validities)	$\geqslant 0.60$	0.31–0.59	<0.31
Responsiveness: sensitivity to change (for example, treatment effects)	Expected direction	Moderate/low; conflicting results	Weak: based solely on *P*-values
Floor/ceiling effects	None	$<20\%$	$\geqslant 20\%$
Interpretability: Meaningfulness of scores, consistency of definitions, results classifications			
Acceptability: Respondent burden and acceptability, provision for completion by proxy			
Feasibility: Administrator burden, expense, disruption and measure availability			

Table 2 Summary of psychometric properties

		Measurement properties	
Instrument	*Number of studies*	*Reliability (intra/inter)*	*Convergent validity*
Classification measures			
Donovan pain classification	1	++/+++	0
Tunks pain classification	2	+/++	0
Siddall (IASP Task Force)	1	++	0
Bryce/Ragnarsson taxonomy	1	++	0
Cardenas pain classification	1	++	0
Pain perception measures			
Graded Chronic Pain Disability Scale (GCP)	2	+++	++
Multidimensional Pain Inventory–Spinal Cord Injury (MPI-SCI)	1	++/+++	++
McGill Pain Questionnaire (MPQ)	1	++	++
Medical outcomes survey (SF-36)	1	0	++
Pain interference measures			
Wheelchair users Pain index (WUSPI)	2	++/+++	++
Brief pain inventory (BPI)	2	+++	+++

+++, excellent evidence; ++, adequate evidence; +, poor evidence; 0, no numerical evidence.

(nociceptive or neuropathic elements) and subtype (regional localization) and Siddall's original model.[7]

Five pain classification schemes met our inclusion criteria: Tunks Classification Scheme,[26] Donovan SCI Pain Classification,[27] Siddall Classification,[7] IASP Taxonomy of SCI Pain,[28] BR-SCI-PT[30] and Cardenas' Pain Classification[29] (Table 4). Each addressed presumably differing underlying pathologies for different subtypes of SCI pain, pain location, clinical presentation and temporal patterns. Adequate but not excellent evidence supporting the quality of reliability as indicated by the magnitude of the coefficient inter-rater reliability was reported for each of these schemas, however, no studies investigating empirical elements of validity of these classifications were identified. The models are difficult to compare given varying formats, number of items and rating scale parameters.

Measurement of self-reported pain

A total of 11 papers investigating measurement issues on 6 different self-report pain scales were identified. These tools were primarily developed for use in other populations. The majority of psychometric studies on measurement of pain sensation in the SCI population reported only reliability data, again predominantly test–retest reliability (Table 4). The McGill Pain Inventory for SCI reported ICC values

Table 3 Pain measures meeting study criteria

Instrument	*Pain construct*	*No. of pain Items*	*Response scale*
Pain perception scales			
Graded Chronic Pain Disability Scale (GCP)	Pain and interference in ADLs Two subscales: Pain intensity Pain interference	7	11-point Likert scale (0–10). Distinguishes 4 subgroups of patients, differentiated by pain intensity and interference with activities: I: Low interference, low pain intensity; II: Low interference, high intensity; III: Moderate interference; IV High interference
McGill Pain Questionnaire (MPQ)	Multidimensional pain measure. Pain intensity with word descriptors. Pain rating index subscale (PRI) comprised of four major groups of descriptors: Sensory (1–10) Affective (11–15) Evaluative (16) Miscellaneous (17–20) Present Pain Intensity Index (PPI)	78	Range from 2- to 6-point Likert scale. PRI is the sum of the applicable pain descriptors PPI 6-point scale anchored from 'no pain' to 'excruciating'
MPQ-Short Form	Pain experience Pain rating index comprised of two major groups of descriptors: Sensory (1–11) Affective (12–15) Present Pain Intensity Index (PPI) Visual analogue scale (VAS)	15 6	4-point Likert scale and VAS. Each descriptor is ranked on a 4-point scale ranging from 0 (none) to 4 (severe); Highest possible PRI: 55 PPI 6-point scale (0–5) anchored from 'no pain' to 'excruciating'. From 'no pain' to 'worst possible pain'
Medical Outcomes Survey (SF-12)	Multiple construct including pain impact and interference Bodily Pain Subscale—one of the two items of this subscale has been used in a number of studies as a measure of pain interference	2	Five-point Likert scale anchored from 'not at all' to 'extremely'. Total range of score for entire scale is 0–100; high score indicates better physical functioning
Multidimensional Pain Inventory–SCI (MPI-SCI)	Multiple construct including severity, impact, others, adaptation to pain. Life interface subscale: Activities of daily living Affects on and support from significant others	20 18 14	7-point numerical rating (0–6) 12 subscale measures
Pain interference scales			
Brief Pain Inventory (BPI)	Pain interference subscale—the location and intensity of pain during everyday life. Interference with function, activities, mood, relationships and life	12	11-point Likert scale (0 to 10); anchored at 'no pain' to 'worst pain possible'
Wheelchair Users Pain Index (WUSPI)	Pain interference with ADLs	15	11-point Likert scale (0–10; anchored at 'no pain' to 'worst pain ever experience'. Scores range from 0 to 150

Abbreviation: ADL, activities of daily living.

ranging from 0.69 to 0.78.[31] The Wheelchair Users Shoulder Pain Index (WUSPI) had the highest reliability measures (ICC = 0.99).[32,33] The Brief Pain Inventory (BPI)[34] and the WUSPI had the highest values for internal consistency with Chronbach's α all greater than 0.91.[35] Of the few validity studies identified, most assessed either convergent or content validity; measures were statistically significant with BPI demonstrating the highest correlations.[35]

Pain intensity

Most studies on SCI pain utilize some form of one-dimensional rating scale for evaluation of self-reported pain intensity (for example, magnitude or severity). Numerical rating scales (NRSs) are the most commonly applied metric for pain report in both the general and SCI pain literatures for subjective estimates of pain experience. NRSs are well-established for validity, application facility and responsiveness; these are the most commonly applied metric for pain report in SCI research studies.[36–38] The most utilized constructions are 11-point Likert Scales with anchors at '0' (no pain) and '10'. Upper-end anchor descriptors vary across studies (for example, pain as bad as it could be, the worst pain imaginable). Most studies assessed in this review employed NRS items of varying anchor descriptions.

Table 4 Pain classification schemas

Instrument	*Tier 1*	*Tier 2*	*Tier 3*	*Item Response Scale*
Siddal (IASP) Three tiers	Nociceptive Neuropathic	Pain subtype: Musculo-skeletal Visceral Pain level	Presumed mechanism (structure, pathology)	Semi-structured interview
Bryce/Ragnarsson Taxonomy Three Tiers	Level of Injury	Pain type Nociceptive Neuropathic	Regional localization	Three-point numerical rating (1–3) and five-point Likert scale (range 1–5)
Cardenas Multi-axial	Neurologic Musculo-skeletal	Neurologic subtypes: SCI Transition zone Ridiculer Visceral	Level of lesion Pain level Injury Completeness Laterality Responsiveness to stimuli	Variable formats

Instrument	*Types*	*Discriminators*	*Item Response Scale*
Donavon Five pain types	Segmental nerve and cauda equina, spinal cord, visceral, mechanical and psychogenic	Mechanism, descriptors, duration	Semi-structured interview
Tunks Eleven pain types	Myofacial (complete/incomplete), syringomyelia, non spinal cord, radicular, fracture, burning, phantom and visceral	Relative to lesion level	Semi-structured interview

Pain sensory symptoms

Measures developed for general chronic pain populations that include various sensory (verbal description) and/or affective (reflective of pain-related distress) descriptors of pain quality are commonly used in SCI pain research (see Appendix 1 for descriptions of the measures included for review). The most frequently reported measure of sensory quality in the SCI literature appears to be the McGill Pain Questionnaire or its' variations.[3,11] The Medical Outcomes Survey-Short form (MOS; SF-12),[39] Graded Chronic Pain Disability Scale (GPS)[40] and Multidimensional Pain Inventory (MPI)[41] have also been employed in the SCI pain literature (MPI-SCI)[42] and report solid reliability psychometric data.

The majority of psychometric studies on measurement of pain sensation in SCI populations reported only reliability data, predominantly test–retest reliability (Table 4). The MPI-SCI reported ICC values ranging from 0.69 to 0.78.[42] All of the self-report pain measures have been assessed for construct or convergent validity with other measures with adequate level for correlations. Grade Chronic Pain Scale and the Brief Pain Inventory (BPI) correlated well with the SF-36 ($r=0.5$ and $r=0.6$, respectively) while the McGill Pain Questionnaire correlated well with Sternbach's Pain Intensity Scale[11] ($r=0.5$). The extent to which short forms (for example, SF-12 and MPQ-SF) of standard measures are adequate for providing a comprehensive picture of SCI pain perception remains unclear.[24] These, and similar scales, are also restricted with regard to inclusion of neuropathic pain elements common to SCI. Three recently developed measures assessing neuropathic pain in general medical conditions are reported in the general pain literature but the range of neuropathic symptom descriptors appear limited and none are specific to SCI pain experience.[17]

Pain interference

Pain interference measures purport to assess the nature and degree to which pain negatively impacts various aspects of functioning. Such measures using NRSs or Likert-type items are commonly used in descriptive and treatment outcome evaluation studies in general, and SCI, pain literature.[43–45] Most studies addressing SCI pain include some form of pain interference items using various modifications of the Brief Pain Inventory (BPI),[34] either independently or in conjunction with other measures. However, variability is the norm for item inclusion and format although most utilize at least one item on pain interference that addresses the ability to participate in customary activities. Anchor descriptors vary (for example, unable to carry on any activities, completely interferes) and are commonly modified to better reflect SCI experience (for example, 'mobility' vs 'walking'). As others have pointed out, adaptations to measures such as these for disability populations should be examined in concert with review of factor structures to ensure face validity and scale integrity.[24]

Only one published measure constructed solely for SCI pain interference was identified. The Wheelchair Users Shoulder Pain Index (WUSPI)[32] appears to be a psychometrically sound instrument that assesses the impact of shoulder pain in persons with SCI who are wheelchair reliant for mobility.[33] The WUSPI reported high reliability values (ICC = 0.99) and showed adequate validity with functional upper extremity range of motion measures ($r=0.47$). Both the BPI and WUSPI reported strong internal consistency (Cronbach α's all greater than 0.91).

Discussion

This study provides information about published psychometric data on pain measures used to evaluate pain issues in

persons with SCI. Despite improvement in the quality of SCI literature over the past two decades, studies on SCI pain measurement are limited compared to pain studies in other populations.[26,46] Very few published studies that reported psychometric properties of pain measurement specific to the SCI population were identified by our search criteria. Variability in the application of clinical and research tools for SCI pain assessment and measurement was evident. This lack of uniformity precludes comparison across SCI pain studies.[4]

Which classification system and pain measures should be used? A number of models have been proposed for the classification of SCI pain. The most recent of these (IASP Taxonomy of SCI Pain,[28] Bryce-Ragnarsson SCI Pain Taxonomy,[30] Cardenas Model[29]) focus on pain description according to region (relative to level of injury) and underlying pathology to differentiate between nociceptive, neurologic and visceral pain. Goals are similar across schemas, namely the improvement of assessment and pain management direction of SCI-related pain. However, with the exception of universal agreement on major pain subtypes (nociceptive/musculoskeletal, neuropathic/neurologic and visceral), nomenclature and inclusion of pain types and elements are variable.

Direct comparisons of each of these models would be useful to determine comparative validity and reliability. Although these models provide some reliability data, validity remains a significant issue for pain classification, complicated in part by limitations in determining pathological mechanisms for pain origin. However, as Siddall has pointed out, for any taxonomy to be useful, it must be consistently applied.[24] Universal acceptance and adoption of any one comprehensive SCI-related pain classification taxonomy remains uncertain. Although the IASP model appears to be the most utilized according to the literature, the need for specific expertise with SCI and complex pain assessment may restrict its general application.

Modifications to this model are anticipated given the recent introduction by the classification subcommittee of the IASP Neuropathic Pain Interest Group of a new definition, classification and grading system (definite, probable and possible) for neuropathic pain.[6] Until an impending updated version is published, researchers and clinicians may be best served by using the current IASP schema for classifying SCI pain.

As with the general literature on pain, SCI pain studies typically report descriptive and treatment outcomes according to one of the three methodologies. The most frequent application is of single instrument use to evaluate pain-related factors such as pain intensity, pain interference/impact and pain-related disability. NRS items are almost universally employed in SCI pain studies and are supported for validity by an extensive pain literature.[47]

Pain intensity alone, however, assumes homogeneity of experience and has limited value in determining outcome. Clinicians and researchers are therefore encouraged to consider recommendations for structured, standard instructions and standard NRS anchor descriptions (presentation of numbers from '0' 'No Pain' to '10' 'Pain as bad as you can imagine') as outlined in Initiative on Methods section, Measurement and Pain Assessment in Clinical Trials (IMMPACT). IMMPACT identifies six core domains for design of clinical trials on pain: pain; physical functioning; emotional functioning; participant ratings of improvement and satisfaction with treatment; symptoms and adverse events; and participant disposition.[47]

With one exception, we observed that original or adapted versions of one-dimensional or multidimensional indices designed for use in populations with chronic and acute pain conditions other than SCI were most commonly used in SCI pain research. The most commonly used measures include various versions of the McGill Pain Questionnaire (MPQ),[31] Graded Chronic Pain Disability Scale (GPS)[40] and the Medical Outcomes Survey-Short Form (MOS; SF-12),[39] all of which report satisfactory, but limited, psychometric information with SCI populations. SCI pain interference has been most commonly addressed by adaptations of the Brief Pain Inventory (BPI).[34]

A recently developed measure, the Pain Outcomes Questionnaire-VA (POQ-VA)[48] is a multi-domain pain treatment outcome instrument that reports strong psychometric data with disability populations, including rigorous studies but unfortunately the paper did not clearly define the population outside of stating they were from the Veteran Affairs clientele who had chronic pain.[17] We might wish to assume some of the subjects were from the SCI population but for the criteria outlined in this study, we excluded this paper. However, multi-method validity and reliability studies were completed on the questionnaire to evaluate the integrity of the measure. Factor analyses of the pain scales along with convergent and discriminant validity examinations in both disability and cross-validation samples were completed. This study represented the most comprehensive treatment of pain measurement in all of the measures reviewed.

Although the studies examined in this review appeared to be relatively clear with regard to stated purpose, suitability of instrument choice was at times unclear and was marked by variability in sensory description. For assessment of sensory experiences of SCI pain, no published instrument to date appears to adequately capture the complex experiences of SCI neuropathic or visceral pain. One instrument that may have possibility is the POQ-VA; a comprehensive tool that provides information on separate domains affected by pain.[48] As the authors point out, this approach may be preferable for comprehensive outcome evaluation over instruments that yield isolated summary scores given variability in individual pain presentation.

Pain symptom screening tools and questionnaires, however, are naturally restricted given the lack of clarity for mechanism. However, SCI pain screening measures, at a minimum, should incorporate pain sensory items specific to and common in SCI conditions such as type (nociceptive or neuropathic); subtype (musculoskeletal or visceral) and level (at, below or above lesion). Information on thermal, dysesthetic and paroxysmal properties may also reliably be identified by SCI pain assessment tools.[28] We look forward to validation studies on such instruments in the future.

There are a number of limitations to this study. While we are relatively confident that our search process captured the

majority of studies meeting our criteria, database search limitations are acknowledged. Our inclusion criteria were highly restrictive and precluded studies on SCI sensory testing or randomized clinical trials, which can provide information on responsiveness.

Conclusion

Determination of which self-report pain indices are most useful for SCI pain assessment requires consideration of a variety of factors, including knowledge of the intent and properties of the measure or measures under deliberation. With few exceptions, SCI pain characteristics other than intensity, sensory descriptors of variable inclusion or impact on functioning were generally lacking in the studies examined. Knowledge of which neuropathic-type pain descriptors are most reflective of various SCI pain presentations remains unclear.

No adequate measure for the symptomatic assessment of SCI-related neuropathic pain has been developed to date. This deficiency should be addressed: development of an SCI-specific pain assessment tool that is also applicable to SCI pain research is encouraged. Temporal aspects of pain (that is, frequency, duration and time to meaningful pain relief) and pain by SCI status (tetraplegia and paraplegia) are not adequately addressed in the SCI pain literature and deserve further examination. Measures of psychological correlates, emotional functioning and global improvement and satisfaction with treatment are also lacking for standard use in the SCI pain assessment literature. The issue of meaning in pain intensity changes has also not been specifically addressed in the SCI pain literature and deserves future consideration.[49]

In summary, we propose a call to SCI researchers to consistently apply psychometric analyses to SCI pain data measures and look forward to increased reporting of SCI pain data and accompanying psychometric information. Greater rigor for assessing psychometric information in SCI pain studies will better inform the SCI research community of the applicability of generic measures to SCI pain investigations. Continued development and publication of psychometrically sound SCI-specific measures is also encouraged.

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References

1 Mariano AJ. Chronic pain and spinal cord injury: review and comment. *Clin J Pain* 1992; **8**: 119–122.
2 Siddall PJ, Taylor DA, McClelland JM, Rutkowski SB, Cousins MJ. Pain report and the relationship of pain to physical factors in the first 6 months following spinal cord injury. *Pain* 1999; **81**: 187–197.
3 Merskey H, Bogduk N. *Classification of Chronic Pain*, 2nd edn. IASP Press: IASP Task Force on Taxonomy, 1994, pp 209–214.
4 Scott RJ. Spinal cord injury pain: impact, classification, treatment trends, and implications from translational research. *Rehabil Psychol* 2005; **2**: 99–102.
5 Jensen TS, Gottrup H, Sindrup SH, Flemming WB. The clinical picture of neuropathic pain. *Eur J Pharmacol* 2001; **429**: 1–11.
6 Treede R, Jensen T, Campbell J, Cruccu G, Dostrovsky J, Griffin J *et al*. Redefinition of neuropathic pain and a grading system for clinical use: Consensus statement on clinical and research diagnostic criteria. IASP Subcommittee Special Interest Group on Neuropathic Pain. Neuropathic Pain Newsletter. *Neurology* 2006 (in press).
7 Siddall PJ, Yezierski R, Loeser J. Pain following spinal cord injury: clinical features, prevalence and taxonomy. *IASP Newsletter* 2000; **3**: 3–7.
8 Siddall PJ, Taylor DA, McClelland JM, Rutkowski SB. Pain report and the relationship of pain to physical factors in the first 6 months following spinal cord injury. *Pain* 1999; **21**: 181–197.
9 Siddall PJ, McLelland JM, Rutkowski SB, Cousins MJ. A longitudinal study of the prevalence and characteristics of pain in the first five years following spinal cord injury. *Pain* 2003; **103**: 249–257.
10 Turner J, Cardenas D, Warms C, McClellan C. Chronic pain associated with spinal cord injuries: a community survey. *Arch Phys Med Rehabil* 2001; **82**: 501–508.
11 Rintala DH, Holmes SA, Feiss RN, Courtade D, Loubser PG. Prevalence and characteristics of chronic pain in veterans with spinal cord injury. *J Rehabil Res Dev* 2005; **42**: 573–584.
12 Cardenas DD, Jensen MP. Treatments for chronic pain in persons with spinal cord injury: a survey study. *J Spinal Cord Med* 2006; **29**: 109–117.
13 Turner J, Cardenas D. Chronic pain problems in individuals with spinal cord injuries. *Semin Clin Neuropsychiatry* 1999; **4**: 186–194.
14 Siddall PJ, Taylor DA, Cousins MJ. Classification of pain following spinal cord injury. *Spinal Cord* 1997; **35**: 69–75.
15 Hicken BL, Putzke JD, Richards JS. Classification of spinal cord injury pain: literature review and future directions. In: Yezierski RP and Burchiel KJ (eds). *Spinal Cord Injury Pain: Assessment, Mechanisms and Management*. IASP Press: Seattle, WA, USA, 2002, pp 25–38.
16 Putzke J, Richards J, Ness R, Kezar L. Interrater reliability of the International Association for the Study of Pain and Tunks' spinal cord injury pain classification schemes. *Am J Phys Med Rehabil* 2003; **82**: 437–440.
17 Bennett MI, Attal N, Backjonja M, Baron R, Bouhaassira D, Freynhagen R *et al*. Using screening tools to identify neuropathic pain (Topical Review). *Pain* 2007; **127**: 199–203.
18 Rasmussen PV, Sindrup SH, Jensen TS, Bach FW. Symptoms and signs in patients with suspected neuropathic pain. *Pain* 2004; **110**: 461–469.
19 Clark ME, Gironda RJ. A Practical Approach to Outcome Measurement. In: Weiner RS (ed). *Pain Management: A Practical Guide for clinicians*, 6th edn. CRC Press: Boca Raton, FL, USA, 2002, pp 995–1010.
20 Miller WC, Curt A, Sawatzky BJ. Outcome measures. In: Eng JJ, Teasell RW, Miller WC, Wolfe D, Townson AF, Aubut J *et al*. (eds) *Spinal Cord Injury Evidence Review*. ICORD: Vancouver, 2006; **22** pp 1–89.
21 Meyers R, Andresen EM, Hagglund K. A model of outcomes research: spinal cord injury. *Arch Phys Med Rehabil* 2000; **81**: S81–S90.
22 Williams RC. Toward a set of reliable and valid measures for chronic pain assessment and outcome research. *Pain* 1988; **35**: 239–251.
23 Gadotti I, Vieira E, Magee DJ. Importance and clarification of measurement properties in rehabilitation. *Rev bras Fisioter* 2006; **10**: 137–146.
24 Andresen EM. Criteria for assessing the tools of disability outcomes research. *Arch Phys Med Rehabil* 2000; **81**: S15–S20.
25 McDowell I, Newell C. *Measuring Health: A Guide to Rating Scales and Questionnaires*. Oxford University Press: New York, NY, USA, 1996.

26 Tunks E. Pain in spinal cord injured patients. In Bloch R, Basbaum M (eds). *Management of Spinal Cord Injuries*. Williams and Wilkins: Baltimore, 1986 pp 180–211.
27 Donovan W, Dimitrijevic M, Dahm L, Dimitrijevic M. Neurophysiological approaches to chronic pain following spinal cord injury. *Paraplegia* 1982; **20**: 135–146.
28 Siddall PJ, Yezierski R, Loeser J. Pain following spinal cord injury: clinical features, prevalence and taxonomy. *IASP Newsletter* 2000; **3**: 3–7.
29 Cardenas DD, Turner JA, Warms C, Marshall H. Classification of chronic pain associated with spinal cord injuries. *Arch Phys Med Rehabil* 2002; **83**: 1708–1714.
30 Bryce T, Dijkers M, Ragnarsson K, Stein A, Chen B. Reliability of the Bryce/Ragnarsson spinal cord injury pain taxonomy. *J Spinal Cord Med* 2006; **29**: 118–132.
31 Melzack R. The McGill pain questionnaire. In: R Melzack (ed) *Pain Measurement and Assessment*. Raven Press: New York, 1975a.
32 Curtis KA, Roach KE, Applegate EB, Amar T, Benbow CS, Genecco TD *et al*. Reliability and validity of the Wheelchair User's Shoulder Pain Index (WUSPI). *Paraplegia* 1995; **33**: 595–601.
33 Curtis KA, Drysdale GA, Lanza RD, Kolber M, Vitolo RS, West R. Shoulder pain in wheelchair users with tetraplegia and paraplegia. *Arch Phys Med Rehabil* 1999; **80**: 453–457.
34 Cleeland RS, Ryan KM. Pain Assessment: global use of the Brief Pain Inventory. *Ann Acad Med* 1994; **23**: 129–138.
35 Andresen L, Fouts S, Romeis J, Brownson C. Performance of health-related quality-of-life instruments in a spinal cord injured population. *Arch Phys Med Rehabil* 1999; **80**: 877–884.
36 Jensen MP, Karoly P. Self-report scales and procedures for assessing pain in adults. In: Turk DC and Melzack R (eds). *Handbook of Pain Assessment*, 2nd edn. Guilford Press: New York, USA, 1992, pp 135–151.
37 Cardenas DD, Jensen MP. Treatments for chronic pain in persons with spinal cord injury: a survey study. *J Spinal Cord Med* 2005; **29**: 109–117.
38 Jensen MP. The validity and reliability of pain measures for use in clinical trials in adults. Presented at the second meeting of the Initiative on Methods, Measurement and Pain Assessment in clinical trials: IMMPACT II: 2003.
39 Ware JE, Kosinski M, Keller SD. A 12-item short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Med Care* 1996; **34**: 220–233.
40 Von Korff M, Ormel J, Keefe F, Dworkin S. Grading the severity of chronic pain. *Pain* 1992; **50**: 133–149.
41 Kerns RD, Turk DC, Rudy TE. The West Haven-Yale Multidimensional Pain Inventory (WHYMPI). *Pain* 1985; **23**: 345–356.
42 Widerström-Noga EG, Duncan R, Felipe-Cuervo DC, Turk E. Assessment of the impact of pain and impairments associated with spinal cord injuries. *Arch Phys Med Rehabil* 2002; **83**: 395–404.
43 Raichle KA, Osborne TL, Jensen RP, Cardena D. The reliability and validity of pain interference measures in persons with spinal cord injury. *J Pain* 2006; **7**: 179–186.
44 Cruz-Almeida Y, Marinez-Arizala A, Widerstrom-Noga EG. Chronicity of pain associated with spinal cord injury: a longitudinal analysis. *J Rehabil Res Dev* 2005; **42**: 585–594.
45 Widerström-Noga E, Felipe-Cuervo E, Yezierski R. Chronic pain after spinal cord injury: interference with sleep and daily activities. *Arch Phys Med Rehabil* 2001; **82**: 1571–1577.
46 Jensen MP, Turner LR, Turner JA. The use of multiple items scales for pain intensity measurement in chronic pain patients. *Pain* 1996; **67**: 45–50.
47 Dworkin RH, Turk DC, Farrar JT, Haythornthwaite JA, Jensen MP, Katz NP *et al*. Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. *Pain* 2005; **113**: 9–19.
48 Clark ME, Gironda RJ, Young RW. Development and validation of the Pain Outcomes Questionnaire-VA. *J Rehabil Res Dev* 2003; **40**: 381–396.
49 Zelman DC, Hoffman DL, Seifeldin R, Dukes EM. Development of a metric for a day of manageable pain control: derivation of pain severity cut-points for low back pan and osteoarthritis. *Pain* 2003; **106**: 35–42.

Appendix

Pain perception measures

Graded Chronic Pain Disability Scale (*GCP*).[40] This brief scale (seven items scored into an 11-point grading system) provides chronic pain disability classifications according to a grading combination of pain intensity and pain intrusion in various activities (work, activities of daily living, recreational and social activities). Level of disability is derived according to the number of days in pain in a previous 6-month period. The GCP has been utilized in SCI research either in total or by subscale, with the three-item disability scale used in a study on pain interference in SCI reporting adequate psychometric properties.

McGill Pain Questionnaire (MPQ).[31] The MPQ is a 78-item adjective list developed to assess both qualitative and quantitative dimensions of pain. The MPQ is widely utilized in clinical pain research and recognized for solid basic structure, reliability and validity, particularly for chronic pain assessment. Intensity-graded scales of word descriptors are categorized into sensory, affective and evaluative. The greatest criticism appears to be related to concerns that the three identified factors are not truly distinct constructs: the Pain Rating Index has been recommended for use given high scale inter-correlations.

A short form (MPQ-SF) demonstrated similar psychometric properties to the original measure, including very high correlations with the MPQ—Long Form and a greater weight of sensory over affective aspects of pain experience.[42] The MPQ-SF consists of 4 affective and 11 sensory descriptors, the original Present Pain Intensity Index (PPI), and a visual analogue scale. The MPQ-SF has been utilized in the SCI literature[7] and appears to be widely used in SCI pain studies.

Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36).[39] The SF-36 is a widely utilized and well-validated instrument for use in general health populations. Eight scales assess domains related to functioning and well being, including pain that results in two main indices (physical and mental summary scores). An acceptable short form (SF-12) has been utilized in SCI pain studies, using the two pain questions related to intensity and interference.

Multidimensional Pain Inventory (MPI-SCI).[41] The MPI is a comprehensive, frequently used measure of pain-related functioning in chronic pain experience. The full version is comprised of 52 items (a 60-item version also exists) divided into three sections (pain impact, responses by significant others, common activities), each of which includes several subscales. There are 15-items specific to pain experience including intensity and interference. Responses are scored on a seven-point continuum anchored at 0 and 6.

Pain interference measures

Brief Pain Inventory of Wisconsin (*BPI-SF*).[34] The BPI is a 12-item inventory first developed to describe cancer pain, including intensity and interference with function. The full interference scale of 12 items as well as various (seven and

10-item) versions generally use employ an 11-point Likert Scale (anchors at 0–10). The BPI is well utilized in SCI research as are various forms of single item questions about SCI pain interference.

Wheelchair User's Shoulder Pain Index (*WUSPI*).[32] The WUSPI is a 15-item questionnaire used to assess the intensity of pain during the performance of activities of daily living such as transfers, loading a wheelchair into a car, wheeling up inclines, dressing, bathing, overhead lifting, driving, performing household chores and sleeping. Subjects rate their intensity of pain during these activities on an 11-point Likert scale anchored at 'no pain' to 'worst pain ever experienced.' Scores range from 0 to 150 and solid reliability and validity data is reported.