

ORIGINAL RESEARCH

Interrater Reliability of the Neuromuscular Recovery Scale for Spinal Cord Injury



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Abstract

Objective: To determine the interrater reliability of the Neuromuscular Recovery Scale (NRS), an outcome measure designed to classify people with complete or incomplete spinal cord injury (SCI) into 4 phase-of-injury groups by assessing motor performance based on normal preinjury function and disallowing use of compensation for 4 treadmill-based items and 6 overground/mat items.

Design: Masked comparison, multicenter observational study.

Setting: Outpatient rehabilitation.

Participants: Raters (N = 14) and a criterion standard expert assigned scores to 10 video NRS assessments of persons with SCI. The raters were volunteers from the NeuroRecovery Network.

Intervention: Not applicable.

Main Outcome Measure: Interrater reliability measured with the Kendall coefficient of concordance (W).

Results: Interrater reliability was generally strong (W = .91–.98; 95% confidence interval [CI], .65–.99), while lower reliability occurred for treadmill stand retraining (W = .87; 95% CI, .06–1) and seated trunk extension (W = .82; 95% CI, .28–.94). Less experienced raters assigned slightly lower scores than the expert for most items, but the difference was less than half a point and did not weaken concordance.

Conclusions: NRS had strong interrater reliability, a necessary first step in establishing its utility as a clinical and research outcome measure. Archives of Physical Medicine and Rehabilitation 2015;96:1397-403

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Measuring outcomes after spinal cord injury (SCI) is a critical component of clinical rehabilitation, translational research, and clinical trials, and assessing the amount of restoration of normal function may be an important factor.¹⁻³ Unfortunately, outcome measures designed specifically for people with SCI are rare. Generalized use of nonspecific assessments have reported limitations in people with SCI including ceiling effects, floor effects, and a low detection of change in some types of SCI (ie, paraplegia, chronic SCI).⁴⁻¹¹ The few instruments created for SCI

allow the use of braces, wheelchairs, and other devices to compensate for lost function.^{9,12} Therefore, a gap exists in measuring recovery of preinjury function for SCI. Recently, a new SCI-specific instrument was introduced, the Neuromuscular Recovery Scale (NRS), which classifies functional performance during mobility, standing, and walking according to normal preinjury capabilities without compensatory movements or assistance.¹³ A description of the NRS is provided in the first article in the series (see companion article by Velozo and colleagues¹⁴).

Recently, the NRS was shown to be more sensitive to functional capacity than the American Spinal Injury Association Impairment Scale (AIS) classification for balance and timed walking tests.¹³ Rasch analysis of the NRS also showed good construct validity without ceiling or floor effects (see companion article by Velozo¹⁴). Despite these positive initial results, other

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Table 1 Demographics of individuals with SCI

Subject No.	Sex	Age (y)	AIS*	Injury Level	Chronicity (mo)	Overall Phase
1	M	24	B	C7	18	1B
2	M	24	D	C6	40	2A
3	M	69	D	C7	119	3A
4	F	53	D	C5	31	3A
5	F	67	D	Thoracic	3	2B
6	F	52	D	C4-5	76	2C
7	M	51	C	C4-5	9	2A
8	M	24	D	T2-4	42	3C
9	M	21	A	C5	45	1A
12	M	45	C	C5-7	30	1C
Summary	7M; 3F	43±18	1A; 1B; 2C; 6D	8C; 2T	36 (3–119)	3 Phase 1; 4 phase 2; 3 phase 3

NOTE. Values in summary are mean ± SD, mean (range), or number in each category.

Abbreviations: C, cervical; F, female; M, male; T, thoracic.

* A, motor and sensory complete SCI; B, motor complete SCI; C, incomplete SCI with pronounced below-level weakness; D, incomplete SCI with moderate to good below-level strength.

psychometric properties of the instrument such as reliability remain unexamined.

The purpose of this study was to determine the interrater reliability of the NRS instrument across International Standards for Neurological Classification of Spinal Cord Injury and AIS grades A through D for people with SCI. We hypothesized that strong interrater reliability would occur for each NRS item and the overall phase score among trained physical therapists. We also tested whether raters with less experience produced reliable NRS scores compared with an expert rater who helped develop the instrument.

Methods

This study received approval from the ethics committee for the administrative center at the University of Florida and at each participating institution: The Institute for Rehabilitation and Research Memorial Hermann, Kessler Institute for Rehabilitation, The Ohio State University, Magee Rehabilitation Hospital, Shepherd Center, and Frazier Rehab Institute. People with SCI and physical therapist raters signed informed consent to participate.

Participants

People with SCI (n=10) were selected as a sample of convenience from a database of 1 investigator at the University of Florida. The participants spanned AIS grades A to D to reflect a wide range of motor impairment (table 1). Two or 3 physical therapist raters from each of 6 centers in the NeuroRecovery Network (NRN) volunteered for this study. The raters had an average of 2.8 years of experience using the NRS. Training in the use of the NRS was part of the NRN protocol including participation in NRN standardization procedures, which included

review of testing procedures on a monthly conference call with video examples for scoring and NRS application with patients at a yearly meeting of all centers (table 2). Based on experience using the NRS, physical therapist raters were considered novice with <1 year or intermediate users with 1 to 5 years of experience. One expert rater who helped develop the NRS, a physical therapist with a PhD and 7 years of experience in the NRN, served as the criterion standard (see table 2). A sample size calculation¹⁵ indicated that a study of 15 raters and 8 individuals would provide sufficient power to detect intraclass correlation coefficients (ICCs) ≥.80 against a null (ICC) of .50. We enrolled 10 subjects to account for potential power loss resulting from the use of a rank-based nonparametric procedure (see Analysis section).

Video cases

We relied on video cases to allow raters in different locations to participate in the study. To ensure that raters had no prior knowledge of the people with SCI being evaluated, we recruited and filmed all cases at the University of Florida. None of the volunteers with SCI had received treatment in the NRN. Two authors and 2 assistants conducted all NRS tests for videotaping. Typically, testing of each subcategory for an item proceeds until failure in performance occurs. To prevent raters from inferring the phase subcategory based on the final criteria tested, we tested additional higher criteria after failure occurred on the videos. Frontal and lateral views were collected by professional videographers using appropriate lighting and audio records. After production of the 10 video cases, they were prescreened for accuracy and clarity of content by 3 authors.

Instrument

The NRS version 2010¹⁶ (see companion article by Velozo¹⁴) was completed for each video case. Eleven functional tasks are evaluated, with higher ratings indicating more normal performance. The number of subcategories that can be scored for each task (range, 4–10) reflects functions that could be placed in a hierarchical order (see companion article by Velozo¹⁴). In

List of abbreviations:

AIS	American Spinal Injury Association Impairment Scale
CI	confidence interval
ICC	intraclass correlation coefficient
NRN	NeuroRecovery Network
NRS	Neuromuscular Recovery Scale
SCI	spinal cord injury

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