Published in final edited form as:

Arch Phys Med Rehabil. 2018 September ; 99(9): 1783–1788. doi:10.1016/j.apmr.2018.02.014.

Sensitivity of the SCI-FI/AT in Individuals with Traumatic Spinal Cord Injury

Tamra Keeney, DPT^{1,2}, Mary Slavin, PhD¹, Pamela Kisala, MA³, Pengsheng Ni, MD¹, Allen W. Heinemann, PhD⁴, Susan Charlifue, PhD⁵, Denise C. Fyffe, PhD⁶, Ralph J. Marino, MD⁷, Leslie R. Morse, DO⁵, Lynn A. Worobey, PhD⁸, Denise Tate, PhD⁹, David Rosenblum, MD¹⁰, Ross Zafonte, DO¹¹, David Tulskey, PhD³, and Alan M. Jette, PhD^{1,2}

¹Health & Disability Research Institute, Boston University School of Public Health

²MGH Institute of Health Professions

³Center for Health Assessment Research and Translation, University of Delaware

⁴Feinberg School of Medicine, Northwestern University and Shirley Ryan AbilityLab

⁵Craig Hospital

⁶Kessler Foundation

⁷Sidney Kimmel Medical College at Thomas Jefferson University

⁸University of Pittsburgh

⁹University of Michigan

¹⁰Gaylord Hospital

¹¹Spaulding Rehabilitation Hospital, Massachusetts General Hospital, Harvard Medical School

Abstract

Objective—To examine the ability of the Spinal Cord Injury Functional Index Assistive Technology (SCI-FI/AT) measure to detect change in persons with SCI.

Design—Multi-site, longitudinal (12-month follow-up)

Setting—9 SCI Model Systems programs

Corresponding Author: Tamra Keeney, MGH Institute of Health Professions, 36 1st Ave, Charlestown, MA 02129, Telephone: (314) 401-8701, Fax: (617) 724-1922, TKeeney1@partners.org. Reprints will not be available from the authors.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

This project was presented at ACRM PIRR 2016.

Disclosure: Dr. Zafonte serves on the Scientific Advisory Boards of Myomo, EIMinda and Oxeia Biopharma. Dr Zafonte has also received book and educational royalties from Demos and Oakstone.

Author Contributions: Dr. Slavin, Dr. Jette, and Dr. Ni contributed to study concept and design. Dr. Keeney and Dr. Ni contributed to statistical analysis and interpretation of data. All authors contributed to oversight of data collection and the preparation of the manuscript.

Participants—165 adults with SCI enrolled in the SCI Model Systems database.

Interventions—Not applicable.

Main Outcome Measures—SCI-FI/AT CAT (Basic Mobility, Self-Care, Fine Motor Function, Wheelchair Mobility, and/or Ambulation) completed at discharge from rehabilitation and 12 months post-SCI. For each domain, effect size (ES) estimates and 95% confidence intervals were calculated for subgroups with paraplegia and tetraplegia.

Results—Sample demographics: 46% paraplegia, 76% male, 57% used a manual wheelchair, 38% used a power wheelchair, 30% were ambulatory. For individuals with paraplegia the Basic Mobility, Self-Care, and Ambulation domains of the SCI-FI/AT detected a significant, large amount of change; in contrast, the Fine Motor and Wheelchair domains detected only small amount of change. For those with tetraplegia, the Basic Mobility, Fine Motor, and Self-Care domains detected a small amount of change; while the Ambulation item domain detected a medium amount of change. The Wheelchair domain for people with tetraplegia was the only SCI-FI/AT domain that did not detect significant change.

Conclusion—SCI-FI/AT CAT item banks detected an increase in function from discharge to 12-months after SCI onset. SCI-FI/AT CAT ES estimates vary by domain and level of lesion. Findings support use of the SCI-FI/AT CAT in the SCI population and highlight the importance of multidimensional functional measures.

Keywords

Spinal Cord Injury; Function; Measurement

Over the last 10 years, researchers have expended considerable effort to develop and implement rehabilitation measures to inform clinical practice.^{1–4} Measures that assess a functional ability can document the benefit of rehabilitative services and monitor changes in function over time. Aggregated functional status data can inform efforts to improve rehabilitation services.

Development of psychometrically-sound functional status measures is a challenge for heterogeneous populations, such as those who sustain a traumatic spinal cord injury (SCI) for whom function varies based on the level (i.e., paraplegia vs tetraplegia) and severity of injury⁵ (i.e., complete vs incomplete). Individuals with SCI demonstrate diverse functional abilities ranging from utilizing power wheelchairs to walking independently. This variability presents a challenge to using static, fixed-form, global change measures. For instance, the Functional Independence Measure (FIM)TM, a generic rehabilitation assessment, is comprised of 13 motor items; the limited range of item difficulty results in floor and ceiling effects when used to assess individuals with SCI.^{6,7} Similarly, the Spinal Cord Independence Measure-III (SCIM III) is comprised of 17 items,⁸ but Rasch analysis revealed inadequate breadth of item coverage as demonstrated by a mistargeting of mobility item difficulty on typical participant performance, with most participants with SCI performing at the lowest levels of the mobility subscale.⁸

Computerized adaptive tests (CATs) can address limitations in the breadth of item difficulty noted for fixed-length measures. CATs are based on calibrated item banks that assess a

unidimensional construct (e.g., mobility). Calibrated item banks are developed using Item Response Theory (IRT), which models how individuals with given trait levels respond to items, based on item difficulty and the ability of the item to discriminate levels of the trait.^{9,10} Comprehensive item banks can be administered efficiently as CATs,¹¹ which use a computer algorithm to select items that match an individual's ability. CATs typically begin with a mid-difficulty question and an algorithm selects subsequent items based on responses to previous items. For example, if a respondent selects a response for an item indicating a low level of ability, the next item selected for administration would be less difficult. With each item administered, the score and the standard error (SE) are recalculated and the assessment ends based on a pre-determined stopping rule (SE or set number of items). Since all items are calibrated on a common metric, scores from CATs, or fixed-length short forms can be compared even though different items were administered.¹² While fixed-length SCI measures limit the number of items so that administration is feasible, CATs can include broad content in calibrated item banks that are administered by selecting items appropriate for each individual.¹³

Technology and Function after SCI

Individuals with SCI use a range of assistive technology (AT) to enhance mobility¹⁴ and increase their ability to eat, bathe, dress, and communicate. Available measures do not address adequately the effect of AT on function.² Lack of a standardized approach to assess an individual's function when using AT may adversely affect clinical interpretation of assessment scores. For example, the FIMTM and SCIM III reduce an individual's score when AT is used for self-care and mobility activities. The Quadriplegia Index of Function (QIF) scores 42 items in 7 content areas with a rating scale that ranges from 0–4 (dependence to independence); it reduces a score when a respondent uses AT.¹⁵ The fact that current measures do not address adequately AT use may result in misinterpretation of an individual's functional ability, affecting a clinician's ability to evaluate the effectiveness of rehabilitation interventions.¹⁶ Moreover, summary scores derived from these measures do not reflect fully the effect of AT on function.² Two individuals with SCI with different functional levels may demonstrate similar function when they use AT. Consideration of the effects of AT on function may also differ depending on the purpose of the assessment. For example, it may be preferable to evaluate function without AT use when assessing motor recovery. In contrast, assessing function with AT may be more important to determine if functional status has changed.

The SCI-Functional Index/Capacity (SCI-FI/C) measurement system was developed to improve the assessment of physical function following SCI. SCI-FI/C item banks assess capacity to perform functional activities without AT in Basic Mobility, Self-Care, Fine Motor Function, and Ambulation.¹⁷ Participants select the response that reflects their level of difficulty doing various activities “without special devices, equipment, or help from another person.” SCI-FI Assistive Technology (AT) item banks extend the SCI-FI measurement system.² We reviewed the SCI-FI/C item banks and items and removed items referencing specific types of AT.² A calibration sample completed items with instructions to select the response that indicates the level of difficulty experienced doing various activities “with the equipment or devices you normally use”.³

The SCI-FI/AT is a patient-reported measure that has been established as a psychometrically sound instrument for quantifying functional status for individuals with SCI. Intraclass Correlation Coefficients (ICC) exceed .97 across all SCI-FI/AT domain scores for individuals with paraplegia and tetraplegia.² The SCI-FI/AT references the ICF framework and provides scores in discrete, unidimensional domains that were supported by confirmatory factor analysis.² The 5 SCI-FI/AT item banks include: 47 Basic Mobility items, 35 Fine Motor items, 71 Self-Care items, 29 Ambulation items, and 56 Wheelchair items.

The objective of this study is to compare the sensitivity of the SCI-FI/AT CAT with legacy measures between discharge from inpatient rehabilitation to one-year follow-up. We also sought to define SCI-FI/AT change scores that demonstrate true functional change.

Methods

The sample included 220 individuals with traumatic SCI who participated in the Spinal Cord Injury Model Systems (SCIMS) database between April 2015 and August 2016. Participants were from 9 SCIMS programs: New England Regional Spinal Cord Injury Center, Kessler Foundation, Craig Hospital, Spaulding Rehabilitation Hospital, University of Louisville, University of Michigan, Shirley Ryan AbilityLab, the Regional Spinal Cord Injury Center of the Delaware Valley, and University of Pittsburgh. Inclusion criteria included inpatient rehabilitation admission; diagnosis of traumatic SCI; age 18 years of age or older; able to read and speak English; and cognitive ability to complete the assessment. Participating programs obtained institutional review board approval. We collected SCI-FI/AT data prior to discharge from in-patient rehabilitation and between 10 to 14 months post-SCI.

We conducted separate analyses by paraplegia vs. tetraplegia and by complete vs. incomplete SCI. We anticipated that the SCI-FI/AT CAT would be more sensitive to functional change across SCI-FI/AT domains than the FIM™ or SRFM.¹³

Clinical Assessment

Research staff recorded demographic and clinical information as part of data collection for the SCIMS National Database. The American Spinal Injury Association (ASIA) Impairment Scale (AIS) grades lesion level, obtained from the medical record at discharge from rehabilitation. Individuals classified as AIS A or B were categorized as having a motor complete SCI and those classified as AIS C, D, or E were categorized as motor incomplete.

18

Functional Status Instruments: FIM™ and SRFM

The FIM™ motor subscale includes 13 ADL and mobility items. Each item is scored based on the amount of assistance needed, from 0 (unable to perform) to 7 (independent). Total scores range from 0 to 91. Research staff collected FIM™ scores using SCIMS procedures.

The Self-Report Functional Measure (SRFM) is a 13-item patient-reported measure of the level of assistance needed to complete the same items as the FIM™ and is reliable for use in the SCI population.¹⁹ Scores for each individual item range from 1 (total dependence) to 4

(complete independence). Total scores range from 13 to 52. The SRFM was administered at the two data collection time points along with the SCI-FI/AT CAT.

SCI-FI/AT CAT

Screening questions were administered to identify relevant domains for each participant. All participants completed the basic mobility, self-care, and fine motor function domains, while the ambulation and wheelchair domains were administered as appropriate for each individual. The SCI-FI/AT CAT was administered by a trained interviewer. SCI-FI/AT CAT standardized z scores are converted to t scores where the mean = 50, with a standard deviation of 10 points.

Change Assessment

Patient completed a retrospective change assessment to measure change over one year at one-year follow-up that included one item for each SCI-FI/AT domain using a 5-point rating scale (0=not applicable; 1=got a lot worse; 2=got a little worse; 3=stayed the same; 4=got a little better; 5=got a lot better).

Data Collection Procedures

Data collectors attended a 1.5-hour web-based training session, successfully completed a certification program and participated in bimonthly conference calls through the duration of the project. Study participants consented to the study after verification of eligibility criteria and were then interviewed by a trained data collector. Data collection was completed via in-person or phone interviews using a custom-designed SCI-FI/AT CAT desktop program that included the SRFM. In keeping with the established SCIMS protocol, baseline assessments were collected within 6 days of discharge from rehabilitation and follow-up data were collected during a 6–12 month window based on the date of injury.

Statistical Analysis

Chi-square and T-tests assessed differences in demographic variables. Differences in baseline SCI-FI/AT scores for those who completed follow-up vs. those who did not follow-up were examined using Wilcoxon rank sum tests. Proportions were calculated to demonstrate the number of participants who reported that they had improved function, measured by the retrospective change assessment at follow-up. All further analyses were performed for the sample with complete longitudinal data.

The mean score with SD and change score with SD were calculated for SCI-FI/AT domains, SRFM, and FIM™ for all participants. For each measure, we calculated the effect size (ES) with the formula: (mean [12-month follow-up] score – mean [baseline] score)/SD of [baseline] score. Bootstrap methods were used to generate five thousand samples from the original data set. The ES from each of those samples were used to calculate the values at the 2.5th and 97.5th percentiles in the distribution, representing the 95% confidence interval (CI) for the ES. We utilized the 95% CI to define significant differences between ES estimates for the SCI-FI/AT, SRFM, and FIM™. If the 95% CI for the difference in ES included zero, the difference was considered non-significant. ES magnitude of effect were classified into three categories described by Cohen: .2 small, .5 medium, and .8 large.²⁰

We calculated the Minimal Detectable Change (MDC_{90}) for each domain of the SCI-FI/AT using the formula: $1.65 \times \text{standard error of measurement} \times 2$. Proportions were calculated to describe the percentage of each sample group that achieved the MDC_{90} for each domain. Previous work has suggested that the MDC_{90} is appropriate for use in trials examining effectiveness of an intervention or measurement.²¹

Results

The sample was predominantly male ($n=125$; 75.8%) and White ($n=120$; 72.7%) (Table 1). Of the original sample of 220, 165 individuals completed follow-up interviews. Reasons for attrition included: site withdrawal, declined follow-up, deceased, and missed follow-up window. No significant demographic or baseline SCI-FI/AT score differences were noted between those who completed the study and those lost to follow-up, except for the ambulation domain for persons with tetraplegia who were completers scored significantly lower ($n=13$, mean=15.92) than non-completers ($n=31$, mean=25.26 points, $p=.0343$).

In basic mobility, 84.6% of the sample reported improvement in function at one-year follow, 87.2% for self-care, 61.7% for fine motor, 60.4% for wheelchair mobility, and 50.3% for ambulation. Figure 1 displays ES point estimates and confidence intervals by domain.

For persons with paraplegia, large ES were noted for basic mobility (.93) and ambulation (1.53). The ES were medium for self-care (.74), the SRFM (.82), and the FIM™ (.72). ES were small for fine motor (.29) and wheelchair (.39).

SCI-FI/AT ES values were medium for persons with tetraplegia for ambulation (.72). ES were small for the SRFM (.44) and FIM™ (.44). ES values were small for SCI-FI/AT basic mobility (.38) and fine motor (.32). The SCI-FI/AT wheelchair domain did not detect significant change during the first year following SCI. Comparisons of ES for the FIM™, SRFM, and SCI-FI/AT did not reveal significant effects.

The MDC_{90} and proportions of individuals with paraplegia and tetraplegia who met the MDC_{90} for each domain of the SCI-FI/AT are displayed in Table 2. The MDC_{90} represents the score that an individual must obtain to demonstrate change that exceeds change associated with measurement error. During the first year following SCI, 54–76% of persons with paraplegia demonstrated change beyond measurement error in basic mobility, self-care, and ambulation. For persons with tetraplegia, 36% of the sample made functional gains in basic mobility, self-care, and fine motor. A larger proportion of persons with tetraplegia made gains in ambulation, possibly due to the large proportion of the sample with incomplete tetraplegia who were ambulatory.

Discussion

The SCI-FI/AT's ability to detect change in function during the first year post SCI was comparable to the motor subscale of the FIM™ and the SRFM. For individuals with paraplegia, the SCI-FI/AT basic mobility, self-care, and ambulation domains detected the greatest change while the fine motor and wheelchair domains detected smaller amounts of change, likely because those with paraplegia usually do not have upper extremity motor

deficits. In fact, 34.2% of the sample with paraplegia had fine motor function scores that were more than 1 (SD) above the mean (score >60).

For individuals with tetraplegia, the FIM™, SRFM, and all SCI-FI/AT domains except wheelchair mobility detected a small amount of change. The SCI-FI/AT wheelchair domain includes manual and power wheelchair items; the small change in wheelchair function detected for persons with tetraplegia and paraplegia may reflect the inclusion of power wheelchair users. Independence in wheelchair mobility is a primary goal for rehabilitation discharge, and therefore may lead to lack of change in wheelchair score at follow-up.

Individuals with SCI exhibit a wide range of abilities across functional domains that reflect the level and severity of their lesions and the time after injury. Although study findings indicate that the sensitivity of the FIM™ and SRFM to detect change is comparable to the SCI-FI/AT in the first-year after SCI discharge, the SCI-FI/AT provides a multidimensional profile of functioning after a SCI and yields scores that are sensitive to change across multiple distinct functional domains. In contrast, FIM™ and SRFM scores do not provide a multi-dimensional picture of functioning after a SCI as they contain a limited number of items that assess each functional domain in one fixed-length instrument. Therefore, the ability to identify domains where change has occurred enhances the clinical relevance of the SCI-FI/AT over that of the FIM™ and SRFM. Most importantly, the SCI-FI/AT addresses activities identified as relevant for individuals with SCI, as items were developed using focus groups of participants with SCI to capture day-to-day activities that go beyond the basic ADL items in the FIM™ and SRFM.² In contrast to fixed-length functional status measures, the SCI-FI/AT provides separate scores for basic mobility, fine motor, self-care, ambulation, and wheelchair domains.

SCI-FI/AT scores provide rehabilitation clinicians with a multidimensional profile of functional status after SCI. The CAT-produced scores provide a precise measurement of function derived from a breadth of functional abilities that span a continuum of difficulty. These scores allow clinicians to pinpoint areas of functional limitation after SCI and allow tailoring of interventions, services, and AT to maximize function.

Study Limitations

Loss to follow-up resulted in a reduced sample size for some functional domains. Some cases were missing follow-up data for FIM™ scores from the SCIMS database, further decreasing the sample. Due to sample limitations, analyses could not be performed stratified by ASIA category. Important differences may exist in the sensitivity of the SCI-FI/AT when examined by ASIA category. Future studies should investigate the magnitude of differences. FIM™ follow-up scores in the SCIMS database were patient-reported rather than observer rated, which may have affected ES values, but no more than SCI-FI/AT scores. Additionally, some cases were not collected within the follow-up window for SCI-FI AT data collection and administration of the FIM™ (n=4, 2.4%). Differences in timing may affect comparisons between the FIM™ and SRFM values and other measures. Finally, this study does not establish whether functional change measured by the SCI-FI/AT, FIM, or SRFM were clinically meaningful, due to homogeneity of responses on the retrospective change

assessment provided at follow-up. Difficulty in establishing MCID for measures used for persons with SCI is a problem in previous work.⁵

Conclusions

The SCI-FI/AT provides improved measurement of specific functional domains following SCI. The ability to identify specific domains where functional change has occurred is critical for clinical and research applications. Notably, rehabilitation clinicians may decide to administer the SCI-FI/C to assess underlying capacity, the SCI-FI/AT to assess function using AT, or both.

Acknowledgments

This work was supported in part by grants funding the Spinal Cord Injury Model System (Grant #: 90SI5015-01-00, 90SI5026, 90SI5012, 90SI5009, 90SI5014, 90SI5000, & 90SI5021-01-00) and by a Promotion of Doctoral Studies (PODS) – Level I Scholarship from the Foundation for Physical Therapy.

Funding Sources:

Rocky Mountain Regional Spinal Injury System: 90SI5015-01-00

Northern New Jersey Spinal Cord Injury System: 90SI5026

Regional Spinal Cord Injury Center of the Delaware Valley: 90SI5012

Midwest Regional SCI Model System: 90SI5009

University of Pittsburgh Model Center on Spinal Cord Injury: 90SI5014

University of Michigan Model Center on Spinal Cord Injury: 90SI5000

Spaulding New England Regional Spinal Cord Injury Center: 90SI5021-01-00

Abbreviations

AIS	ASIA Impairment Scale
AT	Assistive Technology
CAT	Computerized Adaptive Test
CI	Confidence Interval
ES	Effect Size
FIM	Functional Independence Measure
ICC	Intraclass Correlation Coefficient
ICF	International Classification of Functioning, Disability, and Health
MDC	Minimal Detectable Change
QIF	Quadriplegic Index of Function
SRFM	Self-Reported Functional Measure

SCIM	Spinal Cord Independence Measure
SCI	Spinal Cord Injury
SCI-FI	Spinal Cord Injury-Functional Index
SCI-FI/AT	Spinal Cord Injury-Functional Index/Assistive Technology
SCIMS	Spinal Cord Injury Model System

References

1. Slavin MD, Kisala P, Jette AM, Tulskey D. Developing a contemporary functional outcome measure for spinal cord injury research. *Spinal Cord*. 2010; 48:262–267. [PubMed: 19841635]
2. Jette AM, Slavin MD, Ni P, et al. Development and initial evaluation of the SCI-FI/AT. *The Journal of Spinal Cord Medicine*. 2015; 38(3):409–418. [PubMed: 26010975]
3. Jette AM, Tulskey D, Ni P, et al. Development and initial evaluation of the spinal cord injury-functional index. *Archives of Physical Medicine and Rehabilitation*. 2012; 93:1735–1750.
4. Tulskey D, Kisala P, Victorson D, et al. Overview of the spinal cord injury--quality of life (SCI-QOL) measurement system. *The Journal of Spinal Cord Medicine*. 2015; 38(3):257–269. [PubMed: 26010962]
5. Wu X, Liu J, Tanadini L, et al. Challenges for defining minimal clinically important difference (MCID) after spinal cord injury. *Spinal Cord*. 2015; 53:84–91. [PubMed: 25510192]
6. Hall KM, Cohen ME, Wright J, Call M, Werner P. Characteristics of the functional independence measure in traumatic spinal cord injury. *Archives of Physical Medicine and Rehabilitation*. 1999; 80:1471–1476. [PubMed: 10569443]
7. Tooth L, McKenna K, Geraghty T. Rehabilitation outcomes in traumatic spinal cord injury in australia: Functional status, length of stay and discharge setting. *Spinal Cord*. 2003; 41:220–230. [PubMed: 12669086]
8. Catz A, Izkovich M, Tesio L, et al. A multicenter international study on the spinal cord independence measure, version III: Rasch psychometric validation. *Spinal Cord*. 2007; 45:275–291. [PubMed: 16909143]
9. Cook KF, O'Malley KJ, Roddey TS. Dynamic assessment of health outcomes: Time to let the CAT out of the bag? *Health Services Research Journal*. 2005; 40(S pt 2):1694–1711.
10. Slavin MD, Ni P, Tulskey D, et al. Spinal cord injury-functional index/assistive technology short forms. *Archives of Physical Medicine and Rehabilitation*. 2016 epub ahead of print.
11. Tao W, Haley SM, Coster WJ, Ni P, Jette AM. An exploratory analysis of functional staging using an item response theory approach. *Archives of Physical Medicine and Rehabilitation*. 2008; 89(6): 1046–1053. [PubMed: 18503798]
12. Lai J, Cella D, Choi S, et al. How item banks and their application can influence measurement practice in rehabilitation medicine: A PROMIS fatigue item bank example. *Archives of Physical Medicine and Rehabilitation*. 2011; 92(100):S20–S27. [PubMed: 21958919]
13. Haley SM, Siebens H, Black-Schaffer RM, et al. Computerized adaptive testing for follow-up after discharge from inpatient rehabilitation: II. participation outcomes. *Archives of Physical Medicine and Rehabilitation*. 2008; 89(2):275–283. [PubMed: 18226651]
14. Chaves E, Boninger M, Cooper R, Fitzgerald S, Gray D, Cooper R. Assessing the influence of wheelchair technology on perception of participation in spinal cord injury. *Archives of Physical Medicine and Rehabilitation*. 2004; 85:1854–1858. [PubMed: 15520981]
15. Marino R, Huang M, Knight P, Herbison G, Ditunno J, Segal M. Assessing selfcare status in quadriplegia: Comparison of the quadriplegia index of function (QIF) and the functional independence measure (FIM). *Paraplegia*. 1993; 31:225–233. [PubMed: 8493037]
16. Rust K, Smith R. Assistive technology in the measurement of rehabilitation and health outcomes. *American Journal Physical Medicine and Rehabilitation*. 2005; 84(10):780–793.

17. Tulskey D, Jette A, Kisala P, et al. Spinal cord injury functional index: Item banks to measure physical functioning in individuals with spinal cord injury. *Archives of Physical Medicine and Rehabilitation*. 2012; 93(10):1722–1732. [PubMed: 22609299]
18. Spinal Cord Injury Research Evidence Professional. [Accessed August 11, 2017] American spinal injury association impairment scale (AIS): International standards for neurological classification of spinal cord injury (ISNCSCI). <https://scireproject.com/outcome-measures/outcome-measure-tool/american-spinal-injury-association-impairment-scale-ais-international-standards-for-neurological-classification-of-spinal-cord-injury/#1467983894080-2c29ca8d-88af>. Updated 2016
19. Hoenig H, McIntyre L, Sloane R, Branch L, Truncali A, Horner R. The reliability of a self-reported measure of disease, impairment, and function in persons with spinal cord dysfunction. *Archives of Physical Medicine and Rehabilitation*. 1998; 79:378–387. [PubMed: 9552102]
20. Cohen J. *Statistical power analysis for the behavior sciences*. Routledge; 1988.
21. Donoghue D, Stokes E. How much change is true change? the minimum detectable change of the BERG balance scale in elderly people. *Journal of Rehabilitation Medicine*. 2009(41):343–346.

Figure 1.

Table 1

Demographic Characteristics of the Sample

	Baseline (n=220)		Follow-Up (n=165)	
	Paraplegia	Tetraplegia	Paraplegia	Tetraplegia
Days at Rehabilitation, Mean (SD)	50.8 (23.3)	73.9 (72.7)	53.75 (23.8)	74.4 (71.4)
Age (years), Mean (SD)	41.4 (16.7)	47.7 (18.1)	40.5 (16.6)	46.4 (18.9)
FIM Score at D/C from Rehabilitation Mean (SD)	64.2 (14.0)	44.6 (23.0)	63.4 (15.0)	43.8 (22.6)
Ambulatory n (%)	29 (30%)	45 (37%)	18 (24%)	32 (36%)
Manual Wheelchair n (%)	79 (81%)	46 (37%)	61 (80%)	33 (37%)
Power Wheelchair n (%)	14 (14%)	70 (57%)	11 (14%)	52 (58%)
Male n (%)	73 (80%)	90 (79%)	57 (79%)	68 (79%)
Race				
White	66 (73%)	89 (78%)	51 (71%)	69 (80%)
African American	18 (20%)	17 (15%)	14 (19%)	13 (15%)
Other	7 (7%)	8 (7%)	7 (10%)	4 (5%)
Severity of Injury n (%)				
Complete	42 (47%)	39 (35%)	36 (50%)	31 (36%)
Incomplete	47 (53%)	71 (65%)	36 (50%)	55 (64%)

Table 2

Summary of Baseline and Follow Up Scores by SCI-FI/AT Domain

	n (baseline/follow up)	Baseline Score		Follow-Up Score		MDC ₉₀	% Achieved MDC ₉₀
		Mean (SD)	Score Range	Mean (SD)	Score Range		
Paraplegia							
Basic Mobility	76/76	53.1 (6.4)	30.4–66.3	59.0 (7.9)	44.1–75.0	4.6	54%
Self-Care	76/75	56.6 (7.6)	23.6–69.3	61.9 (6.8)	39.9–69.8	4.9	56%
Fine Motor	76/75	55.9 (7.3)	20.0–62.6	58.1 (4.9)	43.6–64.4	7.8	17%
Ambulation	17/36	59.1 (5.0)	49.0–68.0	63.1 (8.4)	50.9–83.1	3.6	76%
Wheelchair	54/56	54.2 (6.7)	28.0–73.0	56.6 (6.7)	39.6–73.3	4.8	38%
Tetraplegia							
Basic Mobility	89/89	47.3 (10.8)	21.2–73.4	51.4 (11.4)	21.2–75.0	5.2	36%
Self-Care	89/88	45.7 (11.5)	6.4–69.4	49.7 (13.3)	6.37–70.2	5.2	36%
Fine Motor	89/88	40.6 (10.1)	17.8–59.0	43.9 (10.5)	17.8–64.4	4.8	36%
Ambulation	31/43	61.4 (4.2)	52.5–68.8	63.6 (6.0)	54.5–83.1	3.0	47%
Wheelchair	77/54	44.9 (7.9)	22.6–66.7	43.7 (8.8)	13.2–59.8	5.9	20%