

ORIGINAL ARTICLE

Using the Spinal Cord Independence Measure III to measure functional recovery in a post-acute spinal cord injury program

P Ackerman¹, SA Morrison², S McDowell³ and L Vazquez⁴

¹Shepherd Center Day Program, Atlanta, GA, USA; ²Shepherd Center Spinal Cord Injury Program, Atlanta, GA, USA; ³Shepherd Center Inpatient Program, Atlanta, GA, USA and ⁴Shepherd Center Marcus Community Bridge Program, Atlanta, GA, USA

Study design: A prospective design was conducted using admission and discharge Spinal Cord Independence Measure III (SCIM-III) data for persons discharged from a post-acute rehabilitation program.

Objective: The purpose of this study is to analyze the functional gains as measured by the SCIM-III that occur during a post-acute rehabilitation program.

Setting: Shepherd Center, Atlanta, GA, USA.

Methods: Participants were included if they had a motor complete spinal cord injury (SCI), were within 12 months from the date of injury and completed the recommended length of stay. Median SCIM-III changes between admission and discharge were calculated by subgroups (C1–4, C5, C6, C7–8, T1–6 and T7–12) based on the American Spinal Injury Association motor injury levels. Ceiling and floor effects were examined by item and the percentage of participants showing change between admission and discharge were calculated.

Results: In all, 114 participants were included in the analysis. The median total SCIM-III score at admission was 42 (range 13–68), whereas the median total SCIM-III score at discharge was 50 (range 16–72). The median improvement of 5 points in total SCIM-III score between admission and discharge was statistically significant. Significant improvements were also observed between admission and discharge across all subgroups except C1–4. Ceiling and floor effects were noted in some subgroups.

Conclusions: The SCIM-III seems to be an effective measure for functional assessment of persons with SCI in a post-acute rehabilitation program. There are some ceiling and floor effects noted; however, the SCIM-III seems to be sensitive enough to capture functional changes during a post-acute rehabilitation program.

Spinal Cord (2010) 48, 380–387; doi:10.1038/sc.2009.140; published online 3 November 2009

Keywords: spinal cord injury; recovery of function; post-acute rehabilitation; SCIM; day program

Introduction

As researchers and clinicians discover methods to restore functional recovery in individuals with a spinal cord injury (SCI), it is important to develop reliable and sensitive measures for validating functional recovery. There is also an increasing need to have sensitive outcome measures to detect change over a shorter period of time and across various continuums of care due to the decreasing lengths of rehabilitation stay in the United States from 115 days in 1974 to 36 days in 2005.¹

The Spinal Cord Independence Measure (SCIM) has been designed specifically for individuals with SCI and measures the ability of performing routine daily tasks.² Three versions of the SCIM have been developed since 1997.³ The SCIM-III

has been shown to be a valid, reliable and efficient measure for functional assessment of individuals with SCI.^{2–5} The SCIM-III consists of three subscales: self-care (scores between 0 and 20), respiration and sphincter management (scores between 0 and 40), and mobility (scores between 0 and 40). These subscales are subdivided into 19 tasks. Each task score is weighted according to the clinical relevance with respect to the overall activity of individuals with SCI. The maximal attainable total score of the SCIM-III is 100 points with higher scores indicating more independence (Table 1).

Shortened length of in-patient rehabilitation stays has generated a need for increased therapeutic services after discharge. The 'day program' concept has emerged to meet this demand. Day program (DP) is defined as an outpatient program for individuals who are medically stable, do not require skilled nursing services during the night, tolerate a minimum of 3 hours of therapy per day and need a coordinated approach for two or more services. Services

Correspondence: SA Morrison, Shepherd Center, 2020 Peachtree Road, NW, Atlanta, GA 30309, USA.

E-mail: sarah_morrison@shepherd.org

Received 19 August 2009; revised 15 September 2009; accepted 20 September 2009; published online 3 November 2009

Table 1 Subitems and maximal scores of the SCIM-III

Area	Subitem	Maximal score
Self-care	Feeding	3
	Bathing upper body	3
	Bathing lower body	3
	Dressing upper body	4
	Dressing lower body	4
	Grooming	3
Total score of area		20
Respiration and sphincter management	Respiration	10
	Bladder management	15
	Bowel management	10
Total score of area	Use of toilet	5
		40
		40
Mobility	Bed mobility	6
	Transfer bed–wheelchair	2
	Transfer wheelchair–toilet–tub	2
	Mobility indoors	8
	Mobility for moderate distances (10–100 m)	8
	Mobility outdoors (> 100 m)	8
	Stair management	3
	Transfer wheelchair–car	2
	Transfer wheelchair–ground	1
Total score of area		40
Total score of SCIM-III		100

Abbreviation: m, meters, SCIM-III: Spinal Cord Independence Measure III.

may include physical therapy, occupational therapy, therapeutic recreation, nursing, counseling or speech therapy.⁶

The aims of this study are (1) to evaluate functional change, as measured by the SCIM-III during DP, in individuals with a motor complete SCI, (2) identify SCIM-III floor or ceiling effects and (3) assess perceptions of clinical staff to the overall ease of use and sensitivity of the SCIM-III.

Methods

Participant selection

A prospective study design was conducted using data from individuals with SCI discharged from a DP between March 2007 and June 2008. The DP participants were included if they had an SCI, were within ≤ 12 months from the date of injury, American Spinal Injury Association (ASIA) Impairment Scale A or B and completed the recommended length of stay. Participants were excluded if they had a brain injury with a resultant Rancho Los Amigos level of ≤ 7 on admission or < 12 years of age. If participants had multiple admissions during the study time frame, only the first program admission was included.

A total of 341 admissions occurred during the study time frame and 114 were included in the analysis. In all, 53% of admissions (180) did not meet the inclusion criteria. Of the 161 individuals that met the inclusion criteria, 47 were excluded because of multiple program admissions (35), incomplete SCIM-III data (5) or ASIA data (7).

SCIM-III

The SCIM-III was administered by occupational therapists, physical therapists, and nursing staff on admission and discharge. Each discipline assessed, by observation, specific SCIM-III items in which they had the most expertise: occupational therapy scored feeding, bathing, dressing, grooming, sphincter management, and use of toilet; nurses scored respiration, as well as collaborated with occupational therapy in regard to sphincter management; and physical therapy scored all mobility components.

International standards for neurological classification of SCI

The ASIA International Standards for Neurological Classification of Spinal Cord Injury examination was administered by trained therapists and all data used for this study were independently validated. The overall motor neurological level determined the aggregate groups.

Questionnaire

A questionnaire was developed to collect process-centered data, including barriers to implementation, staff compliance, repeat training requirements, and process modifications. Data were collected regarding staff satisfaction with using the tool. We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

Data analysis

Data were analyzed using the SPSS version 15.0 for Windows statistical package (SPSS Inc., Chicago, IL, USA). The median SCIM-III change between admission and discharge from DP was calculated and summarized by subgroups based on ASIA motor injury levels. The following subgroups were defined: C1–3, C4, C5, C6, C7–8, T1–6, T7–12 and L1–S1. Subgroups C1–3 and C4 were combined for the analysis because of a small participant number. The L1–S1 subgroup was not used as there were no participants in this subgroup.

The ceiling and floor effects were examined by item, and the percentage of individuals scoring the minimum at discharge (floor effect) and maximum at admission (ceiling effect) was calculated. The DP length of stay was estimated by calculating the number of workdays between admission and discharge. This calculation excludes weekends but does not take into account holidays.

The Wilcoxon signed-rank test was used to examine the statistical significance of the median change observed by injury level. A two-sided *P*-value < 0.05 was defined as statistically significant.

Results

Participant description and injury characteristics

Participant demographics are presented in Table 2. The majority of individuals were male (81%). The most common ASIA Impairment Scale (AIS) was A (80%) and the most common level of impairment was T1–6 (33%).

Table 2 Demographic and injury characteristics of sample

Characteristic	n	
Age at admission in years (median and range)	25	12–64
Time after injury in days (median and range)	98.5	39–337
Sex		
Male	92	81%
Female	22	19%
Level of impairment		
C1–4	13	11%
C5	16	14%
C6	18	16%
C7–8	12	11%
T1–6	38	33%
T7–12	17	15%
L1–S1	0	0%
ASIA impairment scale		
A	91	80%
B	23	20%

Abbreviations: ASIA, American Spinal Injury Association; *n*, number of participants.

Table 3 The SCIM-III median total scores and change by ASIA motor neurological level

Lowest motor neurological level	n	LOS (days)	Admission total SCIM-III	Discharge total SCIM-III	SCIM-III change	Two-sided adjusted <i>P</i> -value*
C1–4	13	11	19.0	19.0	0.0	0.188
C5	16	18.5	21.5	23.5	3.0	0.001
C6	18	25	25.5	34.5	9.0	0.000
C7–8	12	23	39.5	50.0	7.0	0.003
T1–6	38	15	53.5	63.0	5.5	0.000
T7–12	17	13	61.0	66.0	6.0	0.000
All subgroups	114	17	42.0	50.0	5.0	0.000

Abbreviations: ASIA, American Spinal Injury Association; LOS, length of stay; *n*, number of participants; SCIM-III, Spinal Cord Independence Measure III.

**P*-values are exact two-tailed and were calculated based on the Wilcoxon signed-rank test. *P*-values were adjusted for multiple testing using a Bonferroni correction (*P*-values were multiplied by 6 (number of subgroups) and considered significant if *P*-value is < 0.05).

Total SCIM-III scores and changes

Both admission and discharge total SCIM-III scores increased with improved motor levels. All subgroups showed statistically significant, positive changes except C1–4 (see Table 3). The largest changes were observed in the C6 (9 points) and C7–8 (7 points) subgroups, whereas the smallest change was observed in the C1–4 and C5 subgroups (0 points and 3 points).

Self-care subscale median scores are presented in Table 4. Total median score changes were observed in all subgroups except C1–4 and T7–12. Increases in lower body dressing (C7–8, T1–6) and grooming (C6) were observed. Ceiling effects ($\geq 50\%$ of participants scoring maximum at admission) were observed in feeding and grooming (T1–6, T7–12), and floor effects ($\geq 50\%$ of participants scoring minimum at discharge) were observed in the C1–4 subgroup for all items

Table 4 The SCIM-III Self-care subscale median, ceiling and floor effects by ASIA motor neurological level

Subitem	Possible score range	C1–4	C5	C6	C7–8	T1–6	T7–12
Number of participants	N/A	13	16	18	12	38	17
Feeding							
Admission	0–3	0	1	1	2	3	3
Discharge	0–3	0	1	2	2	3	3
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	0	0	17	100	100
Percentage at floor	N/A	62	0	0	0	0	0
Bathing upper body							
Admission	0–3	0	0	1	2	2	2
Discharge	0–3	0	0.5	1	2	2	2
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	0	0	0	0	0
Percentage at floor	N/A	85	50	6	0	0	0
Bathing lower body							
Admission	0–3	0	0	0	1	2	2
Discharge	0–3	0	0	1	1	2	2
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	0	0	0	0	0
Percentage at floor	N/A	85	81	22	0	0	0
Dressing upper body							
Admission	0–4	0	0.5	1	2	2	2
Discharge	0–4	0	1	1	2	2	4
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	0	0	0	21	47
Percentage at floor	N/A	85	44	0	0	0	0
Dressing lower body							
Admission	0–4	0	0	0	1	1.5	2
Discharge	0–4	0	0	1	2	2	2
Change	N/A	0	0	0	1	0.5	0
Percentage at ceiling	N/A	0	0	0	0	5	0
Percentage at floor	N/A	100	88	39	8	0	0
Grooming							
Admission	0–3	0	1	1	2	3	3
Discharge	0–3	0	1	2	2	3	3
Change	N/A	0	0	0.5	0	0	0
Percentage at ceiling	N/A	0	0	0	25	92	88
Percentage at floor	N/A	69	0	0	0	0	0
Self-care subscale							
Admission	0–20	0	2.5	5	9.5	14	14
Discharge	0–20	0	3.5	8	11.5	14	15
Change	N/A	0	1	2	1.5	1	0
Percentage at ceiling	N/A	0	0	0	0	0	0
Percentage at floor	N/A	62	0	0	0	0	0

Abbreviations: ASIA, American Spinal Injury Association; N/A, not applicable; SCIM-III, Spinal Cord Independence Measure III.

and the subscale total, and in upper and lower body bathing and lower body dressing in the C5 subgroup.

The respiration and sphincter management subscale median scores are presented in Table 5. Total median score changes were observed (T1–6, T7–12). Ceiling effects were observed in respiration in all subgroups except C1–4 and floor effects were observed in use of toilet (C1–4, C5, C6).

Mobility subscale median scores are presented in Table 6. Total median score changes were observed in all subgroups

Table 5 The SCIM-III respiration and sphincter management subscale median, ceiling and floor effects by ASIA motor neurological level

Subitem	Possible score range	C1-4	C5	C6	C7-8	T1-6	T7-12
Number of participants	N/A	13	16	18	12	38	17
Respiration							
Admission	0-10	8	10	10	10	10	10
Discharge	0-10	8	10	10	10	10	10
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	75	94	100	100	100
Percentage at floor	N/A	0	0	0	0	0	0
Bladder management							
Admission	0-15	3	3	3	3	11	11
Discharge	0-15	3	3	3	4.5	11	11
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	0	0	0	0	0
Percentage at floor	N/A	31	25	17	25	3	0
Bowel management							
Admission	0-10	5	5	5	5	6.5	8
Discharge	0-10	5	5	5	5	8	8
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	0	0	0	5	24
Percentage at floor	N/A	0	6	6	0	0	6
Use of toilet							
Admission	0-5	0	0	0	0	2	4
Discharge	0-5	0	0	0	1	4	4
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	0	0	0	0	0
Percentage at floor	N/A	92	94	67	33	5	0
Respiration and sphincter management subscale							
Admission	0-40	16	16	18	20	27.5	31
Discharge	0-40	16	16	18.5	21.5	31	33
Change	N/A	0	0	0	0	2	2
Percentage at ceiling	N/A	0	0	0	0	0	0
Percentage at floor	N/A	0	0	0	0	0	0

Abbreviations: ASIA, American Spinal Injury Association; N/A, not applicable; SCIM-III, Spinal Cord Independence Measure III.

except C1-4. Increases in bed mobility (C6, C7-8, T1-6), bed/wheelchair transfers (C6) and stair management (T7-12) were observed. Ceiling effects were observed in bed mobility (T7-12) and floor effects were observed in bed mobility, bed/wheelchair transfers, toilet/tub transfers and car (C1-4, C5), stair management (all subgroups except T7-12) and ground transfers (all subgroups). A summary of floor/ceiling effects and median changes is presented in Table 7.

The frequencies of item level changes are presented in Table 8. Changes were observed for $\geq 50\%$ patients in lower body dressing (C7-8, T1-6), grooming (C6), bed mobility (C6, C7-8, T1-6), bed wheelchair transfers (C6), and stair management (T7-12). No changes were observed across all subgroups in Respiration. Other items with no changes for three or more subgroups included mobility indoors (C7-8, T1-6, T7-12), stair management (C1-4, C5, C6) and ground wheelchair transfers (C1-4, C5, C6).

The presence of comorbidities and complications were identified that may have affected the level of independence individuals achieved. The frequency of these complications is summarized in Table 9.

Staff questionnaire

Results of the staff questionnaire ($n=7$) revealed the following:

1. All respondents reported learning the SCIM-III as 'easy' to 'extremely easy'.
2. Five respondents reported that determining a score was 'easy' to 'extremely easy' with the most difficult items to score being outdoor mobility and bowel and bladder management.
3. Three respondents perceived the tool-captured progress.
4. All respondents reported a perceived floor or ceiling effect.
5. The staff noted that the skill descriptions are not complete, leading to less scoring clarity.
6. Partial assistance for mobility with a power system cannot be captured.
7. There is no scoring benefit for those individuals who self-direct their care.

Discussion

Results of this study confirm that the SCIM-III can yield clinically useful information regarding the functional changes that occur during DP for individuals after an SCI. Although median score changes were not observed for all items, significant total score changes were evident in all groups except for C1-4 and follow a somewhat predictable pattern.⁸ When reviewing data per level of injury for each skill, the overall change seemed to be clinically relevant in various skills for all levels except C1-4. Overall, the changes observed after treatment were similar to those described by Wirth *et al.*⁷

Specific to the C1-4 participants, a floor effect was observed for 13 of the 19 skills. The only skills that did not show a floor effect included respiration, bladder/bowel management and the wheelchair mobility skills. These data are not surprising as these individuals have limited mobility skill potential. One might expect a change in function for the C1-4 subgroup in the area of respiration; however, a change was not identified, presumably because they already reached their maximum potential by the time they were discharged from in-patient. Those individuals, who have not yet weaned from a ventilator or tracheostomy tube, were not expected to do so.

Individuals with a C5 SCI had a median gain of 3.0 in their total SCIM-III score. The most responsive items were feeding (44%) and grooming (44%). Both skills are a common focus for activities of daily living goals and this change was expected. Other responsive items were bed mobility (31%) and bed/wheelchair transfers (31%). Bed mobility skills require more strength and it is expected that participants would not routinely achieve independence with this skill at the time of discharge. On further analysis for bed to wheelchair transfers, the change seems to occur moving from 'requiring total assist' to 'requiring partial assistance'. Most participants are not expected to be independent with this skill. As with the C1-4 subgroup, the C5 subgroup has limited upper extremity capability and showed a floor effect for skills that require stronger upper extremity musculature to perform.

Table 6 The SCIM-III Mobility subscale median, ceiling and floor effects by ASIA motor neurological level

Subitem	Possible score range	C1-4	C5	C6	C7-8	T1-6	T7-12
Number of participants	N/A	13	16	18	12	38	17
<i>Bed mobility</i>							
Admission	0-6	0	0	0	3	4	6
Discharge	0-6	0	0	2	6	6	6
Change	N/A	0	0	2	2	1	0
Percentage at ceiling	N/A	0	0	0	25	39	65
Percentage at floor	N/A	85	63	17	0	0	0
<i>Bed wheelchair transfers</i>							
Admission	0-2	0	0	0	1	1	1
Discharge	0-2	0	0	1	1	1.5	2
Change	N/A	0	0	1	0	0	0
Percentage at ceiling	N/A	0	0	0	8	8	29
Percentage at floor	N/A	100	69	22	0	0	0
<i>Wheelchair toilet/tub transfers</i>							
Admission	0-2	0	0	0	1	1	1
Discharge	0-2	0	0	1	1	1	1
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	0	0	0	3	18
Percentage at floor	N/A	100	88	44	8	3	0
<i>Mobility indoors</i>							
Admission	0-8	1	1	1	2	2	2
Discharge	0-8	1	1	1.5	2	2	2
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	0	0	0	0	0
Percentage at floor	N/A	8	0	0	0	0	0
<i>Mobility moderate distances</i>							
Admission	0-8	1	1	1	2	2	2
Discharge	0-8	1	1	1	2	2	2
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	0	0	0	0	0
Percentage at floor	N/A	8	0	0	0	0	0
<i>Mobility outdoors</i>							
Admission	0-8	1	1	1	1.5	2	2
Discharge	0-8	1	1	1	2	2	2
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	0	0	0	0	0
Percentage at floor	N/A	8	0	0	0	0	0
<i>Stair management</i>							
Admission	0-3	0	0	0	0	0	0
Discharge	0-3	0	0	0	0	0.5	1
Change	N/A	0	0	0	0	0	1
Percentage at ceiling	N/A	0	0	0	0	0	0
Percentage at floor	N/A	100	100	100	67	50	35
<i>Wheelchair car transfers</i>							
Admission	0-2	0	0	0	0.5	1	1
Discharge	0-2	0	0	1	1.0	1	1
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	0	0	0	0	12
Percentage at floor	N/A	100	88	44	8	0	6
<i>Ground wheelchair transfers</i>							
Admission	0-1	0	0	0	0	0	0
Discharge	0-1	0	0	0	0	0	0
Change	N/A	0	0	0	0	0	0
Percentage at ceiling	N/A	0	0	0	0	0	12
Percentage at floor	N/A	100	100	100	92	92	53

Table 6 Continued

Subitem	Possible score range	C1-4	C5	C6	C7-8	T1-6	T7-12
<i>Mobility subscale</i>							
Admission	0-40	3	3	3.5	11	13	15
Discharge	0-40	3	3	8.5	14	16	17
Change	N/A	0	0.5	4.0	3	3	2
Percentage at ceiling	N/A	0	0	0	0	0	0
Percentage at floor	N/A	8	0	0	0	0	0

Abbreviations: ASIA, American Spinal Injury Association; N/A, not applicable; SCIM-III, Spinal Cord Independence Measure III.

The greatest overall median changes were noted among the C6 and the C7-8 subgroups (9.0 and 7.0, respectively). Individuals in the C6 subgroup seemed to have the greatest individual change in lower body bathing (44%), grooming (50%), bed mobility (72%) and bed to wheelchair transfers (56%). For these participants, strength in the upper extremities remains significantly impaired at the onset of DP, but may show significant improvements over time enhancing outcomes. In the respiratory and sphincter section, improvements were expected in the area of bladder management; however, these changes were not realized in the DP environment. On further analysis, it was noted that 3 out of 18 in the C6 group had suprapubic catheters, and although individual changes were noted, this is believed to have affected the overall median score. Individuals in the C7-8 group showed a median increase of 7.0 in the SCIM-III score. The most significant changes were observed in lower body dressing (58%) and bed mobility (67%). This group showed little changes in mobility scores, which may reflect a sensitivity limitation when using the SCIM-III with only motor complete injuries, as a score of ≥ 3 (walking) is not likely. One would also expect that persons with a C7-8 SCI would function more independently than the other levels of tetraplegia as they have more fully innervated musculature. The lengths of stay for C6 (25 days) and C7-8 subgroups (23 days) were longer than that for other subgroups and this could have been an important factor regarding functional improvements, given they had more treatment sessions to improve on their skill acquisition.

Ceiling effects for the T1-6 and T7-12 subgroups for the self care items were expected because of their fully functioning upper extremities. In the subscale of respiration and sphincter management, individuals with paraplegia achieved the highest score possible on the respiration item. The change of 2 points in the SCIM-III for the respiration and sphincter management subscale can be attributed most to the bowel management and use of toilet tasks. The maximum change can be seen in the mobility subscale in which individuals with T1-6 showed a change of 3 points and the T7-12 showed a change of 2 points. The tasks mastered most often were bed mobility and bed transfers, whereas the skills least likely to change were indoor, outdoor and moderate distance mobility skills. As all participants were motor complete, there is limited potential in the mobility skills to be measured using this tool. In addition,

Table 7 Summary of floor/ceiling effect and median change

SCIM-III Subgroup	SCIM-III Item	C1-4	C5	C6	C7-C8	T1-6	T7-12
Self Care	Feeding	■				■	■
	Bathing Upper Body	■	■				
	Bathing Lower Body	■	■				
	Dressing Upper Body	■					
	Dressing Lower Body	■	■		1.0	0.5	
	Grooming	■		0.5		■	■
	Median Change		1.0	2.0	1.5	1.0	
Respiration and Sphincter Management	Respiration		■	■	■	■	■
	Bladder Management						
	Bowel Management						
	Use of Toilet	■	■	■			
	Median Change					2.0	2.0
Mobility	Bed Mobility	■	■	2.0	2.0	1.0	■
	Transfer Bed-Wheelchair	■	■	1.0			
	Transfer Wheelchair-Toilet-Tub	■	■				
	Mobility Indoors						
	Mobility 10-100 meters						
	Mobility Outdoors (>100m)						
	Stair Management	■	■	■	■	■	1.0
	Transfer Wheelchair -Car	■	■				
	Transfer Wheelchair -Ground	■	■	■	■	■	■
Median Change		0.5	4.0	3.0	3.0	2.0	
Total SCIM-III	Median Change		3.0	9.0	7.0	5.5	6.0

Abbreviation: SCIM-III, Spinal Cord Independence Measure III.

Floor effect ■.

Ceiling effect ■■■■■.

the scoring for ground transfers has fewer scoring options, making this task significantly more difficult to have a change in score.⁸

The results of the staff questionnaire noted many advantages of using the SCIM-III for persons admitted to a DP noting ease of use and the seemingly accurate perception that the SCIM-III captures functional change. The identified disadvantages are similar to those as identified by Dawson *et al.*⁹ First, when considering an individual who is dependent on their care, there is no distinction made between an individual who can direct their care versus someone who is unable to direct their care. Although it is recognized that this is a tool to measure the activity level, individuals who experience a high-level cervical injury (C1-4) can be more ‘independent’ in their daily activities because they can seek assistance from more than one or two people. The Quadriplegia Index of Function has successfully incorporated an assessment of the person’s understanding of personal care¹⁰ and the staff perceived that this information would add depth to the SCIM-III assessment. Second, staff also perceived floor effects for scoring some items for persons with high-level tetraplegia (particularly the self-care and mobility items) and ceiling effects for scoring some items for persons with paraplegia (particularly the self-care items).

Dawson *et al.*⁹ identified clustering of extreme values especially for the mobility items.

There are some weaknesses of this study. The overall specific objectives of the services being rendered in DP may bias the scores. Individuals who participate in DP require an intense interdisciplinary program because of the complexity of their needs. Another weakness is the use of a facility-specific electronic medical record. The electronic medical record had a limited number of characters to describe the different levels of independence and the staff had to refer to the full description of the SCIM-III before documenting in the computer.

Conclusions

The SCIM-III is sensitive to changes in individuals with SCI with injury levels between C5 and T12 who participate in a DP. Suggestions for further refinement of the SCIM-III include: (1) add an assessment of the individual’s understanding of personal care, (2) increase levels of independence for the ground-wheelchair transfer and (3) create a training manual for users to reduce questions in regard to some of the definitions of the scale.

Table 8 The SCIM-III changes item based on percentages of individuals who showed change (not median change) and ASIA motor neurological level

Subitem	C1-4	C5	C6	C7-8	T1-6	T7-12
Number of participants	13	16	18	12	38	17
<i>Feeding</i>						
Increase ≥ 1 level (%)	8	44	44	33	0	0
No change (%)	92	56	56	67	100	100
<i>Bathing upper body</i>						
Increase ≥ 1 level (%)	8	12	33	25	5	0
No change (%)	92	88	67	75	95	100
<i>Bathing lower body</i>						
Increase ≥ 1 level (%)	8	0	44	25	26	0
No change (%)	92	100	56	75	74	100
<i>Dressing upper body</i>						
Increase ≥ 1 level (%)	8	6	17	42	8	12
No change (%)	92	94	83	58	92	88
<i>Dressing lower body</i>						
Increase ≥ 1 level (%)	0	6	33	58	50	41
No change (%)	100	94	67	42	50	59
<i>Grooming</i>						
Increase ≥ 1 level (%)	15	44	50	42	5	12
No change (%)	85	56	50	58	95	88
<i>Respiration</i>						
Increase ≥ 1 level (%)	0	0	0	0	0	0
No change (%)	100	100	100	100	100	100
<i>Bladder management</i>						
Increase ≥ 1 level (%)	0	0	22	25	21	18
No change (%)	100	100	78	75	79 ^a	82
<i>Bowel management</i>						
Increase ≥ 1 level (%)	0	6	11	8	34	41
No change (%)	100	94	89	92	66 ^a	59
<i>Use of toilet</i>						
Increase ≥ 1 level (%)	8	0	22	25	45	18
No change (%)	92	100	78	75	55	82
<i>Bed mobility</i>						
Increase ≥ 1 level (%)	15	31	72	67	50	29
No change (%)	85	69	28	33	50	71
<i>Bed wheelchair transfers</i>						
Increase ≥ 1 level (%)	0	31	56	25	42	41
No change (%)	100	69	44	75	58	59
<i>Wheelchair toilet/tub transfers</i>						
Increase ≥ 1 level (%)	0	12	44	25	24	18
No change (%)	100	88	56	75	76	82
<i>Mobility indoors</i>						
Increase ≥ 1 level (%)	15	12	28	0	0	0
No change (%)	85	88	72	100	100	100
<i>Mobility moderate distances</i>						
Increase ≥ 1 level (%)	15	6	28	17	3	0
No change (%)	85	94	72	83	97	100
<i>Mobility outdoors</i>						
Increase ≥ 1 level (%)	8	12	22	8	21	18
No change (%)	92	88	78	92	79	82

Table 8 Continued

Subitem	C1-4	C5	C6	C7-8	T1-6	T7-12
<i>Stair management</i>						
Increase ≥ 1 level (%)	0	0	0	33	45	59
No change (%)	100	100	100	67	55	41
<i>Wheelchair car transfers</i>						
Increase ≥ 1 level (%)	0	6	44	42	21	29
No change (%)	100	94	56	58	79	71
<i>Ground wheelchair transfers</i>						
Increase ≥ 1 level (%)	0	0	0	8	8	35
No change (%)	100	100	100	92	92	65

Abbreviations: ASIA, American Spinal Injury Association; SCIM-III, Spinal Cord Independence Measure III.

^aOne client showed a decrease in score for this item.

Table 9 Frequency of medical complications that may have affected the level of independence for each diagnostic category

Medical complication	C1-4	C5	C6	C7-8	T1-6	T7-12	Total
Pain	0	1	2	2	6	2	13
Skin compromise	0	2	3	2	1	0	8
Suprapubic catheter	0	0	3	4	0	0	7
Spasticity	0	1	1	1	2	1	6
High BMI (>35)	0	1	3	0	2	0	6
UE limitations	0	2	0	0	0	1	3
Other	0	0	4	0	2	0	6

Abbreviations: BMI, body mass index; UE, upper extremity.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgements

We acknowledge that this work was supported by Shepherd Center, Inc.

References

- 1 *Spinal Cord Injury Facts and Figures at a Glance*. University of Alabama, National Spinal Cord Injury Statistical Center. Spinal cord injury facts and figures at a glance. Birmingham, AL, 2008.
- 2 Catz A, Itzkovich M, Steinberg F, Philo O, Ring H, Ronen J *et al*. The Catz-Itzkovich SCIM: a revised version of the Spinal Cord Independence Measure. *Disabil Rehabil* 2001; **23**: 263-268.
- 3 Anderson K, Aito S, Atkins M, Biering-Sørensen F, Charlifue S, Curt A *et al*. Functional recovery measures for spinal cord injury: an evidence-based review for clinical practice and research. *J Spinal Cord Med* 2008; **31**: 133-144.
- 4 Catz A, Itzkovich M, Tesio L, Biering-Sørensen F, Weeks C, Laramie MT *et al*. A multi-center international study on the Spinal Cord Independence Measure, version III: Rasch psychometric validation. *Spinal Cord* 2007; **45**: 275-291.
- 5 Itzkovich M, Gelernter I, Biering-Sørensen F, Weeks C, Laramie MT, Craven BC *et al*. The Spinal Cord Independence Measure (SCIM) version III: reliability and validity in a multi-center international study. *Disabil Rehabil* 2007; **29**: 1926-1933.
- 6 Atrice MB, Morrison SA, McDowell SL, Ackerman PM, Foy TA. Traumatic spinal cord injury. In: Umphred DA (ed). *Neurological Rehabilitation*, 5th edn. Mosby: St Louis, MO, 2007, p 612.

- 7 Wirth B, van Hedel H, Kometer B, Dietz V, Curt A. Changes in activity after a complete spinal cord injury as measured by the Spinal Cord Independence Measure II (SCIM-II). *Neurorehabilitation and Neural Repair* 2008; **22**: 279–287.
- 8 Consortium for Spinal Cord Medicine. *Outcomes Following Traumatic Spinal Cord Injury: Clinical Practice Guidelines For Health-Care Professionals*. Paralyzed Veterans of America: Washington, DC, 1999.
- 9 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.
- 10 Gresham GE, Labi MLC, Dittmar SS, Hicks JT, Joyce SZ, Stehlik MA. The Quadriplegia Index of Function (QIF): sensitivity and reliability demonstrated in a study of thirty quadriplegic patients. *Paraplegia* 1986; **24**: 38–44.