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ORIGINAL ARTICLE

Validity and responsiveness of the spinal cord index of function: an instrument on activity level

C Johansson[1], P Bodin[1] and M Kreuter[1,2]

[1]*The Sahlgrenska University Hospital, Gothenburg, Sweden and* [2]*Department of Neuroscience and Rehabilitation, Sahlgrenska Academy at the University of Gothenburg, Institute of Neuroscience and Physiology, Gothenburg, Sweden*

Objectives: To evaluate the validity and responsiveness of the Spinal Cord Index of Function (SIF), a new instrument on activity level, measuring the ability to perform various transfers in non-walking patients with a spinal cord lesion.
Settings: Spinal Injuries Unit, Sahlgrenska University Hospital, Gothenburg, Sweden.
Methods: Twenty-nine patients with a spinal cord lesion classified as grade A, B or C according to the American Spinal Injury Association/International Medical Society of paraplegia classification were included. Each patient was evaluated from the acute phase until discharge, every second week, by their physiotherapist, according to SIF and the Swedish physiotherapy clinical outcome variables (S-COVS). To determine validity, Spearman's rho correlation coefficient was calculated between the total scores of SIF and S-COVS, and the determination coefficient was calculated. Responsiveness was determined by computing effect sizes.
Results: Spearman's correlation between SIF and S-COVS was 0.933 and the determination coefficient was 0.87. The effect size for SIF was 9.1.
Conclusion: The results of the study prove that SIF is a valid and sensitive instrument, which will be useful for physiotherapists in goal-planning programs and in evaluating progress during a patient's rehabilitation. SIF could also be used in research and in evaluating the patient's functional ability at follow-ups.
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Introduction

The ability to perform basic activities in daily life for a person with a spinal cord lesion (SCL) predicts his/her ability to live independently[1] and has a major correlation with both mental and physical health.[2,3] The instruments used to evaluate functional ability in patients with SCL are the functional independence measure,[4] the quadriplegia index of function[5] and the modified barthel index.[6] There are doubts with regard to the efficiency of the quadriplegia index of function and the modified barthel index in reflecting changes in the function of patients with SCL in terms of validity.[5,7] The functional independence measure was not developed specifically for patients with SCL and has been proven to be insensitive to changes in the functional ability of patients with tetraplegia as a consequence of SCL.[6,7] Another instrument is the spinal cord independence measure.[8] The spinal cord independence measure is reliable and more sensitive to changes than the functional independence measure, but includes several self-care parameters not included in physiotherapy training. The Swedish physiotherapy clinical outcome variables (S-COVS)[9] is an instrument available for physiotherapists that has been tested on geriatric patients and has been shown to be reliable; it has, however, not been tested on patients with SCL. The original instrument, clinical outcome variables, has been shown to be reliable and valid for a group of 120 patients with various diagnoses, wherein 20 patients had SCL.[10]

There is a need for an instrument that has been specifically designed to follow patients' improvements in ability to transfer and to prove the effectiveness of the physiotherapy treatment of patients with SCL. Patients with SCL present a challenge to developing a valid and easier way of measuring activity. Various kinds of transfers need to be covered, as patients with spinal cord lesions have to learn several transfers in order to enhance their independence. For clinical use, there is no instrument on activity level especially developed for patients with SCL that can be used to specifically evaluate their ability to perform various kinds of transfers.

To ensure that an instrument is a useful tool for assessing patients' ability to transfer, the validity and responsiveness

Correspondence: Professor M Kreuter, Department of Neuroscience and Rehabilitation, Sahlgrenska Academy at the University of Gothenburg, Institute of Neuroscience and Physiology, Box 455, SE 405 30 Gothenburg, Sweden.
E-mail: margareta.kreuter@gu.se
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of the instrument have to be known. The purpose of this study was to examine the validity and responsiveness of a new instrument aimed at measuring a patient's ability to perform various transfers taught by the physiotherapist.

Materials and methods

Study group

The study included 29 newly traumatically injured patients with SCL, recruited from the spinal cord unit of the Sahlgrenska University Hospital, Gothenburg, Sweden. Inclusion criteria included a traumatic lesion falling under the American spinal injury association/International Medical Society of Paraplegia[11] classification grade A, B or C. The patients had to understand the Swedish language and follow instructions. Exclusion criteria were cognitive dysfunctions and/or severe mental illness.

The mean age of patients at injury was 42 years. A total of 17 patients had cervical injuries, 5 had thoracic injuries and 7 had injuries in the lumbar part of the spine. In all, 4 women and 25 men were included in the study.

Measurements

Spinal Cord Index of Function (SIF) (see Appendix for details) is a new instrument developed by the authors and physiotherapists with substantial experience in SCL rehabilitation at the Sahlgrenska University Hospital, Gothenburg, and consists of nine parameters: (1) moving legs up in bed; (2) turning to the side; (3) getting into a sitting position; (4) transferring from bed to wheelchair; (5) transferring from wheelchair to bed with a difference in level; (6) transferring from wheelchair to shower chair; (7) transferring from wheelchair to toilet; (8) transferring from floor to wheelchair; and (9) wheelchair manoeuvring. The scores for each item range from 1 to 6. Score 1 means that the patient cannot perform the activity without maximum help. Score 6 means that the patient can perform the activity independently, without supervision and in a safe manner, within a reasonable period of time. The maximum score is 54 points. SIF has been shown to be reliable[12] in a study on 23 patients with SCL. Content validity for SIF can be claimed, as physiotherapists with a substantial experience of working with SCL rehabilitation discussed and agreed upon which transfers should be included in the instrument and how the scores for the various parameters were to be determined.

Procedure

Evaluations were carried out every second week by the attending physiotherapist according to S-COVS and SIF and were continued during rehabilitation, from the acute phase until discharge from the spinal cord unit or until the patient was classified as grade D according to the American spinal injury association /International Medical Society of Paraplegia classification. The evaluations lasted between 8 and 38 weeks (Mean: 19 weeks). Four physiotherapists were involved in evaluating the patients. The instruments were discussed before the evaluations started to ensure that all four physiotherapists interpreted the parameters in the same way.

Statistical method

To determine validity, the correlation between SIF and S-COVS measurements was calculated using Spearman's rho correlation coefficient and the determination coefficient was calculated. Correlation was interpreted using Curriers' criteria: <0.69 indicating poor, 0.70–0.79 indicating fair, 0.80–0.89 indicating good and 0.90–0.99 indicating high.[13]

Responsiveness was determined by computing effect sizes, interpreted using Cohen's arbitrary criteria: 0.2 indicating small, 0.5 indicating moderate and 0.8 indicating large.[14] All statistical analyses were carried out using computer software Statistical Package for Social Sciences for Windows (version 16:1) and P values <0.01 were considered statistically significant.

Results

The result of Spearman's rho correlation between the scores of SIF and the scores of S-COVS was 0.933, which showed that SIF is a valid instrument. The determination coefficient was 0.87, showing that 87% of the variability within the SIF scores can be accounted for by the S-COVS scores. Figure 1 shows a scatter plot of the SIF scores and the corresponding S-COVS scores.

The effect size calculating the magnitude of change in ability to transfer, from the time of admission to the study until discharge, proved to be 9.1 for SIF and 3.9 for S-COVS, showing a high magnitude of change, proving the instrument's responsiveness to changes. Table 1 shows the effect size for each item individually.

Discussion

The validity of SIF was shown to be high, as the SIF scores correlated highly with the scores of S-COVS and the determination coefficient was 87%. The effect size of SIF proves its ability to detect clinically important changes in

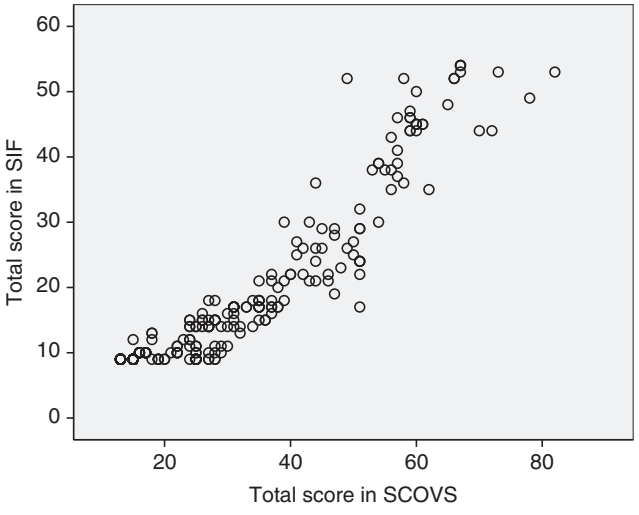

Figure 1 Scatterplot of the spinal cord index of function (SIF) scores and the corresponding Swedish physiotherapy clinical outcome variables (S-COVS) scores.

Table 1 Effect size for each item in the SIF

Item	*Effect size*
1. Moving legs up in bed	7.4
2. Turn to the side	8.2
3. Getting to a sitting position	7.6
4. Transfer from bed to wheelchair	8.1
5. Transfer from wheelchair to bed with differences in level	11.1[a]
6. Transfer from wheelchair to shower chair	13.0
7. Transfer from wheelchair to toilet	12.3
8. Transfer from floor to wheelchair	2.9[a]
9. Wheelchair manoeuvring	3.0

[a]All 29 patients had the same score (1) at first evaluation in item five and nine, the effect size was therefore calculated from the evaluation in which the first patient showed progress (score >1).

the outcomes of interest. Measurement of validity is often subdivided into several types, the correlation with the S-COVS scores in this study evaluates the construct validity of SIF. Construct validity shows that an instrument is valid by relating it to another element that is supposedly valid. Content validity is evidence that the content domain of an instrument is appropriate, relative to its intended use. Expert panels in terms of clarity and comprehensiveness of the parameters can assure this.

S-COVS does not include as many transfer parameters as does SIF, but includes walking and arm function, whereas SIF focuses on various kinds of transfers. SIF shows higher effect sizes than does S-COVS, which indicates that SIF has a higher sensitivity for detecting changes in the ability to transfer. When a patient, after being partly paralyzed and dependent on a wheelchair, becomes a walker to some extent, he/she is scored very high on transfer parameters to/from the wheelchair; of course non-walking patients are scored low on walking parameters. To get a more specific result on the ability to walk and transfer, it is preferable to separate these categories of patients by using different instruments for evaluation. There are two instruments that are used to evaluate the ability to walk in patients with SCL: the walking index for spinal cord injury (WISCI II)[15] and the spinal cord injury functional ambulation inventory.[16]

While calculating the effect size for each item, figures showed that all patients scored the lowest score at the first evaluation in two of the parameters: transfer from wheelchair to plinth, with height variations, and transfer from floor to wheelchair. It is usually not possible for a patient with SCL to carry out these transfers in the acute phase of rehabilitation because of their medical condition. These transfers are taught later in the rehabilitation period as soon as the patients' medical condition is stabilized.

While developing the instrument, transfers executed on a daily basis during physiotherapy were chosen; several possible transfers, such as from wheelchair to a car or from wheelchair to a sofa, were excluded. These transfers are not taught on a daily basis by the physiotherapist and the inclusion of these transfers in the instrument would not make it easy to be used in the clinic. It would also be difficult to standardize the test situation. The possibility of executing these transfers during physiotherapy training could also be different between spinal cord units. The item 'legs up in bed' was chosen as a separate item as we found it to be a critical part of transferring from wheelchair to bed. This part is often the most complicated part of transfer for the patient.

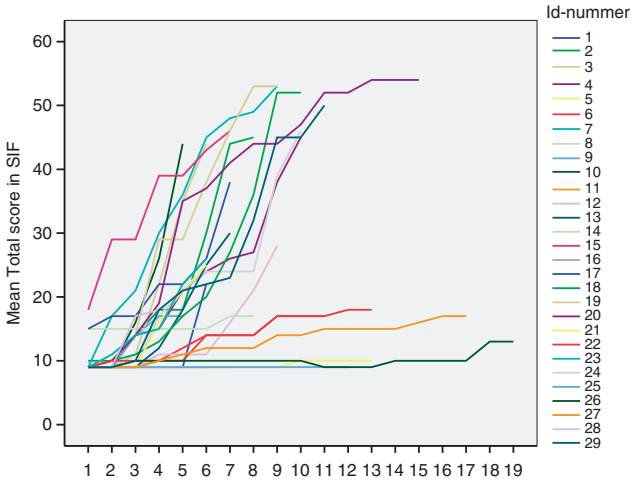

Figure 2 Each patient's progress in spinal cord index of function (SIF) scores from the acute phase until discharge.

Both SIF and S-COVS contain wheelchair manoeuvrability, which is a requirement for transfer. However, the ability to manoeuvre a wheelchair contains far more elements than the parameter concerning wheelchair locomotion in SIF and S-COVS involves. There are more specific instruments that can be used if the ability to manoeuvre a wheelchair is of specific interest, namely, the wheelchair skills program.[17]

As shown in Figure 2, five patients had almost no progress in their ability to transfer. These patients had highly complete cervical injuries. These patients will not be physically independent, but may learn to be verbally independent. Patients who need to learn oral independence will easily be detected by SIF, as they will show low scoring. The ability to instruct how to transfer with maximal assistance should be evaluated using a different instrument measuring verbal independence. An instrument used to evaluate the outcome of rehabilitation in patients with SCL is The needs assessment checklist.[18] The needs assessment checklist takes verbal independence into account, but contains several domains besides transfers. No instrument solely measuring verbal independence in transfers has been found.

The results of this study prove that SIF is a valid and sensitive instrument that will be useful for physiotherapists in evaluating progress in a patient's rehabilitation. SIF clearly shows which movements need to be further taught by the physiotherapist and could be included in national registers. SIF could be used in research and in evaluating a patient's functional ability at the annual follow-up as well as in goal-planning programs for the patient during their stay at the hospital.

References

1 Falconer J, Naughton BJ, Hughes SL, Chang RW, Singer RH, Sinacore JM. Self-reported functional status predicts change in

level of care in independent living resident of a continuing care retirement community. *J Am Geriatr Soc* 1992; **40**: 255–258.
2 Spiegel JS, Leake B, Spiegel TM, Paulus HE, Kane RL, Ward NB *et al*. What are we measuring? An examination of self-reported functional status measures. *Arthritis Rheum* 1988; **31**: 721–728.
3 Wilson IB, Cleary PD. Linking clinical variables with health related quality of life: A conceptual model of patient outcomes. *JAMA* 1995; **273**: 59–65.
4 Guide for the uniform data set for medical rehabilitation (Adult FIM) version 4.0. UB Foundation Activities, Inc. Buffalo, NY, USA, 1993, p A37.
5 Gresham GE, Labi ML, 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.
6 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.
7 Meyers AR, Andresen EM, Hagglund KJ. A model of outcomes research: spinal cord injury. *Arch Phys Med Rehabil* 2000; **81**: 81–90.
8 Catz A, Itzkovich M, Agranov E, Ring H, Tamir A. SCIM-Spinal cord independence measure: a new disability scale for patients with spinal cord lesions. *Spinal Cord* 1997; **35**: 850–856.
9 Hasselgren-Nyberg L, Omgren M, Nyberg L, Gustafsson Y. S-COVS. Den svenska versionen av physiotherapy clinical outcome variables. *Nordisk Fysioterapi* 1997; **1**: 109–113.
10 Seaby L, Torrence G. Reliability of a physiotherapy functional assessment used in a rehabilitation setting. *Physiother Can* 1989; **41**: 264–271.
11 Ditunno JF, Young W, Donoran WH, Creasy G. The international standards booklet of neurological and functional classification of spinal cord injury. *Paraplegia* 1994; **32**: 70–80.
12 Johansson C, Aaroe E, Bodin P, Kreuter M. Spinal cord index of Function: an inter-rater reliability test of an instrument on activity level. Submitted.
13 Currier DP. *Elements of Research in Physical Therapy*. Williams & Wilkins, cop: Baltimore, 1979.
14 Cohen J. *Statistical Power Analysis for the Behavioural Sciences*, 2nd edn. Lawrence Erlbaum: Hillsdale, 1988.
15 Ditunno PL, Ditunno Jr JF. Walking index for spinal cord injury (WISCI II): scale revision. *Spinal cord* 2001; **39**: 654–656.
16 Field-Fote EC, Fluet GG, Schafer SD, Schneider EM, Smith R, Downey PA *et al*. The spinal cord injury functional ambulation inventory (SCI-FAI). *J Rehabil Med* 2001; **33**: 177–181.
17 Kirby RL, Dupuis DJ, Macphee AH, Coolen AL, Smith C, Best KL *et al*. The Wheelchair Skills Test (version 2.4): measurement properties. *Arch Phys Med Rehabil* 2004; **85**: 794–804.
18 Kennedy P, Hamilton LR. The needs assessment checklist: a clinical approach to measuring outcome. *Spinal cord* 1999; **37**: 136–139.

Appendix

Spinal cord index of function

Facilities mean an object, which is not normally found in the surroundings. If the patient uses, for example, the edge of the mattress to help in turning, the mattress does not count as a tool. A bed gate, however, is regarded as a tool.

Supervision means the need for the presence of a person to ensure the patient's safety or to give instructions, but excludes any form of physical help.

1. Moving legs up in bed

Starting position: sitting on the edge of the bed.
Facilities: for example, handle and loop on clothes.

1. Needs help of at least two persons with or without aids.
2. Needs help from one person with or without aids.
3. Supervision with or without aids.
4. Independent with aids.
5. Independent without aids, but moves slowly and with effort. For example, the patient gets increased tonus, takes an abnormally long time for movement or is careless and makes the movement in a way that may cause bodily harm.
6. Independent.

2. Turning to the side

Starting position: supine position
Accessibility: for example, handle, hoist and electric back support.
The patient may turn to the side he/she prefers. Before testing, bed rails and any davits are removed.

1. Needs help of at least two persons with or without aids.
2. Needs help from one person with or without aids.
3. Supervision with or without aids.
4. Independent with aids.
5. Independent without aids, but moves slowly and with effort. For example, the patient gets increased tonus, takes an abnormally long time for movement or is careless and makes the movement in a way that may cause bodily harm.
6. Independent.

3. Getting to a sitting position

Starting position: supine position
Accessibility: for example, hoist

1. Needs help of at least two persons with or without aids.
2. Needs help from a person with or without aids.
3. Supervision with or without aids.
4. Independent with aids.
5. Independent without aids, but moves slowly and with effort. For example, the patient gets increased tonus, takes an abnormally long time for movement or is careless and makes the movement in a way that may cause bodily harm.
6. Independent.

4. Transfer from bed to wheelchair

Starting position: seated
Accessibility: for example, gliding board and lift
The patient may move in the direction he/she prefers.

1. Needs help of at least two persons with or without aids.
2. Needs help from one person with or without aids.
3. Supervision with or without aids.
4. Independent with aids.
5. Independent without aids, but moves slowly and with effort. For example, the patient gets increased tonus, takes an abnormally long time for movement or is careless and makes the movement in a way that may cause bodily harm.
6. Independent.

5. Transfer from wheelchair to bed, with a difference in level

Starting position: seated in a wheelchair
Accessibility: for example, gliding board
The patient may move to the side he/she prefers.

The level difference is measured from the front edge of the wheelchair's cushion to the bunk's upper edge.

1. Cannot transfer despite no difference in level.
2. Manages 5 cm with aids.
3. Manages 5 cm without tools.
4. Manages 15 cm with aids.
5. Manages 15 cm without tools.
6. Manages 20 cm with or without aids.

6. Transfer from wheelchair to shower chair
Starting position: seated in a wheelchair
Accessibility: for example, gliding board, slip mat and lift

1. Needs help of at least two persons with or without aids.
2. Needs help from one person with or without aids.
3. Supervision with or without aids.
4. Independent with aids.
5. Independent without aids, but moves slowly and with effort. For example, the patient gets increased tonus, takes an abnormally long time for movement or is careless and makes the movement in a way that may cause bodily harm.
6. Independent.

7. Transfer from wheelchair to toilet
Starting Position: seated in a wheelchair
Accessibility: for example sliding board, lift and toilet heightening

1. Needs help of at least two persons with or without aids.
2. Needs help from one person with or without aids.
3. Supervision with or without aids.
4. Independent with aids.
5. Independent without aids, but moves slowly and with effort. For example, the patient gets increased tonus, takes an abnormally long time for movement or is careless and makes the movement in a way that may cause bodily harm.
6. Independent.

8. Transfer from floor to wheelchair
Starting position: seated on the floor.
Accessibility: for example, stool and lift

1. Needs help of at least two persons with or without aids.
2. Needs help from one person with or without aids.
3. Supervision with or without aids.
4. Independent with aids.
5. Independent without aids, but moves slowly and with effort. For example, the patient gets increased tonus, takes an abnormally long time for movement or is careless and makes the movement in a way that may cause bodily harm.
6. Independent.

9. Wheelchair manoeuvring

1. Cannot manoeuvre independently. Needs assistance of another person.
2. Manages to manoeuvre on the flat indoors. Does not manage barriers.
3. Manages to maneuver around obstacles, but not over thresholds or edges.
4. Manages low thresholds and uneven surface outdoors.
5. Manages an edge of 5 cm.
6. Manages an edge of 12 cm.