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A Twelve-Item Symptom Intensity Rating Scale for Cervical Spine Dysfunction

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Study Design. Retrospective cohort study.

Objective. To evaluate the internal consistency, construct validity, and test-retest reliability of the Symptom Intensity Rating Scale (SIRS) in a clinical sample of people with cervical spine dysfunction.

Summary of Background Data. The SIRS was developed by experienced clinicians at the Melbourne Whiplash Centre as an assessment tool and outcome measure for people with cervical spine dysfunction. The 12-item scale rates the severity of neck, shoulder, shoulder blade and arm pain, neck and arm weakness, headaches dizziness nausea neck stiffness, pins and needles, and numbness.

Methods. Internal consistency was explored by itemitem and corrected item-total correlations, Cronbach alpha, and Principle Components analysis. Construct validity was examined by correlation of SIRS scores with Neck Disability Index (NDI) scores, and with cervical range of motion (ROM). Test-retest reliability was determined by examining a subset of patients with NDI scores that changed by less than 10% points.

Results. A dataset of 397 cases was analyzed. Missing data for the SIRS was very low. Item intercorrelations ranged from weak (<0.3) to moderate (>0.6). Corrected item-total correlations ranged from 0.35 to 0.63. Cronbach alpha was 0.85. Principle Components Analysis identified 2 correlated subscales. SIRS total scores were correlated with NDI scores at initial (r = 0.574) and final (r = 0.757) assessment. Correlations between initial SIRS scores and ROM were absent or weak, and correlations between final SIRS and ROM were stronger. Test-retest reliability Intraclass Correlation Coefficient (2,1) of the SIRS for a subset of 65 cases with unchanged NDI scores was 0.858 (95% CI, 0.766–0.913). The standard error of measurement was 8 points and the Minimum Detectable Change (90% confidence) 18.7 points.

Conclusion. The SIRS is a sufficiently reliable, internally consistent scale that can be used to make valid inferences about symptom severity in ambulatory patients with cervical spine dysfunction.

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Neck pain is a common and sometimes disabling condition. The reported annual prevalence in adults ranges from 12% to 72%, with most estimates falling between 30% and 50%.[1,2] The reported annual prevalence of neck pain that interferes with daily activities ranges from 11% to 14% and the reported incidence of neck pain in working adults ranges from 6% to 44%, with the highest incidence occurring in office workers.[1]

A review by Sterner and Gerdle[3] identified the most commonly reported physical symptoms in acute and chronic whiplash as neck pain (94%), neck stiffness (96%), headache (44%), interscapular pain (35%), numbness/paresthesias(22%), dizziness (15%), auditory symptoms (13%) and visual symptoms (12%). Although there are a number of questionnaires designed to assess neck-related disability,[4–10] few include assessment of the symptoms related to neck pain.

The Core Outcomes for Neck Pain[10] has 2 questions on pain "bothersomeness." The Northwick Park Pain Questionnaire[6] has questions on pain intensity, pins and needles or numbness at night, and duration of symptoms. The Bournemouth Questionnaire for the Neck[5] and the Whiplash Disability Questionnaire[7] assess only pain intensity. The Neck Pain and Disability Scale[9] includes 3 pain intensity questions and a neck stiffness question. The Neck Disability Index (NDI)[8] has 1 question on pain intensity and 1 on headache.

The Cervical Spine Outcomes Questionnaire[4] includes a 6-item pain scale for neck and shoulder/arm pain, and a physical symptoms scale that covers swallowing, headaches, numbness, weakness or tingling in arms or hands, numbness or clumsiness or weakness in the legs, and sleep disturbance. The Cervical Spine Outcomes Questionnaire was developed for patients undergoing surgery for cervical spine disorders and is a comprehensive questionnaire assessing pain, disability, psychological distress, physical symptoms, health care utilization, and patient satisfaction. The choice of symptoms such as swallowing and lower extremity symptoms reflects the tertiary clinical setting in which it was developed.

In response to a perceived need to adequately assess symptoms and the lack of a suitable scale, clinicians at the Melbourne Whiplash Centre developed a symptom rating scale, the Symptom Intensity Rating Scale (SIRS). The SIRS

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(see Appendix) was developed as a patient selfreport assessment tool and outcome measure for people with cervical spine dysfunction seeking treatment at a primary care clinic. The 12 items were based on the most common presenting symptoms of the client group of this practice. The self-administered SIRS asked patients to rate the severity of their symptoms on a 0 to 10 scale, where 0 indicates no symptoms and 10 indicates extreme symptoms. The patient rates the severity of neck, shoulder, shoulder blade and arm pain, neck and arm weakness, headaches dizziness nausea neck stiffness, pins and needles, and numbness. The item scores are summed to a total score ranging from 0 to 120, with a higher score indicating greater symptom severity. Shoulder and arm symptoms are included to represent people with symptoms referred *via* cervical structures to the upper extremity.

The aim of this study was to evaluate the internal consistency, construct validity, and test-retest reliability of the 12-item SIRS in a clinical sample of people with cervical spine dysfunction.

MATERIALS AND METHODS

The study was a retrospective cohort design that analyzed deidentified data from an existing database. Data were collected from patients undergoing treatment for cervical spine disorders at the Melbourne Whiplash Centre in Melbourne, Australia, from January 1998 to March 2007. Data were included if the person was more than 17 years of age. Patients provided signed consent at the time of their treatment for their deidentified data to be used in research and formal ethics approval was granted by the Faculty of Health Sciences Human Ethics Committee at La Trobe University.

Patients attending the Melbourne Whiplash Centre are routinely assessed using the SIRS, the NDI,[8] cervical range of motion (ROM), and isometric muscle strength using the BTE Technologies Inc. Multi-Cervical Unit (MCU). The NDI has 10 sections investigating the extent to which neck pain affects "your ability to manage in everyday life" (p. 411).[8] The NDI has 10 items: pain intensity, personal care, lifting, reading, headache frequency, concentration, work, driving, sleeping, and recreation. Each item has 6 response options scored from 0 to 5. Item scores are summed and converted to a percentage score and a higher score indicates greater disability. Test-retest reliability coefficients of between 0.90 and 0.93 and Cronbach alpha values between 0.74 and 0.93 have been reported.[11] The minimum detectable change and the minimum clinically important difference of the NDI have been reported as between 10% and 20% points.[12–14] Convergent validity has been demonstrated for the NDI scores with other pain and disability questionnaires and NDI change scores with global ratings of change.[11] The NDI has been used as an outcome measure in a large number of clinical trials and is widely used as an outcome measure in clinical practice.[11]

Cervical ROM was measured using the BTE Technologies Inc. MCU (BTE Technologies Inc., Hanover MD). The patient is seated and aligned within the MCU and is instructed on the testing technique. Testing of range of flexion, extension, rotation, and lateral flexion occurs within a multiaxial head brace, which allows free motion of the cervical spine. Measurements are captured by software that records and displays the data. After allowing patients to become familiar and comfortable with the testing procedure, ROM was measured as the average of 3 consecutive test movements. Test-retest reliability coefficients of between 0.82 and 0.96 have been reported for active ROM measurement in persons with neck pain.[15]

Analysis

The characteristics of the group for whom initial SIRS data were available were compared to those for whom it were not, for age (independent *t* test), gender and payment type (χ^2 test for independence), symptom duration, number of treatments, and treatment duration (Mann-Whitney *U* test due to non-normally distributed data).

Internal consistency of the SIRS is concerned with the relatedness of the items with each other and with the scale as a whole. The internal consistency of the SIRS was explored by item-item and corrected item-total correlations, Cronbach alpha, and Principal Components Analysis (PCA). If the item set is tapping aspects of a single underlying construct, then each item should correlate with other items to a greater or lesser degree, and with the sum of the other item scores. Cronbach alpha values between 0.70 and 0.90 are considered acceptable with higher values suggesting item redundancy.[16] These analyses were performed on initial SIRS data only.

PCA was performed using the steps described by Pallant.[17] The first step is to determine whether the data are suitable for PCA using sample size, identifying correlations between some items exceeding 0.3, a value greater than 0.6 for Kaiser-Meyer-Olkin Measure of Sampling Adequacy, and a significant value ($\leq$0.05) for Bartlett Test of Sphericity. An unrotated analysis is then performed and the results examined to determine the number of components that should be extracted. The appropriate number of components is determined using Kaiser criterion (eigenvalue $\geq$1) and examination of the scree plot, and confirmed by a parallel analysis. The parallel analysis uses a Monte Carlo procedure to generate 100 random datasets and calculate average eigenvalues. Components are retained if the PCA eigenvalue is greater than the criterion value in the parallel analysis. PCA analysis was performed on initial SIRS data.

Construct validity was examined by correlation (Pearson product-moment correlation coefficient) of SIRS scores with NDI scores and with cervical ROM at initial and final assessment. This strategy of exploring construct validity of a scale by comparing scores with measures of the same or related constructs is also called convergent validity. Symptom severity would logically be associated with reduced cervical spine movement and increased disability. A study by Hermann and Reese[18] of 80 patients with cervical spine disorders reported moderate correlations of a single pain intensity score with the NDI (rho = 0.65, $P = 0.0001$) and with cervical ROM (rho = -0.40, $P < 0.001$). We therefore expected moderate correlations of SIRS scores with the NDI

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and with cervical ROM. A positive correlation with NDI was anticipated because of the expected impact of symptom severity on activities of daily living, as well as some shared content of the 2 scales.

Test-retest reliability was determined by examining a subset of patients with NDI scores that changed by less than 10 NDI percentage points between initial and final assessments. Ten points was selected as a cutoff point to indicate a subgroup of patients who had not changed by a clinically meaningful amount. A paired t test was applied to the initial and final NDI scores of the subgroup to confirm they had not changed significantly over the treatment period. This approach to test-retest reliability ensures that information about measurement error reflects the random variability in scores over a typical treatment period in stable individuals.

An Intraclass Correlation Coefficient (2,1) was used to quantify test-retest reliability. The standard error of measurement (SEM) was calculated by multiplying the standard deviabation of SIRS scores by the square root of 1 minus the reliability coefficient.[16] The minimum detectable change at 90% confidence (MDC_{90}) was calculated by multiplying the SEM by the square root of 2, then by 1.64.

Analysis was performed using PASW Statistics 17. For all analyses, the *exclude cases pairwise* option was selected and a case therefore was only excluded from analysis if it was missing the data required for that particular analysis. Parallel analysis was performed using Monte Carlo PCA for Parallel Analysis 2.3.

TABLE 1. Sample Characteristics of 252 With Initial SIRS Forms

Variable	n	%	Mean (SD)	Median (IQR)	Range
Gender					
Female	170	67.5			
Male	82	35.5			
Total	252	100.0			
Age	240		40.25 (11.33)	39.50 (16)	18–74
Symptom duration (mo)	215		85.18 (91.86)	52.00 (100)	1–480
No. treatments	215		18.81 (8.57)	18.00 (4)	3–63
Duration of treatment (wk)	215		13.66 (10.02)	10.00 (11)	3–62
Payment					
Private	162	64.3			
Third party payer	90	35.7			
Total	252	100.0			

SD indicates standard deviation; IQR, interquartile range; SIRS, Symptom Intensity Rating Scale.

RESULTS

Data for 404 consecutive patients were recorded in the database. Of these, 7 cases were excluded because the patient was younger than 18 years. SIRS data were available for 252 cases at initial assessment (63.5%) and 248 cases at final assessment (61.4%). Initial and final assessment SIRS were available for 232 cases.

Descriptive data for the 252 patients with completed initial SIRS is shown in Table 1. These patients were not significantly different to the 145 patients for whom an initial SIRS was not recorded on any characteristic (data not shown) except payment type ($\chi^2 = 6.037$, $df = 1$, $P = 0.014$). The patient group with initial SIRS had a greater proportion with a third party payer (insurer) than those without. Mean scores for initial and final SIRS assessments at item and total level are shown in Table 2. Paired *t* tests of differences were all significant ($P < 0.0001$).

Missing data in completed SIRS forms were low. For initial completion, only 6 of 252 forms had missing data and for all but 1 form data were missing for only 1 item. The remaining form had 2 items uncompleted. For SIRS forms at final assessment, only 5 forms had missing data and all were only missing a single item. Missing data

TABLE 2. Initial and Final SIRS Scores for Items and Total

SIRS Item	Initial Assessment Range	Initial Assessment Mean (SD)	Final Assessment Range	Final Assessment Mean (SD)	Difference Mean (SD)
Neck pain	1–10	6.51 (2.11)	0–10	3.75 (2.42)	2.80 (2.57)
Shoulder pain	0–10	5.16 (2.81)	0–10	3.11 (2.57)	2.08 (2.85)
Headaches	0–10	5.32 (3.11)	0–10	2.99 (2.69)	2.35 (2.92)
Dizziness	0–10	2.04 (2.53)	0–8	0.99 (1.72)	1.11 (2.21)
Nausea	0–10	1.79 (2.50)	0–10	0.72 (1.71)	1.11 (2.45)
Stiff neck	0–10	6.44 (2.52)	0–10	3.52 (2.67)	2.96 (2.99)
Shoulder blade pain	0–10	4.44 (3.12)	0–9	2.65 (2.68)	1.84 (2.99)
Arm pain	0–10	2.59 (2.92)	0–10	1.34 (2.09)	1.16 (2.40)
Pins and needles	0–10	1.76 (2.60)	0–9	0.89 (1.92)	0.84 (2.24)
Numbness	0–10	1.72 (2.68)	0–8	1.68 (1.60)	1.00 (2.40)
Neck weakness	0–10	5.51 (3.15)	0–9	2.67 (2.46)	2.84 (3.06)
Arm weakness	0–10	3.03 (3.22)	0–8	1.47 (2.16)	1.50 (2.67)
Total score (maximum 120)	6–105	46.20 (20.58)	0–90	24.62 (18.32)	21.61 (19.28)

All paired t *test results for item and total scores were* $P < 0.0001$.
SD indicates standard deviation; SIRS, Symptom Intensity Rating Scale.

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were spread across items and no item was consistently missed.

Internal Consistency

Interitem correlations ranged from weak (<0.3) to moderate (>0.6). The Nausea item showed the weakest correlations (<0.2) with 5 other items. Corrected item-total correlations ranged from 0.350 for nausea to 0.632 for neck pain. Cronbach alpha for the 12 items (n = 250) was 0.850 and alpha with each item removed ranged from 0.831 and 0.850.

As the analysis included 252 cases equating to 21 for each item on the test, there were many item-item correlations exceeding 0.3, Bartlett test of sphericity was significant ($P < 0.0001$) and the Kaiser-Meyer-Olkin index was 0.811, we concluded that PCA was appropriate.[17]

The initial unrotated solution identified a large first component (eigenvalue 4.671) explaining 38.92% of variance, and 2 smaller components (eigenvalue 1.512 and 1.331) explaining a total of 62.61% of variance. The Kaiser criterion (eigenvalues over 1) identified 3 components while examination of the scree plot suggested only 1 component, appearing above the sharp bend in the line, should be retained. Parallel analysis identified that the eigenvalues of the first 2 components were larger than the criterion value obtained by the Monte Carlo method and therefore the PCA was continued with 2 components extracted (Oblimin with Kaiser Normalization).

The rotated solution extracting 2 components revealed that 7 items relating to neck, shoulder, arm pain, and weakness comprise the first component (items 1,2,6,7,8,11 and 12), and the remaining 5 items relating to other symptoms load comprise the second component (items 3,4,5,9, and 10). The correlation between the 2 components was 0.39.

TABLE 3. Initial and Final Mean Scores on Correlated Variables

	Initial Mean (SD)	Final Mean (SD)
SIRS	46.20 (20.58)	24.62 (18.32)
NDI	37.15 (15.00)	23.20 (16.27)
Flexion	57.42 (12.82)	62.75 (10.75)
Extension	47.01 (12.77)	52.33 (10.79)
Left lateral flexion	38.52 (10.31)	45.65 (10.42)
Right lateral flexion	35.23 (10.31)	42.60 (10.45)
Left rotation	64.70 (15.81)	73.74 (13.42)
Right rotation	59.57 (15.54)	68.41 (13.84)

All range of motion values are degrees.
SD indicates standard deviation; SIRS, Symptom Intensity Rating Scale; NDI, Neck Disability Index.

TABLE 4. Correlation SIRS and ROM

	Initial	P	Final	P
Flexion	−0.248	0.005	−0.416	<0.0001
Extension	−0.176	0.005	−0.321	<0.0001
Left lateral flexion	−0.067	0.291	−0.353	<0.0001
Right lateral flexion	−0.010	0.872	−0.304	<0.0001
Left rotation	−0.186	0.004	−0.333	<0.0001
Right rotation	−0.245	<0.0001	−0.370	<0.0001

n ranged from 234 to 252.
SIRS indicates Symptom Intensity Rating Scale; ROM, range of motion.

Construct Validity

Table 3 shows the initial and final scores for the SIRS, NDI, and ROM. SIRS scores were moderately correlated to NDI scores at initial assessment ($r = 0.574$, $P < 0.0001$) and strongly at final assessment ($r = 0.757$, $P < 0.0001$). Correlations between initial SIRS scores and ROM were absent or weak, and correlations between final SIRS and ROM were stronger, but remained weak (Table 4).

Test-Retest Reliability

A total of 214 cases had complete initial and final NDI and SIRS data. Of these, 65 (30.37%) had changed by less than 10 points on the NDI and were therefore classified as remaining relatively stable over the retest period. The mean age of this subgroup was 42.2 years (SD, 10.9), 61.5% were female and 64.6% were private patients. Average symptom duration for this subgroup was 78.45 months (SD, 91.28), the average number of treatments was 18.02 (SD, 8.14), and the average time between initial and final assessment was 12.84 weeks (SD, 9.61; range, 3–38 weeks). NDI and SIRS initial and final scores for this subgroup are shown in Table 5. A paired t test confirmed that the group was unchanged on both the NDI and SIRS scores ($P < 0.0001$). The Intraclass Correlation Coefficient (2,1) between the pre- and post-test SIRS scores (average measures) was 0.858 (95% CI: 0.766–0.913, $P < 0.0001$). The SEM was 8 points and the MDC_{90} was 18.6 points.

DISCUSSION

The 12-item SIRS was developed as a practical tool to aid the clinical assessment of people with cervical spine dysfunction.

TABLE 5. NDI and SIRS Scores on Patients Classified as Unchanged (n = 65)

	Initial Mean (SD)	Final Mean (SD)	Change Mean (SD)
NDI	35.62 (16.59)	32.41 (17.70)	3.21 (4.75)
SIRS	45.05 (21.59)	33.43 (21.21)	11.62 (15.12)

SD indicates standard deviation; NDI, Neck Disability Index; SIRS, Symptom Intensity Rating Scale.

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This is the first scale to provide a neck-specific measure of symptom severity to complement disability scales such as the NDI.

The results suggest that the 12 items form an internally consistent scale. The exploratory PCA suggested that the items can be viewed as 2 related subscales, one measuring severity of pain and weakness in the neck, shoulder, and arm, and the other measuring the severity of headaches, dizziness, nausea, and paraesthesia.

Evidence for the construct validity of the SIRS was generated by examining the relationship of SIRS scores with measures of other related constructs of disability and cervical ROM. As expected, the SIRS and NDI scores were moderately to strongly correlated. However, the relationship between the SIRS scores and cervical ROM was weaker than expected, particularly at the initial assessment. We based our expectations on a previous study showing a moderate correlation of a single neckpain intensity rating scale with cervical ROM.[18] With hindsight, it is explicable that the range of symptoms assessed by the SIRS, relating as they do to head, neck, shoulder, and arm symptoms, may not have a predictable relationship with neck movements.

The test-retest reliability results indicates that a change of 19 points or more on a patients SIRS score over time could be considered, with 90% confidence, to reflect change beyond the measurement error of the scale. To identify a subgroup to analyze test-retest reliability, we applied a criterion of lack of change in NDI scores beyond measurement error at 90% confidence. Limitations of this design are that the SIRS and NDI questionnaires were completed at the same time by patients and may not therefore be entirely independent, and the retest period was not consistent. The SEM and MDC_{90} of the SIRS should be confirmed on another sample using a short and consistent retest period.

Another limitation of the study was the retrospective and incomplete nature of the data analyzed. The sample analyzed had chronic neck pain (median symptom duration 50 months) and more than one-third were compensable patients of third party payer schemes such as the Transport Accident Commission and the Victorian Workcover Authority. Evidence for test validity is generally accumulated over time as the measurement properties of a scale are examined in various settings, countries, and clinical populations. This study provides the first evidence for the reliability and validity of the SIRS, but further studies, particularly on prospective samples, are recommended.

CONCLUSION

The SIRS is a neck-specific measure of symptom severity. This first study of the SIRS shows it to be a sufficiently reliable, internally consistent scale that can be used to make valid inferences about symptom severity in ambulatory patients with cervical spine dysfunction.

➢ Key Points

- ❑ The Symptom Intensity Rating Scale is a 12-item neck-specific symptom rating scale designed for ambulatory settings.
- ❑ SIRS scores correlated moderately to strongly with scores on a disability questionnaire, but absent to weak correlations were observed with cervical range of motion.
- ❑ A change of 19 points provides 90% confidence that observed change is not explained by measurement error.

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Appendix. Symptom Intensity Rating Scale

For Each Category Below, Please Indicate the Severity of the Symptom Using the 0–10 Point Scale Where:

0 = No Symptoms

10 = Extreme Symptoms

(Circle Response)											
1. Neck pain	0	1	2	3	4	5	6	7	8	9	10
2. Shoulder pain	0	1	2	3	4	5	6	7	8	9	10
3. Headaches	0	1	2	3	4	5	6	7	8	9	10
4. Dizziness	0	1	2	3	4	5	6	7	8	9	10
5. Nausea	0	1	2	3	4	5	6	7	8	9	10
6. Stiff neck	0	1	2	3	4	5	6	7	8	9	10
7. Shoulder blade pain	0	1	2	3	4	5	6	7	8	9	10
8. Arm pain	0	1	2	3	4	5	6	7	8	9	10
9. Pins and needles	0	1	2	3	4	5	6	7	8	9	10
10. Numbness	0	1	2	3	4	5	6	7	8	9	10
11. Neck weakness	0	1	2	3	4	5	6	7	8	9	10
12. Arm weakness	0	1	2	3	4	5	6	7	8	9	10
Score __/120											

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