ORIGINAL ARTICLE

Prediction of somatic and non-somatic depressive symptoms between inpatient rehabilitation and follow-up

JS Krause¹, KS Reed¹ and JJ McArdle²

¹Department of Health Sciences and Research, College of Health Professions, Medical University of South Carolina, Charleston, SC, USA and ²Department of Psychology, College of Letters, Arts, and Sciences, University of Southern California, Los Angeles, CA, USA

Study design: Longitudinal.

Objective: We identified changes in the association of somatic and non-somatic symptoms (as measured by the Patient Health Questionnaire-9, PHQ-9) between inpatient rehabilitation after spinal cord injury (SCI) and 1 year after discharge.

Setting: A specialty hospital in the Southeastern USA.

Methods: A total of 584 adults with traumatic SCI were administered the PHQ-9 during inpatient rehabilitation. Of them, 227 completed the PHQ-9 by survey at 1-year follow-up. We performed time-lagged regression between times of measurement for somatic and non-somatic factors of the PHQ-9.

Results: The non-somatic factor at baseline was significantly predictive of the non-somatic ($r=0.67$, $P=0.002$) and somatic factors at follow-up ($r=0.53$, $P=0.019$). The somatic factor did not significantly predict either the somatic ($r=0.10$, n.s.) or non-somatic factors at follow-up ($r=-0.01$, NS). Factor analysis also indicated changing factor structure between inpatient rehabilitation and follow-up.

Conclusions: Our results question the interpretation of somatic items during inpatient rehabilitation, as they are not predictive of either somatic or non-somatic symptoms at follow-up.

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Introduction

Spinal cord injury (SCI) is associated with immediate and generally permanent changes in sensory and motor functions.¹ Depressive disorders are more prevalent among persons with SCI and are associated with poor outcomes in several areas including rehabilitation, health, activities of daily living and community integration, as well as lower levels of quality of life.²

Diagnostic criteria for major depression include somatic symptoms that parallel physiologic responses to SCI or prolonged hospitalization. Differential validity of psychological measures with SCI was first noted more than 40 years ago in studies of the MMPI.³ Similar concerns have been noted in conditions with HIV,⁴ as some depressive symptoms correspond with symptoms of HIV infection. Removing these somatic items improved the clinical utility of the Beck Depression Inventory⁵ and the Center for Epidemiologic Studies Depression Scale.⁶ They concluded somatic symptoms will inflate depression scores in people living with HIV infection.⁴

Several studies have addressed the factor structure of depressive symptoms after SCI using the Patient Health Questionnaire-9 (PHQ-9),⁷ a nine-item self-report measure intended to assist in identification of major depressive disorders (MDD). It has been used in a number of recent studies with SCI,^{8–10} as well as with traumatic brain injury¹¹ and stroke.¹²

Because the PHQ-9 items are based on the Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV)¹³ criteria for major depression, assessing the factor structure has the potential to differentiate somatic items from non-somatic ones. Evaluating patterns of item endorsement also addresses the potential differential item validity of somatic items.

Richardson and Richards⁸ evaluated the factor structure of the PHQ-9 using data from the SCI Model Systems in the USA during preliminary 1-year follow-up and then again at each 5-year follow-up through 25 years after injury (that is, 1, 5, 10, 15, 20 and 25 years). A two-factor solution best fit the data on each occasion. The findings differed in some respects across time, as psychomotor changes loaded with the somatic factor on some occasions but not others. Both the somatic and non-somatic factors were negatively correlated with life satisfaction.

Bombardier *et al.*⁹ investigated depressive symptoms in 849 participants 1 year after injury. Of them, 22% scored at

Correspondence: Dr JS Krause, Department of Health Sciences and Research, College of Health Professions, Medical University of South Carolina, 77 President St, Suite 117, MSC 700, Charleston, SC 29425, USA.
E-mail: krause@musc.edu

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or above the cutoff for MDD (10 or higher), and 11.4% met the criteria for probable major depression based on the presence of one of two cardinal symptoms of depression and endorsement of five of the symptoms on more than half of the days. The most frequently endorsed symptoms (occurring on more than half the days) were sleep disturbance (25.9%), poor energy (24.3%) and anhedonia (19.8%).

Krause *et al.*¹⁰ used confirmatory factor analysis to compare four alternative structures of the PHQ-9 during inpatient rehabilitation after SCI. A two-factor solution, with three distinctive somatic items (sleep disturbance, poor energy and appetite change) best fit the data. These three items also had the highest endorsement rates. The physiologic complications of SCI are most likely to parallel or mimic the somatic symptoms of a depressive disorder during the inpatient hospitalization, as this occurs immediately after the onset of SCI.

The presence of the somatic factor, in and of itself, is not problematic, in that somatic content is highly predictive of major depressive episodes. For instance, using an international primary care population, Barkow *et al.*¹⁴ found that pain and somatic complaints were associated with depressive episodes after 1-year follow-up. Hein *et al.*¹⁵ conducted a study among elderly participants who had never previously reported a depressive disorder and identified several pre-clinical symptoms of a depressive disorder that included dysphoria, change in appetite, insomnia, lack of energy, morning depth, lack of joy and interest, inferiority feeling, lack of self-confidence, poor concentration, indecisiveness, thinking about death, wish to die and joint pain. Yet, other investigators have identified an association between sleep loss and major depression.¹⁶

Taken together, these studies suggest that somatic complaints may represent preclinical symptoms of a depressive disorder in primary care and elderly participants. However, because of the profound nature of physiologic changes associated with SCI, it is important to determine whether the somatic symptoms will be predictive of later depressive symptoms and disorders among those with SCI.

Purpose

The purpose of this study was to identify the association of somatic and non-somatic symptoms measured during inpatient rehabilitation with somatic and non-somatic symptoms measured 1 year after hospital discharge. Our working hypothesis is that, compared with somatic symptoms, non-somatic symptoms measured during inpatient rehabilitation will be more highly correlated with depressive symptoms at 1 year after discharge (both somatic and non-somatic symptoms). Our rationale is that somatic symptoms endorsed during inpatient rehabilitation are confounded with actual somatic changes due to SCI or hospitalization and will not be highly correlated with depressive symptoms that are not otherwise accounted for by the condition (that is, those not related to the symptoms of SCI or prolonged hospitalization) 1 year after discharge.

Materials and methods

Procedures

Participants were recruited from the inpatient census of a specialty hospital in the Southeastern USA. The inclusion criteria were (1) traumatic SCI, (2) currently hospitalized for initial rehabilitation and (3) at least 16 years of age. A total of 707 participants consented and 584 completed the research materials before discharge (82.6%). Median number of days between onset of SCI and time of interview was 44.

The peer support coordinator met with participants and obtained informed consent. As needed, a research assistant helped the participant complete the materials. Participants were given US\$25 remuneration.

The follow-up was initiated 12 months after discharge. Participants were again offered \$25 remuneration to complete the materials by mail. Because of constraints in the timeline of the study, only 410 of the 584 participants were included in the follow-up. (Of the 410 cases, only 377 received both a follow-up mailing and phone call due to time restrictions and termination of the funding cycle.) A total of 227 participants returned completed materials approximately 1 year after discharge (55%).

Statement of ethics

We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

Measures

The PHQ-9⁷ consists of nine items, each identifying symptoms that are commonly associated with a depression diagnosis based on DSM-IV criteria. The participants are asked to identify how each symptom has been a problem over the past 2 weeks using the following four categories: (1) not at all, (2) several days, (3) more than half the days or (4) nearly every day. The PHQ-9 is both reliable and valid as a brief measure of depression. Kroenke *et al.*⁷ found 0.89 internal consistency and 0.84 test-retest reliability.

Data analysis

Primary data analyses were conducted using Mplus,¹⁷ (Los Angeles, CA, USA) specialized software for a wide range of structural equation models (SEM), which calculates parameters in the presence of incomplete data by using the missing at random (MAR) assumption.¹⁸ This means all available data, including that of those participants who only responded at baseline, were used to derive estimates used in the time-lagged regression analyses. The MAR assumption applies only to those variables not in the equation. Therefore, maximum likelihood was used to create unbiased estimates of the parameters using all available information¹⁹ from baseline responses to adjust follow-up estimates as if the data were complete.

The primary analyses included factor analysis and time-lagged regression analysis. Factor analysis is a component of SEM that is used to identify the underlying dimensions, or measurement model, of a specific set of items or an instrument. We conducted factor analysis of participant

responses during inpatient rehabilitation and at 1 year (a single analysis) using maximum likelihood with a Promax rotation. The root mean square error of approximation (RMSEA) was used to evaluate the fit of the model. The RMSEA is a function of N , the χ^2 and the degrees of freedom and is determined by the discrepancy per degrees of freedom and corrects for model complexity. The fit of the model improves as the RMSEA decreases, and values of less than 0.05 represent an excellent fit.²⁰

We then conducted a time-lagged regression analysis. Latent somatic and non-somatic dimensions at follow-up were regressed on somatic and non-somatic dimensions observed during inpatient rehabilitation. Because the goal of this study was to identify the extent to which somatic and non-somatic items are predictive of similar content between inpatient rehabilitation and follow-up, we used the inpatient factor structure on both occasions. The time-lagged regression analyses used correlations between factors across time, as scores on one factor at time 1 were used to predict scores on the other factor at time 2. Beta weights were generated as coefficients, and RMSEA and the χ^2 statistics were used to determine model fit.

There was no attempt to include biographic or injury variables as covariates, as Mplus calculates parameters using the MAR assumption such that additional factors only complicate the interpretation. However, SPSS Inc. (Chicago, IL, USA) was used to compare the 227 follow-up respondents to the 357 who did not participate in the 1-year follow-up. Descriptive statistics were also generated to characterize the

participant sample. The mean number of items endorsed for the somatic (three items) and non-somatic factors (six items) was compared between the inpatient baseline and 1-year follow-up using paired t -tests. The McNemar statistic was used to compare changes in the percentage of endorsement of individual items between baseline and the 1-year follow-up when items were dichotomized based on participants stating the symptom occurred on at least half the days, except for self-harm where it was based on reporting the symptom any days.

Results

Participants

At follow-up, 73.6% of the participants were Caucasian; 74.4% were men. Average age at onset was 35.5 years. Nearly half of the participants (48%) had cervical injuries. The primary etiology of injury was motor vehicle crash (48.9%). The average number of years of education was 13.1.

Characteristics of follow-up respondents and nonrespondents

Respondents were older, had higher levels of education and were more likely to be women (Table 1).

Changes in item and score distribution over time

Significant changes in the proportion of participants who reported the symptom on at least half of the days between inpatient and follow-up were noted for three symptoms (Table 2). The portion of participants endorsing appetite

Table 1 Characteristics of the respondents and nonrespondents at follow-up

Variable at baseline ($N = 584$)	Respondents ($N = 227$) <i>M (s.d.)</i>	Nonrespondents ($N = 357$) <i>M (s.d.)</i>	Significance
Age	35.6 (12.8)	30.5 (10.8)	$t(421.69) = -4.98, P < 0.001$
Age at injury	35.5 (12.8)	30.3 (10.8)	$t(421.26) = -4.99, P < 0.001$
Days since injury	53.8 (37.5)	54.2 (73.8)	$t(558.86) = 0.080, NS$
Years of education	13.1 (2.5) %	12.3 (2.5) %	$t(481.59) = -4.01, P < 0.001$
Gender			
Male	74.4	81.6	$\chi^2 (1, n = 540) = 4.02, P = 0.045$
Female	25.6	18.4	
Race			
Caucasian	73.6	66.9	$\chi^2 (1, n = 584) = 2.87, NS$
Non-Caucasian	26.4	33.1	
Injury level			
Cervical	48.0	53.7	$\chi^2 (3, n = 573) = 3.36, NS$
Thoracic	44.0	40.2	
Lumbar	7.6	6.0	
Sacral	0.4	0	
Etiology			
Motor vehicle	48.9	52.7	$\chi^2 (5, n = 584) = 8.39, NS$
Fall/flying objects	18.5	18.5	
Sporting	11.5	12.3	
Violence	10.1	11.2	
Medical/surgical	3.1	2.5	
Other	7.9	2.8	

Abbreviation: NS, not significant.

Table 2 Percentage of the change in distribution of the endorsement of each item 50% or more of the time

Variable	N	Baseline (%)	Follow-up (%)	McNemar statistics
Little interest	219	15.5	20.1	0.237
Feel down	210	9.5	16.7	0.024
Sleep disturbance	216	29.2	31.0	0.716
Poor energy	211	27.0	25.1	0.724
Appetite change	214	29.0	17.3	0.003
Feel bad about self	214	10.7	18.2	0.026
Trouble concentrating	219	12.3	14.2	0.627
Psychomotor changes	214	9.3	13.1	0.243
Self-harm	219	3.7	6.8	0.143

Table 3 Grouped frequency of the overall scores using the breakdown by symptom severity based on scores

Symptom severity	Baseline (N = 540) %	Follow-up (N = 219) %
No depressive symptoms (PHQ-9 = 0)	9.8	16.4
Minimal depressive symptoms (PHQ-9 = 1 to 4)	32.4	33.3
Mild depressive symptoms (PHQ-9 = 5 to 9)	35.9	27.9
Moderate depressive symptoms (PHQ-9 = 10 to 14)	13.3	11.4
Moderate/severe depressive symptoms (PHQ-9 = 15 to 19)	6.1	7.3
Severe depressive symptoms (PHQ-9 = 20 to 27)	2.4	3.7

change decreased from inpatient (29.0%) to follow-up (17.3%). In contrast, there were significant increases in the proportion of participants endorsing feeling down (inpatient = 9.5%, follow-up = 16.7%) and feeling bad about self (inpatient = 10.7%, follow-up = 18.2%).

A summative score for the three somatic items did not significantly change from baseline, although non-somatic items increased ($t(208) = 2.42, P = 0.016$).

Whereas only 9.8% of the participants reported no depressive symptoms at baseline, 16.4% reported no symptoms at the 1-year follow-up (Table 3). Similarly, whereas only 8.5% reported scores of 15 and higher at baseline, 11% scored in this range at follow-up.

Factor analysis

The exploratory factor analysis across the two times of measurement resulted in four factors (RMSEA = 0.045), χ^2 (d.f. = 87) = 191.14, $P = 0.000$. The first and third factors reflect the baseline (those used in the time-lagged regression), whereas the others reflect follow-up data (Table 4). The baseline factors include six items loading with the non-somatic factor and three items loading with the somatic factor (sleep disturbance, poor energy and appetite change). The follow-up factors appear to be quite different, as four items loaded with each factor and the final item, sleep disturbance, loaded nearly identical in both factors (0.42, -0.38).

Table 4 Exploratory factor analysis of all PHQ-9 items across two times of measurement (baseline and 1-year follow-up)

	1	2	3	4
Baseline				
Little interest	(0.41)	-0.09	0.22	-0.03
Feel down	(0.65)	0.23	0.07	0.21
Sleep disturbance	0.02	0.08	(0.62)	0.10
Poor energy	0.00	0.03	(0.79)	0.05
Appetite change	0.21	-0.02	(0.46)	0.03
Feel bad about self	(0.79)	0.06	-0.07	0.11
Trouble concentrating	(0.55)	-0.22	0.11	-0.25
Psychomotor changes	(0.40)	-0.14	0.17	-0.28
Suicidal ideation	(0.48)	0.10	-0.09	-0.04
Follow-up				
Little interest	-0.10	(0.68)	0.18	-0.14
Feel down	0.04	(0.85)	-0.02	-0.03
Sleep disturbance	-0.08	(0.42)	0.12	(-0.38)
Poor energy	-0.04	0.37	-0.01	(-0.57)
Appetite change	0.01	0.24	0.07	(-0.53)
Feel bad about self	0.14	(0.58)	-0.07	-0.22
Trouble concentrating	-0.07	0.24	0.01	(-0.53)
Psychomotor changes	-0.03	-0.08	-0.17	(-0.78)
Suicidal ideation	0.25	(0.49)	-0.14	0.02

The bold values identify the factor with which the item loads.

Figure 1 Model regressing follow-up somatic (S) and non-somatic (NS) latent scores on baseline latent scores. S_B, baseline somatic factor; NS_B, baseline non-somatic factor; S_1, follow-up somatic factor; NS_1, follow-up non-somatic factor.

Regression: time 1 to time 2

Figure 1 summarizes the model regressing follow-up somatic and non-somatic latent scores on baseline latent scores. The vertical lines represent the correlation between the two factors at a single point in time (either at baseline or follow-up), whereas the horizontal lines represent the correlation of a factor measured at baseline with the same factor measured at follow-up. The diagonal lines are the essential component of the time-lagged correlation, as they represent the beta weight of one factor at baseline with the other factor at follow-up (that is, the extent to which each factor at baseline predicts scores on the other factor at follow-up).

The model proved to be a good fit (RMSEA = 0.054). The non-somatic factor at baseline was significantly related to both the non-somatic (+0.67, $P = 0.002$) and somatic factors (+0.53, $P = 0.019$) at follow-up. In contrast, the somatic factor during baseline was not significantly related to either the somatic (+0.10, n.s.) or the non-somatic (-0.01, n.s.)

factors at follow-up. Both latent factors were significantly correlated at baseline ($+0.24$, $P=0.000$) and follow-up ($+0.39$, $P=0.000$).

Discussion

Overall, it appears that somatic symptoms during inpatient rehabilitation are not predictive of future depressive symptoms, either somatic or non-somatic. In contrast, the presence of non-somatic symptoms during inpatient rehabilitation is predictive of future depressive symptomatology, including somatic symptoms.

There is ambiguity over the meaning of somatic items measured during inpatient rehabilitation. Because somatic symptoms during hospitalization were not related to somatic symptoms at 1-year after discharge, the presence of such symptoms during hospitalization is of limited value in predicting future depressive symptoms. These findings are consistent with earlier research with SCI³ and with HIV research that indicated difficulty interpreting somatic symptoms.⁴ However, these findings are inconsistent with research on elderly participants in primary care settings, so the findings do not generalize to all populations and settings.

Limitations

First, although the data are longitudinal, they span only the first approximate 15 months after SCI onset and represent only two points in time of data collection. Second, as with most studies of depressive symptoms, the data are limited to self-report. Similarly, there is no psychological assessment that could be used for diagnostic purposes to help differentiate whether the somatic items are reflective of depression or another parameter. Third, we have no data on types of treatment participants had received. Finally, attrition was relatively high in this study with about 45% lost cases among those who were the focus of the follow-up. Although higher response rates are always preferable, it is important to note that SEM represents a powerful methodology for imputing missing data based on the characteristics and responses of those who do and do not complete follow-up materials. Similarly, we did not include biographic and injury characteristics in the regression analyses, as the differences in characteristics between respondents and nonrespondents were relatively small.

Clinical implications

Because somatic items are of limited value in predicting future depressive symptoms, the presence of somatic complaints during inpatient rehabilitation should be interpreted with caution by rehabilitation psychologists and other professionals. When used in diagnosis, they should only be considered in conjunction with other key symptoms, particularly depressed mood and loss of interest.

Treatment approaches should target non-somatic symptoms. Specifically, treatment strategies may focus on improving affect and increasing participation in activities.

When psychotropic medications are used, they should be evaluated based on changes in non-somatic symptoms.

Although these findings suggest that the PHQ-9 must be used with caution in both clinical evaluations and research studies, the findings do not preclude its use, even during inpatient rehabilitation. However, independent measurement of somatic and non-somatic domains is appropriate.

Future research

At least three types of research are needed. First, more research is needed on the natural course of development of symptoms over time. Second, we need to identify the coping strategies, both favorable and unfavorable, that relate to depressive symptomatology. Lastly and most importantly, we need well-designed intervention studies to develop and test interventions to reduce or eliminate depressive symptoms.

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