Predictive Value of Fear Avoidance in Developing Chronic Neck Pain Disability: Consequences for Clinical Decision Making

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ABSTRACT. Nederhand MJ, IJzerman MJ, Hermens HJ, Turk DC, Zilvold G. Predictive value of fear avoidance in developing chronic neck pain disability: consequences for clinical decision making. Arch Phys Med Rehabil 2004;85: 496-501.

Objective: To improve clinical decision making in posttraumatic neck pain by investigating the additional value of fear-avoidance variables in predicting chronic neck pain disability.

Design: An inception cohort with baseline assessment 1 week posttrauma and outcome assessment 24 weeks posttrauma. Predictive factors include pain intensity, Neck Disability Index (NDI), catastrophizing, fear of movement (Tampa Scale for Kinesiophobia [TSK]), and avoidance muscle behavior.

Setting: Hospital emergency department of a general hospital.

Participants: A consecutive sample of 90 people reporting of pain in neck or head region after a motor vehicle collision. Eighty-two subjects (91.1%) of the sample provided 24-week follow-up on the outcome.

Interventions: Not applicable.

Main Outcome Measure: The NDI assessing physical disability of subjects with neck pain.

Results: By using a combination of the baseline NDI and TSK, it appears to be possible to predict chronic disability with a probability of 54.3% (95% confidence interval [CI], 35.2%–72.3%) after entering the NDI (cutoff, 15) as a first test, and with a probability of 83.3% (95% CI, 70.3%–91.3%) after entering the TSK (cutoff, 40) in a second test.

Conclusions: A simple rating of baseline neck pain disability within a week of the trauma, separately or in combination with a test for fear of movement, can be used to predict future outcome. Patients showing fear of movement can be offered an intervention that focuses on reduction of this fear.

Key Words: Fear; Muscles; Rehabilitation; Whiplash injuries.

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IN WESTERN INDUSTRIALIZED society, the development of chronic pain and related disability after a whiplash injury has become a significant public health problem. Incidence rates vary between 70 per 100,000 yearly in Quebec (Canada)[1] and 106 per 100,000 in Australia.[2] Not only does chronic neck pain affect patients' physical and psychologic well-being, but it also puts a great burden on societal and health care financial resources. The indirect costs per whiplash patient in Canada are estimated to be around Can $2500.[1,3] Consequently, prevention of chronic disability after a whiplash injury is an important objective. The efficacy of prevention is based on 2 essential factors: (1) patients at risk should be identified correctly and (2) preventive actions must have proven to be effective. A thorough understanding of the mechanism by which chronic disability develops is required to accomplish this aim.

With respect to identifying patients at risk, Coté et al[4] systematically reviewed the prognostic factors in whiplash-associated disorder. Coté concluded that the initial pain intensity and related physical manifestations (eg, neck pain on palpation and muscle pain) are important predictors of recovery. In addition, however, sociocultural factors, such as expectation of pain and type of compensation system, appeared to be important predictors. These results indicate that prognosis is multifactorial, integrating physical and nonphysical dimensions.

In addition to the prognostic factors identified in whiplash-associated disorders, recent conceptions in spinal pain suggest that psychologic factors play an important role in the transition of the acute to the chronic phase.[5,6] These factors may have relevance in predicting future outcome in acute posttraumatic neck pain as well. In particular, the fear-avoidance model of Vlaeyen et al[7] offers a framework for conceptualizing the process of developing chronic musculoskeletal pain. It postulates 2 opposing behavioral responses: confrontation and avoidance. In addition, the model suggests possible pathways by which injured patients become enmeshed in a downward spiral of increasing avoidance, disability, and pain. The central element in this model is that avoidance behavior will evolve. This is especially the case in patients who interpret pain as threatening (pain catastrophizing) and exhibit fear of movement (or kinesiophobia). Several prospective studies[8-12] have confirmed the importance of this model, demonstrating that catastrophizing and fear-avoidance beliefs are important predictors of the development of chronic low back pain (CLBP).

A recent study[13] in patients with whiplash-associated disorders suggested that the fear-avoidance model could, in addition to its relevance in low back pain (LBP), be generalized to posttraumatic neck pain. In that study, neck pain patients with a high degree of disability showed avoidance of contraction of painful neck muscles during exercise. An additional analysis confirmed the assumption that the decrease in activation level was associated with fear of movement (Nederhand MJ et al, unpublished data, 2003).

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The aim of our study was to improve clinical decision making in patients with acute posttraumatic neck pain and to enable an early intervention to prevent chronic symptoms. Therefore, we investigated whether fear-avoidance variables have additional value in predicting future outcome when compared with established prognostic factors in posttraumatic neck pain. Characterization of the behavioral response to pain—confrontation or avoidance—will provide an initial indication of the target for intervention. The question addressed in this study was to what extent the fear-avoidance variables of *catastrophizing*, *fear of movement*, and the associated *avoidance muscle behavior* can predict chronic neck pain disability.

METHODS

Participants

The sample of subjects included in our study was part of an inception cohort. Their characteristics have been described in detail in an earlier article[13] Briefly, the sample consisted of patients admitted to the emergency department of a general hospital after a motor vehicle collision (MVC), between July 1999 and December 2001. Patients were considered eligible for our study if they were between 18 and 70 years and reported pain in neck or head region that started within 48 hours of the collision. Furthermore, some form of acceleration or deceleration of the motor vehicle, caused by colliding either with another vehicle or with a stationary object (eg, a wall or traffic light), was identified. Subjects with signs of a concussion, retrograde or posttraumatic amnesia, serious injuries (eg, fractures, traumatic internal organic pathology), or any neurologic signs were excluded. Thus, the subjects met the Quebec criteria for whiplash-associated disorders grades 1 or 2. To be included, subjects also had to be able to speak and read the Dutch language. Approval of the medical ethics committee was obtained, and all participants were asked to complete an informed consent form before the study began.

Predictive Factors

Neck Disability Index. The Neck Disability Index (NDI) is a 10-item, self-reporting instrument for the assessment of physical disability of subjects with neck pain, particularly from whiplash-type injuries.[14] The index was developed as a modification of the Oswestry Disability Index for LBP.[15] The NDI has been shown to have a high degree of test-retest reliability, internal consistency, and an acceptable level of validity being sensitive to severity levels and to changes in severity over time.[14,16] Disability categories for the NDI are 0 to 4, no disability; 5 to 14, mild; 15 to 24, moderate; 25 to 34, severe; and above 34, complete. A 5-point change is required to be clinically meaningful.[16]

Pain intensity. Pain intensity was performed by using a visual analog scale (VAS; consisting of 2 vertical marks placed 100mm apart, marked on the left with "No pain" and on the right with "Worst pain ever experienced"). Subjects were asked to rate the average pain intensity they experienced during the period from onset of the pain to the electromyographic assessments. A pain VAS score of 30mm or more is considered moderate pain, and VAS scores above 54mm are considered severe pain.[17]

Fear of movement and/or (re)injury. The Dutch version of the Tampa Scale for Kinesiophobia[18] (TSK) is a 17-item questionnaire that is designed to assess fear of movement (eg, "Simply being careful that I do not make any unnecessary movements is the safest thing I can do to prevent my pain from worsening") and fear of (re)injury (eg, "Pain always means I have injured my body"). Several studies[7,19,20] have found support for the validity (ie, predictive validity, construct validity) and reliability (ie, internal consistency, test-retest reliability). Each item is scored on a 4-point Likert-type scale, ranging from "strongly agree" to "strongly disagree." Sum scores range from 17 to 68, with higher scores indicating more fear of movement and/or (re)injury.

Catastrophizing. The Pain Cognition List–Experimental version (PCL-E) is a 77-item questionnaire designed to assess distorted pain cognitions and experienced self-control. The PCL has been shown to have a high degree of test-retest reliability, internal consistency, and an acceptable level of validity (ie, predictive validity, construct validity).[21] The results are presented in pain impact, catastrophizing, outcome efficacy, acquiescence, and reliance on health care. For our study only, the PCL catastrophizing subscale was used. This variable is considered an exaggerated negative orientation toward noxious stimuli and correlates highly with depressive symptoms (eg, "My thoughts are always focused on the pain" or "When the pain gets more serious I feel anger and hostility"). The mean value $\pm$ standard deviation (SD) for a group of 188 patients with CLBP was 49.1 ± 14.3.[21] Higher scores indicate more catastrophizing thoughts.

Isometric muscle activation. The methods we used to assess surface electromyography of the upper trapezius muscles have been described in detail elsewhere.[13] Briefly, the isometric muscle activity was obtained with the subjects seated in a desk chair with their backs supported and their hips and knees in 90° of flexion. Arms were held straight and horizontal in 90° of abduction in the frontal plane of the body, with the hands relaxed and the palms pointing downward. Four epochs of upper trapezius raw electromyographic activity were obtained and processed to a smooth rectified electromyogram. Each epoch lasted 15 seconds, separated by a 1-minute rest between the consecutive epochs. The mean smooth rectified electromyographic activity was calculated for the middle 10 seconds of each recorded epoch. Isometric muscle activity is computed as the mean muscle activity of the dominant arm during the performance of the isometric physical task. Isometric muscle activity is considered to reflect avoidance muscle behavior, as was shown in additional analysis of the data of our study. These investigations showed that the decrease in muscle activity was associated with kinesiophobia (MJ Nederhand et al, unpublished data, 2003).

Outcomes

We divided the cohort of subjects into 1 group that recovered from initial complaints (NDI score, <15) and a second group that developed chronic neck pain disability (NDI score, ≥ 15) at 24 weeks postinjury. We chose this cutoff point because all the patients enrolled in our multidisciplinary rehabilitation program have NDI scores higher than 15 (NDI mean, 24.4 ± 7.1; personal data). In this population, the extent of disability was so severe that it was associated with a high degree of interference with daily life and a high degree of medical consumption.

Statistical Analysis

Differences in baseline characteristics between the recovered and disabled groups were analyzed by the Student t test for scale measures and by the chi-square test for nominal and ordinal measures. Differences in outcome of the experimental group and the group of subjects that completed only the questionnaire at 24 weeks (fig 1) were tested with the nonparametric Mann-Whitney U test. As such, we could test whether the results of the experimental group were biased because of differences in selection.

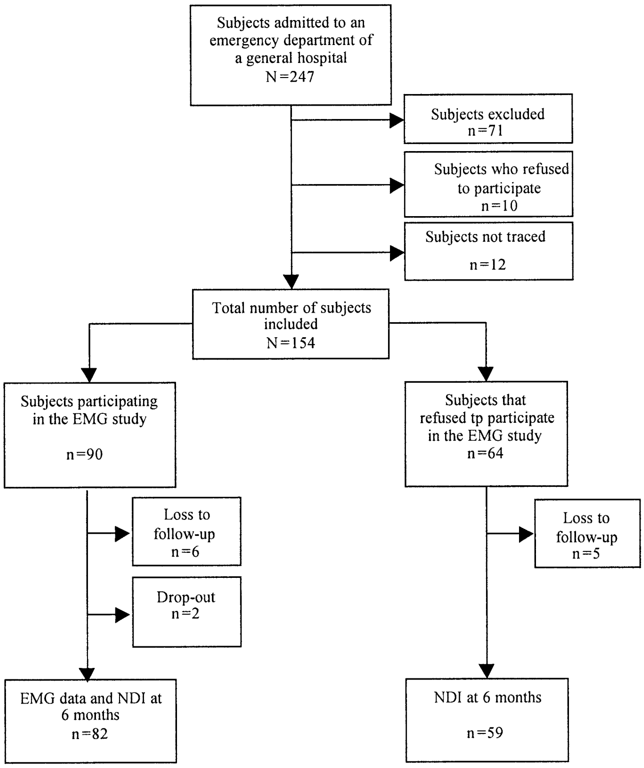

Fig 1. Patients participating in the study. Abbreviation: EMG, electromyographic.

Receiver operating characteristic (ROC) curves were used to determine the overall accuracy of each variable separately and in combination with a second variable. We used 90% sensitivity as the decisive criterion in determining the cutoff points for dichotomizing the sample. The actual cutoff values that were determined for the different determinants are displayed in table 1. Sensitivity instead of specificity was used because we did not expect serious adverse effects of treatment in patients with a false-positive test result.

The variable with the most optimal predictive value was analyzed first, followed by each of the other variables, conditional on the first test. The increase in posttest probability of the second test was calculated conditional on the posttest probability of the first test. Data were analyzed by using the SPSS statistical package, version 10.0,[a] for Windows. *P* values less than .05 were considered statistically significant.

RESULTS

Of the 247 admitted patients, 71 failed to meet the inclusion criteria, 10 refused to participate, and 12 could not be traced because of unknown telephone number or address. Of the 154 subjects eligible for the study, 90 (58%) participated. The remaining 64 subjects did not participate in the study but agreed to be contacted at follow-up for assessing the NDI. In the group of 90 subjects, 6 subjects were lost to follow-up without known reason, 1 subject dropped out because of a second collision, and 1 subject was not included in the analysis because of suspected malingering (fig 1). Thus, 91.1% (n=82) of the sample provided 24-week follow-up on the NDI. In the group of 64 subjects who did not participate in the study, 5 subjects were lost to follow-up without known reason. At 24 weeks, the NDI score of the experimental group (mean NDI score, 10.2; 10th–90th percentile, 0.0–25.7) did not differ significantly from the group of subjects that only completed the NDI (mean, 8.2; 10th–90th percentile, 0.0–24) (Mann-Whitney *U* test, $z=-.953$, $P=.341$). Thus, selection bias related to disability level at the time of initial assessment was unlikely.

Patient characteristics, electromyographic assessments, and the questionnaires were obtained on average 8.1±3.7 days after the MVC. Twenty-four weeks later, the subjects were classified on the basis of their NDI scores as disabled (n=27) and recovered (n=55). Baseline characteristics of the 2 groups (table 2) revealed that the disabled patients have a higher mean body mass index (BMI), suffer from more intense neck pain and disability, and have higher responses on the TSK and PCL catastrophizing subscale and lower isometric muscle activity levels. There were no significant differences on any of the demographic or collision-related variables.

The overall accuracy of the 5 predictive tests, as determined by ROC curves, showed an area under the curve (AUC) that was statistically significant higher than 0.5 (table 1). The NDI (AUC=.872; 95% confidence interval [CI], .794–.950) and pain VAS (AUC=.820; 95% CI, .727–.912) showed the greatest capacity to predict outcome 24 weeks postaccident. Isometric muscle activity levels appeared to have the least predictive ability (AUC=.707; 95% CI, .588–.826). We chose to use the NDI as a first test, as the best predictor, and then to test whether further improvement in predictive value could be achieved when combining this variable with each of the other variables. The overall test accuracy showed that each combination of tests resulted in a statistically significant AUC higher than 0.5 (table 1). The TSK score (AUC=.770; 95% CI, .634–.907) appeared to have the best ability to further increase the predictive value, when used as a second test.

Figure 2 visually depicts an evaluation scenario using the combination of NDI with a cutoff point of 15 as a first test,

Table 1: Test Performance of 5 Predictive Tests, Separately and in Combination

			First Test					Second Test (conditional on NDI as first test)	
	AUC	95% CI	Cutoff	LR+	PPV	LR−	NPV	AUC	95% CI
NDI	.872	.794–.950	15	2.4	54.3	0.11	5.6		
VAS	.820	.727–.912	27	1.9	48.1	0.14	6.9	.718	.569–.867
TSK	.763	.659–.866	34	1.7	45.5	0.16	7.7	.770	.634–.907
PCL-E	.782	.676–.888	15	1.4	41.7	0.2	9.5	.734	.588–.881
IMA	.707	.588–.826	165	1.3	38.5	0.26	11.8	.683	.523–.843

NOTE. For calculation of the positive predictive value (PPV) and the negative predictive value (NPV), the prevalence of disability was estimated from our study.
Abbreviations: AUC, area under the receiver operating curve; CI, confidence interval; IMA, isometric muscle activity; LR−, likelihood ratio for a negative test result; LR+, likelihood ratio for a positive test result; PCL-E, PCL-E catastrophizing subscale.

Table 2: Baseline Characteristics of Posttraumatic Neck Pain Patients

	Nondisabled (n=55)	Disabled (n=27)	Difference
Age (y)	33.0±11.2	38.0±12.7	.071‡
Men/women	20/25	5/22	.128‖
BMI (kg/m²)	24.1±4.0	26.8±5.7	.015‡
Site of collision (front/rear/side)	10/37/8	3/22/2	.399‖
Estimated speed of collision* (kph)	50.4±23.1	56.2±25.0	.355‡
Isometric muscle activity	141.2±70.3	96±50.1	.004‡
VAS	33.6±20.5	60.7±19.4	.000‡
TSK (10th–90th percentile)	35.0 (26.0–45.0)	41.5 (33.8–50.4)	.000†
PCL-E catastrophizing subscale	28.6±22.2)	53.2±24.4)	.000‡
NDI (10th–90th percentile)	14.2 (4.6–25.4)	27.9 (15.4–40.0)	.000†

NOTE. Values are mean ± SD or as otherwise indicated.
*Depending on the direction of travel and the site of impact of cars, the speed at the time of collision was estimated by the addition of the 2 speeds in case of head-on collision, the difference in the speed of the 2 cars in case of rear collision, and the speed of the car colliding from the side in case of side collision.
†Mann-Whitney *U* test.
‡Student *t* test.
‖Chi-square test.

followed by the TSK with a cutoff point of 40 as a second test. Scoring positive (NDI score, ≥15) in the NDI as a first test resulted in a probability of disease of 54.3% (95% CI, 35.2%–72.3%). Following the positive NDI test score with a positive TSK score (TSK score, ≥40) further increased the prediction of disease to 83.3% (95% CI, 70.3%–91.3%) in 18 of 46 patients. However, when a positive NDI test score was followed by a negative TSK score (TSK, <41), 28 of the 46 patients did not benefit from the second test because the resulting probability of disability was almost similar to the pretest probability of 33%. The negative predictive value determined by the NDI in a first test was 5.6%, or conversely, the probability of a favorable outcome was 94.6%, and this was valid for 36 of 82 patients. Additional testing with the TSK did not improve this posttest probability substantially.

DISCUSSION

The aim of our study was to improve clinical decision making in patients with acute posttraumatic neck pain caused by a whiplash injury. The results indicated that a simple rating of baseline neck pain disability (NDI) can be used to predict which patients will still be disabled 6 months after a whiplash injury. Furthermore, combining the baseline neck pain disability with fear of movement improves the prediction of outcome significantly. These variables, either separately or in combination, are capable of identifying which patients require an early intervention to prevent chronic disability. Interventions that promote physical activity have proven to be most effective in the early treatment of posttraumatic neck pain patients[22-24]; consequently, patients showing avoidance behavior should be encouraged to confront physical activity, despite pain, to prevent chronic symptoms.

Our study differs from others investigating the prediction of chronic posttraumatic neck pain in several ways. The results of our study provide additional information that may be useful in the management of acute posttraumatic neck pain. By evaluating the involvement of fear avoidance in the acute pain situation, the patients at risk for showing an avoidance behavior style can be identified. This behavior may seriously interfere with the active intervention programs and thus slow recovery. Thus, providing patients who have high fear of movement with a structured treatment program, focusing on gradual confrontation with fear-eliciting activities, might increase the efficacy of active treatment. The effectiveness of

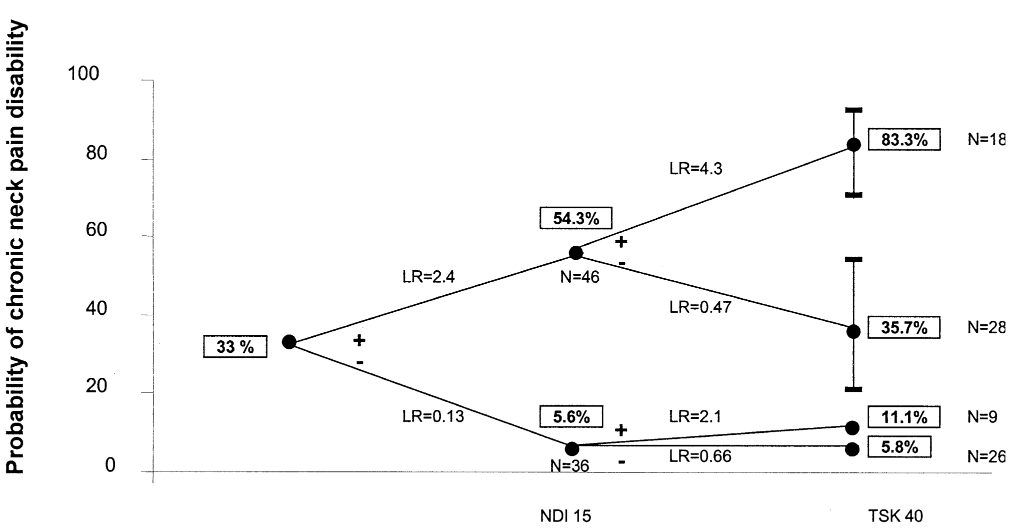

Fig 2. Probability plot combining the NDI (cutoff, 15) and TSK (cutoff, 40). Abbreviation: LR, likelihood ratio. Legend, −, negative test result; +, positive test results.

such a "graded exposure in vivo" treatment program was shown in patients with CLBP.[25,26] By gradually confronting the patients with physical activity that was perceived as harmful, the level of fear of movement, fear of pain, and pain catastrophizing were decreased. This was accompanied by an improvement in physical functioning.

Another difference between our study and other prognostic studies concerns the methodology. Most often, a regression model is used that calculates the most optimal combination of tests that can maximally predict outcome. The choice of determinants in such a model is based on statistical grounds. In our study, we calculated the subsequent change in probability of the second test conditional on the first test. Such a test sequence not only enables us to calculate the additional predictive value of a second test, but it also provides clinical information on 4 test results with easier interpretation for clinical purpose. The increase in prediction of outcome by using the TSK as a second test gives direction to treatment strategy. The baseline NDI cutoff point of 15 identifies patients who perceive the acute pain situation as seriously interfering with daily activities. If their situation does not change, they may need intensive multidimensional rehabilitation in the future. Furthermore, the TSK cutoff point of 40 was chosen because the study by Vlaeyen et al[25] showed that particularly those patients with such a high fear of movement (or higher) may benefit from graded exposure in vivo treatment, focusing on confrontation with fear-eliciting activities.

In addition to the effectiveness of graded exposure in vivo in clinical experiments, use of a booklet with information and advice on fear-avoidance beliefs in the primary care setting have proven to be effective in improving clinical outcome.[27] Structured advice and an information booklet may also be very helpful in the emergency department of hospitals[28] because pain originating from traumatic events may cause fear-avoidance beliefs.[29]

The role of the isometric muscle activation in predicting outcome was modest. The test accuracy was low compared with the NDI and the TSK. However, the additional advantage of isometric muscle activity is that it may identify patients in whom fear of movement actually is accompanied by a change in physical performance. The fear-avoidance model assumes that a persistent reduction in daily physical activity may result in a worsened physical condition in the long term, thereby contributing to physical disability.[30,31] Although the decrease in muscle activity has been shown to be associated with fear of movement (MJ Nederhand et al, unpublished data), whether persistence of this decreased muscle activity will result in physical deconditioning needs to be demonstrated. It is not clear whether retraining of normal muscle coordination can increase the effectiveness of an active intervention program.

The results of our study need to be interpreted cautiously. Particularly in posttraumatic neck pain, symptom expectation and amplification are suggested to contribute to chronicity of the condition.[32] This is supported by the fact that, in cultures with low therapeutic involvement and no litigation, symptoms tend to be short lived with little or no link to chronicity.[33,34] Because the sample of subjects in this study was assessed repeatedly during follow-up for other analyses,[13] it is likely that there was increased attention to the symptoms. The assessments took place in a research department of a rehabilitation clinic that is well known in the region for its rehabilitation of whiplash patients. Consequently, because of repeated visits to the research laboratory, the effects of symptom expectation and amplification in some patients cannot be ruled out. In general, the validity of prediction of a (set of) variables requires external validation (eg, in an independent population, or alternatively, by using a statistical technique with sample splitting). To decrease the effects of symptom amplification, a replication of our study with only a baseline and outcome assessment may result in a more representative prevalence of disabled patients and in more accurate predictive values.

CONCLUSIONS

With regard to the practical implications of our study, the assessments of the NDI and the TSK ask simple questions, which appear to be easily understood and require only a few minutes to complete. This implies that, even in emergency departments, a quick risk profile can be achieved and the decision to prescribe an active intervention program or just watchful waiting can be easily made. In addition, because of the hectic situation in emergency departments, booklets with advice and information on fear-avoidance[27,28] beliefs may be used as a good alternative to more extensive intervention.

References

1. Spitzer WO, Skovron ML, Salmi LR, et al. Scientific monograph of the Quebec Task Force on Whiplash-Associated Disorders: redefining "whiplash" and its management. Spine 1995;20(8 Suppl):S1-73.
2. Mills H, Horne G. Whiplash—manmade disease? N Z Med J 1986;99:373-4.
3. Suissa S, Harder S, Veilleux M. The relation between initial symptoms and signs and the prognosis of whiplash. Eur Spine J 2001;10:44-9.
4. Coté P, Cassidy JD, Carroll L, Frank JW, Bombardier C. A systematic review of the prognosis of acute whiplash and a new conceptual framework to synthesize the literature. Spine 2001;19: E445-58.
5. Linton SJ. A review of psychological risk factors in back and neck pain. Spine 2000;25:1148-56.
6. Turk DC, Okifuji A. Psychological factors in chronic pain: evolution and revolution. J Consult Clin Psychol 2002;70:678-90.
7. Vlaeyen JW, Kole-Snijders AM, Rotteveel A, Ruesink R, Heuts PH. The role of fear of movement/(re)injury in pain disability. J Occup Rehabil 1995;5:235-52.
8. Burton AK, Tillotson KM, Main CJ, Hollis S. Psychosocial predictors of outcome in acute and subchronic low back problem. Spine 1995;20:722-8.
9. Hasenbring M, Marienfeld G, Kuhlendahl D, Soyka D. Risk factors of chronicity in lumbar disk patients. A prospective investigation of biologic, psychologic, and social predictors of therapy outcome. Spine 1994;19:2759-65.
10. Klenerman L, Slade PD, Stanley IM, et al. The prediction of chronicity in patients with an acute attack of low back pain in a general practice setting. Spine 1995;20:478-84.
11. Picavet HS, Vlaeyen JW, Schouten JS. Pain catastrophizing and kinesiophobia: predictors of chronic low back pain. Am J Epidemiol 2002;156:1028-34.
12. Potter RG, Jones JM. The evolution of chronic pain among patients with musculoskeletal problems: a pilot study in primary care. Br J Gen Pract 1992;42:462-4.
13. Nederhand MJ, Hermens HJ, Ijzerman MJ, Turk DC, Zilvold G. Chronic neck pain disability due to an acute whiplash injury. Pain 2003;102:63-71.
14. Vernon H, Mior S. The Neck Disability Index: a study of reliability and validity. J Manipulative Physiol Ther 1991;14:409-15.
15. Fairbank JC, Couper J, Davies JB, O'Brien JP. The Oswestry low back pain disability questionnaire. Physiotherapy 1980;66:271-3.
16. Stratford PW, Riddle DL, Binkley JM, Spadoni G, Westaway MD, Padfield B. Using the Neck Disability Index to make decisions concerning individual patients. Physiother Can 1999;51: 107-12.
17. Collins SL, Moore RA, McQuay HJ. The visual analogue pain intensity scale: what is moderate pain in millimeters? Pain 1997; 72:95-7.

18. Goubert L, Crombez G, Vlaeyen JW, van Damme S, Van den Broeck A, Van Houdenhove B. De Tampa schaal voor kinesiofobie. Gedrag Gezondheid 1999;28:54-62.
19. Crombez G, Vlaeyen JW, Heuts PH, Lysens R. Pain related fear is more disabling than pain itself: evidence on the role of pain-related fear in chronic back pain disability. Pain 1999;80:329-39.
20. Crombez G, Vervaet L, Lysens R, Baeyens F, Eelen P. Avoidance and confrontation in painful, backstraining movements in chronic back pain patients. Behav Modif 1998;22:62-77.
21. Vlaeyen JW, Geurts SM, Kole Snijders AM, Schuerman JA, Groenman NH, van Eek H. What do chronic pain patients think of their pain? Towards a pain cognition questionnaire. Br J Clin Psychol 1990;29:383-94.
22. Borchgrevink GE, Kaasa A, McDonagh D, Stiles TC, Haraldseth O, Lereim I. Acute treatment of whiplash neck sprain injuries. A randomized trial of treatment during the first 14 days after a car accident. Spine 1998;23:25-31.
23. Peeters GG, Verhagen AP, de Bie RA, Oostendorp RA. The efficacy of conservative treatment in patients with whiplash injury. A systematic review of clinical trials. Spine 2001;26:E64-73.
24. Provincialli L, Baroni M, Illuminati L, Ceravolo MG. Multimodal treatment to prevent the late whiplash syndrome. Scand J Rehabil Med 1996;28:105-11.
25. Vlaeyen JW, de Jong J, Geilen M, Heuts PH, van Breukelen G. Graded exposure in vivo in the treatment of pain related fear: a replicated single case experimental design in four patients with chronic low back pain. Behav Res Ther 2001;39:151-66.
26. Vlaeyen JW, de Jong J, Geilen M, Heuts PH, van Breukelen G. The treatment of fear of movement/(re)injury in chronic low back pain: further evidence of the effectiveness of exposure in vivo. Clin J Pain 2002;18:251-61.
27. Burton AK, Waddell G, Tillotson M, Summerton N. Information and advice to patients with back pain can have a positive effect. A randomised controlled trial of a novel educational booklet in primary care. Spine 1999;24:2484-91.
28. McClune T, Burton AK, Wadell G. Whiplash associated disorders: a review of the literature to guide patient information and advice. Emerg Med J 2002;19:499-506.
29. Turk DC, Holzman AD. Chronic pain: interfaces among physical, psychological and social parameters. In Holzman AD, Turk DC, editors. Pain management: a handbook of psychological treatment approaches. New York: Pergamon; 1986. p 1-9.
30. Wagenmakers AJ, Coakley JH, Edwards RH. The metabolic consequences of reduced habitual activities in patients with muscle pain and disease. Ergonomics 1988;31:1519-27.
31. Vlaeyen JW, Linton SJ. Fear avoidance and its consequences in chronic musculoskeletal pain: a state of the art. Pain 2000;85:317-32.
32. Ferrari R, Schrader H. The late whiplash syndrome: a biopsychosocial approach. J Neurol Neurosurg Psychiatry 2001;70:722-6.
33. Obelieniene D, Schrader H, Bovim G, Miseviciene I, Sand T. Pain after whiplash: a prospective controlled inception cohort study. J Neurol Neurosurg Psychiatry 1999;66:279-83.
34. Partheni M, Constantoyannis C, Ferrari R, Nikiforidis G, Voulgaris S, Papadakis N. A prospective cohort study of the outcome of acute whiplash injury in Greece. Clin Exp Rheumatol 2000;18:67-70.

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a. SPSS Inc, 233 S Wacker Dr, 11th Fl, Chicago, IL 60606.