Predictive Factors for Abnormal Illness Behavior in Low Back Pain

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The objective of this study was to develop a self-administered checklist of behavioral characteristics indicative of abnormal illness behavior. A 32-item questionnaire was distributed to 237 consecutive patients with primary complaints of low back pain in fifteen rehabilitation facilities across Canada. Multivariable (forward stepwise) logistic regression revealed five key predictors of abnormal illness behavior: (1) blaming others for his or her situation, (2) negative family/workplace/social situations, (3) receiving financial compensation, (4) involved in litigation, and (5) sleep disturbance. For those with fewer than three predictors, the chance of abnormal illness behavior was about 40 percent. The chance of abnormal illness behavior jumped to more than 96 percent for those with four or more predictors. This validated questionnaire is both sensitive and specific.

Key words: *abnormal illness, back pain, behavior, logistic, predictor, questionnaire, regression, validation*

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Introduction

Psychologic and behavioral changes are a normal, universal human response to pain. Mechanic[1] coined the term illness behavior to denote the way individuals perceive, evaluate, and react to painful sensations.

The importance of psychologic distress and illness behavior is well recognized in low-back pain.[2] While most individuals are able to resolve or significantly reduce their pain experience either spontaneously or through suitable treatment, some patients react inappropriately to the original nociceptive pain stimulus in the motion segment and develop abnormal, nonphysiologic behavioral and psychological responses. When this occurs, the dominant disability is no longer primarily musculoskeletal and the medical explanation for the physical symptoms is secondary. For this subset of patients the presentation is influenced significantly by superimposed psychosocial factors, and motor performance does not necessarily reflect physical capacity or structural limitations of neuromusculoskeletal function.

Abnormal illness behavior exists when psychologic distress is communicated in bodily terms and no adequate

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organic cause can be established for the physical symptoms. It is a maladaptive, persistent mode of experiencing, perceiving, evaluating, or responding to one's own state of health.[3]

Patients whose low back pain is one manifestation of such abnormal illness behavior present a diagnostic challenge. Because these individuals have generally not adopted effective pain-coping strategies, they exhibit a perplexing mixture of persistent signs and symptoms. Negative attitudes and low expectations create disease conviction and strong resistance to clinicians' reassurance. This typical psychological profile influences the outcome. As a result, chronic low back disability has become a difficult, costly diagnostic and therapeutic dilemma, absorbing considerable medical care.

Psychologic characteristics are strong predictors of response to physiotherapeutic treatment. Decades of research and clinical experience with chronic low back pain patients have generated an extensive catalog of psychosocial manifestations and personality traits characteristic of pain behavior. A literature review by Cats-Baril and Frymoyer[4] showed a multitude of predominantly non-biological factors correlated with low back pain disability. Waddell's[5] signs of non-organic pain behavior are most likely in the group with greater than 3 months of pain, but these tests have not shown an ability to identify acute patients at risk for abnormal illness behavior. Numerous psychometric instruments, including the Modified Somatic Perception Questionnaire[6] the Zung Depression Scale,[7] and the Illness Behavior Questionnaire,[8] have been developed to detect psychologic disturbances. While these are useful tools to explicate suspected psychologic disorders, their length and complexity often deter the busy clinician from using them to screen for the early manifestations of non-organic pain behavior.

Burton et al[9] demonstrated that distress can present early in the course of low back pain, indicating that the psychosocial aspects of disability are not necessarily a function of chronicity. The early identification of patients at risk for pain and distress behaviors leading to chronic disability may help focus treatment and reduce costs.

Using a short, simple questionnaire may help identify those at risk for developing significant psychosocial disturbances and disability. To be clinically useful and cost-effective, the questionnaire would have to improve upon the capability of an experienced examiner to accurately identify incipient pain behavior. In the acute stage, such a questionnaire might then alert the clinician to patients requiring special attention or additional care.

Purpose

The objective of this study was to develop a self-administered checklist of behavioral characteristics indicative of abnormal illness behavior among individuals with low back pain complaints. The goal was to provide clinicians with a simple, brief, comprehensive, easily administered questionnaire to help identify or predict abnormal illness behavior.

Methods

From November 1 to December 31, 1996, a 32-item questionnaire was distributed to 237 consecutive patients at their initial assessment for a primary complaint of low back pain in 15 physiotherapy rehabilitation clinics across Canada. The authors developed the questions based upon a review of the existing literature, input from an expert panel, and personal clinical experience treating chronic pain and illness behavior patients. All questions required yes/no binary responses. Questionnaires were forwarded to the Canadian Back Institute (CBI) Research Department. Only the 200 completed questionnaires were analyzed.

Experienced physiotherapists examined every patient using a standardized complete history and physical examination to diagnose the pattern of mechanical back pain. The history included information on pain location, intensity, frequency, duration, and response to activity. History addressed mechanism of injury, past history, and previous treatment. The physical assessment included mechanical and neurologic examinations, repetitive movements to establish symptom response, and Waddell's non-organic tests.[5]

At the end of the first visit and without reference to the questionnaire, the clinician used a nine-item checklist to categorize the patient as exhibiting either abnormal illness behavior (IB) (study) or no abnormal illness behavior (control). The checklist was based on the history and the patient's ability to complete the physical examination. Those with at least four positive attributes were diagnosed as having abnormal illness behavior.

No significant difference was observed between groups for the variables of age and gender. Both were consistent with the average demographics of the general CBI patient population. The overall mean age was 42.5 years (standard deviation [SD] 13.5 years, range 18–82 years). In the abnormal illness behavior group, the mean age was 41.7 years (SD 11.5 years, range 23–73 years); in the non-abnormal illness behavior group, the mean age was 42.9 years (SD 14.4 years, range 18–82 years). Males comprised 52 percent of the total sample; 51 percent in the abnormal illness behavior group, 52 percent in the non-abnormal group.

The clinics used to accumulate patient volunteers are primary access, rehabilitation facilities that focus on pain control in acute, sub-acute, and chronic ambulatory populations. Patients typically present with mechanical spinal pain of musculoskeletal origin. Patients with suspected systemic disease or cases resulting from trauma sufficient to produce severe bony injury or major neurologic sequelae are referred elsewhere.

Analysis

Statistical analysis was performed using the SAS System for Windows version 6.10 (SAS Institute, Cary, NC, 1993). To reduce the number of variables, eight questions were deleted from the analysis because of the similarity to other questions; two were not analyzed because they were open-ended questions; three other questions were not analyzed because patients frequently changed the wording of either the questions or the responses thereby altering the meaning/intent of the questions.

Regression modeling

Logistic regression analysis was used to model the relationship between the binary response variable (abnormal illness behavior present/absent) and the remaining nineteen explanatory variables (questionnaire responses coded 0 = no, 1 = yes). Univariate logistic regression analysis was used to identify significant associations between each potential predictor and the dichotomous outcome. An alpha level of 0.05 (two-sided) was used as the criterion for statistical significance. The subset of significant univariate predictors was included in a logistic regression to find the best multivariable model predicting the outcome. The values for the unadjusted (univariate) and adjusted (multivariable—forward stepwise) analyses are derived from the Wald test of significance of each covariate.

The potential predictors were entered into the model in a stepwise manner, beginning with the feature that accounted for the largest proportion of the variance of the outcome. In this way, it was possible to identify the minimum number of features that had independent prognostic significance.[10] Each variable that was not significant in the univariate analyses was added one at a time to the chosen model to find if it then made a significant contribution. Since model selection techniques are exploratory, and because of the criticisms of model selection algorithms,[12] the Best Subset Selection method[12] was also used for model development.

Probabilities

Predicted probabilities were calculated from the binary logistic regression model to estimate the probability that a given individual has abnormal illness behavior. The probabilities differed slightly depending on which predictive factors from the final model were present. Because of the large number of combinations in this sample, the predicted probabilities were averaged and summarized based upon the presence of any one factor or combination of factors.

Validation

If the same set of data used to fit the model is used to test the predictive accuracy of the model, it is likely to be positively biased. Two methods for obtaining a nearly unbiased internal assessment of the predictive accuracy of a model from the original sample are: (1) datasplitting and (2) receiver operating characteristic (ROC) curve.

During datasplitting, a random sample of approximately two thirds of the completed questionnaires (n=135) was used to develop the model (BUILD sample). This BUILD sample and the remainder of the data were then pooled together (TEST sample) to assess the accuracy of the prediction model.

The ROC curve is a graphic display that measures the predictive accuracy of a logistic regression model over a range of cutoff points. The area under the curve is not an extremely sensitive measure when comparing models but is ideally suited for independent data that are not used to fit the model.[13] A ROC curve was computed for the validation sample (TEST sample).

Results

Modeling

For the 200 patients with fully completed surveys, seventy individuals were independently judged to display abnormal illness behavior. The randomly selected BUILD sample contained forty-six of these patients. Univariate logistic regression on the BUILD sample showed statistically significant increases in odds of abnormal illness behavior for fourteen of the factors in the survey (Table 1).

After controlling for the effects of the other variables, five of the predictors remained significant in the multivariable analysis. Five key factors relating to abnormal illness behavior were: (1) blaming others for his or her situation, (2) negative family/workplace/social situations, (3) receiving

Table 1

UNIVARIATE LOGISTIC REGRESSION STATISTICS FOR THE ASSOCIATION BETWEEN INDIVIDUAL QUESTIONNAIRE ITEMS AND ABNORMAL ILLNESS BEHAVIOR USING A 2/3 RANDOM SAMPLE (BUILD SAMPLE) OF THE FULL DATASET

Variable	Parameter Estimate	Standard Error	Odds Ratio	*p*-value
1. blaming others	3.6181	0.6583	37.267	0.0001
2. multiple injuries†	0.7043	0.3972	2.022	0.0762
3. financial compensation	2.7535	0.4468	15.697	0.0001
4. deteriorating condition	1.1514	0.3894	3.163	0.0031
5. assistance with personal care	2.0954	0.5575	8.129	0.0002
6. high previous level of activity	1.2384	0.3892	3.450	0.0015
7. constant pain	1.7611	0.4455	5.819	0.0001
8 poor response to medication	1.9643	0.4042	7.13	0.0001
9. sexual dysfunction	2.6266	0.4636	13.827	0.0001
10. multiple consultations	1.509	0.409	4.522	0.0002
11. litigation	2.47	0.5492	11.822	0.0001
12. in pain > 6 months†	0.4521	0.3703	1.572	0.2221
13. currently employed	1.4077	0.5916	4.086	0.0173
14. negative F.W.S. situations	0.9436	0.4829	18.984	0.0001
15. insisting physical diagnosis	1.9985	0.524	7.378	0.0001
16. sleep disturbance	2.509	0.5648	12.293	0.0001
17. walking aids†	0.6817	1.017	1.977	0.5026
18. age†	–0.015	0.0145	0.985	0.299
19. sex†	–0.1476	0.3704	0.863	0.690

†not statistically significant
F.W.S. = family, workplace, social

financial compensation, (4) involved in litigation, and (5) sleep disturbance (Table 2). The Best Subset Selection modeling method confirmed the same five predictors as the model with the highest score value based on the BUILD sample. These were the predictors that were subject to validation.

The goodness of fit of this model was tested using two measures: (1) Akaike Information Criterion (AIC) and (2) Hosmer and Lemeshow goodness of fit test.[12] As each of the five predictors was added to the baseline intercept only model, the AIC continued to decrease from 125.9 to 80.2, indicating increasing goodness of fit. The Hosmer and Lemeshow goodness of fit test for logistic regression models with binary responses had a value of 4.69 on 5 degrees of freedom (p=0.4547) for this model. Thus, the null hypothesis that the model provides a good fit to the data cannot be rejected.

Tables 3a and 3b show the predicted probabilities of abnormal illness behavior for the TEST sample. Only one patient with abnormal illness behaviors had no predictors present. For those with fewer than three predictors, the chance of abnormal illness behavior was about 40 percent. The chance of abnormal illness behavior increased to more than 96 percent for those with four or more predictors. No patient without abnormal illness behavior had more than three predictors present. Out of the 130 non-abnormal patients, only four had three predictors.

Validation

Datasplitting method. All patients with probabilities greater than a minimum cutoff value were classified as abnormal illness behavior; patients with scores less than the cutoff were classified as non-abnormal (negative). The predictive precision of the derived model is given by the percentage of the fitted groups (in the TEST sample) that were correct.[9] For the BUILD sample, 91.1 percent ([85+38]/135) of the patients were classified correctly by the logistic model (Table 4a). Of the 46 abnormal patients, 82.6 percent (38) were cor-

Table 2

FORWARD STEPWISE MULTIVARIABLE LOGISTIC REGRESSION OF THE SIGNIFICANT PREDICTORS (FROM TABLE 1) FOR THE ASSOCIATION BETWEEN INDIVIDUAL QUESTIONNAIRE ITEMS AND ABNORMAL ILLNESS BEHAVIOR USING A 2/3 RANDOM SAMPLE (BUILD SAMPLE) OF THE FULL DATASET

Variable	Parameter Estimate	Standard Error	Odds Ratio	*p*-value
1. blaming others for situation	2.6784	0.802	14.562	0.0008
2. negative family/workplace/social situations	2.0757	0.6744	7.97	0.0021
3. receiving financial compensation	2.2481	0.6923	9.47	0.0012
4. involved in litigation	2.3685	0.8617	10.681	0.006
5. sleep disturbance	1.8275	0.8812	6.219	0.0381

rectly classified. Only eight patients with abnormal illness behavior were mistakenly classified as negative (false negatives). To overcome these biased estimates, the TEST sample was used to evaluate the model. The percentages decreased slightly, as expected; 87.0 percent ([123+51]/200) of the patients were classified correctly by the logistic model (Table 4b). Of the seventy abnormal illness behavior patients, 72.9 percent (51) were correctly classified. Only nineteen abnormal illness behavior patients were mistakenly classified as negative (false negatives).

ROC Curve method. Figure 1 displays the ROC curve for the TEST sample. The ROC curve rises quickly resulting in a large area under the curve, indicating the model developed using the BUILD sample has high predictive accuracy for the TEST sample.

Discussion

The objective of this study was strictly discriminatory and did not attempt to explain associations. Dionne et al[14] suggested that building the predictive model should focus on the identification of a few variables that can be easily identified and reliably collected in a clinical setting. This strategy resulted in a simple, brief, comprehensive, easily administered questionnaire to help identify abnormal illness behavior in a sample of low back pain patients.

The quality of many epidemiologic studies relies heavily on the accurate measurement of the dependent variable. One potential weakness of this study was that selected physiotherapists, not psychologists, made the clinical decision regarding the presence of abnormal illness behavior.

Table 3a

PREDICTED PROBABILITIES OF ABNORMAL ILLNESS BEHAVIOR FOR PATIENTS WITH ABNORMAL ILLNESS BEHAVIOR FROM THE FULL DATASET (TEST SAMPLE: N=70)

# of predictors present	n	%	mean probability of abnormal illness behavior	standard deviation
0	1	1.4	0.014	0
1	7	10.0	0.107	0.023
2	12	17.1	0.421	0.014
3	25	35.7	0.826	0.040
4	14	20.0	0.965	0.009
5	11	15.7	0.993	0

Table 3b

PREDICTED PROBABILITIES OF ABNORMAL ILLNESS BEHAVIOR FOR PATIENTS WITHOUT ABNORMAL ILLNESS BEHAVIOR FROM THE FULL DATASET (TEST SAMPLE: N=130)

# of predictors present	n	%	mean probability of abnormal illness behavior	standard deviation
0	62	47.7	0.014	0
1	38	29.2	0.108	0.019
2	26	20.0	0.414	0.048
3	4	3.1	0.809	0.034
4	0	0	0	0
5	0	0	0	0

Table 4a

2 X 2 TABLE OF FREQUENCY OF RESPONSES FOR MEASURING THE PREDICTIVE ACCURACY OF THE LOGISTIC REGRESSION MODEL USING A TWO THIRDS RANDOM SAMPLE (BUILD SAMPLE) OF THE FULL DATASET

		PREDICTED		
		negative IB	abnormal IB	total
OBSERVED	negative IB	85	4	89
	abnormal IB	8	38	46
	total	93	42	135

Percentages: Correct = 91.1, Sensitivity = 82.6, Specificity = 95.5
probability cutpoint = 0.41

These therapists received additional training, specific guidelines, and had substantial clinical experience to give a reasonable diagnosis if not a definitive opinion.

For this sample, a regression model predicted the probability of abnormal illness behavior with an accuracy comparable to other prediction studies.[9,14–16] The validation strategy used two methods of modeling and two forms of validity testing to identify five key predictive factors. Future research is required in which the predictors are subjected to external validation on a new independent sample of low back pain patients. This will provide an overall assessment of the validity. However, a rigorous epidemiologic approach showed consistent results for each of the analysis tools employed. High percent correct, sensitivity, and specificity values for the datasplitting technique produced strong validation results for this model. While reliability of a clinical tool is necessary, reliability was not assessed in this study because these subjects were gathered from a clinical setting where the treatment program was aimed at resolution of pain and disability. Reliability studies involving clinical measures should be conducted among people not receiving care to avoid the treatment program from becoming a confounding variable.

The predictive probabilities and subsequent validation results are strong indications of potential applicability of

Table 4b

2 X 2 TABLE FOR MEASURING THE PREDICTIVE ACCURACY OF THE LOGISTIC REGRESSION MODEL USING THE FULL DATASET (TEST SAMPLE)

		PREDICTED		
		negative IB	abnormal IB	total
OBSERVED	negative IB	123	7	130
	abnormal IB	19	51	70
	total	142	58	200

Percentages: Correct = 91.1, Sensitivity = 82.6, Specificity = 95.5
probability cutpoint = 0.41

Correct—probability that the model correctly classifies the data for a chosen probability cutpoint.

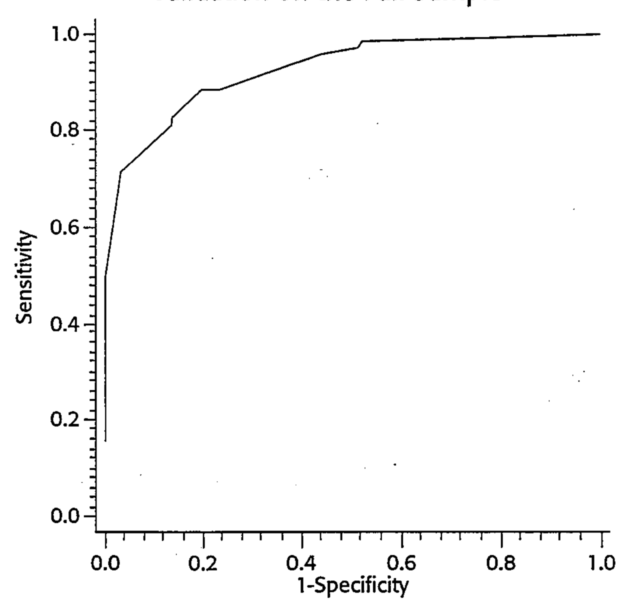
Sensitivity—a measure of accuracy for predicting events. It is the proportion of those with abnormal illness behaviour that the model predicts correctly for a chosen probability cutpoint.

Specificity—a measure of accuracy for predicting non events. It is the proportion of those without illness behavior that the model predicts correctly for a chosen probability cutpoint.

cutpoint—the point at which all patients with probabilities greater than this value are classified as abnormal illness behavior; patients with scores less than the cutoff are classified as negative.

IB—illness behavior

Receiver Operating Characteristic (ROC) Curve
Validation on the Full Sample



The dataset used to display the ROC curve lists the estimated event probabilities in descending order so that both sensitivity and 1-specificity increase the probabilities decrease.

1-specificity = the number of false positives divided by the number of nonevents.

Figure 1. ROC curve for the TEST sample.

this model. The presence of one or two of the five key predictors placed the probability of abnormal illness behavior at about 40 percent. Patients with four predictors had a probability of abnormal illness behavior of 96 percent while those with all five exceeded ninety-nine percent. For this study, the key predictors within the questionnaire carried powerful predictive ability.

Although patient age and sex were part of the initial modeling strategy, they were not significant predictors and in this sample, abnormal illness behavior was not affected by these variables. This lack of predictive ability for age and sex has been reported in previous low back pain research.[4,17–20] Other studies have found one or both of these variables to help with prediction.[10,21,22] The finding that being in pain for more than 6 months had no bearing on the final model is similar to Burton et al's[9] research demonstrating that distress can present early in the course of low back pain.

An important feature of this model is the high sensitivity and specificity, important considerations when choosing any diagnostic test.[23] A sensitivity of 1 and a specificity of 0 will classify all observations as events. Conversely, a specificity of 1 and a sensitivity of 0 will classify all observations as non-events. Sensitivity and specificity vary according to the probability value chosen to decide if an observation represents an event or a non-event. A highly sensitive test should be chosen when there is an important consequence for missing a disease. In the context of this study, false positives, labeled with abnormal illness behavior, may receive more intensive treatment than necessary. False negatives, where the identification of abnormal illness behavior is missed, may be denied necessary rehabilitation, prolonging recovery. A 0.41 cutpoint resulted in 72.9 percent sensitivity and 94.6 percent specificity. Since lowering the probability cutpoint increases the number of false positives as it decreases the number of false negatives, which is the desired effect, the arbitrary cutpoint was set slightly lower than previous research.[4]

Despite its statistical validity, no questionnaire can capture the entire picture. Measurement errors will further decrease precision.[18] The information must be used in conjunction with a thorough clinical assessment. Accurate prognosis for low back pain resolution is partly dependent upon the ability of the treating professional to detect underlying factors that might hinder recovery. The progress of low back pain is highly variable and it will never be possible to eliminate the inherent uncertainty in predicting outcome, but an awareness of significant contributing non-physical factors can help to forecast its course more accurately.

Overly optimistic predictions of back pain risk creating disappointment, anxiety, and anger when the patient's recovery does not proceed as planned. Forecasting a strong chance of abnormal illness behavior may have a negative impact when recovery is uncomplicated.[24] The inherent uncertainty of prognostication can never be eliminated, but this study identifies patient characteristics associated with a high probability of abnormal illness behavior.

Clinically, this instrument can be used as an outcome measure to analyze the success of rehabilitation. High proportions of patients with abnormal illness behavior at discharge may suggest that an alternative or complementary method of treatment, which promotes positive coping strategies, is required. More appropriately, this instrument can be used to identify, early in the course of treatment, challenging patients in need of more comprehensive rehabilitation. The early initiation of aggressive intervention, such as controlled exercises to reduce illness behavior[25] and promotion of positive coping strategies, might improve outcomes in the form of shortened periods of incapacity and reduction in the likelihood of chronicity.

With this method for accurately identifying low back pain patients with abnormal illness behavior, future outcomes research should focus on appropriate treatment strategies for this challenging segment of the back pain population.

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