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Clinical Studies

Presurgical biopsychosocial variables predict medical and compensation costs of lumbar fusion in Utah workers' compensation patients

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Abstract

BACKGROUND CONTEXT: Elective lumbar fusion surgery is a prevalent and costly procedure that requires a lengthy rehabilitation. It is important to identify presurgical biopsychosocial predictors of medical and compensation costs in such patients.
PURPOSE: To determine if presurgical biopsychosocial variables are predictive of compensation and medical costs in a cohort of Utah lumbar fusion patients receiving workers' compensation.
STUDY DESIGN/SETTING: A retrospective-cohort study consisting of a review of presurgical medical records and accrued medical and compensations costs.
PATIENT SAMPLE: A consecutive sample of 203 compensated workers from Utah who underwent lumbar fusion from 1990 to 1995. Patients were at least 2 years postsurgery.
OUTCOME MEASURES: Total accrued medical and compensations costs.
METHODS: A retrospective review of presurgical biopsychosocial variables and total accrued medical and compensation costs was conducted.
RESULTS: Presurgical variables from each of the biopsychosocial domains were statistically significantly correlated with medical and compensation costs. Social and biological variables were the best predictors of total compensation costs, whereas psychological variables were better predictors of total medical costs.
CONCLUSIONS: Compensation and medical costs associated with posterolateral lumbar fusion can be predicted by preintervention biopsychosocial variables. Cost reduction programs might benefit from identifying biopsychosocial factors related to increased costs. © 2003 Elsevier Inc. All rights reserved.

Keywords: Lumbar fusion; Medical costs; Compensation costs; Biopsychosocial; Prediction

Introduction

The rates of lumbar spine fusion surgery are increasing each year in the United States [1]. The central rationale for lumbar fusion is the belief that instability of vertebral bodies is a primary cause of low back and extremity pain and associated neurological impairment [2]. It is believed that surgical fusion can resolve this instability and consequently reduce pain and disability. Lumbar fusion patients require a lengthy rehabilitation period, often up to 6 months, for a solid fusion to form and longer for maximum functional recovery [3].

Lumbar fusion surgery has been criticized for producing inconsistent results [3–6]. Turner et al. [6] reviewed 47 published spinal fusion studies (1966 to 1991) and reported the percentage of patients with satisfactory outcomes varied from 16% to 95% with an average of 68%. Workers' compensation patients who have lumbar fusion appear

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to be at increased risk for poor outcomes [3–5,7,8]. In a recent study of lumbar fusion outcomes among compensated workers in Utah, a significant number of fusion patients reported that back pain was worse (36.1%) and overall quality of life was no better or worse (35.4%) than before surgery when measured at least 2 years after surgery [4]. Twenty-three percent of lumbar fusion patients in Utah never return to work [4], and disability rates for compensated lumbar fusion patients in other states are even higher [5].

Given the long rehabilitation and frequently problematic clinical and disability outcomes associated with this procedure, compensation cases involving it are often extremely costly [3,8,9]. It is advantageous to develop statistical tools that will allow prediction of medical and compensation costs. This will allow for identification of patients who have characteristics that predict higher costs and may lead to development of appropriate procedures (e.g., presurgical psychosocial interventions, proactive case management, intensive rehabilitation) to potentially improve outcomes and contain costs. Indeed, there is some preliminary evidence that a comprehensive postoperative rehabilitation program can improve surgery outcomes (discectomy and fusion) of workers' compensation patients [10].

The "biopsychosocial model" has been successfully used for identifying presurgical risk factors for clinical lumbar fusion outcomes [4] and for predicting response to treatment of disabled workers with low back pain [11]. This model posits that an interrelated array of biological, psychological and social factors are implicated in any given state of health or illness [12,13] and stands in contrast to the biomedical approach that suggests that illness is solely a function of pathophysiology, thus rendering psychological and social factors as independent of disease processes [12]. Perhaps the most important evidence that justifies viewing low back pain from a biopsychosocial perspective is the finding that significant lumbar spine pathophysiology is often present in asymptomatic persons [14]. Further, presurgical diagnosis [4–6] and the severity of lumbar spinal pathology [4] are not predictive of lumbar fusion outcomes. Finally, many lumbar fusion patients do not experience functional recovery despite successful surgical repair of the physiological defect [3–7].

Other types of presurgical patient variables, including demographic, disability and psychosocial antecedents, have been used in predicting lumbar surgery outcomes [4–7] and nonfusion back surgical outcomes [15–18]. A consistent preliminary finding among these studies is that disability, demographic, work and psychosocial antecedents appear to be more predictive of outcomes than presurgical or pretreatment biologic factors. For example, Waddell et al. [19] concluded that a major factor contributing to the difficulty in predicting outcome with low back surgery cases was that physical impairment accounted for less than one-half of the total disability. Waddell et al. [19] indicated that psychosocial and psychophysiological factors could play a major role in determining success of back surgery patients. Frymoyer [20] concluded that psychosocial factors were just as important as physical factors in predicting low back pain disability. Franklin et al. [5] found that certain psychosocial antecedents (e.g., time on work disability before fusion, longer time from injury to fusion) were highly predictive of patient disability status after lumbar fusion surgery. Older age, history of smoking, duration of chronic pain, number of prior back operations, presence of litigation and presence of depression have all been shown to be predictive of lumbar fusion outcomes [4–6]. In Utah, for example, poor lumbar fusion outcomes can be consistently predicted by the following presurgical variables: increased number of prior low back operations, lower income at time of injury, older age, presence of litigation, alcohol use and presence of depression [4]. Although identification of presurgical biopsychosocial risk factors has been conducted relative to lumbar fusion outcomes, no studies have examined how such factors might be predictive of medical and compensation costs.

The purpose of this study was to determine if a set of presurgical biopsychosocial variables are related to medical and compensation costs among a population of Utah lumbar fusion patients receiving workers' compensation. The selection of variables for this study was based on prior studies of lumbar fusion patients showing relationships between such biopsychosocial variables and clinical outcomes [4–6]. Our central prediction was that variables from all three model domains (biological, social and psychological) would be predictive of both medical and compensation costs.

Methods

Study design

This was a retrospective-cohort study consisting of a coding of presurgical information documented in patient medical records and assessment of medical and compensation costs accrued during the course of the compensation claim. All data were gathered by means of hard copy medical files or computer systems at the Workers' Compensation Fund of Utah (WCFU). The institutional review boards from the University of Utah Medical School and Utah State University approved this study, and the WCFU provided permission to access patient medical records and compensation data.

Patient sample

All patients who had undergone posterolateral lumbar fusion surgery from 1990 to 1995, did not have a presurgical diagnosis of vertebral fracture and were at least 2 years postsurgery at the time of follow-up were eligible for inclusion (N=203). Patients were identified by means of current procedural technology codes in WCFU databases. For each patient, lumbar fusion surgery resulted from a verified workplace low-back injury. Workers covered by federal workers' compensation systems and self-insured employers were excluded because of inability to access data. The WCFU insures approximately 53% of Utah workers.

Medical record information

Presurgical medical record data were gathered by means of independent and standardized review of medical chart information and review of WCFU computer databases. The data abstractor was a trained doctoral student who was not involved in treatment of study patients, used an objective coding instrument and routinely met with authors to review and resolve coding problems. The biological variables coded for this study included number of vertebral levels fused, age at the time of injury, number of prior low back operations and gender. A measure of presurgical diagnostic severity based on independent review of presurgical radiology reports by two orthopedic surgeons and one occupational medicine physician was also included as a biological variable. This measure allowed for coding of six major types of common lumbar spinal diagnoses (degenerative changes, disc bulge, listhesis, lysis, foraminal stenosis and central stenosis) and provided a graduated scale for each diagnosis from none (0) to severe (3). It was applied to four vertebral levels (L2–L3, L3–L4, L4–L5, L5–S1), and a total score was achieved by adding the single scores for each of the assessed lumbar levels. A high degree of correspondence was achieved by the three raters (92% agreement). Discrepancies (8%) were resolved by conference. This measure was previously published [4]. Smoking was not included as a predictor in the present study because of insufficient documentation in the medical charts.

The psychological variables included depressive disorder (*Diagnostic and Statistical Manual of Mental Disorder*, Fourth Edition, major depressive disorder, dysthymia or adjustment disorder with depressed mood) documented in preoperative medical records, degree of pain report before surgery and completion of a presurgical psychological evaluation. The social variables included education level at time of injury, weekly income at time of injury, litigation as defined by patient private lawyer involvement in the compensation case at the time of surgery and number of prior industrial claims.

Cost information

Compensation costs included all wage replacement and the final impairment settlement. Medical costs included all direct and ancillary medical care, including rehabilitation services. The time interval for calculating costs was from initial injury date to point of maximum medical improvement (MMI). MMI is defined in Utah as the point in time at which an injured worker has realized the maximum amount of improvement from an injury given the current standard of medical care. The operating surgeon is responsible for monitoring the patient's status and declaring the date of MMI. At the point of MMI, the patient's functional capabilities and degree of impairment are assessed and the surgeon can recommend return to previous work, return to modified or lighter work, job retraining or no return to work. Occasionally, an independent medical evaluation was conducted to verify a surgeon's opinion of MMI or resolve disputed MMI dates. The specific date for MMI used in this study was the official date coded in WCFU computer records. Financial information was obtained by means of WCFU computer databases. It should be noted that the WCFU covers lifetime medical costs for work-related injuries, and thus it is possible for lumbar fusion patients to achieve additional medical costs beyond MMI. Because medical payout can occur anytime during a patient's lifetime, we needed to draw a logical line for calculating total medical costs. MMI appeared to be the point at which the majority of total medical costs are achieved for most patients.

Results

Presurgical patient and follow-up data

A total of 203 consecutive patients were included in the study cohort. Patients received their surgeries between August 23, 1990, and April 21, 1995. There were 167 men (82.3%) and 36 women (17.7%) whose medical charts were reviewed. Ninety-five percent of the sample were white, 3% were Hispanic, 0.5% were Native American and 0.5% were Asian. Preoperative diagnoses for the 203 patients were as follows: disc herniation (70.4%), degenerative disc disease (46.3%), segmental instability (28.6%), spondylolisthesis (17.7%), spinal stenosis (17.7%) and pseudarthrosis (2.5%). Subjects could receive multiple presurgical diagnoses. All received posterolateral lumbar fusions, and instrumentation was used in 83.7% of cases. Pedicle screw fixation was used in 91% of instrumented cases. A total of 28 surgeons were involved in the 203 operations. The cohort had a total of 91 prior lumbar spine operations (some patients had multiple operations) consisting of the following percentage breakdown: discectomy (17.2%), laminectomy (12.8%), laminectomy/discectomy (7.4%) and lumbar fusion (5.4%).

Descriptive statistics for the patient cohort

The descriptive statistics for each of the presurgical variables are presented in Table 1. The prototypic patient in this study was male, had moderate presurgical imaging severity, a single-level fusion, was approximately 38 years old at the time of injury, had no prior low back surgeries, did not have a history of depression, reported severe pain before surgery, did not complete a presurgical psychological evaluation, possessed a high school degree or general equivalency diploma, was making $408.38 a week at the time of injury, did not have a lawyer involved with the compensation case and did have prior industrial claims. The average time to MMI was 364 days (SD=227), and the average medical costs for the patient cohort were $30,103 (SD=$16,399). The average compensation costs were $27,219 (SD=$15, 139).

Table 1
Descriptive statistics for presurgical biopsychosocial variables

Presurgical variable	Descriptive statistics: Mean or proportion		SD	Minimum	Maximum
Imaging severity total score	7.14		4.26	0	21
Number of vertebral levels fused	1=1 level	50.2%			
	2=2 level	46.3%			
	3=3 or more	3.4%			
Age at time of injury	37.50		9.17	20	63
Number of prior low back operations	0=none	55.2%			
	1=one	33.0%			
	2=two	8.9%			
	3=3 or >	3.0%			
Gender	1=male	82.3%			
	2=female	17.7%			
Depression diagnosis (presurgical)	1=no	89.2%			
	2=yes	10.8%			
Degree of pain before surgery	1=mild	4.4%			
	2=moderate	30.0%			
	3=severe	65.5%			
Presurgical psychological evaluation	1=psych eval	79.8%			
	2=no psych	20.2%			
Educational level at time of injury	1=some HS	26.1%			
	2=HS/GED	35.5%			
	3=technical	22.7%			
	4=some col.	11.3%			
	5=col. grad	3.9%			
	6=grd. study	0.5%			
Weekly income level at time of injury	$408.4		$189.5	$36.0	$1,096
Lawyer involvement at time of surgery	1=no lawyer	59.6%			
	2=lawyer	40.4%			
History of prior industrial claims	1=no	46.3%			
	2=yes	53.7%			

Correlational results

Table 2 presents the intercorrelations among the presurgical biopsychosocial variables. Because these variables were used in subsequent regressions, it was prudent to examine the extent of multicollinearity among predictors. Correlations ranged from 0.0 to −0.38 (income level with gender), and there were only two correlations greater than 0.20 within the entire matrix. Consequently, the correlations among predictors were overall extremely low, which helped to maximize predictive power and interpretation of regression weights.

Table 3 presents the correlations (Pearson or point-biserial) between the presurgical biopsychosocial variables and costs variables. Interestingly, the pattern of correlations is quite different for compensation versus medical costs. In

Table 2
Intercorrelations among presurgical biopsychosocial variables

Measures	1	2	3	4	5	6	7	8	9	10	11	12
1. Imaging severity total score	1.00											
2. Number of vertebral levels fused	.13	1.00										
3. Age at time of injury	.26*	.00	1.00									
4. Number of prior low back operations	.06	.12	.16*	1.00								
5. Gender	−.04	.04	.13	−.01	1.00							
6. Depression diagnosis (presurgical)	−.04	−.02	−.03	.22*	.00	1.00						
7. Degree of pain before surgery	.10	.05	.09	.00	.14	.07	1.00					
8. Presurgical psychological evaluation	−.02	.09	−.04	−.01	.02	.18*	.04	1.00				
9. Educational level at time of injury	−.10	−.08	.04	−.06	.07	−.02	−.06	−.13	1.00			
10. Income level at time of injury	.08	.10	.14*	.10	−.39*	.02	.01	−.05	.05	1.00		
11. Lawyer involvement at time of surgery	.05	.01	.00	.03	.09	.13	.09	.14	−.18*	−.15*	1.00	
12. History of prior industrial claims	.10	.02	.11	.14	−.19*	.14	−.03	.10	−.11	.16*	.04	1.00

*$p < .05$.

Table 3
Correlations between presurgical biopsychosocial variables and cost variables

	Outcome variables		
	Total compensation costs	Total medical costs	Male-only compensation costs
Biological variables			
Imaging severity total score	.022	.059	.026
Number of vertebral levels fused	.125	.163*	.148
Age at time of injury	.174*	.021	.263*
Number of prior low back operations	.186*	.234*	.211*
gender	−.375*	−.034	
Psychological variables			
Depression	.173*	.305*	.229*
Degree of pain before surgery	.101	.167*	.162*
Referral for psychological evaluation	.150*	.259*	.212*
Social variables			
Education level	−.236*	−.105	−.245*
Income level	.314*	−.012*	.180*
Lawyer involvement	.148*	.213*	.197*
Prior industrial claims	.258*	.000	.209*

*$p<.05$.

terms of biological variables, gender was the most significant predictor of total compensation costs (female gender was associated with lower compensation costs), followed by number of prior low back operations and age at time of injury. Only number of prior low back operations and number of vertebral levels fused were biological predictors of total medical expenses. In terms of psychological variables, depression and completion of a presurgical psychological evaluation were modest predictors of total compensation costs. Depression and completion of a presurgical psychological evaluation were stronger predictors of total medical expenses. The degree of pain before surgery was also a modest psychological predictor of total medical expenses. All of the social variables (education, income, lawyer, prior industrial claims) proved to be statistically significant predictors of total compensation costs, whereas only lawyer involvement was predictive of total medical expenses. In general, these patterns of correlations support the biopsychosocial model for predicting compensation and medical costs accrued during the treatment of lumbar fusion patients.

Regression results

The next statistical analyses involved using the 12 presurgical biopsychosocial variables in two independent simultaneous-entry multiple regression equations predicting total compensation and medical costs. Table 4 contains the results of the simultaneous-entry multiple regression predicting total compensation costs. As may be seen, the multiple R for this equation was .61 (F=9.275; p=.00). Two biological variables (age, gender) and three social variables (education, income level, lawyer) had statistically significant regression weights. None of the regression weights for the three

Table 4
Simultaneous entry multiple regression: predicting total compensation costs with presurgical variables as predictors*

	Unstandardized coefficients		Standardized coefficients	
Variable	β	SE	β	p Value
Imaging severity total score	−401.1	216.8	−.11	.07
Number of vertebral levels fused	2,633.6	1,593.8	.10	.10
Age at time of injury	338.2	103.6	.21	.00
Number of prior low back operations	1,632.6	1,189.1	.08	.17
Gender (1=male/2=female)	−13,652.1	2,605.7	−.35	.00
Depression diagnosis (presurgical)	4,755.4	2,974.6	.10	.11
Degree of pain before surgery	2,761.6	1,560.3	.11	.08
Presurgical psychological evaluation	3,387.6	2,249.6	.09	.13
Educational level at time of injury	−2,308.0	805.9	−.17	.01
Income level at time of injury	12.7	5.2	.16	.02
Lawyer involvement at time of surgery	4,184.8	1,849.8	.14	.02
History of prior industrial claims	3,077.0	1,834.2	.10	.09
(constant)	1,498.6	8,102.8		.85

*R^2=.37, p=.000.

psychological variables were statistically significant. Thus, when the 12 variables are considered simultaneously in a linear multiple regression predicting compensation costs, biological and social variables are revealed as statistically significant predictors accounting for 37% of the total variance.

Because being male was the greatest predictor of higher compensation costs at both the simple correlation level and in the simultaneous entry regression, and because men constituted over 80% of this industrial worker sample, we were interested in determining the pattern of correlations and the regression findings for total compensation costs when men only were considered. A separate equation for women was not calculated because of their relatively small numbers in the study. However, similar analyses with larger samples of women are encouraged. Table 3 reveals that the pattern of simple correlations for men only is quite similar to that for the total sample. However, the rank order of the correlations changed somewhat. Additionally, degree of pain before surgery obtained a significant correlation for men only, whereas none was found for the total sample. Number of vertebral levels fused approached significance among the men (r=.15, p=.057). The multiple R for the men only regression equation was .53 (F=5.57; p=.00). One biological variable (age) and two social variables (education, income level) had statistically significant regression weights. The equation accounted for 28% of the total variance in compensation costs.

Table 5 contains the results of the simultaneous-entry multiple regression predicting total medical costs. As may be seen, the multiple R for this equation was .49, (F=4.979; p=.00). Two biological variables (vertebral levels fused, number prior low back operations), three psychological variables (depression, degree of pain prior to surgery, presurgical psychological evaluation) and one social variable (lawyer) had statistically significant regression weights. Thus, when the 12 variables are considered simultaneously in a linear multiple regression predicting medical costs, biological, psychological and social variables are revealed as statistically significant predictors accounting for 24% of the total variance.

Finally, we examined if the biopsychosocial model could predict high-combined cost versus nonhigh combined cost cases. Total combined costs were calculated by adding total compensation and medical costs. We then computed a dichotomous outcome variable based on splitting the sample into those cases that accrued costs above the 75th percentile (approximately $68, 808), which we labeled as high-combined cost cases, and all other cases were grouped as nonhigh cost cases. We consulted with the Workers' Compensation Fund of Utah to determine a meaningful cut point for high total costs. Next, we conducted a multivariate logistic regression analysis predicting high combined cost cases versus nonhigh combined cost cases. The omnibus chi-squared test for this model was 54.525 (df=12) and was statistically significant (p=.00). Results of this analysis are presented in Table 6. As may be seen, greater number of vertebral levels fused, older age, male gender, completed presurgical psychological evaluation and lower levels of education were associated with greater risk of being classified in the high combined cost group. The presence of a lawyer and a higher degree of pain before surgery came very close to achieving statistical significance (p=0.09 for both variables). The overall correct classification hit rate for this model was 83%, which represents a substantive improvement in prediction over the base rate percentage. Interestingly, the statistically significant predictors of total combined high-cost versus nonhigh combined cost cases included an amalgamation of variables that were predictive of compensation and medical costs within their separate regressions. In addition, the statistically significant variables

Table 5
Simultaneous entry multiple regression: predicting total medical costs with presurgical variables as predictors*

	Unstandardized coefficients		Standardized coefficients	
Variable	β	SE	β	p Value
Imaging severity total score	106.2	258.6	.03	.68
Number of vertebral levels fused	3,692.7	1,901.0	.13	.05
Age at time of injury	33.3	123.6	.02	.79
Number of prior low back operations	3,678.9	1,418.3	.17	.01
Gender (1=male/2=female)	−4,706.2	3,108.0	−.11	.13
Depression diagnosis (presurgical)	1,1601.4	3,548.0	.22	.00
Degree of pain before surgery	3,760.0	1,861.1	.13	.04
Presurgical psychological evaluation	7,864.9	2,683.2	.19	.00
Educational level at time of injury	−281.0	961.2	−.02	.77
Income level at time of injury	−4.024	6.2	−.05	.52
Lawyer involvement at time of surgery	4,739.7	2,206.3	.14	.03
History of prior industrial claims	−2,978.6	2,187.8	−.09	.17
(constant)	−6,118.0	9,664.6		.53

*R^2=.24, p=.000.

Table 6
Multiple logistic regression predicting high combined cost cases versus nonhigh combined cost cases

Variable	β	p Value	Exp (B)	95% Confidence intervals
Imaging severity total score	−0.08	.11	0.92	(0.84–1.02)
Number of vertebral levels fused	0.78	.02	2.16	(1.12–4.15)
Age at time of injury	0.06	.01	1.06	(1.01–1.11)
Number of prior low back operations	0.32	.19	1.38	(0.85–2.24)
Gender (1=male/2=female)	−1.86	.01	0.16	(0.04–0.65)
Depression diagnosis (presurgical)	0.63	.27	1.88	(0.60–5.87)
Degree of pain before surgery	0.64	.09	1.90	(0.91–3.97)
Presurgical psychological evaluation	1.39	.00	4.00	(1.67–9.62)
Educational level at time of injury	−0.48	.02	0.62	(0.41–0.93)
Income level at time of injury	0.00	.24	1.00	(1.00–1.00)
Lawyer involvement at time of surgery	0.69	.09	1.99	(0.90–4.39)
History of prior industrial claims	−0.30	.46	0.74	(0.33–1.66)
Constant	−6.22	.001	0.00	

in this logistic regression model represented all three biopsychosocial domains. Thus, the biopsychosocial model demonstrated preliminary utility for predicting high-combined cost versus nonhigh combined cost lumbar fusion cases.

Discussion

This study examined 12 presurgical biopsychosocial variables and accrued compensation and cost information in a consecutive cohort of 203 compensated lumbar fusion patients from Utah. The purpose of the study was to determine the extent to which the biopsychosocial variables were predictive of compensation and medical costs. The average time to MMI was 364 days (SD=227), and the average medical and compensation costs for the patient cohort were $30,103 and $27,218, respectively. A series of multiple linear regressions revealed different biological predictors for increased compensation costs (older age, male gender) versus increased medical costs (increased number of vertebral levels fused and prior low back operations). Psychological variables were statistically significant predictors of total medical costs (depression, more presurgical pain, completion of presurgical psychological evaluation) and were not statistically significant predictors for total compensation costs. Social variables were predictive of compensation costs (education level, income level, lawyer involvement) and were, with the exception of lawyer involvement, not predictive of medical costs. In general, the regressions indicated that psychological variables were more predictive of medical costs, social variables were predictive of compensation costs and differing biological variables were predictive of both medical and compensation costs. Finally, a logistic regression predicting combined high-cost versus nonhigh combined cost cases demonstrated the predictive utility of the biopsychosocial model when considering both types of costs additively.

This study adds to a rapidly expanding database regarding the biopsychosocial model [4,7,11–13,16] and suggests that it is not only applicable in terms of treatment decisions but is also useful for predicting costs, in this specific case for both workers' compensation payments and medical expenses. These findings are particularly noteworthy because, after years of stabilization or record low rates of growth, annual health-care costs are increasing steeply [21]. Making wise use of limited resources is important, and this study demonstrates the usefulness of considering variables from the biological, psychological and social realms when estimating costs associated with low back pain and surgery. Previously, we demonstrated that in an uncontrolled, naturalistic setting, individuals referred for psychological evaluation have generally worse functional outcomes (although equivalent physiological outcomes) and higher costs after low back surgery than those not referred for these evaluations [3]. This study questioned the effectiveness of presurgical psychological evaluations and pointedly noted that the sampled reports submitted to surgeons and treatment teams often offered imprecise or vague recommendations for presurgery intervention. However, significant research in related medical areas [22–24] indicates that psychological interventions, when rigorously, thoughtfully (i.e., theoretically driven) and specifically conducted, improve treatment outcomes and reduce costs. These latter findings imply two key points. First, consideration and intervention in the areas of biological, psychological and social functioning may improve outcomes and reduce costs. Second, the quality of the psychosocial interventions is of utmost importance for these benefits to be realized. Clearly, further research on how to optimize low back surgery outcomes by means of implementation of psychological intervention is necessary.

A most interesting, and somewhat surprising, finding from this study was that the pattern of predictors for the compensation and medical costs showed variation. That is, although biological variables provided some predictability for both sets of costs, the psychological variables predicted medical expenses better than they did compensation costs, whereas the opposite was true for the social variables. How can these differences be explained?

First, physicians estimate that approximately 66% of their time is allocated to patients who have either medically insignificant symptoms or symptoms resulting from psychological dysfunction [25]. These data provide an impetus and growing trend to use the assessment and intervention expertise of psychologists specifically trained for working in primary care settings [26]. The concerns treated by these psychologists include everything from medical treatment compliance to emotional distress. In particular, depression and anxiety are prominent among medical populations, although they often first manifest as somatic symptoms. This is not to deny the reality of the physical symptoms or to suggest any degree of malingering. It is, however, to acknowledge the importance of a holistic view of individuals as suggested by the biopsychosocial model. This model may also apply in the field of spinal surgery [13]. It has been known for many years that behavioral and psychological factors are significant in determining the experience of pain and the extent to which it interferes with daily functioning and emotional well-being. An orthopedic surgeon we have worked with often commented that for many of his cases, back pain was the socially legitimate "ticket" to accessing medical care, when, in fact, less "acceptable" emotional factors were of equal or greater clinical importance. Again, he was not denying the reality of the pain or even the biological basis for it, but was simply acknowledging that more needs were being presented in the office than a straightforward examination and treatment of the spinal column could meet. In this light, from the present study it is interesting that depression was the most potent predictor of medical costs both when considered singly in the simple bivariate correlations and as part of the regression equation. An obvious conclusion is that emotional factors, notably depression, are involved in elevating medical costs associated with back surgery. Clearly, this suggests consideration of a spine patient's depression before and after surgery and the development of interventions to address this issue among such patients [27].

Although psychological variables had some modest predictability for the compensation costs, it was the social variables (education and income levels, lawyer involvement and prior industrial claims) that, as a group, were more prominent. To analyze this difference, we need to understand the different nature of the two costs. Medical costs consist of expenses paid to physicians and hospitals for office visits and procedures as well as reimbursement to patients for travel. These accrue as a result of actual treatment of the patient that carries with it significant interpersonal interaction with the health-care provider and system. The nature of this interaction is one of doctor-patient and implies a degree of collaboration in working toward a common goal (i.e., improved health) and includes a significant psychological component. Compensation costs, on the other hand, cover wage replacement and, if applicable, a final permanent disability settlement related to the injury. The nature of the relationship between payer (compensation system) and payee (patient) is tenuous and often adversarial. It is one in which competing interests are obvious. Given this, it is informative, although not surprising, that the cluster of variables we have termed "social" predict compensation costs. In short, those workers who make more money, have had prior industrial claims (and therefore learned how the compensation system works), have lower education and obtained the services of a lawyer before their surgery are more likely to have higher compensation costs.

The income variable is worth particular mention. Because amount of income at the time of injury is the most important factor in determining weekly wage replacement during the course of the treatment and rehabilitation, and is ultimately related to the dollars received as a result of a disability settlement, its relationship with total compensation costs is to some extent artifactual, that is, integral for the calculations of the system. It should be noted, however, the total compensation cost variable, as assessed in this study, is also a function of the length of time on disability and, if applicable, the total disability settlement that is dependent on the permanent total or permanent partial body impairment rating determined at MMI. For example, a person with a larger salary who is on wage replacement a short amount of time may have lower costs than a patient with a smaller salary who is on it for an extended period. Given these issues, we decided to investigate what would happen to the social variables with the influence of income covaried out of the equation. Therefore, we calculated a hierarchical regression analysis predicting compensation costs with the effects of income controlled (held constant). We controlled for income by means of forcing this variable into the regression on the first step and then entering the other 11 additional variables as a block on the second step. The final regression weights for the social variables did not change, and interpretations remained the same as with the full model. These data suggest the identified predictors of compensation costs are valid and not simply a spurious function of their colinearity with income. Thus, the importance of the social variables is maintained when income was held constant within the regression analysis.

Because men constituted over 80% of the sample and because being male predicted higher total compensation costs, we examined the findings for men only. The men only regression closely mirrored that for the overall sample. When the simple correlations were examined, however, a few differences emerged. In particular, age at time of injury, depression and referral for a psychological evaluation demonstrated notable increases in their relationship with compensation costs compared with the values obtained for the overall sample, and their rank order in terms of magnitude of the correlation changed as well. That is, age for men only had the highest correlation; for the total group, it ranked fifth. Depression ranked third for males only; for the total group, it was sixth. Referral for a psychological evaluation ranked fourth for males only; for the total group, it was seventh. On the other hand, income slipped from having the highest correlation for the overall group to a position of eighth for males only and, surprisingly, lawyer involvement also slipped from a position of second to sixth. Clearly, not too much should be made of these changes because their absolute magnitude is only notable, not extreme. It is, however, interesting that such variables as age and depression seem to be important correlates of total compensation costs for men. It has often been noted that men tend to express depression with anger. Those who have worked in the compensation system may be familiar with this dynamic as it applies in this particular setting. The age variable may also be implicated. As men age, the work required of many manual labor positions may become increasingly difficult to perform and, consequently, more aversive. This may create significant incentive to avoid the work, and receiving compensation for an injury (and resultant surgery) may provide one viable method of doing this. Add to this depression and the likelihood of compensation costs increasing. For men, these variables are more predictive of higher compensation costs than income or even involving a lawyer in the case. Again, this suggests that interventions aimed at treating depression may be useful in reducing compensation costs.

Overall, this study lends credence to the importance of the biopsychosocial model as a predictor of costs among low back surgery patients. The resulting implications are not only that social and psychological variables should be considered along with biological factors but, perhaps more importantly, that interventions be developed to mitigate the negative impact of psychosocial variables on treatment and cost outcomes. One astute reviewer of this paper suggested that many of the statistically significant predictors of costs identified in this paper are not amenable to presurgical intervention. Because this is an exploratory study, we believed it was important to identify predictors of costs even if they initially appear as immutable. We simply do not know, for example, what aspects of male gender or age account for their relationship to costs. It might well be certain psychosocial features of these variables (e.g., type A behavior in men, age-related declines in social support), rather than biological features, that might explain their relationship to costs. These types of psychosocial issues are likely amenable to presurgical intervention.

It is also important to note that the present biopsychosocial model was unable to account for 63% and 76% of the total variance in compensation and medical costs, respectively. This demonstrates the need for researchers to further investigate and refine the specific predictive constructs presented here and to investigate other types of potential predictors.

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Twenty-five Years Ago in Spine . . .

Before 1978, arachnoiditis of the lumbar spine had long been a topic of observation and speculation, confused by poor definition and multiple etiologies. That year, the term was clarified and understanding of the spectrum of the disorder was enhanced by publication of material presented at a symposium at the International Society of the Lumbar Spine in Utrecht during the previous year. A series of articles provided nomenclature, detailed observations of pathology and discussed various etiologies [1]. The relationship between iophendylate myelography and arachnoiditis was made particularly clear.

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