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The Spine Journal ■ (2011) ■

THE SPINE JOURNAL

Clinical Study

Presurgical biopsychosocial variables predict medical, compensation, and aggregate costs of lumbar discectomy in Utah workers' compensation patients

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Received 18 October 2010; revised 14 January 2011; accepted 23 March 2011

Abstract

BACKGROUND CONTEXT: Elective lumbar discectomy among injured workers is a prevalent spine surgery that often requires a lengthy rehabilitation. It is important to determine presurgical biopsychosocial predictors of compensation and medical costs in such patients.
PURPOSE: To determine if presurgical biopsychosocial variables are predictive of compensation and medical costs in a cohort of Utah patients who have undergone open or microlumbar discectomy that are receiving workers' compensation.
STUDY DESIGN/SETTING: A retrospective cohort study consisting of a review of presurgical medical records and accrued medical and compensation costs.
PATIENT SAMPLE: A consecutive sample of 266 compensated workers from Utah who had undergone either open discectomy or microlumbar discectomy from 1994 to 2000. All patients were at least 2 years postsurgery at the time of follow-up.
OUTCOME MEASURES: Total accrued medical, compensation, and aggregate costs.
METHODS: A retrospective review of presurgical biopsychosocial variables and total accrued medical, compensation, and aggregate costs.
RESULTS: Presurgical variables were statistically significantly correlated with medical and compensation costs. Multiple linear regression models accounted for 31% of variation in compensation costs, 32% in medical costs, and 43% in total aggregate costs.
CONCLUSIONS: Presurgical biopsychosocial variables are important predictors of compensated lumbar discectomy costs. Medical cost control programs might benefit from identifying biopsychosocial variables related to increased costs. Published by Elsevier Inc.

Keywords: Biopsychosocial; Costs; Lumbar discectomy; Workers' compensation

Introduction

Approximately 326,000 patients undergo spinal discectomy surgery annually [1]. Lumbar discectomy rates have increased to 77% from 1992 to 2003 in the United States, accounting for approximately one-third of Medicare spending on spine surgery in 2003 [2]. The central foundation for discectomy is the belief that a bulging or herniated disc can apply pressure on nerve roots in the spine, and this may result in low back/extremity pain and/or neurological symptoms. Discectomy allows for removal of bulging or herniated disc material and decompression of nerve roots and thus is associated with reductions in back pain, disability, and neurological problems [3]. Lumbar discectomy patients

FDA device/drug status: not applicable.

Author disclosures: ***MSD:*** Research Support (Staff/Materials): Utah State University's Faculty Grant Program (C).

The disclosure key can be found on the Table of Contents and at www.TheSpineJournalOnline.com.

This article should not be construed as an endorsement of lumbar discectomy for injured workers by the authors, Utah State University, or the Workers' Compensation Fund of Utah.

This project was supported from grants provided by Utah State University. No funds were received from a commercial entity related to this research.

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1529-9430/$ - see front matter Published by Elsevier Inc.
doi:10.1016/j.spinee.2011.03.018

commonly require a lengthy rehabilitation period, often up to 12 months for maximum functional recovery [3].

Lumbar discectomy has been criticized in the medical literature for producing unreliable results [3–6]. It has been suggested that approximately 20% to 40% of patients have sciatica or recurring back pain after discectomy surgery and 5% to 15% will have recurrent disc herniation [3,4]. Workers' compensation patients who undergo lumbar discectomy are at increased risk for poor outcomes [3]. A recent study of compensated lumbar discectomy patients found a significant number of patients who reported that they were somewhat-to-extremely dissatisfied with their back condition (40%) and that 22% had back/leg pain that was worse than expected [3]. Moreover, 13% of these patients were too disabled to work, underscoring the potential burden placed on workers' compensation carriers and disability compensation systems.

In light of the challenging recovery process and variable outcomes associated with this procedure, compensation cases involving it can incur dramatic costs [3,5,7]. Developing statistical tools to aid in the prediction of medical and compensation costs may be of great benefit to clinicians, public and private policymakers, and underwriters. This may allow for identification of patients who are at risk to incur higher costs and lead to the development of appropriate procedures (eg, presurgical psychosocial interventions, proactive case management, intensive rehabilitation) to lower this risk and potentially improve outcomes. Some evidence already suggests that a comprehensive postoperative rehabilitation program can improve surgery outcomes (for both lumbar discectomy and fusion) of workers' compensation patients [8].

The biopsychosocial model has been successfully used for identifying presurgical risk factors for clinical lumbar discectomy [3] and fusion outcomes [9], and for predicting medical and compensation cost outcomes of disabled workers receiving lumbar fusion [10]. This model submits that biological, psychological, and social factors together influence any given state of health or illness [11,12] and stands in contrast to the biomedical approach, which suggests that illness is solely a function of pathophysiology, limiting the consideration of social and psychological factors [11]. One key example of 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 [13]. Furthermore, biological factors such as diagnostic pathology and related severity have had limited predictive power in lumbar discectomy and fusion outcomes [3,9]. Finally, many lumbar discectomy patients become totally and permanently disabled despite successful surgical repair of the physiological defect [3–6].

In the search for greater predictive power, demographic, psychosocial, and disability factors have been used in predicting lumbar surgery outcomes [3–7,14–18]. It has been consistently found that these types of antecedents appear more predictive of outcomes than presurgical or pretreatment biological factors. For example, Waddell et al. [17] 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 and that psychosocial and psychophysiological factors could play a major role in determining success of patients with back surgery. In previous work in the state of Utah, poor lumbar discectomy outcomes have been consistently predicted by the following presurgical variables: increased number of prior low back operations, claim-related litigation, age, assignment to nurse case management, and the time between injury and surgery [3]. Although the biopsychosocial model has been used to predict functional outcomes in lumbar discectomy, no study has yet examined how such factors might predict 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 discectomy patients receiving workers' compensation. The selection of variables for this study was based on a prior study of lumbar discectomy patients showing relationships between such biopsychosocial variables and clinical outcomes [3]. Our central prediction was that variables from all the 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 patients' medical records and assessment of medical and compensation costs accrued during the course of the compensation claim. All data were gathered using hard copy medical files or computer systems at the Workers' Compensation Fund of Utah (WCFU).

Patient sample

All patients who had undergone either open discectomy or microlumbar discectomy from 1994 to 2000 and were at least 2 years postsurgery at the time of follow-up were included in this consecutive cohort (N=266). Patients were identified by means of current procedural technology codes in WCFU databases. For each patient, lumbar discectomy resulted from a verified work injury. Workers covered by federal workers' compensation and self-insured employers were excluded because of the inability to access data. Workers' Compensation Fund of Utah covers approximately 53% of Utah workers.

Medical record information

Presurgical medical record data were gathered via independent and standardized review of medical chart information and review of WCFU computer databases. Supervised and trained graduate students who had no involvement in patient treatment were responsible for data abstraction. The biological variables coded for this study included gender, age at time of surgery, number of prior low back operations, time delay (injury to surgery), number of comorbid health conditions (eg, diabetes, heart disease, stroke, arthritis, asthma, hypertension, colitis, cancer history, trauma history, infectious history, autoimmune history, steroid usage, and ''other'' category), and type of discectomy (open discectomy vs. microdiscectomy). The psychological variables included a history of or current depressive disorder diagnosis (*Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*, major depressive disorder, dysthymia, or adjustment disorder with depressed mood). The social variables included education at time of injury, litigation as defined by private lawyer involvement in the compensation case at the time of surgery, assignment to nurse case management, and household income at time of injury.

Summary of outcome variables

Compensation costs included all wage replacement and the final impairment settlement when applicable. Medical costs included all direct and ancillary medical care, including rehabilitative services. The time interval for calculating cost was determined by the difference between the initial injury dates to time of maximum medical improvement (MMI). Maximum medical improvement 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 who was monitoring the patients' status determined the actual date of the MMI, at which time the patient's functional capabilities and degree of impairment were assessed, and the surgeon recommended either return to previous work, return to modified or lighter work, job retraining or no return to work. An independent medical evaluation was conducted in the rare occasion it was necessary to verify the surgeons' opinion of the MMI or resolve disputed MMI dates. For the purposes of this study, the official date used for MMI was the date coded in WCFU computer records. Financial information was obtained via the WCFU computer databases.

Results

Presurgical characteristics of the study sample

A total of 266 Utah workers' compensation patients were included in this study's cohort. Patients received their surgeries between June 1, 1994, and December 30, 1999. As reflected in Table 1, the sample included 218 men (82%) and 48 women (18%). The mean age for the cohort was 38.1 years (standard deviation [SD]=10.3). Ninety-four percent of the sample was Caucasian. Patients included in the study had preoperative diagnoses that included either disc herniation (94.8%), degenerative disc disease (3.2%), or spinal stenosis (2.0%). The number of prior low back operations for the 266 patients was as follows: zero (89.7%), one (8.1%), two

Table 1
Descriptive statistics for biopsychosocial variables

Biopsychosocial variable	Means or proportion, %	SD
Gender		
Male	82.0	
Female	18.0	
Age at time of surgery (y)	34.1	10.3
Prior low back surgery		
None	89.5	
One	8.3	
Two	1.9	
Three	0.4	
Time delay from injury to surgery (d)	336.7	644.7
Number of comorbid health conditions		
None	50.8	
One	33.8	
Two	10.9	
Three	4.1	
Four	0.4	
Type of discectomy		
Open	54.9	
Microdiscectomy	45.1	
Depression		
No	83.8	
Yes	16.2	
Alcohol use		
No	65.8	
Yes	34.2	
Education		
<12 y	12.8	
High school degree/General Education Development degree	45.9	
Some college	17.3	
Trade school/associate's degree	18.0	
College degree	5.3	
Graduate degree	0.8	
Lawyer involvement		
No	82.7	
Yes	17.3	
Case management		
No	78.6	
Yes	21.4	
Average weekly income ($)	562.06	351.04
Mean compensation costs ($)	16,180.63	13,287.00
Mean medical costs ($)	18,966.45	16,916.00

SD, standard deviation.

(1.8%), and three (0.4%). The average time to MMI was 555 days (SD=299), and the average medical and compensation costs per patient were $19,783 (SD=$19,220) and $16,372 (SD=$14,428), respectively. The number of comorbid health conditions was as follows: zero (50.8%), one (33.8%), two (10.9%), three (4.1%), and four (0.4%). About 45.1% of patients received lumbar microdiscectomies, whereas 54.9% had open discectomies. Depression was diagnosed in 16.2% of the cohort. In the sample, 12.8% patients had less than 12 years of education, 45.9% had their high school or General Educational Development degree, 17.3% had some college with no degree, 18.0% went to trade school and received their associate's degree, 5.3% had a college degree, and 0.8% had an advanced degree. Of the 266 patients, 17.3% had lawyer involvement at the time of surgery and 21.4% had a nurse case manager assigned. The average weekly income for the sample was $562.06 (SD=$351).

Correlation results

Table 2 presents the correlations between presurgical biopsychosocial variables and cost variables. Biological variables showing a statistically significant relationship with increased costs included older age, prior low back operations, and number of comorbid health conditions. The only significant psychological correlate of increased costs was alcohol use. Social predictors related to increased costs included lower education level, lawyer involvement, and assignment of a nurse case manager.

Regression results

Analyses were conducted using 11 presurgical biopsychosocial variables in three independent simultaneous-entry multiple regression equations predicting total compensation, medical, and aggregate costs. Table 3 contains the results of the simultaneous-entry multiple regression predicting total compensation costs. Two biological variables (gender and prior back surgeries), one psychological variable (alcohol use), and three social variables (lawyer involvement, nurse case manager, and level of education) had statistically significant regression weights. These biopsychosocial variables accounted for 30% of the variance in compensation costs. Table 4 contains the results of the simultaneous-entry multiple regression predicting total medical costs. Two biological variables (prior low back surgeries and time delay) and two social variables (lawyer involvement and nurse case manager) had statistically significant regression weights. These biological and social variables accounted for 32% of the variance in medical costs. Table 5 contains the results of the simultaneous-entry multiple regression predicting total aggregate costs. Two biological variables (prior back surgeries and time delay), one psychological variable (alcohol use), and three social variables (education, lawyer involvement, and nurse case manager) had statistically significant regression weights. These biopsychosocial variables accounted for 43% of the variance in total aggregate costs.

Discussion

The present study sought to determine whether a presurgical biopsychosocial model was predictive of medical and compensation costs of patients undergoing lumbar discectomy surgery via the workers' compensation system. Presurgical variables and cost outcomes were gathered for a cohort of 266 patients receiving workers' compensation in the state of Utah. The average time to MMI was 555 days, average medical costs were $18,966, and average compensation costs were $16,180. Multivariable linear regression models were predictive of both compensation and medical costs, as well as aggregate costs, using biological, social, and psychological variables. When predicting medical and compensation costs combined, this 11-variable model accounted for 43% of the variance.

The results of these regression models are encouraging compared with a similar study predicting cost outcomes for lumbar fusion patients, which accounted for roughly 15% and 21% of the costs for compensation and medical care, respectively (unpublished data). We believe the greater predictive power of the biopsychosocial model to be due in part to the less rapid expansion of rates and

Table 2
Correlations between presurgical biopsychosocial variables and cost variables

	Outcome variables		
Presurgical variable	Total compensation costs	Total medical expenses	Total aggregate costs
Gender (1=male/2=female)	−0.15*	0.00	−0.77
Age at time of surgery	0.13*	0.14*	0.14*
Number of prior low back operations	0.24*	0.25*	0.29*
Time delay	0.07	0.17*	0.14
Number of comorbid health conditions	0.16*	0.20*	0.21*
Type of discectomy (1=open/2=microdiscectomy)	−0.03	−0.08	−0.08
Depression	0.09	0.05	0.11
Alcohol use	0.24*	0.17*	0.24*
Education level	−0.25*	−0.16*	−0.25*
Lawyer involvement (1=no/2=yes)	0.33*	0.37*	0.44*
Nurse case manager (1=no/2=yes)	0.30*	0.33*	0.39*

*p<.05.

Table 3
Simultaneous-entry multiple regression: predicting total compensation costs with presurgical variables as predictors

	Unstandardized coefficients		Standardized coefficients	
Variable	B	Standard error	β	p Value
Gender (1=male/2=female)	−5,064.4	5,629.1	−0.15	.01
Age at time of surgery	136.2	75.1	0.10	.07
Number of prior low back operations	3,815.7	1,744.7	0.12	.03
Time delay	1.4	1.1	0.06	.21
Number of comorbid health conditions	163.2	931.8	0.01	.86
Type of discectomy (1=open/2=percutaneous)	194.6	717.9	0.02	.76
Depression	1,172.9	1,995.7	0.03	.56
Alcohol use	3,448.9	1,070.9	0.18	.00
Education level	−1,495.7	643.3	−0.13	.02
Lawyer involvement (1=no/2=yes)	9,585.9	1,960.4	0.27	.00
Nurse case manager (1=no/2=yes)	6,853.1	1,757.9	0.22	.00
Constant	−5,651.9	5,629.1		.32

R=0.55, R-squared=0.30, and p=.00.

costs of discectomy when compared with lumbar fusion [2]. This predictive ability may change, however, if new technologies relative to lumbar discectomy are adopted in the future.

Two of the most statistically significant predictors of compensation, medical, and aggregate costs were the assignment to nurse case management and the presence of litigation related to the patient's compensation claim. With respect to the former, it is somewhat counterintuitive to think that being assigned to a risk management program such as nurse case management would be predictive of higher costs. However, we believe that this is merely a reflection of the type of high-risk patients participating in this program, and at best, it may be an indication that the appropriate referral to nurse case management is being made within this particular workers' compensation environment. We submit that future investigations should look at the cost-effectiveness of nurse case management, perhaps by comparing both functional and cost outcomes of patients in systems that do and do not provide nurse case management. This would provide an in-depth look at what components of nurse case management (eg, scheduling assistance, psychosocial support) are particularly beneficial for compensated patients.

In contrast to nurse case management, lawyer involvement in compensation claims is likely a much more direct contributor to costs. Litigation in these cases may yield retroactive or extended wage replacement payments, additional medical examinations (eg, a second physician impairment rating), or permanent disability settlements. Moreover, this has been shown in previous studies of discectomy and lumbar fusion to be a significant predictor of poorer functional outcomes [3,9], likely acting as a catalyst for increased medical costs. What is unclear about this predictor is specifically what aspects of lawyer involvement are hindering functional improvement. It may be that the contestation of a compensation claim indicates limited motivation to recovery, diminished opportunity to return to work, or restricted financial resources, all of which could withhold patients from reaching their full recovery potential. This is certainly a topic worth investigating to further consider how consistently it is found.

Alcohol use and educational level were also both significant predictors of compensation and aggregate costs. Although it is unlikely that either of these factors can be remediated in the short term, they are items that can be addressed before and after surgery with specific interventions

Table 4
Simultaneous-entry multiple regression: predicting total medical costs with presurgical variables as predictors

	Unstandardized coefficients		Standardized coefficients	
Variable	B	Standard error	β	p Value
Gender (1=male/2=female)	−417.9	2,399.9	−0.01	.86
Age at time of surgery	136.8	95.5	0.08	.15
Number of prior low back operations	5,668.1	2,203.1	0.14	.01
Time delay	4.1	1.4	0.16	.00
Number of comorbid health conditions	1,015.9	1,184.2	0.05	.39
Type of discectomy (1=open/2=percutaneous)	−544.7	908.0	−0.03	.55
Depression	−2,138.1	2,564.7	−0.04	.41
Alcohol use	2,707.5	1,363.6	0.11	.05
Education level	−719.6	813.5	−0.05	.38
Lawyer involvement (1=no/2=yes)	13,481.6	2,491.8	0.30	.00
Nurse case manager (1=no/2=yes)	11,772.1	2,224.3	0.29	.00
Constant	−16,526.7	7,113.4		.02

R=0.56, R-squared=0.32, and p=.00.

Table 5
Simultaneous-entry multiple regression: predicting total aggregate costs with presurgical variables as predictors

	Unstandardized coefficients		Standardized coefficients	
Variable	B	Standard error	β	p Value
Gender (1=male/2=female)	−6,396.9	3,517.6	−0.09	.07
Age at time of surgery	276.9	139.3	0.10	.05
Number of prior low back operations	9,610.3	3,235.8	0.15	.00
Time delay	5.6	2.0	0.13	.00
Number of comorbid health conditions	1,083.8	1,728.2	0.03	.53
Type of discectomy (1=open/2=percutaneous)	−493.9	1,331.4	−0.02	.71
Depression	773.2	3,701.4	0.01	.84
Alcohol use	6,403.5	1,986.3	0.16	.00
Education level	−2,541.5	1,193.2	−0.10	.03
Lawyer involvement (1=no/2=yes)	26,362.7	3,635.8	0.36	.00
Nurse case manager (1=no/2=yes)	20,247.2	3,260.4	0.30	.00
Constant	−26,490.9	10,439.9		.01

R=0.66, R-squared=0.43, and $p<.01$.

tailored to individual patients where appropriate. A patient with a limited level of education may benefit from vocational rehabilitation, for example, if they are unable to return to their previous job because of an injury.

One particular limitation to this study is its generalizability to populations outside the workers' compensation system in Utah. The literature has suggested great variation in the procedural costs of spine surgery across regions of the United States [2], and it is thus unclear how prediction of these costs may differ across the country. Research on utilization trends for lumbar discectomy among compensated patients is relatively limited, and we believe that this is both a limitation of our study and also an opportunity for future research.

In light of these limitations, the present study lends further support to the use of the biopsychosocial model when evaluating the risk for abnormally high costs in compensated lumbar discectomy patients. This research follows several previous studies that used the biopsychosocial model to predict costs, as well as functional outcomes, among patients receiving both lumbar discectomy and lumbar fusion. Now more than ever, we support the careful consideration of social and psychological factors, which may weigh on a patient's potential for amassing unnecessarily high medical and compensation costs in addition to their potential for recovery. Finally, relatively low-cost interventions to address some of these factors are available, and assessing the usefulness of such interventions is a possible direction for future research.

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