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Early Predictors of Lumbar Spine Surgery After Occupational Back Injury

Results From a Prospective Study of Workers in Washington State

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Study Design. Prospective population-based cohort study.

Objective. To identify early predictors of lumbar spine surgery within 3 years after occupational back injury.

Summary of Background Data. Back injuries are the most prevalent occupational injury in the United States. Few prospective studies have examined early predictors of spine surgery after work-related back injury.

Methods. Using Disability Risk Identification Study Cohort (D-RISC) data, we examined the early predictors of lumbar spine surgery within 3 years among Washington State workers, with new workers compensation temporary total disability claims for back injuries. Baseline measures included worker-reported measures obtained approximately 3 weeks after claim submission. We used medical bill data to determine whether participants underwent surgery, covered by the claim, within 3 years. Baseline predictors ($P < 0.10$) of surgery in bivariate analyses were included in a multivariate logistic regression model predicting lumbar spine surgery. The area under the receiver operating characteristic curve of the model was used to determine the model's ability to identify correctly workers who underwent surgery.

Results. In the D-RISC sample of 1885 workers, 174 (9.2%) had a lumbar spine surgery within 3 years. Baseline variables associated with surgery ($P < 0.05$) in the multivariate model included higher Roland-Morris Disability Questionnaire scores, greater injury severity, and surgeon as first provider seen for the injury. Reduced odds of surgery were observed for those younger than 35 years, females, Hispanics, and those whose first provider was a chiropractor. Approximately 42.7% of workers who first saw a surgeon had surgery, in contrast to only 1.5% of those who saw a chiropractor. The area under the receiver operating characteristic curve of the multivariate model was 0.93 (95% confidence interval, 0.92–0.95), indicating excellent ability to discriminate between workers who would *versus* would not have surgery.

Conclusion. Baseline variables in multiple domains predicted lumbar spine surgery. There was a very strong association between surgery and first provider seen for the injury even after adjustment for other important variables.

Key words: lumbar spine surgery, back injury, workers' compensation, predictors, prospective study.

Level of Evidence: 2

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Back pain is the most costly and prevalent occupational health condition among the US working population.[1,2] Costs relating to occupational back pain increased more than 65% from 1996 to 2002 after adjustment for medical and general inflation.[3] Spine surgical procedures after occupational back injury represent approximately 21% of these costs[4] and face increasing scrutiny regarding effectiveness and efficacy.[5,6] There is little evidence that spine surgery is associated with improved population outcomes,[5] yet surgery rates have increased dramatically since the 1990s.[7–10] Reducing unnecessary spine surgery is important for improving patient safety and outcomes and reducing surgery complications and health care costs.[11,12] Although previous studies have investigated predictors of outcomes after lumbar spine surgery,[13–17] little research has focused on identifying early (after injury) factors associated with receipt of surgery.[18,19] Knowledge of early predictors of lumbar spine surgery after occupational back injury may help identify workers likely to undergo surgery, which, in turn, has potential to improve patient outcomes by targeting evidence-based care to such workers. Furthermore, such information is essential for comparative effectiveness studies so that factors associated with receipt of surgery can be assessed and included in adjustment techniques to increase comparability of treatment groups.

We used data from the Washington State Workers' Compensation Disability Risk Identification Study Cohort (D-RISC), a sample of workers with temporary total disability for a back injury, to assess rates of lumbar spine surgery in the first 3 years of the claim. We aimed to identify early predictors of such surgery, develop a multivariate predictive model of surgery, and evaluate the model's ability to predict surgery.

We used previous occupational injury, back injury, chronic back pain–related disability, and lumbar spine surgery literature to identify potential early predictors available in the D-RISC baseline data, which include measures in 7 domains (sociodemographic, employment-related, pain and function, clinical status, health care, health behavior, and psychological).[20–23] We hypothesized that the following baseline variables would be associated with subsequent lumbar spine surgery: older age,[9,10] higher pain ratings,[17,20,24,25] prescription of opioid medication within 6 weeks from the first medical visit for the injury,[18,26] worker perception that the job is "hectic,"[20] no employer offer of job accommodation after the injury,[20] worse psychological factors,[16,17,22,23] worse injury severity,[5,6,18,20] rural residence,[9,27] and a history of back injuries.[28] We also hypothesized that Hispanic,[10,17,29,30] non-white,[9,10,17,30] and female workers,[9,10,30] and workers with shorter current job duration[31] would have reduced odds of surgery, and that rates of surgery would vary by first provider seen for the injury.[32]

MATERIALS AND METHODS

Setting and Participants

The D-RISC has been described previously.[20–23,26,33] In brief, workers with back injuries were identified prospectively through weekly claims review from the Washington State Department of Labor and Industries (DLI) State Fund, which covers approximately two-thirds of the state's nonfederal workforce. Workers who received wage-replacement compensation for temporary total disability (4 d off work) due to the injury were potentially eligible for the study.

In the D-RISC, 4354 potential participants were identified from the DLI claims database between June 2002 and April 2004. As previously reported,[20] 1178 (27.1%) workers could not be contacted soon after the injury, 909 (20.9%) declined enrollment into the study, and 120 (2.8%) were ineligible. The remaining 2147 (49.3%) workers enrolled in D-RISC and completed a telephone interview, which was conducted a median of 18 days after claim receipt. Study participants were excluded from the D-RISC analysis if they were not eligible for compensation in the claim's first year (n = 240), were hospitalized for the initial injury (n = 16), were missing data on age (n = 3), or did not have a back injury according to medical record review (n = 3). Thus, 1885 (43.3%) workers were included in the D-RISC analysis sample. As previously reported,[20] this sample, compared with workers who received wage-replacement compensation for a back injury but were not in D-RISC, was slightly older, mean age (SD) = 39.4 (11.2) *vs*. 38.2 (11.1) yr, $P = 0.001$, contained more females (32% *vs*. 26%, $P < 0.001$), and had more workers receiving wage-replacement compensation 1 year after claim submission (13.8% *vs*. 11.3%, $P = 0.02$).

Baseline Variables

The D-RISC baseline data came from 3 sources: administrative claims and medical bill data, medical record review, and worker self-report in telephone interviews.[20–23,26,33] A measure of injury severity was developed for D-RISC, and trained occupational health nurses reviewed medical records of visits for the injury and rated injury severity.[23] See Table 1 and Supplemental Digital Content Appendix 1 (available at http://links.lww.com/BRS/A724) for additional information about the baseline variables.

Outcome Measure

The outcome measure was a lumbar spine surgery covered by DLI within 3 years of submission of a new back injury claim regardless of the worker's surgical history. We used the DLI computerized medical bill database, which includes dates of service and *Current Procedural Terminology* (*CPT*) codes for all medical bills paid by DLI in the claim. We identified all lumbar spine surgery bills, using the *CPT* codes shown in Supplemental Digital Content Appendix 2 (available at http://links.lww.com/BRS/A724). Our *CPT* codes vary slightly from a previous code list[34] for lumbar spine surgery, primarily by not including codes that imply spine defects or repeat surgical procedures; there were no differences in counts or types of surgical procedures when we used that list. The date of surgery was defined as the first date of service for an included *CPT* code. We identified operations within 3 years (1095 d) from the date DLI received the claim for the back injury. This period was the longest time surgical data were available for all 1885 D-RISC participants. We categorized the surgical procedures into fusion, decompression, or both operations for descriptive purposes but combined them for analytical purposes.

Statistical Analyses

Initially, we conducted bivariate logistic regression analyses to examine associations between baseline variables of interest and lumbar spine surgery, adjusted for worker age and sex. We then constructed a multivariate model for predicting surgery that included baseline variables bivariately associated ($P < 0.10$) with lumbar spine surgery. This criterion of $P < 0.10$ was used because a standard 0.05 level in a bivariate analysis may exclude variables that may be significant in a multivariate model.[35] Analyses were conducted using Stata MP12.[36] To evaluate the ability of the multivariate model to distinguish between workers who did *versus* did not undergo surgery by

3 years, we determined the area under the receiver operating characteristic (AUC) curve and used 10-fold cross validation to estimate the AUC in subsamples of the D-RISC data.[37] An AUC from 0.70 to 0.80 is considered acceptable and 0.80 to 0.90 excellent.[20,35]

RESULTS

Sample Characteristics

Study participants (N = 1885) were mostly non-Hispanic white (71%; Hispanic 15%; and Other 14%) and male (68%). By 3 years after claim receipt, 174 (9.2%) workers underwent a lumbar spine operation under the same claim as the index injury. Among the 174 workers with an operation, 137 (78.7%) had decompression only as the first operation in the claim, 6 (3.4%) had fusion only, and 31 (17.8%) had both on the same day. For those who underwent surgery in the first 3 years, the median number of days between claim receipt and the first surgery was 180 (interquartile range, 91–350 d). Six (3.4%) participants underwent the first surgery within 30 days, 37 (21.3%) between 31 and 90 days, 45 (25.9%) between 91 and 180 days, 44 (25.3%) between 181 and 365 days, 27 (15.5%) in the second year after claim receipt, and 15 (8.6%) in the third year after claim receipt.

Bivariate Analyses

Table 1 shows the baseline variables that had bivariate associations with surgery ($P < 0.10$). Variables that were not significant in bivariate analyses are listed in Supplemental Digital Content Appendix 1 (available at http://links.lww.com/BRS/A724). All 7 domains contained variables associated with lumbar spine surgery, including all variables from the pain and function, health care, and psychological domains. In the sociodemographic domain, suburban residence was associated with higher odds of surgery; younger age, female sex, Hispanic ethnicity, and non-white race were associated with reduced odds. Perception of job as fast-paced, working at current job for less than 6 months, not having returned to original work duties, and not receiving a job accommodation offer from the employer were associated with undergoing surgery. In the clinical status domain, injury severity, pain radiating below the knee, missing at least 1 month of work due to previous occupational injury (any type), and receipt of an opioid prescription for the injury were associated with surgery. Using tobacco daily (health behavior domain) was also associated with surgery.

Multivariate Model

The multivariate model (Table 2) included variables that were associated with surgery in bivariate analyses. All of the variables in the pain and function and psychological domains were bivariately significant. We examined correlations between variables in these domains. There were no significant ($P < 0.05$) correlations between any of the psychological variables, and we included all of them in the multivariate model. In the pain and function domain, several variables were significantly correlated. We did not include pain interference with daily activities,[38] pain interference with work,[38] 36-item Short-Form version 2 (SF-36v2) Physical Function,[39] and SF-36v2 Role Physical[39] in the multivariate model. We did include number of pain sites, pain intensity, and the Roland-Morris Disability Questionnaire (RMDQ).[40] We elected to keep the RMDQ in the final model because it is widely used and has been extensively validated as a measure of back pain–related disability. Similarly, 0 to 10 ratings of pain intensity are also widely used and validated, and the single rating is brief, not copyrighted, and can easily be obtained in clinical settings. In a model containing age, sex, the RMDQ, pain intensity, pain interference with daily activities, and pain interference with work, neither interference score was associated with surgery. The number of pain sites provides information about a different construct (pain diffuseness in the body) and has been found to predict worse back pain outcomes.[20,24] We did not include self-report of pain radiating below the knee because we preferred to use the injury severity measure rated by occupational nurses, which includes a category of radiculopathy.[20] Although there was evidence of some minor collinearities, none altered the model substantially, changed the direction of the variables, substantially impacted our key variables of interest, or led us to alter our conclusions.

Because of missing data on some variables, the multivariate model included 1857 (98.5%) workers. These workers, compared with the 28 who were in the D-RISC sample but not in the multivariate model, were less likely to have some college education (52% *vs*. 61%, $P = 0.01$). No other differences, including undergoing surgery, were identified.

As can be seen in Table 2, a total of 6 variables from 4 domains contributed independently ($P < 0.05$) to the prediction of lumbar spine surgery in the multivariate model. Workers with high baseline RMDQ scores had 6 times the odds of surgery compared with those with low scores. Those with greater injury severity and those whose first provider seen for the injury was a surgeon also had significantly higher odds of surgery. The surgery provider category included orthopedic surgeons (n = 104 workers seen), neurosurgeons (n = 34), and general surgeons (n = 33). Factors associated with significantly reduced odds of surgery included age less than 35 years, female sex, Hispanic ethnicity, and chiropractor as first provider seen for the injury. No measures in the employment-related, health behavior, or psychological domains were significant.

The AUC value was 0.93 (95% confidence interval [CI], 0.92–0.95), indicating a very high ability for the model to distinguish between participants who did and did not undergo lumbar spine surgery.[35] The cross-validation AUC was also 0.93 (95% CI, 0.91–0.95). In additional analyses, inclusion of only the RMDQ score, injury severity, and first provider seen for the injury resulted in an AUC value of 0.89 (95% CI, 0.87–0.91) and a cross-validation AUC of 0.89 (95% CI, 0.86–0.91).

DISCUSSION

In this sample, 9.2% of workers receiving temporary total disability compensation soon after an occupational back injury

TABLE 1. Baseline Variables Associated ($P < 0.10$) With Lumbar Spine Surgery by 3 Years After Claim Receipt for Occupational Back Injury*

Domain and Variables	No Surgery (n = 1711), n (%)	Surgery (n = 174), n (%)	OR†	95% CI	*P*
Sociodemographics					
Age, yr (ref = 35–44 yr)	507 (29.6)	72 (41.4)			<0.001
≤24	194 (11.3)	4 (2.3)	0.15	0.05–0.41	
25–34	450 (26.3)	27 (15.5)	0.42	0.26–0.66	
45–54	394 (23.0)	48 (27.6)	0.86	0.59–1.27	
≥55	166 (9.7)	23 (13.2)	1.00	0.61–1.66	
Sex (ref = male)	1154 (67.4)	128 (73.6)			0.08
Female	557 (32.6)	46 (26.4)	0.73	0.51–1.04	
Region of worker residence‡§ (ref = urban)	1016 (59.3)	90 (51.7)			0.06
Suburban	257 (15.0)	41 (23.6)	1.77	1.16–2.69	
Large town	207 (12.1)	18 (10.3)	1.02	0.60–1.75	
Rural	179 (10.5)	18 (10.3)	1.15	0.65–2.03	
Race/ethnicity (ref = non-Hispanic white)	1173 (68.6)	145 (83.3)			<0.001
Hispanic	295 (17.2)	12 (6.9)	0.36	0.20–0.67	
Other	243 (14.2)	17 (9.8)	0.56	0.33–0.95	
Employment-related					
Fast pace¶ (ref = strongly disagree/disagree)	416 (24.3)	35 (20.1)			0.02
Agree	687 (40.2)	63 (36.2)	1.21	0.78–1.88	
Strongly agree	602 (35.2)	76 (43.7)	1.78	1.16–2.74	
Job duration‖ ≥6 mo	1319 (77.1)	129 (74.1)			0.09
<6 mo	388 (22.7)	45 (25.9)	1.38	0.95–1.98	
Employer offered job accommodation (ref = Yes)	800 (46.8)	55 (31.6)			0.001
No/don't know	911 (53.2)	119 (68.4)	1.78	1.27–2.49	
Returned to paid work by baseline interview (ref = Yes, same job)	593 (34.7)	14 (8.0)			<0.001
Yes, light duty or different job	444 (25.9)	25 (14.4)	2.44	1.25–4.76	
No	673 (39.3)	135 (77.6)	8.28	4.72–14.56	
Pain and function					
Number pain sites** (ref = 0–2 sites)	840 (49.1)	28 (16.1)			<0.001
3–4 sites	607 (35.5)	110 (63.2)	5.15	3.34–7.94	
5–8 sites	264 (15.4)	36 (20.7)	4.22	2.50–7.11	
Pain intensity, past week (0 = no pain, ref = 0–3)[38]	451 (26.4)	7 (4.0)			<0.001
4–5	457 (26.7)	38 (21.8)	5.50	2.42–12.48	
6–7	456 (26.7)	53 (30.5)	8.23	3.68–18.37	
8–10	344 (20.1)	76 (43.7)	15.26	6.90–33.72	
Pain interference with daily activities, past week (0 = no interference, ref = 0–3)[38]	587 (34.3)	7 (4.0)			<0.001

(*Continued*)

TABLE 1. (*Continued*)

Domain and Variables	No Surgery (n = 1711), n (%)	Surgery (n = 174), n (%)	OR†	95% CI	*P*
4–5	384 (22.4)	26 (14.9)	5.80	2.48–13.52	
6–7	333 (19.5)	49 (28.2)	13.04	5.82–29.26	
8–10	398 (23.3)	98 (56.3)	19.82	9.05–43.38	
Pain interference with work, past week†† (0 = no interference, ref = 0–3)[38]	625 (36.5)	7 (4.0)			<0.001
4–5	314 (18.4)	22 (12.6)	6.44	2.72–15.29	
6–7	312 (18.2)	39 (22.4)	11.41	5.03–25.88	
8–10	449 (26.2)	105 (60.3)	21.34	9.80–46.48	
Roland-Morris Disability Questionnaire[40]‡‡ (0 = no disability) (ref = 0–8)	524 (30.6)	4 (2.3)			<0.001
9–16	601 (35.1)	37 (21.3)	8.55	3.02–24.19	
17–24	586 (34.2)	133 (76.4)	31.69	11.59–86.63	
SF-36v2 Physical Function[39]§§ (ref = >50)	445 (26.0)	8 (4.6)			<0.001
41–50	325 (19.0)	5 (2.9)	0.85	0.28–2.64	
30–40	469 (27.4)	29 (16.7)	3.53	1.59–7.83	
<30	471 (27.5)	132 (75.9)	16.16	7.77–33.62	
SF-36v2 Role Physical[39]§§ (ref = >50)	402 (23.5)	3 (1.7)			<0.001
41–50	332 (19.4)	7 (4.0)	2.85	0.73–11.13	
30–40	446 (26.1)	29 (16.7)	8.88	2.68–29.43	
<30	528 (30.9)	135 (77.6)	33.71	10.63–106.93	
Pain change since injury (ref = better)	1213 (70.9)	65 (37.4)			<0.001
Same	325 (19.0)	54 (31.0)	3.31	2.24–4.87	
Worse	157 (9.2)	54 (31.0)	6.72	4.46–10.12	
Clinical status					
Injury severity[23]¶¶ (ref = mild strain/sprain)	991 (57.9)	38 (21.8)			<0.001
Major strain/sprain with substantial immobility but no evidence of radiculopathy	361 (21.1)	20 (11.5)	1.36	0.78–2.38	
Evidence of radiculopathy	306 (17.9)	95 (54.6)	7.80	5.21–11.68	
Reflex, sensory or motor abnormalities	43 (2.5)	21 (12.1)	11.57	6.19–21.65	
Pain radiates below knee (ref = no)	1303 (76.2)	57 (32.8)			<0.001
Yes	408 (23.8)	117 (67.2)	6.43	4.58–9.05	
Previous injury (any type) with ≥1 mo off work (ref = no)	1275 (74.5)	100 (57.5)			<0.001
Yes	429 (25.1)	74 (42.5)	1.83	1.32–2.54	
Opioid Rx within 6 wk of injury‡ (ref = no)	1131 (66.1)	77 (44.3)			<0.001
Yes	541 (31.6)	94 (54.0)	2.46	1.78–3.39	
Health care					
Specialty, first provider seen for injury‡ (ref = primary care)	635 (37.1)	45 (25.9)			<0.001

(*Continued*)

TABLE 1. (*Continued*)

Domain and Variables	No Surgery (n = 1711), n (%)	Surgery (n = 174), n (%)	OR†	95% CI	*P*
Surgeon	98 (5.7)	73 (42.0)	10.41	6.72–16.11	
Occupational medicine	107 (6.3)	16 (9.2)	2.09	1.13–3.87	
Chiropractor	534 (31.2)	8 (4.6)	0.21	0.10–0.45	
Other	337 (19.7)	32 (18.4)	1.36	0.84–2.19	
Time from injury to first medical visit for injury‡ (ref = 0–6 d)	1336 (78.1)	119 (68.4)			<0.001
7–13 d	193 (11.3)	20 (11.5)	1.08	0.65–1.79	
≥14 d	138 (8.1)	32 (18.4)	2.58	1.67–3.98	
Health behavior					
Tobacco use (ref = no)	986 (57.6)	84 (48.3)			0.07
Occasionally/frequently	267 (15.6)	24 (13.8)	1.04	0.64–1.67	
Daily	505 (29.5)	66 (37.9)	1.49	1.06–2.11	
Psychological					
Catastrophizing[41]‖‖ (ref = 0–1)	551 (32.2)	15 (8.6)			<0.001
Low (>1 to <2)	282 (16.5)	23 (13.2)	3.02	1.55–5.90	
Moderate (2 to <3)	490 (28.6)	70 (40.2)	5.30	2.99–9.42	
High (3–4)	388 (22.7)	66 (37.9)	6.39	3.57–11.43	
Recovery expectations[42]*** (0–10 scale, 10 = extremely certain will be working in 6 mo, ref = 10)	993 (58.0)	65 (37.4)			<0.001
High (7–9)	331 (19.3)	65 (37.4)	3.04	2.10–4.40	
Low (0–6)	328 (19.2)	39 (22.4)	1.86	1.22–2.84	
Blame for injury[42]††† (ref = work)	823 (48.1)	92 (52.9)			0.02
Self	339 (19.8)	20 (11.5)	0.52	0.31–0.85	
Someone/something else	237 (13.9)	33 (19.0)	1.25	0.81–1.92	
Nothing/no one	265 (15.5)	28 (16.1)	0.91	0.58–1.42	
Work fear avoidance[43]‡‡‡ (ref = <3, very low)	361 (21.1)	15 (8.6)			<0.001
Low-moderate (>3 to <5)	567 (33.1)	39 (22.4)	1.71	0.93–3.16	
High (5–6)	783 (45.8)	120 (69.0)	3.85	2.21–6.70	
SF-36v2 Mental Health[39]§§ (ref = >50)	688 (40.2)	30 (17.2)			<0.001
41–50	417 (24.4)	56 (32.2)	3.27	2.05–5.20	
≤40	604 (35.3)	88 (50.6)	3.53	2.29–5.45	

Percentages may not sum to 100 due to rounding and missing values.

**Missing, "don't know," and refusal responses for each variable were combined into 1 response (unless stated otherwise) for each variable if 15 or more of responses qualified (results not shown). The following variables had missing responses: region of worker residence (n = 59), fast pace (n = 6), job duration (n = 4), returned to paid work by baseline interview (n = 1), pain intensity (n = 3), pain interference with daily activities (n = 9), pain interference with work (n = 12), SF-36v2 Physical Function (n = 1), SF-36v2 Role Physical (n = 3), pain change since injury (n = 17), injury severity (n = 10), previous injury (any type) with 1 month or more off work (n = 7), opioid Rx within 6 weeks of injury (n = 42), time from injury to first medical visit for injury (n = 48), tobacco use (n = 3), recovery expectations (n = 64), blame for injury (n = 48), and SF-36v2 Mental Health (n = 2).*

†Age and sex were included in bivariate analyses along with the variable of interest.

‡From the DLI database.

§By residential zip code, using the Washington State guidelines classifications at http://www.doh.wa.gov/Data/Guidelines/RuralUrban.

(*Continued*)

TABLE 1. (*Continued*)

¶My job requires working very fast. Would you say disagree strongly, disagree, agree, or agree strongly?

‖Continuous data for job duration were categorized for analyses.

***The 8 pain sites were head, neck, shoulders, back, arms/hands, buttocks/hips, abdomen, and legs/feet. We summed the number of "Yes" answers to create the variable for the number of pain sites.*

††In the past week, how much has pain interfered with your ability to work, including housework, rated on a scale from 0 to 10, where 0 is "no interference" and 10 is "unable to carry on any activities"?

‡‡Measures self-reported back disability; higher scores indicate more disability.

§§36-item Short-Form version 2 (SF-36v2) Physical Function, Role Physical, and Mental Health scales; higher scores indicate better functioning.

¶¶Rated by trained nurses, based on medical records early in the claim.

‖‖Mean of responses to 3 questions from the Pain Catastrophizing scale.

****How certain are you that you will be working in 6 months, using a scale of 0 to 10, where 0 is "not at all certain" and 10 is "extremely certain"? The ratings (0–10) were categorized for analyses.*

*†††Who or what do you think is to blame for your injury? Would you say work (*e.g., *work conditions, employer, coworker), yourself, no one or nothing, or someone or something else?*

‡‡‡Mean of responses to 2 questions from the Fear Avoidance Beliefs Questionnaire work scale.

OR indicates odds ratio; CI, confidence interval; ref, reference group; Rx, prescription.

underwent lumbar spine surgery in the next 3 years. This rate is similar to rates of lumbar spine surgery after occupational back injury reported in other studies (Webster *et al*[18]: 9.8%; and Bonauto *et al*[29]: 10.8%). Measures in 4 domains predicted surgery: sociodemographic, pain and function, clinical status, and health care.

The most striking predictor of surgery was the baseline RMDQ score. In the multivariate model, workers with baseline RMDQ scores of 17 or higher on the 0- to 24-point scale had 6 times the odds (adjusted odds ratio, 6.12; 95% CI, 1.84–20.42) of surgery compared with those with scores of 0 to 8. The RMDQ has also been shown to predict chronic work disability (in a previous study using the D-RISC sample),[20] longer duration of sick leave,[44] chronic pain,[25] and other measures of function.[45]

Several psychological variables predicted surgery in bivariate analyses, but none were significant in the multivariate model. In other studies, patients with lumbar spinal stenosis and discogenic back pain who did *versus* did not have surgery did not differ prior to surgery on bivariate measures of mental health and pain catastrophizing.[19,46] In the previous study using the D-RISC sample, baseline psychological measures were highly significant predictors of chronic work disability in bivariate analyses but were significant in a multivariate model only when the RMDQ was excluded from the model.[20] Past research has demonstrated significant associations between the RMDQ and a variety of psychological measures.[20,47] We conducted additional analyses to assess the possibility that shared variance between the RMDQ and the psychological variables in predicting surgery resulted in the failure of the psychological variables to predict surgery. In regression models with age, sex, and the RMDQ, work fear avoidance[43] was the only psychological variable that, when added, contributed significantly ($P < 0.05$) to the prediction of surgery. Such findings are consistent with the possibility that patients who communicate considerable distress and dysfunction do so across self-report measures and are more likely to undergo surgery.

The D-RISC injury severity rating was a significant predictor of surgery. This is consistent with previous findings that radiculopathy influences back pain outcomes, including surgical procedures.[17,18,25,45] Surgery may be appropriate treatment of radiculopathy.[48] The odds of surgery were highest for workers with reflex, sensory, or motor abnormalities (19/58, or 32.8%, received surgery). Odds were also high for workers with symptomatic radiculopathy without such abnormalities (85/344, or 24.7%, received surgery). In future studies investigating lumbar spine surgery, it may be informative to separate these categories.

In Washington State workers' compensation, injured workers may choose their medical provider. Even after controlling for injury severity and other measures, workers with an initial visit for the injury to a surgeon had almost 9 times the odds of receiving lumbar spine surgery compared with those seeing primary care providers, whereas workers whose first visit was to a chiropractor had significantly lower odds of surgery (adjusted odds ratio, 0.22; 95% CI, 0.10–0.50). Approximately 43% of workers who first saw a surgeon had surgery within 3 years, in contrast to only 1.5% of those who first saw a chiropractor. It is possible that these findings indicate that "who you see is what you get."[32] Previous studies have noted similar findings, using provider surveys of hypothetical patients.[32,49] Persons with occupational back injuries who first saw a chiropractor had lower odds of chronic work disability and early receipt of magnetic resonance imaging in previous reports of data from the D-RISC sample[20,33] and higher rates of satisfaction with back care.[50] However, patients who see chiropractors may differ from patients who choose other provider types.[20,51] It may be of interest to workers' compensation programs to evaluate a gatekeeper approach to help ensure the need for lumbar spine surgery.

TABLE 2. Multivariate Model Predicting Lumbar Spine Surgery by 3 Years From Baseline Variables					
Domain and Variables	**Bivariate OR***	**Bivariate 95% CI**	**Multivariate OR†**	**Multivariate 95% CI**	**Multivariate *P***
Sociodemographics					
Age, yr (ref = 35–44 yr)					0.003
≤24	0.15	0.05–0.41	0.23	0.07–0.73	
25–34	0.42	0.26–0.66	0.49	0.27–0.89	
45–54	0.86	0.59–1.27	0.70	0.41–1.18	
≥55	1.00	0.61–1.66	1.43	0.73–2.82	
Sex (ref = male)					0.0001
Female	0.73	0.51–1.04	0.40	0.25–0.65	
Region of worker residence (ref = urban)					0.17
Suburban	1.77	1.16–2.69	2.00	1.17–3.41	
Large town	1.02	0.60–1.75	1.31	0.65–2.64	
Rural	1.15	0.65–2.03	1.08	0.55–2.13	
Race/ethnicity (ref = non-Hispanic white)					0.002
Hispanic	0.36	0.20–0.67	0.30	0.14–0.66	
Other	0.56	0.33–0.95	0.51	0.26–0.9991	
Employment-related					
Fast pace (ref = strongly disagree/disagree)					0.25
Agree	1.21	0.78–1.88	1.45	0.81–2.61	
Strongly agree	1.78	1.16–2.74	1.63	0.90–2.95	
Job duration ≥6 mo					0.71
<6 mo	1.38	0.95–1.98	1.10	0.68–1.77	
Employer offered job accommodation (ref = Yes)					0.43
No/don't know	1.77	1.26–2.48	1.22	0.74–2.01	
Returned to paid work by baseline interview (ref = Yes, same job)					0.74
Yes, light duty or different job	2.44	1.25–4.76	1.23	0.55–2.88	
No	8.28	4.72–14.56	1.34	0.64–2.79	
Pain and function					
Number pain sites (ref = 0–2 sites)					0.60
3–4 sites	5.15	3.34–7.94	1.34	0.76–2.35	
5–8 sites	4.22	2.50–7.11	1.28	0.65–2.52	
Pain intensity, past week (0 = no pain, ref = 0–3)[38]					0.18
4–5	5.50	2.42–12.48	2.39	0.90–6.36	
6–7	8.23	3.68–18.37	1.67	0.62–4.49	
8–10	15.26	6.90–33.72	2.36	0.86–6.50	
Roland-Morris Disability Questionnaire[40]‡ (0 = no disability) (ref = 0–8)					0.0003

(*Continued*)

TABLE 2. (*Continued*)

Domain and Variables	Bivariate OR*	Bivariate 95% CI	Multivariate OR†	Multivariate 95% CI	Multivariate *P*
9–16	8.55	3.02–24.19	2.52	0.78–8.10	
17–24	31.69	11.59–86.63	6.12	1.84–20.42	
Pain change since injury (ref = better)					0.50
Same	3.31	2.24–4.87	1.06	0.62–1.80	
Worse	6.72	4.46–10.12	1.56	0.84–2.90	
Clinical status					
Injury severity (ref = mild strain/sprain)					<0.0001
Major strain/sprain with substantial immobility but no evidence of radiculopathy	1.36	0.78–2.38	0.84	0.43–1.62	
Evidence of radiculopathy	7.80	5.21–11.68	4.34	2.62–7.17	
Reflex, sensory or motor abnormalities	11.57	6.19–21.65	5.73	2.62–12.52	
Previous injury (any type) with ≥1 mo off work (ref = no)					0.32
Yes	1.83	1.32–2.54	1.19	0.86–1.66	
Opioid Rx within 6 wk of injury (ref = no)					0.38
Yes	2.46	1.78–3.39	0.87	0.65–1.18	
Health care					
Specialty, first provider seen for injury (ref = primary care)					<0.0001
Surgeon	10.41	6.72–16.11	8.69	5.03–15.01	
Occupational medicine	2.09	1.13–3.87	1.39	0.67–2.87	
Chiropractor	0.21	0.10–0.45	0.22	0.10–0.50	
Other	1.36	0.84–2.19	1.38	0.78–2.45	
Time from injury to first medical visit for injury (ref = 0–6 d)					0.32
7–13 d	1.08	0.65–1.79	0.74	0.39–1.40	
≥14 d	2.58	1.67–3.98	1.49	0.82–2.72	
Health behavior					
Tobacco use (ref = no)					0.38
Occasionally/frequently	1.04	0.64–1.67	0.66	0.36–1.21	
Daily	1.49	1.06–2.11	0.95	0.60–1.50	
Psychological					
Catastrophizing[41]§ (ref = 0–1)					0.18
Low (>1 to <2)	3.02	1.55–5.90	1.75	0.73–4.18	
Moderate (2 to <3)	5.30	2.99–9.42	2.28	1.05–4.93	
High (3–4)	6.39	3.57–11.43	2.15	0.94–4.90	
Recovery expectations[42] (0–10 scale, 10 = extremely certain will be working in 6 mo, ref = 10)					0.38
High (7–9)	3.04	2.10–4.40	0.87	0.51–1.48	

(*Continued*)

TABLE 2. (*Continued*)

Domain and Variables	Bivariate OR*	Bivariate 95% CI	Multivariate OR†	Multivariate 95% CI	Multivariate *P*
Low (0–6)	1.86	1.22–2.84	0.97	0.56–1.67	
Blame for injury[42] (ref = work)					0.09
Self	0.52	0.31–0.85	0.72	0.38–1.35	
Someone/something else	1.25	0.81–1.92	1.17	0.67–2.06	
Nothing/no one	0.91	0.58–1.42	0.96	0.52–1.76	
Work fear avoidance[43]¶ (ref = <3, very low)					0.27
Low-moderate (>3 to <5)	1.71	0.93–3.16	1.00	0.47–2.16	
High (5–6)	3.85	2.21–6.70	1.47	0.71–3.04	
SF-36v2 Mental Health[39] (ref = >50)					0.26
41–50	3.27	2.05–5.20	1.31	0.72–2.40	
≤40	3.53	2.29–5.45	0.87	0.48–1.58	

Each baseline variable included in this table was associated (P < 0.10) in bivariate analyses with lumbar spine surgery by 3 years after occupational lumbar spine surgery.

**Adjusted for age and sex, except for age and sex.*

†Adjusted for all other variables in the multivariate model.

‡Measures self-reported back disability; higher scores indicate more disability.

§Mean of responses to 3 questions from the Pain Catastrophizing scale.

¶Mean of responses to 2 questions from the Fear Avoidance Beliefs Questionnaire work scale.

OR indicates odds ratio; CI, confidence interval; ref, reference group; Rx, prescription.

As hypothesized, Hispanic participants had lower odds of surgery. Prior research has also observed lower rates of spine surgery among Hispanics.[9,10,29,30,52] In an earlier study, Spanish-speaking workers had significantly fewer lumbar spine surgical procedures within 2 years of work injury than non-Hispanic white workers (7.4% *vs.* 11.0%).[29] These lower odds may reflect cultural barriers and less willingness to undergo surgical procedures[10,53]; lack of familiarity or understanding of surgery[10,54]; fewer physician referrals to surgery[30]; and discouragement, lack of information, or bias from employers.[5]

Receipt of a prescription for an opioid medication within 6 weeks of claim receipt was not significant in the multivariate model. A previous study linked early opioid use to receiving lumbar spine surgery for a work-related injury, although the study inclusion criteria and methods differed from D-RISC.[18] When we matched our inclusion criteria and methods to that study, an opioid prescription was still not significant. We speculate that the difference may be that a measure of worker-related function was not included; in our study, the RMDQ was a highly significant predictor of surgery and opioid prescription was no longer significant after adjusting for RMDQ socres.[18]

The multivariate model had excellent ability to distinguish between workers who did or did not have surgery. A model that included only the RMDQ, injury severity, and first provider seen for the injury also had a very high ability to identify workers who did or did not undergo surgery. These 3 variables may be of use in future research to predict lumbar spine surgery after occupational back injury; they are relatively simple to obtain, use, and interpret.

Our study has some limitations. We could not capture information on surgery covered outside DLI, although it is reasonable to assume that surgical procedures for the accepted index back injury claim would be covered. Although the D-RISC sample consisted of workers with back injuries, some *CPT* codes are not restricted to lumbar-specific spine surgical procedures. The extent to which our findings may generalize to other settings is unknown. Given the large number of potential predictors examined, some may have been statistically significant because of chance. Nonetheless, the study has notable strengths, including complete data for the entire population-based sample on surgery covered by workers' compensation and a large prospective sample of workers who provided detailed information shortly after injury on several factors, as well as data from medical record and medical payment sources.

Variables from several domains predicted lumbar spine surgery after occupational back injury. Surgical procedures were predicted by factors beyond aspects of the injury, such as age, sex, ethnicity, and first provider seen for the injury. Knowledge of surgery predictors may inform interventions or studies on care management of workers with occupational back injuries, including comparative effectiveness studies of surgery for back pain.

➢ Key Points

- Of 1885 workers, 174 (9.2%) workers had 1 or more lumbar spine surgical procedures within 3 years of filing workers' compensation claim for temporary total disability from an occupational back injury. In the claim, 137 workers had a decompression procedure, 6 had a fusion without decompression, and 31 had both as the first surgery.
- Significant worker baseline variables in a multivariate model predicting 1 or more lumbar spine surgical procedures within 3 years of claim submission included higher RMDQ scores, greater injury severity, and first seeing a surgeon for the injury. Participants younger than 35 years, females, Hispanics, and those whose first visit for the injury was to a chiropractor had lower odds of surgery.
- The multivariate model had excellent ability to distinguish between those who did and did not undergo lumbar spine surgery (AUC curve = 0.93).

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