The Incidence and Outcomes of Surgery

Among Workers' Compensation Back Claims

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Abstract

This paper analyzes the incidence and outcomes of surgery for work-related back pain, with particular focus on differences between cases treated by a managed care network or by fee-for-service providers. The data for the study come from a census of workers' compensation claims from three large insurers in three states (California, Connecticut, Texas).After restrictions, there are 7,812 cases in the analysis data set. Of these, 81 received surgery for their back pain.

The results show that some non-clinical factors including age, gender, insurance carrier, and state, are significantly related to the probability of receiving surgery for back pain. Workers who receive surgery have poorer outcomes than those receiving non-surgical treatments. The results also indicate that both network and non-network providers generally follow the recommended practice guidelines for back pain.

Introduction:

Back injury claims are particularly important in workers' compensation. Among working-age people, 50 percent admit to back symptoms each year, and back pain is the most common cause of disability for persons under 45. The trunk, including the back, is the body part most affected by disabling work incidents in almost every major industry. The proportion of back injuries to the total number of nonfatal occupational injuries and illnesses is 25 percent, the largest proportion among all injuries in every major industry. Back injuries account for one third of the cost of all workplace injuries (NCCI, 1992). The total annual losses, including lost productivity, to back claims are estimated between $20 and $50 billion (Bigos, et al1994).

Despite the high incidence rates and high costs of work-related back pain, there is no consensus among health care providers regarding the most cost-effective treatments. The most costly approach is surgery. However, there has been little research to determine if surgical treatments are cost effective, or to identify the types of patients that are most likely to receive back surgery.

The Agency for Health Care Policy and Research (AHCPR) has developed practice guidelines for back surgery. The practice guidelines are systematically developed statements that assist physicians and patients in making decisions about treatment for back injuries. The guidelines recommend different treatments for different kinds of diagnoses and severities. Three categories of back surgery are identified as "surgery for herniated disc," "surgery for spinal stenosis" and "spinal fusion." For each category, the guidelines carefully define which methods should be considered depending on the time elapsed after the first symptom, what therapies other than surgery have been provided, what their expected outcome will be, and so on. The guidelines also indicate the risks and possible serious complications for each method.

This paper analyzes the incidence and outcomes of surgery for work-related back pain. One objective of the paper is to identify non-clinical factors that are significantly related to the probability of surgical treatments. A second objective is to evaluate outcomes for a sample of back cases treated with surgery relative to a comparison group of non-surgical cases. The final objective is to determine whether providers follow the AHCPR practice guidelines for back surgery in the treatment of workers' compensation cases.

A variable of particular interest is whether the case was treated by a managed care network or by fee-for-service providers. The following questions are addressed: Is the incidence of back surgery significantly different between network and non-network back cases? Do the outcomes of surgery, or the types of cases who receive surgery differ in the two groups? Are network or fee-for-service providers more likely to follow the practice guidelines with regard to surgery for back pain?

Literature review:

Williams et. al.(1998) analyze patterns of health care and indemnity costs associated with the natural progression of low back pain. The study is based on a random sample of 520 workers' compensation back claims extracted from the Detailed Claim Information (DCI) database monitored and maintained by the National Council on Compensation Insurance (NCCI). The samples are restricted to claims from four states (Oregon, Illinois, Pennsylvania and Florida), from 1988 to 1992.

Claims are partitioned into four groups based on the length of time the workers received indemnity payments for lost work time: less than 30 days, 30-90 days, 91-180 days, more than 180 days. This grouping characterizes the natural history of work disability associated with back pain. The onset of back pain is defined as acute pain (less than 7 days restriction) or subacute pain (7 days to 7 weeks). If the symptoms persist beyond the seventh week after onset, the condition is defined as chronic pain. The second alert happens after three months (90 days) of continuous symptoms and attempts to prevent the chronic phase of the disorder from taking root. The third timing is six months (180 days) after onset because it is well accepted that the probability of a patient returning to work after this point drops precipitously. This strategy for grouping patients has been used previously for analyzing aggregate compensation costs, although the lengths of intervals vary. It is representative of the continuous disability curve for back pain.

The study shows that the three most important sources of health care expenditures across the disability curve are diagnostic procedures, surgery, and physical therapy. The most costly service category is diagnostic procedures, which accounts for 25 percent of total medical costs, followed by surgical procedures at 21 percent, and physical therapy at 20 percent. Indemnity costs account for 33 percent of total claim costs for low back cases. Further, indemnity costs are disproportionately related to different health care services provided to low back pain patients: 60 percent of health care costs are spent on the 20 percent of claimants with more than four months of disability.

The authors contend that surgery is the last resort in the majority of workers' compensation back cases. The majority of individuals with occupational low back pain are not typically surgical candidates because surgically correctable disease is observed in only five to ten percent of cases. The longer an individual is off work the more limited the outcome of surgical interventions are likely to be with regard to return to work, symptom reduction, and functional improvement.

Shekelle et. al. (1995) compare the costs of back pain care across different provider types in a population representative of the U.S. This study is the first to present comparisons across provider types in a community sample that uses episodes of care as the unit of analysis.

The data are from the RAND Health Insurance Experiment (HIE), which is a population-based, randomized controlled trial tracking the use of medical services and health status of enrollees over a three to five year period. The data are collected from six sites representing the four U.S. census regions and urban and rural areas. The sample is designed to be socio-demographically similar to the non-elderly US population. There are 1020 episodes of back pain care from 686 different persons and including 8825 visits.[1] The results show economically significant differences in the costs of back pain care for persons seeing chiropractors, general practitioners, internists and orthopedic surgeons. Orthopedic surgeons have the highest mean cost per episode, while general practitioners have the lowest cost.

Although the study demonstrates that surgical care for back pain is more costly than other types of treatment, there are no measures of the outcomes of different types of treatment, so it is impossible to evaluate the cost effectiveness of surgical care. Further, workers' compensation cases are excluded from the sample, so the study has limited value for comparisons to back pain associated with work-related injuries.

Carey et. al. (1995) conducted an observational study to determine whether the costs and outcomes of care for back pain differ among primary care practitioners, chiropractors, and orthopedic surgeons. They randomly selected 208 practitioners from North Carolina representing six strata: urban primary care physicians, rural primary care physicians, urban chiropractors, rural chiropractors, orthopedic surgeons, and primary care providers at a group-model health maintenance organization (HMO). The sample was collected from June 1992 to March 1993, and a total of 1633 patients were included in the study.

1. A health care episode is "the period of time during which a specific disease process, illness, health care problem, or treatment process is present. It is characterized by an onset, or beginning, and a resolution, or ending, between which the health problem state applies"(Hornbrook et. al.1985, P_{168}). In the Shekelle study, the following decision rules were used to group visits into episodes of care: 1) any period of time of three months or greater between back pain related visits signaled the start of a new episode; 2) all qualifying visits that did not contain a gap of three months or more were considered to be part of the same episode of care; 3) no visits coded for non-back-pain-related symptoms or services were included in the episode of care.

The criteria for enrollment included back pain of less than 10 week's duration, no previous history of back pain, back surgery, or cancer, and no pregnancy at time of the initial visit. Workers' compensation was involved in 31 percent of the cases.

In each stratum, 59 percent or more of the patients had acute back pain of less than two week's duration. Overall, patients had rapid improvement with a median of 8 days and a mean of 16 days to functional recovery. Primary care practitioners provided the least expensive care for acute low back pain; but outcomes were similar for patients who received care from primary care practitioners, chiropractors, or orthopedic surgeons. Only 5 percent of the patients had not reported some functional recovery at six months, but 31 percent of the patients had not completely recovered at six months.

Bentkover et. al.(1992) study the effects of certain demographic, socioeconomic, and medical characteristics on the likelihood of patients hospitalized with low back pain receiving either laminectomies or spinal fusions.[2] The characteristics considered include being white, male, well insured, young; being a routine admission; being admitted to a medium-sized hospital; being admitted to a teaching hospital; being admitted to a hospital with a high occupancy rate; and being discharged to home.

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[2].**Laminectomy**: a surgical procedure which is designed to relieve pressure on the spinal cord or nerve root that is caused by a slipped or herniated disc in the lumbar spine. This procedure is also used in the treatment of spinal stenosis. This procedure includes removal of a portion of the bone comprising a vertebra. Recovery is generally 7-10 days. An alternative to this is a micro-disc surgery.

Spinal fusions: A procedure that involves fusing together two or more vertebrae in the spine using either bone grafts or metal rods (Harrington rods). This procedure may be used to correct kyphosis or scoliosis. It is also used in those who require spine stabilisation due to vertebral damage from ruptures discs, fractures, osteomyelitis, osteoarthritis or tumour. (The On-line Medical Dictionary --http://www.graylab.ac.uk/omd/)

The data come from the Massachusetts Health Data Consortium and the American Hospital Association and pertain to fiscal years 1984 to 1985. The data include 35,574 discharges of patients from 110 Massachusetts hospitals. Two models are estimated: In the first model, using hospital-level data, the dependent variable reflects the proportion of patients who received a laminectomy, spinal fusion, or both. In the second model, estimated on patient-level data, the dependent variable reflects the likelihood of a patient having a laminectomy or spinal fusion, or both. This model is most closely related to the current study.

The results show that the likelihood of surgery for back pain increases with good insurance coverage, is higher for whites than for blacks, and for males than for females (with the exception of spinal fusions). There are some limitations to the models in the study. Because the data are abstracted from hospital discharge summaries, it is impossible to characterize the patients uniquely. That is, some patients may be readmitted to the hospital, so the observations are not necessarily independent. Also, there is no analysis of patient comorbidities and outcomes, especially in terms of potential benefits of different therapies.

Franklin et. al.(1994) study the outcomes of lumbar fusion among Washington state workers' compensation cases. They examine the work disability status, reoperation rate, and measures of patient satisfaction.

The data come from the claim and medical bill payment databases of the Washington State workers' compensation system, covering a large, population-based cohort of workers in Washington state who received the lumbar fusion for low back pain between August 1,1986 and July 31, 1987.

The results show that the overall lumbar fusion incidence rate in the Washington workers' compensation system is 0.04 percent. Each 10-year increase in age increased the risk of a poor outcome by 37 percent, and a two-level fusion increased the risk of a poor outcome by 78 percent compared with the single-level procedure. A poor outcome means the worker is functionally disabled from work, that is, they are in time loss or pension status two years after the index surgery. The reoperation rate is 23 percent, that is, nearly one-fourth of patients who underwent lumbar fusion had a subsequent lumbar spine operation. More than two-thirds of lumbar fusion patients were totally disabled two years after the surgery. The satisfaction review shows that a majority of patients reported that the pain was worse after surgery and quality of life was no better or worse than before. Nevertheless, they believed they would have the surgery again.

Because patients in the sample were not randomly assigned to fusion or no-fusion, there is a problem of the retrospective design and re-creating a control group. The study is based on medical/hospital data in which treatment decisions are determined by the physicians, so researchers cannot randomly assign cases to surgical or non-surgical treatments. They can control for observed factors, like age, gender and occupation, in multivariate regression models, but cannot control for unobserved factors, such as severity of injury, that are significantly related to the outcome of surgery. As a result, there might be some overestimate or underestimate of the effect of clinical and non-clinical factors that are related to the unobservables and to the outcome of surgery. The same problem occurs in the present study.

There has been little or no research on the effect of managed care networks on surgery for workers' compensation back cases. Johnson et. al.(1999) report that "workers' compensation networks are associated with much lower medical costs," (P_{xiii}), but it has not been tested whether or not the lower network costs are associated with lower rates of surgery.

The Agency for Health Care Policy and Research (AHCPR) has developed practice guidelines for the assessment and treatment of back pain. Because 90 percent of patients with back problems spontaneously recover within one month, the guidelines recommend that no special tests or procedures are needed during this period of time.

As for surgical treatment, it is the last resort for back pain treatment. Surgery has been found to be helpful in only 1 out of 100 cases with low back problems. In general, if the limitations due to consistent symptoms have persisted for one month or more, surgical-related studies, such as imaging, should be carried out. Surgery is always considered if the symptoms last more than three months. It is recommended that surgery for a herniated disc should be considered for patients with sciatica after four to eight weeks of conservative therapy; surgery for spinal stenosis including laminectomy should not be considered in the first three months of symptoms; and it is also recommended that the use of spinal fusion should be considered only after the first three months of symptoms.

DATA:

The data for the study come from a census of workers' compensation claims from three large insurers in three states: California, Connecticut and Texas. The data include over 300,000 claims with injury dates between August 1995 and June 1997. The data include the following types of variables: demographic characteristics of injured workers (state, gender, marital status, age, date of injury, etc.); characteristics of the worker's compensation claim (nature of injury, part of body, types of accident, etc.); information on all payments (indemnity payments, medical payments, permanent partial disability payments, temporary total disability payments, etc.); and detailed data on the health care services provided to injured workers (network/non-network, number of services provided, amount paid for each service, type of services, etc.)

The sample for this study is restricted to closed claims, which means the workers have either returned to work or received final permanent disability settlements. The sample is also restricted to claims with positive medical and indemnity payments. In other words, all the workers were absent from work long enough to qualify for wage loss benefits (a minimum of four lost workdays). The sample is further restricted to back claims, with no missing data, and age between 15 and 80 at the time of injury. Because there are no surgical cases with onset dates after January 1,1997, the sample is restricted to claims beginning in 1995 or 1996. After these restrictions, the sample size is 7,812.

Two types of claims are included in the data: “temporary disability only” (TDO) and “permanent partial disability” (PPD) claims. The major difference between the two claim types is the disability status at claim closing and the types of compensation awarded. Both types of patients get all medical bills paid. If the injured workers have not returned to work after the waiting period for disability benefits (7 days in Texas, 3 days in Connecticut and California), they receive wage loss compensation until they recover and return to work (TDO claims). If the injured workers are permanently disabled as a result of their injury (PPD claims), they are not only awarded workers’ compensation wage loss benefits until maximum medical improvement, but they also receive a permanent disability settlement, which is not contingent on work absence.

The first task is to identify cases receiving surgery for back pain. Surgical procedures are identified by the CPT4 code on provider invoices. CPT4 codes are standard codes used to classify all medical and surgical treatments, procedures, and services. The data identify a primary and second CPT code for each injured worker. The primary CPT4 code refers to the medical service that accounts for the largest proportion of payments out of all services received; while the secondary CPT4 code refers to the service that accounts for the second largest proportion of payments. Workers with any of the following primary or secondary CPT4 codes: 22554, 22558, 22625, 22845, 63020, 63042, 63045, 63046, 63030, 63035, 63047, 63075, 63780, 63081 are grouped to the surgery treatment. The codes 22554 and 22558 belong to the “Anterior or Anterolateral Approach Technique” surgical treatment, and 63020 to 63047 indicate the surgical treatment is a “Laminotomy/Laminiectomy”. There are 81 observations in the surgery group based on the criteria above.

Methods:

The first objective is to identify non-clinical factors that are significantly related to the probability of surgical treatments for work-related back pain. A probit analysis model is estimated to identify the effect of these non-clinical factors on the probability of surgical treatment. Assume there is an underlying dependent variable y_i^* defined by the regression relationship:

$$y_i^* = \boldsymbol{b}' x_i + u_i \qquad (1)$$

that represents the unobservable propensity to receive surgery. What is observed is a dummy variable y_i defined by:

$y_i = 1$ if $y_i^* > 0,$ and the worker receives surgery,

$y_i = 0$ if otherwise. (2)

If u_i is assumed to be normally distributed. then:

$$\Pr ob(y_i = 1) = \Pr ob(u_i > -\boldsymbol{b}' x_i) = 1 - F(-\boldsymbol{b}' x_i) \qquad (3)$$

where F is the cumulative distribution function of a normal random variable.

In this case estimates of the parameters $\boldsymbol{b}$ that determine the probability a case involves surgery can be obtained by maximizing the likelihood function:

$$L = \prod_{y_i=0} F(-\boldsymbol{b}' x_i) \prod_{y_i=1} [1 - F(-\boldsymbol{b}' x_i)]. \qquad (4)$$

In this model, the dependent variable y is a dummy variable that equals to one, if the patient receives back surgery, and zero otherwise.

The independent variables in the model identify clinical and non-clinical factors that may influence the decision to perform surgery. The non-clinical factors include: age at the time of injury, a dummy variable identifying males; state dummy variables identifying whether the worker is from California, Connecticut or Texas; carrier dummies identifying if insurance is provided by Carrier1, Carrier2 or Carrier3, and three dummy variables describing the time period of the onset of injury: period before January 1,1996; period from January 1,1996 to July 1,1996; period from July 1,1996 to January 1,1997. The time dummies control for any changes in practice patterns over the period that might influence the choice of treatment, and for the time allowed to become a closed claim before our data were collected.

The clinical variables include a dummy variable identifying whether health care services were provided by a managed care network, and five dummies identifying different diagnoses for back pain. The diagnoses are based on the ICD9 ("The International Classification of Diseases, 9th Revision") codes from provider invoices. Each case is assigned to a diagnosis group based on the ICD9 code that corresponds to the largest portion of payment. Diagnoses for back pain include: intervertebral disc disorders

(ICD1), other disorders of the cervical region (ICD2), other/unspecified disorders of the back (ICD3), sprains and strains (ICD4) and miscellaneous back diagnoses[3] (ICD5).

The second objective is to evaluate outcomes for a sample of back cases treated with surgery relative to a comparison group of non-surgical cases. The primary outcome evaluated is whether or not the case becomes a permanent partial disability claim. I also compare duration of work absence, medical costs, and indemnity costs for surgical and non-surgical cases.

A second probit analysis estimates how surgical treatment and other clinical and non-clinical factors are related to the probability of a permanent partial disability claim. Assume there is an underlying dependent variable z_i^* defined by the regression relationship:

$$z_i^* = \boldsymbol{a}' q_i + \boldsymbol{e}_i \qquad (5)$$

that represents the possibility of becoming a PPD claim. What is observed is a dummy variable z_i defined by:

$z_i = 1$ if $z_i^* > 0$, and the worker becomes a PPD claim;

$z_i = 0$ if otherwise. (6)

If $\boldsymbol{e}_i$ is assumed to be normally distributed, then:

$$\Pr ob(z_i = 1) = \Pr ob(\boldsymbol{e}_i > -\boldsymbol{a}' q_i) = 1 - F(-\boldsymbol{a}' q_i) \qquad (7)$$

where F is the cumulative distribution function for of a normal random variable.

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[3] These codes include diagnoses such as soft tissue disorders, non-allopathic lesions, ill-defined conditions and injuries to the back.

In this case estimates of the parameters, α , that determine that probability of a case becoming a PPD claim can be obtained by maximizing the likelihood function:

$$L = \prod_{z_i=0} F(-\alpha' q_i) \prod_{z_i=1} [1 - F(-\alpha' q_i)]. \tag{8}$$

In this model, the dependent variable z is a dummy variable that equals one, if the claim type is a permanent partial disability claim, and zero otherwise (temporary disability claim type).

The independent variables in this model include the same independent variables in the probit analysis on probability of receiving surgical treatment, and a dummy variable identifying whether the patients are in the surgical group to see the relationship between surgical treatment and becoming a permanent partial disability claim. Two variables identifying the two most common surgical treatments for low back pain diagnoses "laminotomy/laminectomy or excision of herniated intervertebral disks" (63030) and "diskectomy, anterior, with decompression of spinal cord and/or nerve roots" (63075) are included to see if specific surgical procedures are related to the probability of a permanent partial disability claim.

The AHCPR guidelines for back pain recommend no surgical treatment within the first four weeks after injury and, for most patients, surgery should not be considered in the first three months. I use an OLS model to determine if network or non-network providers are more likely to follow the guidelines by delaying surgery. The model is estimated for the intervertebral disc disorders, the diagnosis group that includes the largest proportion of surgical cases. The form of the estimated model is:

$$\ln t_i = a + bw_i + d_i \, , i = 1,......, n \qquad (9)$$

where t is the dependent variable representing the days elapsed between the date of injury and surgery. The vector of independent variables w_i identifies clinical and non-clinical factors defined above, and d_i is a normally distributed random error term with mean 0 and constant variance.

Results:

The 81 surgical cases represent 1.04 percent of the total sample. Table 1 shows the distribution of the surgical and non-surgical cases across the five most common diagnoses for back pain. The intervertebral disc disorder cases are most likely to have surgical treatment. There are 77 surgical cases in this group, which account for 8.3 percent of the total 925. The proportions of surgical cases in the other four groups ("Other disorders of the cervical region," "Other/unspecified disorders of back," "Sprains and strains" and "Miscellaneous diagnoses") are all less than one percent.

Table 2 shows means and estimated coefficients of the probit analysis on the probability of surgical treatment with respect to the clinical and non-clinical factors. Results are shown for all back cases (columns 1 and 2) and for the intervertebral disc disorder cases which have the largest proportion of surgical cases among the five diagnosis groups. Marginal effects are shown in brackets.

First, focus on the results for all back cases. Compared to the omitted category "disorders of the cervical region", intervertebral disc disorder cases are 2.23×10^{-3} percent more likely to receive surgical treatment. This difference is significant at the one percent level or better. Workers with sprains and strains are less likely to receive surgery than the comparison group, and this difference is also significant at the one percent level or better. Neither of the other diagnosis codes is significantly different from the omitted group.

Compared to California, back pain patients in Texas are more likely to receive surgery (2.35×10^{-3} percent), and this difference is significant at the five percent level. Males are more likely to have surgical treatment than females, all else equal. Among the three insurance carriers, patients served by carrier 2 or carrier 3 are more likely to have surgical treatment than patients served by carrier 1, and the differentials are significant at the one percent level or better. Actually, only one of the injured workers covered by carrier1 received surgery for his/her back pain. There is no significant difference in the probability of having surgery between patients treated by network or non-network providers in this model.

The more recent the onset of injury, the less likely the patients would have received surgical treatments. As the practice guidelines recommend, the longer the back pain persists, the more likely it is that surgical treatment will be implemented. Cases with earlier onset of injury have more time to receive surgery and recover before the cut-off date for our data collection on June 30, 1997.

When the same analysis is conducted for the group with intervertebral disc disorders, it shows that patients treated by a managed care network are about 0.596 percent more likely to have surgical treatment than non-network cases and this differential is significant at the five percent level. Thus, the results are not consistent with the view that managed care restric ts costly services to workers' compensation patients. There is no significant difference between males and females in the probability of receiving surgical treatment in this model. Other results are consistent with the findings for all back cases.

Table 3 shows the comparison of outcomes of treatment across the surgical and non-surgical cases. The proportion of PPD claim is much greater for the surgical cases than for the non-surgical cases. The mean duration of work absence is about three times longer for surgical cases, and surgical cases also have much higher medical and indemnity costs.

Table 4 shows means and estimated coeffcients of the probit analysis on the probability of becoming a permanent partial disability claim. The model is estimated for all back cases (columns 1 and 2) and separately for intervertebral disc disorder cases (columns 3 and 4).

Patients who ever had surgery are 0.3 percent more likely than non-surgery patients to have a PPD claim, and the difference is significant at the one percent level or better. There are two possible explanation for this result, one could be the poor outcome of the surgery. The other could be that the surgical cases had more severe injuries to start with, so they would have poorer outcome, whatever the treatment the patients receive.

Patients served by a managed care network are 1.1 percent less likely to have a PPD claim, and this differential is significant at the one percent level or better. Workers injured in Texas are 5.8 percent more likely to have a PPD claim than workers injured in California. With a one year increase in age, the probability of becoming a PPD claim increases by 0.1 percent. Compared to the omitted diagnosis group "other disorders of the cervical region," workers with intervertebral disc disorder cases are more likely to have a PPD claim, while workers with "other/unspecified disorders of the back " and "sprains and strains" are less likely to have a PPD claim. Both carrier 2 and carrier 3 have a higher proportion of PPD claims than carrier 1. The more recent the onset of injury, the less likely the worker will have a PPD claim, which is consistent to the effect of injury dates on the probability of surgery.

In the model estimated for the intervertebral disc disorder cases, the network effect is not significant. The only other difference between the two models is that age is not significantly related to the probability of having a PPD claim among disc disorder cases.

Table 5 shows that the distribution of the duration between the date of injury and date of surgery for all surgical cases and separately for cases treated by network and non-network providers. According to the practice guidelines, in most cases, surgical treatment is not recommended before three months after injury. That is quite consistent with the mean duration of 107 days for all three groups. Approximately five percent of the patients receive surgical treatment within 30 days after the injury, whether served by network or non-network providers.

Table 6 shows the OLS estimates of how the clinical and non-clinical factors relate to the time elapsed between the date of injury and surgery date. Only the period of time to the onset of injury from July 1, 1996 to January 1,1997 (the most recent period) is significant at the one percent level in this model. The mean duration to surgery for patients with onset of injury within this period of time are 50.5 percent[4] less than the mean duration for patients with onset of injury before January 1,1996. There is no significant differences in the days elapsed to surgery between patients served by network and non-network providers.

Conclusions:

The probability of receiving surgery for work-related back pain depends on non-clinical factors, such as patient characteristics, as well as clinical factors, such as ICD9 diagnosis code. The non-clinical factors shown to be important in my model include age, gender, state, insurance carrier and date of onset of injury. Network care is not a significant determinant of surgery for all back cases, but is significantly related to surgical treatment among disc disorder cases.

Surgery is highly correlated with poor outcomes, including becoming a permanent partial disability claim. Poor outcomes are also more likely for older patients, cases treated by insurance carrier 2 or carrier 3 and workers in Texas. The results indicate that both network and non-network providers generally follow the practice guideline for back pain

[4] The percentage effect of the dummy variable in the semi-logarithmic equations (Halvorsen and Palmquist, 1980) is: $100 \cdot g = 100 \cdot \{\exp(c) - 1\}$, where $100 \cdot g$ is the percentage effect when the value of the dummy variable changes, and c is the estimated coefficient from the OLS model. In this model, the estimated coefficient of this variable is – 0.703.

indicating that no surgical treatment should be performed within the first month after injury.

The major limitation in my paper is the data selection and sample design. Because the data come from the medical records, the surgery and non-surgery groups are determined by the physicians. I cannot randomly assign cases to surgical and non-surgical treatment to control for unobservable factors, such as severity of injury, which could affect outcomes, this may lead to biased estimates of the effect of surgical treatment on workers' compensation claims.

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Table1: Surgical/Non-surgical Cases Across ICD9 Groups		
ICD9 Code Group	**Non-Surgical Case**	**Surgery Case**
Intervertebral disc disorders (N=925)	848 (91.68%)	77 (8.32%)
Other disorders of cervical region (N=208)	206 (99.04%)	2 (0.96%)
Other/unspecified disorders of back (N=1031)	1030 (99.90%)	1 (0.10%)
Sprains and strains (N=5310)	5309 (99.89%)	1 (0.02%)
Miscellaneous Diagnoses (N=338)	338 (100%)	0 (0%)
Total	7731	81
Source: Claims records from three insurers, 1995-1997		

Table 2: Means and Maximum Likelihood Estimates for Probit Equation: Surgery				
	All Back cases (N=7812)		**Disc disorder cases (N=925)**	
	Mean	Coefficient	Mean	Coefficient
Surgery	0.010 (0.101)	——	0.083 (0.276)	——
Network	0.311 (0.463)	0.262 (0.139) [1.77×10^{-5}]	0.261 (0.439)	0.338* (0.148) [5.96×10^{-3}]
Texas	0.338 (0.473)	0.339* (0.165) [2.35×10^{-5}]	0.560 (0.497)	0.365* (0.181) [6.87×10^{-3}]
Connecticut	0.209 (0.409)	0.227 (0.190) [1.10×10^{-5}]	0.209 (0.407)	0.318 (0.207) [3.91×10^{-3}]
Age (at time of injury)	34.25 (10.83)	0.004 (0.006) [1.06×10^{-6}]	36.93 (10.46)	0.002 (0.006) [1.53×10^{-4}]
Male	0.663 (0.473)	0.291* (0.138) [3.45×10^{-5}]	0.703 (0.457)	0.271 (0.149) [9.46×10^{-3}]
ICD9: Intervertebral disc disorders	0.118 (0.323)	0.905** (0.252) [2.23×10^{-5}]	——	——
ICD9: Other/unspecified disorders of back	0.132 (0.338)	-0.768 (0.422) [-4.85×10^{-5}]	——	——
ICD9: Sprains and strains	0.680 (0.467)	-1.175** (0.400) [1.13×10^{-3}]	——	——
ICD9: Others	0.043 (0.203)	-4.836 (6216.1) [-8.08×10^{-5}]	——	——
Carrier 2	0.358 (0.479)	1.255** (0.349) [5.53×10^{-5}]	0.450 (0.498)	1.274** (0.353) [0.019]
Carrier 3	0.292 (0.455)	1.274** (0.352) [4.95×10^{-5}]	0.350 (0.477)	1.257** (0.356) (0.016)

Injury date: Jan.1.1996-Jul.1.1996	0.384 (0.486)	-0.202 (0.128) [-2.3×10^{-5}]	0.392 (0.489)	-0.199 (0.137) [-0.005]
Injury date: Jul.1.1996-Jan.1. 1997	0.333 (0.471)	-0.688** (0.188) [-9.23×10^{-5}]	0.240 (0.427)	-0.662** (0.196) [-0.017]

* = Significant at 0.05 level or better, ** = Significant at 0.01 level or better
Standard deviation of means and standard errors of estimates shown in patentees
Marginal effect in bracket
Base group: 'other disorder of cervical region' for ICD9 code group
'Carrier 1' for Carriers
'Period of time before January 1,1996' for period of time of onset of injury
Source: Claims records from three insurers, 1995-1997

Table 3: Comparisons of the Outcomes of Surgical and Non-Surgical Cases		
Outcomes	Surgical case (n=81)	Non-surgical case (n=7731)
PPD claim	0.889 (0.316)	0.177 (0.382)
Medical Payments	$15,786.42 (7,214.42)	$2,314.11 (3,553.78)
Indemnity Payments	$16,869.00 (12,912.29)	$2,387.68 (5,251.27)
Duration of Work Absence (days)	25.27 (17.03) *(n=44)**	6.86 (14.53) *(n=2751)**

Standard errors shown in patentees
*Other data missing
Source: Claims records from three insurers, 1995-1997

Table 4: Means and Maximum Likelihood Estimates for Probit Equation: PPD

	All Back cases (N=7812)		Disc disorder cases (N=925)	
	Mean	Coefficient	Mean	Coefficient
PPD Claim	0.185 (0.388)	—	0.483 (0.500)	—
Surgery	0.010 (0.101)	1.230** (0.406) [0.003]	0.083 (0.276)	1.580** (0.548) [0.004]
Network	0.311 (0.463)	-0.145** (0.045) (-0.011)	0.261 (0.439)	-0.077 (0.109) [-0.002]
Texas	0.338 (0.473)	0.786** (0.043) [0.058]	0.560 (0.497)	0.992** (0.116) [-0.004]
Connecticut	0.209 (0.409)	-0.059 (0.055) [-0.003]	0.209 (0.407)	-0.049 (0.146) [-0.064]
Age (at time of injury)	34.25 (10.83)	0.005** (0.002) [0.001]	36.93 (10.46)	0.0001 (0.004) [4.25×10^{-5}]
Male	0.663 (0.473)	0.014 (0.040) [0.002]	0.703 (0.457)	0.023 (0.101) [0.001]
ICD9: Intervertebral disc disorders	0.118 (0.323)	0.278** (0.107) [0.008]	—	—
ICD9: Other/unspecified disorders of back	0.132 (0.338)	-0.350** (0.108) [-0.093]	—	—
ICD9: Sprains and strains	0.680 (0.467)	-0.474** (0.099) [-0.093]	—	—
ICD9: Others	0.043 (0.203)	-0.049 (0.127) [-5.27×10^{-4}]	—	—
Carrier 2	0.358 (0.479)	0.754** (0.051) [0.059]	0.450 (0.498)	0.513** (0.129) (0.060)
Carrier 3	0.292 (0.455)	0.747** (0.053) [0.049]	0.350 (0.477)	0.596** (0.134) [0.057]
Injury date: Jan.1.1996-Jul.1.1996	0.384 (0.486)	-0.376** (0.043) [-0.039]	0.392 (0.489)	-0.437** (0.105) [-0.060]
Injury date: Jul.1.1996-Jan.1. 1997	0.333 (0.471)	-0.888** (0.052) [-0.084]	0.240 (0.427)	-0.911** (0.127) [-0.111]
Back1	0.007 (0.085)	-0.125 (0.465) [-0.003]	0.061 (0.239)	-0.417 (0.591) [-0.001]
Back2	0.001 (0.034)	5.298 (3434.5) [0.041]	0.010 (0.098)	5.178 (5618.9) [0.002]

* = Significant at 0.05 level or better, ** = Significant at 0.01 level or better
Standard deviation of means and standard errors of estimates shown in patentees
Marginal effect in bracket
Base group: ‘other disorder of cervical region’ for ICD9 code group
‘Carrier 1’ for Carriers
‘Period of time before January 1,1996’ for period of time of onset of injury
Source: Claims records from three insurers, 1995-1997

Table 5: Days Elapsed Between Date of Injury and Surgery Date: Network vs. Non-network

	N	Mean	Min	5%	Median	75%	Max
All Cases	81	107	15	29	87	134	378
Network Cases	24	107	15	29	71	151	378
Non-network Cases	57	107	24	27	90	134	273

Source: Claims records from three insurers, 1995-1997

Table 6. OLS Estimates of Duration Between Injury Date and Surgery Date		
Variable	**Estimate**	**Standard Error**
Intercept	4.263**	0.905
Network	0.047	0.188
Intervertebral disc disorders	-0.131	0.342
Connecticut	-0.482	0.269
Texas	-0.078	0.226
Age at Injury	-0.005	0.008
Male	-0.024	0.201
Carrier 2	0.743	0.724
Carrier 3	0.951	0.721
Injury date: Jan.1.1996-Jul.1.1996	-0.160	0.156
Injury date: Jul.1.1996-Jan.1. 1997	-0.703*	0.302
R^2 =0.1755		

* Significant at 0.05 level or better, ** = Significant at 0.01 level or better

Base group: ‘before January 1,1996’ for period of onset of injury

Source: Claims records from three insurers, 1995-1997