Original Research

Performance of Pain Interventionalists From Different Specialties in Treating Degenerative Disk Disease-Related Low Back Pain

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KEYWORDS
Cost-benefit analysis; Injections, epidural; Intervertebral disc degeneration; Low back pain; Physical therapy modalities; Radiculopathy; Rehabilitation

Abstract
Objectives: To examine the utilization of current common treatments by providers from different specialties and the effect on delaying spinal surgery in patients with disk degenerative disease (DDD) related low back pain.

Design: Retrospective observational study using data from the MarketScan Commercial Claims and Encounters database (2005-2013).

Setting: Not applicable.

Participants: Patients (N=6229) newly diagnosed with DDD-related low back pain who received interventional treatments from only 1 provider specialty and continuously enrolled in the database for 3 years after diagnosis.

Main Outcome Measures: Measures of treatment utilization and cost were constructed for patients who received spinal surgery within 3 years after diagnosis. Cox proportional hazards models were used to examine cost differences among provider specialties. Generalized linear models were used to examine time to surgery among provider specialties.

Results: Of the 6229 patients, 427 (6.86\%) underwent spinal surgery with unadjusted mean interventional treatment costs ranging from $555 to $851. Although the differences in mean costs across provider specialties were large, they were not statistically significant. Cox
Low back pain (LBP) is one of the leading causes of disability (ie, mobility restrictions) and can affect functional status in the work force. Approximately 80% of the population experiences at least 1 episode of low back pain in their lives, with 5% to 10% of patients developing persistent chronic LBP. The prevalence of LBP is rising and can affect anyone at any time. One of the major causes of LBP is intervertebral disk degenerative disease (DDD), which is typically the presentation of the natural aging of the intervertebral disks and only progresses to a disease state, or DDD, when it causes pain, radicular symptoms, and weakness. Generally, the prognosis of DDD-related LBP is favorable, and treatments for the condition include conservative management (non-interventional and interventional) and spinal surgery. Conversely, patients with persistent DDD symptoms who have not responded to conservative treatments may be likely candidates for spinal surgery. Surgeries such as diskectomy with or without decompression, including minimally invasive microdiskectomy, have shown effectiveness in treating disk herniation with neurological symptoms, but likely lead to either a significant risk of recurrence, spinal instability leading to fusion, or so-called failed back surgery syndrome. Invasive surgeries such as lumbar artificial total disk replacement have yet to provide reliably good results. Because of the uncertainty of long-term outcomes, patients with DDD-related LBP often request nonsurgical treatments to prevent or, when possible, delay these spine surgeries.

Conservative treatments, including noninterventional modalities, such as medications, exercise, and physical therapy, and interventional procedures, such as epidural injections have proven effective for pain relief, functional improvement, and avoiding or delaying surgery. Recommendations and guidelines for interventional pain management physicians have been published by both the American Society of Interventional Pain Physicians and the International Spine Intervention Society. However, research has not found a common comprehensive standard or guideline that is strictly followed by physicians. Health insurance policies in the United States might also affect treatment outcomes for patients with DDD. For example, Aetna’s policy for interlaminar epidural injection states: "Initially, the individual may receive the first three injections at intervals of no sooner than two weeks." Moreover, because of flexibility in the certification requirements for spinal interventional procedures, a variety of providers from different specialties, even without subspecialty board certification, can perform these procedures. In fact, non–board-certified practitioners performed 37.7% of these interventional procedures according to a recent study in Florida. Given the various medical backgrounds and paths to becoming an interventional pain specialist, the training and skill level among provider types vary widely and could influence treatment outcomes for patients.

The past few decades have witnessed a tremendous increase in spinal interventional procedure rates and more nonpain specialty providers performing these procedures in the United States, although interventional therapies, such as epidural injections, for persistent LBP should be limited to selected patients according to current recommendations. Although possible overutilization of interventional spinal procedures has been observed across all performing specialties, medical professionals have yet to agree on the most cost-effective conservative treatment protocol for DDD-related LBP. It is important to have a model for physicians to follow in terms of judicious use of conservative treatments and cost-effectiveness. Thus, this study aims to address this gap by using private health insurance data to assess conservative treatments provided by various provider specialties, including their outcomes and cost, to inform clinical practice.

Methods

Data retrieval

All data for this study were retrieved from the Truven Health MarketScan Commercial Claims and Encounters Database (2005-2013). MarketScan files contain deidentified medical and health care claim records for the employees and dependents of large and medium firms and health plans. Patients were identified using International Classification of Diseases—9th Revision codes along with current procedural terminology codes. The Penn State College of Medicine Institutional Review Board and Human Subjects Protection Office approved this study.

To be included in our study sample, patients had to be diagnosed with lumbar or lumbosacral intervertebral disk disorder (722.52), be continuously enrolled in a health
insurance plan for at least 3 years, and receive interventional treatments from only 1 provider specialty within 3 years of diagnosis. We excluded patients with any of the following diagnoses 1 year before their index diagnosis: lumbar or lumbosacral intervertebral disk disorder, displacement of lumbar intervertebral disk without myelopathy (722.10), LBP (724.2), intervertebral disk with myelopathy (722.7), and other diseases of the spine (336).

We focused on interventional treatments provided by 6 provider specialties: anesthesiology, neurosurgery, orthopedics, pain management, physiatry, and radiology. To compare treatment outcomes and intervention treatment costs by provider specialty, we further limited our sample to those who received surgery and studied all outcomes before surgery (see appendix 1 for treatment and surgical codes). Because patients diagnosed with radiculopathy have greater pain and possible chronicity than those with isolated LBP, we hypothesized that such patients would have a different treatment plan. Thus, we further subdivided the sample into those with and those without radiculopathy. We identified physical medicine, rehabilitation modalities, and therapeutic procedures (hereafter, physical therapy) separate from other conservative treatments. Our outcome measures included average time to surgery, average number of interventional visits before surgery, total costs of all intervention visits before surgery, use of other conservative treatments, and physical therapy utilization. Our control variables included sex, age at DDD diagnosis, radiculopathy diagnosis, provider specialty, and geographic region.

### Data analysis

First, we calculated statistics describing sociodemographic, treatment, comorbid diagnoses, and medical provider specialty characteristics for our study population. Next, among those who received spinal surgery, we compared treatment outcomes and costs by provider specialty in the 3 years after DDD diagnosis. We grouped the resultant surgery sample into those with and those without radiculopathy and then compared their treatment costs and outcomes by provider specialty. We then used a generalized linear model with a log link and gamma distribution to test for differences in cost among provider types, controlling for patient clinical and demographic characteristics. A Cox proportional hazards model was then used to identify variables independently associated with time to surgery. Analyses conducted using SAS 9.4 and Stata.

### Results

A total of 6229 patients with DDD met our inclusion criteria. The average age of the sample was 50.8 years and a majority (56.5%) were women. Comorbid diabetes and radiculopathy (without myelopathy) were present in 20% and 54.8% of our sample, respectively. More than half of our sample received additional conservative treatments for their DDD (physical therapy, 58.3%; other conservative treatments, 21.9%). A little over one-third (39%) received only interventional treatments. Anesthesiologists saw the most patients for interventional treatments (2520; 40.5%) whereas neurosurgeons saw the least (140; 2.3%). During our study period, 427 people (6.86%) underwent surgery (table 1).

The mean unadjusted cost of interventional treatments differed by provider specialty and ranged from $555 (radiology) to $851 (pain management) (table 2). The average time to surgery ranged from 197 days (physiatry) to 325 days (neurosurgery). On average, patients saw their providers for 4 intervention treatments before receiving surgery. When grouped into those with and without radiculopathy, the average time to surgery ranged from 201 days (physiatry) to 354 days (orthopedics) for those with radiculopathy and from 165 days (orthopedics) to 379 days (neurosurgery) for those without radiculopathy (table 3). On average, those with radiculopathy received significantly more intervention treatments before surgery (4.87 vs 3.38; P < .0001). The average cost of intervention treatments ranged from $534 (radiology) to $1085 (pain management) for those with radiculopathy and from $561 (pain management) to $732 (orthopedics) for those without radiculopathy (see table 3).

The generalized linear model showed no significant cost differences between provider specialties for interventional treatments. The Cox proportional hazards model showed no significant difference between provider specialties in the time from DDD diagnosis to surgery and in the region in which patients lived (table 4). However, being diagnosed with DDD at a younger age, receiving physical therapy, and having radiculopathy significantly delayed the time to surgery (hazard ratio [HR], 0.66; 95% confidence interval [CI], 0.54-0.81; HR, 0.77; 95% CI, 0.62-0.96; and HR, 0.79; 95% CI, 6.5-9.8, respectively) (see table 4).
Table 2  Characteristics of patients who received surgery after being treated with interventional treatments from one provider specialty (n = 427)

| Provider Specialty | n    | Percentage of Total Provider Specialty | Time to Surgery, d | Number of Visits to Provider | Cost of Intervention Treatment, United States Dollars |
|--------------------|------|----------------------------------------|--------------------|------------------------------|-----------------------------------------------------|
| Anesthesiology     | 148  | 5.87                                   | 224.45 ± 263.43    | 3.99 ± 3.63                  | 668 ± 829                                           |
| Neurosurgery       | 16   | 11.43                                  | 325.38 ± 229.52    | 4.00 ± 2.39                  | 819 ± 963                                           |
| Orthopedics        | 37   | 8.15                                   | 282.76 ± 322.00    | 4.16 ± 3.93                  | 639 ± 847                                           |
| Pain management    | 114  | 9.26                                   | 258.08 ± 281.50    | 5.17 ± 4.96                  | 851 ± 1074                                          |
| Physiatry          | 80   | 6.13                                   | 197.20 ± 225.36    | 3.74 ± 2.87                  | 698 ± 859                                           |
| Radiology          | 32   | 5.54                                   | 250.34 ± 294.55    | 3.47 ± 3.45                  | 555 ± 762                                           |

Discussion

In our sample of patients diagnosed with DDD and treated with interventional treatments, we found that more than half received conservative treatments for their DDD (physical therapy, 58.3%; other treatments, 21.9%) and 427 (6.86%) underwent surgery within 3 years of diagnosis. Among those who underwent surgery, the average cost of their interventional treatment by provider specialty ranged from $555 (radiology) to $851 (pain management), and patients saw their provider for an average of 4 treatments before surgery. Although our regression analysis showed no differences in cost and time to surgery by provider specialty, it did show that receiving physical therapy, being diagnosed with radiculopathy, and being diagnosed with DDD at a younger age significantly delayed the time to surgery.

Spine health providers perform similarly in treating DDD-related low back pain

The data presented herein demonstrated that there were no differences in cost and performance in treating DDD-related LBP among different provider types (see Table 4). In other words, a provider’s primary specialty type is not a contributing factor in his or her performance in treating patients with DDD-related LBP. The standard training

Table 3  Characteristics of patients who received surgery after being treated with interventional treatments from one provider specialty by radiculopathy status

| Provider Specialty | n    | Percentage of Total Diagnosed With Radiculopathy | Time to Surgery, d | Number of Visits to Provider | Cost of Intervention Treatment, United States Dollars |
|--------------------|------|--------------------------------------------------|--------------------|------------------------------|-----------------------------------------------------|
| Anesthesiology     | 86   | 6.59                                             | 241.94 ± 269.82    | 4.62 ± 3.28                  | 823 ± 860                                           |
| Neurosurgery       | 9    | 11.84                                            | 283.56 ± 214.68    | 4.78 ± 2.28                  | 1073 ± 1202                                         |
| Orthopedics        | 23   | 8.75                                             | 354.17 ± 333.52    | 4.57 ± 2.94                  | 583 ± 433                                           |
| Pain management    | 63   | 9.13                                             | 293.76 ± 311.56    | 6.13 ± 5.43                  | 1085 ± 1182                                         |
| Physiatry          | 47   | 5.70                                             | 200.70 ± 201.97    | 4.26 ± 2.73                  | 719 ± 693                                           |
| Radiology          | 18   | 7.06                                             | 269.83 ± 277.96    | 3.67 ± 3.76                  | 534 ± 702                                           |

| Provider Specialty | n    | Percentage of Total Without Radiculopathy | Time to Surgery, d | Number of Visits to Provider | Cost of Intervention Treatment, United States Dollars |
|--------------------|------|------------------------------------------|--------------------|------------------------------|-----------------------------------------------------|
| Anesthesiology     | 62   | 5.10                                     | 200.19 ± 254.48    | 3.13 ± 3.94                  | 453 ± 738                                           |
| Neurosurgery       | 7    | 10.94                                    | 379.14 ± 253.48    | 3.00 ± 2.31                  | 494 ± 414                                           |
| Orthopedics        | 14   | 7.33                                     | 165.43 ± 273.93    | 3.50 ± 5.24                  | 732 ± 1286                                          |
| Pain management    | 51   | 9.43                                     | 214.00 ± 234.80    | 3.98 ± 4.07                  | 562 ± 848                                           |
| Physiatry          | 33   | 6.86                                     | 192.21 ± 258.27    | 3.00 ± 2.94                  | 668 ± 1064                                          |
| Radiology          | 14   | 4.33                                     | 225.29 ± 323.50    | 3.21 ± 3.14                  | 583 ± 861                                           |
LBP were associated with physical therapy referrals. Other studies found that, on average, only 10% of primary care visits for the National Ambulatory and National Hospital Ambulatory Medical Care Surveys between 1997 and 2010, Zheng et al found that, on average, only 10% of primary care visits for LBP were associated with physical therapy referrals. Other studies have found physical therapy referrals made in 21% to 33% of their samples.43,44,47

Conservative noninterventional treatments delay spine surgery

Physical therapy utilization in this study is considerably higher (41.6%) than that observed in a Medicare population (16.2%) but close to that observed in a German cohort of primary care physicians (49%). Physical therapy is a widely accepted and powerful tool in the treatment of chronic LBP of a variety of pathologies, yet it is nationally underutilized for LBP and guidelines advise delaying physical therapy referrals to allow for spontaneous recovery. Using the National Ambulatory and National Hospital Ambulatory Medical Care Surveys between 1997 and 2010, Zheng et al found that, on average, only 10% of primary care visits for LBP were associated with physical therapy referrals. Other studies have found physical therapy referrals made in 21% to 33% of their samples.43,44,47

Among patients who received spinal surgery, our results also showed that patients with physical therapy had a significantly delayed time to surgery. There are numerous benefits of patients diagnosed with LBP engaged in physical therapy. Using commercial health insurance data for 6 states, Frogner et al compared differences in opioid prescription, health care utilization, and costs among patients with LBP who saw a physical therapist. They found that when LBP patients saw a physical therapist first, they had lower opioid use and lower utilization of high-cost medical services. In addition, Fritz et al also found engagement in physical therapy to be associated with a decreased risk of using opioid medications, as well as a decreased risk of surgery, additional physician visits, and reduced medical costs.

Given the many benefits of physical therapy, our finding that physical therapy was beneficial even among those patients who did receive spinal surgery supports an increased engagement of physical therapy. However, we did not quantify the number of conservative treatments patients received before surgery. Typically, these treatments continue until their benefits plateau, patients are unable to tolerate further treatments, or patients have reached the maximum number allowable by their insurance companies.

Patients with radiculopathy had delayed time to spine surgery

In our study, we found that patients with radiculopathy had their spinal surgeries later than those without radiculopathy (P = .027). As demonstrated by our results, patients with radiculopathy also received more interventional procedures than those not diagnosed with radiculopathy. This could be due to the fact that the distribution pattern of the involved nerve root and the utilization of electromyogram makes the LBP relatively easy to localize in patients with radiculopathy, and thus, targeted steroid injections usually work effectively. In contrast, patients without radiculopathy likely have vague LBP, so-called diskogenic pain, confounded by some sacral and facetogenic pain, which is usually refractory to conservative treatments, including interventional procedures. Therefore, it seems logical to conclude that the next best treatment option will be spine surgery, even though the surgical outcome may not be as effective as expected. In more than 85% of the patients with chronic LBP, a pathoanatomical diagnosis cannot be made, which makes effective treatment difficult. Thus, in reality, these patients receive surgeries even earlier than patients with a specific pathoanatomical diagnosis (such as defined radiculopathy), largely because of the fact that conservative treatment options are limited for non-specific LBP.

Study limitations

Although the MarketScan database provides a large, nationwide patient cohort enabling high statistical power, as with any data source, there are limitations, largely owing to the nature of claims data. Because the data are from private insurance, our results may not be generalizable to Medicare, Medicaid, and uninsured populations. Second, because therapeutic transforaminal epidural steroid injections and diagnostic selective nerve root blocks share the same current procedural terminology code, we could not distinguish between these procedures. However, selective nerve root block is likely a preoperative diagnostic procedure requested by the spine surgeon to test whether a patient’s pain is neural in origin and whether a specific nerve root is pain producing in patients with equivocal

| Parameter                      | χ²       | P value | Hazard Ratio | 95% Confidence Limits |
|-------------------------------|----------|---------|--------------|------------------------|
| Age at diagnosis              | 15.85    | <.0001  | 0.66         | 0.54 0.81              |
| Sex                           |          |         |              |                        |
| Male (reference)              |          |         |              |                        |
| Female                        | 0.06     | .802    | 0.97         | 0.79 1.20              |
| Radiculopathy                 | 4.87     | .027    | 0.79         | 0.65 0.98              |
| Physical therapy              | 5.31     | .021    | 0.77         | 0.62 0.96              |
| Other conservative treatments | 0.09     | .766    | 0.95         | 0.69 1.31              |
| Region                        |          |         |              |                        |
| Northeast (reference)         |          |         |              |                        |
| North central                 | 0.64     | .425    | 0.84         | 0.54 1.29              |
| South                        | 0.00     | .965    | 1.01         | 0.67 1.52              |
| West                         | 0.28     | .594    | 1.14         | 0.71 1.83              |
| Unknown                      | 0.17     | .679    | 1.55         | 0.20 12.33             |
| Provider Specialty            |          |         |              |                        |
| Radiology                     |          |         |              |                        |
| Anesthesiology                | 0.39     | .532    | 1.15         | 0.75 1.76              |
| Neurosurgery                  | 1.08     | .299    | 0.70         | 0.36 1.37              |
| Orthopedics                   | 0.000    | .996    | 1.00         | 0.59 1.68              |
| Pain management               | 0.01     | .930    | 1.02         | 0.66 1.57              |
| Physiatry                     | 1.24     | .266    | 1.29         | 0.82 2.04              |
clinical and imaging studies. Therefore, we believe this comprised only a small portion of all lumbar epidural steroid injections, if any.

Conclusions

In summary, our findings suggest that, although the costs of interventional procedures differ by medical provider specialty, the cost differences are not significantly different, and no specialty performed better in delaying surgery for patients with chronic back pain. Additionally, receiving physical therapy significantly delayed time to spinal surgery among patients diagnosed with DDD at a younger age and those with radiculopathy. Therefore, more should be done to increase the utilization of physical medicine and rehabilitation modalities and therapeutic procedures for patients diagnosed with chronic back pain.

Suppliers

a. MarketScan Commercial Claims and Encounters Database; Truven Health Analytics.
b. SAS 9.4; SAS Institute, Inc.
c. Stata; StataCorp.

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Appendix

Appendix 1 Current Procedural Terminology Codes Used to Identify Treatments and Surgical Procedures

| Treatments and Procedures | CPT Codes |
|---------------------------|-----------|
| Interventional Procedures | 62280     |
| Injection/infusion of neurolytic substance (eg, alcohol, phenol, iced saline solutions), with or without other therapeutic substance; subarachnoid ultrasonic guidance for needle placement (eg, biopsy, aspiration, injection, localization device), imaging supervision and interpretation (not covered for chemical ablation [including but not limited to alcohol, phenol, or sodium morrhuate] of facet joints) | 62287 |
| Nucleoplasty/percutaneous Injection procedure for chemonucleolysis, including diskography, intervertebral disk, single or multiple levels, lumbar | 62292 |
| Chemonucleolysis Injection, anesthetic agent and/or steroid, interlaminar epidural, lumbar/sacral | 62293 |
| Injection, including catheter placement, continuous infusion or intermittent bolus, not including neurolytic substances, with or without contrast (for either localization or epidurography), of diagnostic or therapeutic substance(s) (including anesthetic, antispasmodic, opioid, steroid, other solution), epidural or subarachnoid; lumbar | 62311 |
| Injection, anesthetic agent and/or steroid, transforaminal epidural, lumbar | 62319 |
| Multiple level transforaminal epidural injections | 64483 |
| Lumbar or sacral ultrasonic guidance for needle placement (eg, biopsy, aspiration, injection, localization device), imaging supervision and interpretation | 64484 |
| Fluoroscopic guidance for needle placement | 64636 |
| Surgeries and Procedures | 77003 |
| Percutaneous laminotomy/laminectomy (intralaminar approach) for decompression of neural elements, (with or without ligamentous resection, discectomy, facetectomy and/or foramotomy) any method under indirect image guidance (eg, fluoroscopic, CT), with or without the use of an endoscope, single or multiple levels, unilateral or bilateral; lumbar | 0275T |
| Anterior interbody fusion, lumbar | 22558 |
| Posterolateral fusion, lumbar | 22612 |
| Posterior interbody fusion, lumbar | 22630 |

(continued on next page)
Appendix 1 (continued)

| Description                                                                 | Code   |
|------------------------------------------------------------------------------|--------|
| Combined fusion, posterolateral fusion, with posterior interbody fusion       | 22633  |
| Posterior instrumentation                                                     | 22840-22844 |
| Application of biomechanical device (cages, etc)                              | 22851  |
| Total disk arthroplasty (artificial disk), anterior approach, (other than for decompression) | 22857  |
| Revision including replacement of total disk arthroplasty (artificial disk), anterior approach | 22862  |
| Percutaneous lysis of epidural adhesions using solution injection (eg, hypertonic saline, enzyme) or mechanical means (eg, catheter) including radiologic localization (includes contrast when administered), multiple adhesiolysis sessions | 62263  |
| Percutaneous lysis of epidural adhesions using solution injection (eg, hypertonic saline, enzyme) or mechanical means (eg, catheter) including radiologic localization (includes contrast when administered), multiple adhesiolysis sessions | 62264  |
| Percutaneous aspiration within the nucleus pulposus, intervertebral disk, or paravertebral tissue for diagnostic purposes | 62267  |
| Epidural, lumbar, sacral (caudal) (not covered for chemical ablation [including but not limited to alcohol, phenol or sodium morrhuate] of facet joints) | 62282  |
| Decompression procedure, percutaneous, of nucleus pulposus of intervertebral disk, any method, single or multiple levels, lumbar (eg, manual or automated percutaneous diskectomy, percutaneous laser diskectomy) | 62287  |
| Laminectomy, diskectomy and related procedures (eg, decompression of spinal cord) | 63001-63091 |
| Laminectomy with rhizotomy                                                     | 63185-63190 |
| Epidurography, radiological supervision, and interpretation                   | 72275  |
| Allograft (morselized)                                                        | 20930  |
| Allograft (structural)                                                        | 20931  |
| Autograft (rib/lamina/spinous process, same incision)*                        | 20936  |
| Autograft (morselized, separate incision)*                                   | 20937  |
| Autograft (structural, separate incision)*                                   | 20938  |
| Removal of total disk arthroplasty (artificial disk), anterior approach, each additional interspace, lumbar* | 0164T  |

Conservative Treatments

| Description                                                                 | Code   |
|------------------------------------------------------------------------------|--------|
| Physical medicine and rehabilitation modalities and therapeutic procedures (physical therapy) | 97001-97140 |
| Other conservative treatments                                                | 90832, 90834, 90837, 96116, 97810, 98940-98943 |

* Add-on code.

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