ORIGINAL ARTICLE

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Medical versus Surgical Treatment for Low Back Pain: Evidence and Clinical Practice

CONTEXT. Although low back pain is one of the most common health problems, it is still difficult to choose between surgical and medical treatment.

OBJECTIVE. To examine the evidence of the efficacy of surgical and medical treatment of the two most common indications for spinal surgery for low back pain—lumbar disc herniation and spinal stenosis—and to assess geographic variation in the use of surgery for these conditions in the United States.

METHODS. The MEDLINE database (1966–1999) was searched for all studies that compared surgical and medical treatments for low back pain. Data from the Health Care Financing Administration were used to examine geographic variation in spinal surgery rates for patients enrolled in Medicare (1996–1997).

RESULTS. Eight observational studies and one randomized clinical trial were identified. In general, these studies suggest better short-term outcomes (e.g., functional status and employability) with surgery than with medical approaches, but they indicate that long-term results are similar with both types of treatment. Methodologic flaws in the observational studies, particularly selection bias, preclude definitive conclusions about relative efficacy. In 1996 and 1997, more than 98,000 Medicare enrollees had surgery for disc herniation or spinal stenosis. Among hospital referral regions, rates of surgery for disc herniation varied 8-fold, from 0.24 to 1.96 per 1000 Medicare enrollees, and rates of surgery for spinal stenosis varied 12-fold, from 0.29 to 3.34 per 1000 Medicare enrollees.

CONCLUSIONS. The literature comparing the efficacy of surgical and medical treatment for low back pain is limited. Not surprisingly, the use of surgery for low back pain varies widely across the United States. To establish clinical consensus, we need better evidence about the efficacy of surgery.

Low back pain is one of the most prevalent and costly health problems in the industrialized world. Approximately 80% of persons in the United States report having had low back pain at some point in their lives,[1, 2] and back pain results in more lost productivity than any other medical condition.[3, 4]

Although physicians frequently evaluate low back pain (it is second only to the common cold as a reason for primary care office visits),[3] identifying the cause of symptoms is notoriously difficult. Low back pain has numerous spinal and extraspinal causes with similar manifestations, and findings on physical examination or imaging often fail to correlate with symptoms.[5] Most patients who seek treatment are thought to have "non-specific low back pain" and are treated medically (i.e., with bedrest, anti-inflammatory drugs, or physical therapy). For about 15% of patients, however, treatment options include both medical and surgical interventions. Unfortunately, choosing between medical and surgical options can be difficult. The indications for surgery are unclear, and there is little consensus even on the appropriate measure of treatment success (i.e., cor-

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rection of an anatomical defect or improvement in subjective well-being). Overall, about 4% of persons in the United States have spinal surgery at some point in their lives.[6,7]

In this paper, we review the medical literature to summarize what is known about the relative efficacy of surgical and medical treatment for low back pain. We focus on lumbar disc herniation and spinal stenosis, the two most common indications for spinal surgery in patients with low back pain.[8] Then, using the methods of small-area analysis, we describe the extent to which the use of surgery for these conditions varies across the United States.

Clinical Overview

Intervertebral Disc Herniation

With age, intervertebral discs undergo degenerative changes that may result in herniation of the nucleus pulposus into the spinal canal.[9] The characteristics of disc herniation are summarized in **Table 1**. The pathophysiology of the condition is not completely understood, but pain probably results from both mechanical and biochemical irritation of adjacent nerve roots.[10] Patients typically report back pain followed by the development of pain and paresthesias that radiate to the leg (sciatica). Back pain frequently becomes less severe with the onset of sciatica. On physical examination, most patients have positive results on a straight-leg test (radicular pain occurs with a straight-leg elevation of 60 degrees or less) and may have associated reflex, sensory, or motor deficits.[10] A clinical diagnosis is made when imaging studies confirm an abnormality that corresponds to the physical findings. Lumbar disc herniations most often occur between 30 and 50 years of age at the L4–L5 and L5–S1 levels of the spine.[11] Male sex; obesity; smoking; and certain occupational conditions, such as prolonged sitting or repetitive twisting motions, are frequently cited risk factors.[11]

Medical therapy for disc herniation includes brief bedrest, nonsteroidal anti-inflammatory drugs, and progressive exercise and physical therapy.[10] Epidural corticosteroid injections[12] and brief use of narcotic pain medications (for 1 week) are sometimes used during the acute phase of treatment.[10] Surgical treatment involves removal of the affected disc (i.e., discectomy).[12] Open discectomy often requires partial or complete removal of the lamina (laminotomy or laminectomy). Other, less invasive techniques, such as microdiscectomy and percutaneous discectomy, may avert removal of bone.[12]

Degenerative Spinal Stenosis

Spinal stenosis is characterized by degenerative changes in the disks, ligamentum flavum, and facet joints. These changes narrow the spinal canal, thereby putting pressure on the neural elements and their blood supply[13] (**Table 1**). Patients usually present with insidious onset of back, buttock, and leg pain that increases with standing or walking and subsides with rest (neurogenic claudica-

TABLE 1

Characteristics of Intervertebral Disc Herniation and Degenerative Spinal Stenosis

CHARACTERISTIC	INTERVERTEBRAL DISC HERNIATION	DEGENERATIVE SPINAL STENOSIS
Pathophysiology	Herniation of the nucleus pulposus of an intervertebral disc into the spinal canal with irritation of adjacent nerve roots (most common at L4–L5 and L5–S1)	Degenerative changes in disks, ligamentum flavum, and facet joints cause narrowing of the spinal canal and pressure on the neural elements and their blood supply (most common at L3–L4 and L4–L5)
Clinical features	Pain and numbness radiating from back to buttocks, legs, and feet; symptoms worsen with sitting and improve with standing or lying supine	Insidious onset of back, buttock, and leg pain that worsens with walking and improves with rest (neurogenic claudication)
Typical patient	Man in 50s	Persons in their 50s or 60s
Medical treatment	2 or fewer days of bedrest, nonsteroidal anti-inflammatory drugs, exercise, and physical therapy; epidural steroid injections are sometimes used	Nonsteroidal anti-inflammatory drugs, exercise, and physical therapy; epidural steroid injections are sometimes used
Surgical treatment	Discectomy, laminectomy, or both to decompress the involved nerve root	Removal of bony or soft tissue elements that are compressing the dural sac and nerve roots, the use of bone grafts and/or fixation devices to treat resulting spinal instability, or both

tion).[14] Diagnosis is made from imaging studies that confirm the narrowing of the spinal canal.[14] It is generally agreed that an anteroposterior diameter of less than 12 mm indicates pathologic narrowing of the spinal canal.[15] Spinal stenosis usually becomes symptomatic during the fifth and sixth decades of life and most frequently affects the L3–L4 and L4–L5 spinal levels.[14]

Medical treatment consists of temporary limitations on physical activity and use of nonsteroidal anti-inflammatory drugs. Epidural corticosteroid injections and physical therapy are also sometimes used.[16] Surgical therapy involves decompression, which involves removal of bony or soft tissue elements that are compressing the dural sac and nerve roots. The use of bone grafts (arthrodesis) or fixation devices (instrumentation) to fuse the affected levels (fusion) are sometimes used to treat spinal instability resulting from extensive decompression.[16]

Review of Evidence

Structured Literature Review

We searched the MEDLINE database (1966–1999) for studies of potential relevance to this review. We searched for English-language papers by using the following medical subject headings: human adults, intervertebral disc displacement, spinal stenosis, discectomy, laminectomy, surgical decompression, spinal fusion, randomized controlled trials, and comparative study. The search yielded 129 articles. We used titles and abstracts to determine which papers were potentially

TABLE 2

Observational Studies Comparing Surgical and Medical Treatment for Intervertebral Disc Herniation*

TYPE OF STUDY, INTERVENTION, AND SETTING	LENGTH OF FOLLOW-UP	OUTCOME MEASURE	PATIENTS ACHIEVING OUTCOME MEASURE	
			MEDICAL	SURGICAL
Retrospective cohort study				
			(n = 30)	(n = 25)
Discectomy vs. medical therapy for truck drivers in the northeastern United States[35]	1–5 years	Clinical outcome poor by medical record	20%	20%
		Able to work	64%	72%
Prospective cohort studies				
			(n = 30)	(n = 212)
Partial laminectomy and flaval fenestration vs. medical treatment (bedrest, physical exercise, traction, injections, corsets) at a hospital in Finland[26]	1 year	Subjective improvement	82%	91%†
		Able to work	80%	88%
			(n = 122)	(n = 220)
Disectomy vs. medical therapy at two hospitals in Finland[37]	1 year	Reporting sciatica	81%	68%‡
		Symptoms assessed as no change or worse	41%	9%†
		Able to work	86%	93%‡
	13 years	Reporting sciatica	68%	67%
		Symptoms assessed as no change or worse	44%	19%†
		Able to work	79%	79%
			(n = 10)	(n = 219)
Discectomy vs. medical treatment (bedrest, back exercises, traction, corset or brace, transcutaneous electrical nerve stimulation, physical therapy, spinal manipulation, epidural steroids, narcotics, or other alternative treatments) from orthopedic surgery and neurosurgery practices in Maine[38]	1 year	Mean change in SF-36 physical function§	17.5	40.3†
		Mean change in SF-36 bodily pain scale§	20.4	44.0†

**Specific components of medical therapy are listed where reported. SF-36 = Medical Outcome Survey Short Form-36.*
†$P < 0.001$.
‡$P < 0.05$.
§*Higher change scores mean larger improvements.*

relevant, and these papers were retrieved, read, and searched for further citations.

We excluded 17 articles that examined treatments that have fallen out of favor. Eleven of these papers compared surgery with chemonucleolysis rather than standard medical therapies.[17–27] Chemonucleolysis has been used only rarely since the publication of placebo-controlled clinical trials with conflicting results and the negative publicity following case reports of catastrophic complications.[28] The other 6 articles—each at least 40 years old—defined standard conservative medical therapy as inpatient treatment with bedrest and traction[29–34]; in contrast, contemporary treatment emphasizes outpatient treatment with physical therapy and limits bedrest. In total, we identified 8 original studies that compared surgical and medical treatment for lumbar disc herniation (5 papers)[35–39] or spinal stenosis (3 papers).[40–42]

These studies report a wide variety of outcome measures over different time frames. The absence of standardized measurement makes comparison across studies difficult. Where possible, we report subjective outcomes (e.g., patient report of symptoms and satisfaction), objective outcomes (e.g., findings on clinical examination), and functional outcomes (e.g., ability to work). For simplicity, when papers provided several outcome measures, we report global assessments and those measures that are most easily interpretable by readers without specialized knowledge.

Lumbar Disc Herniation

Observational Studies

Four observational cohort studies compared medical and surgical treatments for lumbar disc herniation: One was retrospective, and three were prospective (**Table 2**). The three prospective studies showed a statistically significant advantage for surgery. The relative benefits of surgical and medical treatment vary with the outcome measure being considered. For example, symptomatic improvement was significantly more common in surgical patients than in patients receiving medical treatment, but differences in employability were small. The relative advantage of surgery with respect to symptoms also seemed to diminish over time in a study in Finland with 13-year follow-up.

These studies have important limitations. They are susceptible to selection bias (i.e., bias resulting from the reasons why patients were offered a particular treatment), and important differences in baseline characteristics may therefore account for many of the differences seen at follow-up. For example, in the studies by Atlas and colleagues,[38,42] statistically significant and substantial differences were seen between the treatment groups at baseline with regard to narcotic use in the past month, findings on physical examination and imaging, frequency and duration of symptoms, and function and disability. Several studies did not include sufficient information with which to assess the baseline comparability of the treatment groups. The retrospective study was further complicated by inconsistent recording of baseline and follow-up data gathered from medical records. In addition, most results were based on a single practice setting. Finally, the comparison of surgery with medical therapy is difficult to interpret because medical treatment varied among patients and only three studies reported the specific components of medical therapy.

Randomized Trial

The results of the one randomized clinical trial are shown in **Table 3**. At 1 year, patients assigned to surgery

TABLE 3

Randomized Clinical Trial Comparing Surgical and Medical Treatment for Lumbar Disc Herniation

INTERVENTION AND SETTING	OUTCOME MEASURE	PATIENTS ACHIEVING OUTCOME MEASURE, %	
		MEDICAL (n = 66)	SURGICAL (n = 60)
Discectomy (with or without laminectomy) vs. 2-week regimen of bedrest, isometric exercises, and analgesia at a hospital in Norway (1970–1971)[39]	Physician assessment of patient satisfaction with outcome as good at 1 year	36%	65%*
	Able to work at 4 years	88%	95%
	Able to work at 10 years	88%	87%
	Free of back pain at 4 years	58%	63%
	Free of back pain at 10 years	79%	84%
	Free of radicular pain at 4 years	68%	79%
	Free of radicular pain at 10 years	99%	98%

*$P < 0.05$.

were more likely than patients assigned to medical treatment to have a satisfactory outcome by physician assessment (65% vs. 36%; $P < 0.05$).[39] However, this difference narrowed with time and was no longer statistically significant at 4 years (67% vs. 52%). By 10 years, the results were almost identical (56% vs. 58%). Other outcome measures—ability to work, freedom from low back pain, and freedom from radicular pain—did not differ significantly in the two groups.

This trial, although it is widely cited in the literature on the spine and was central to the formation of the Agency for Health Care Policy and Research practice guidelines on the management of acute low back pain,[43] has several potentially important flaws. First, the validity and reliability of one of the main outcome measures—physician assessment—is open to challenge. Outcome evaluation consisted of a nonstandardized physician assessment of patient satisfaction with the results of treatment. The clinical and functional meaning of this outcome and the extent to which it agrees with the patient's evaluation are unknown. Other reported outcomes (employability and pain) were ascertained during a follow-up examination, but it is unclear how these were measured. Second, the high crossover rate (26% of patients assigned to medical therapy eventually had surgery) biases the result toward no difference and may account for the null findings seen after 1 year.

Spinal Stenosis

The three observational studies that compared medical and surgical treatment for spinal stenosis (two were retrospective, and one was prospective) are summarized in **Table 4.** Two studies reported significantly better symptomatic improvement with surgery.[40, 42] One showed that surgery was superior with respect to visual analogue improvement scales (but not with respect to the proportion of patients free of symptoms) at follow-up.[40] Another showed no significant difference in function as assessed by clinical examination,[41] and the third showed improvement in physical function and pain scores on the Medical Outcome Survey Short Form-36 (SF-36).[42]

These studies have the same methodologic flaws as the observational studies that compare medical and surgical treatments for disc herniation. They were also small (no comparison group had more than 75 patients), and none reported long-term outcomes (i.e., outcomes beyond

TABLE 4

Studies Comparing Medical and Surgical Approaches to the Management of Spinal Stenosis

TYPE OF STUDY, INTERVENTION, AND SETTING	LENGTH OF FOLLOW-UP	OUTCOME MEASURE	PATIENTS ACHIEVING OUTCOME MEASURE	
			MEDICAL	SURGICAL
Retrospective cohort studies				
Laminectomy and facetectomy vs. no treatment at a Swedish hospital[40]	Approximately 4 years (average)		(n = 19)	(n = 44)
		Free of symptoms	42%	41%
		Improvement from baseline by visual analogue scale	32%	59%*
Laminectomy (with or without facetectomy) vs. medical treatment at a British university hospital[41]†	Approximately 4 years (average)		(n = 54)	(n = 54)
		Normal function on clinical examination	94%	91%
Prospective cohort study				
Laminectomy, discectomy, or fusion vs. medical treatment (bedrest, back exercises, traction, corset, or brace, transcutaneous electrical nerve stimulation, physical therapy, spinal manipulation, epidural steroids, narcotics, or other alternate treatments) from orthopedic surgery and neurosurgery practices in Maine[42]	1 year		(n = 58)	(n = 72)
		Mean change in SF-36 physical function‡	1.0	26.5‖
		Mean change in SF-36 pain scale‡	12.0	42.4‖

*$P < 0.05$.
†*Surgically and medically treated patients were matched according to age, sex, myelographic findings, and type and duration of symptoms.*
‡*Higher change scores mean larger improvements. SF-36 = Medical Outcome Short Survey-36.*
‖$P < 0.001$.

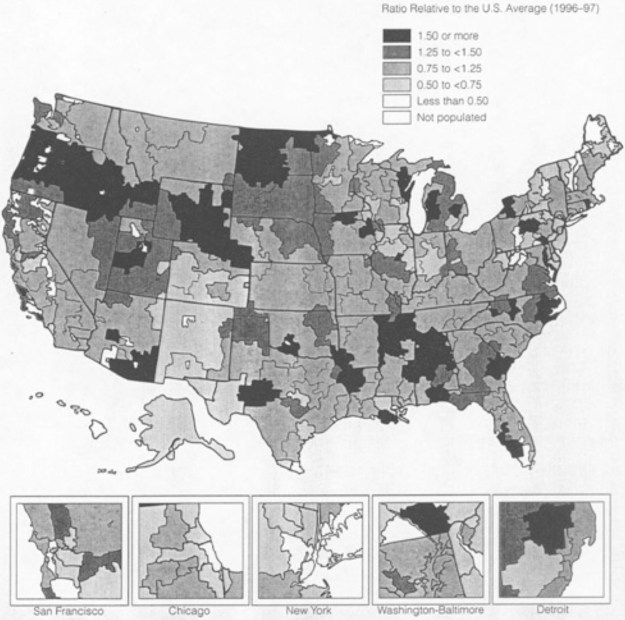

FIGURE 1. Ratio of rates of surgery for lumbar disc herniation.

an average of 4 years). The validity and reliability of the visual analogue scale used in one study are unknown, highlighting the lack of standardized outcome measures.

Most studies showed an advantage of surgery over medical therapy (at least in the short term), but serious methodologic problems preclude definitive conclusions about the relative efficacy of surgical and medical treatment. Having reviewed the evidence relevant to the choice of treatment for lumbar disc herniation and spinal stenosis, we next reviewed the actual patterns of treatment for these conditions in the United States.

Clinical Practice in Spinal Surgery

Although geographic variation in aggregate rates of spinal surgery has been documented,[44–47] variation in the use of spinal surgery for lumbar disc herniation and spinal stenosis has not been shown. As part of our work with *Dartmouth Atlas of Healthcare*, we used the methods of small-area analysis and data obtained from the Health Care Financing Administration (1996–1997) to assess geographic variation in the use of surgery for these indications in the U.S. Medicare population.

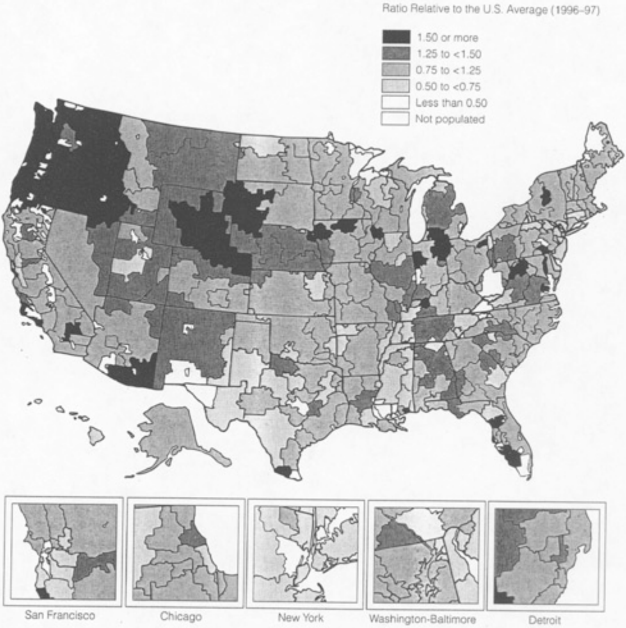

FIGURE 2. Ratio of rates of surgery for spinal stenosis.

Small-Area Analysis Methods

We calculated surgery rates as follows. For the numerator, we obtained procedure counts from the Medicare Provider Analysis and Review (MEDPAR) file, which contains all hospital discharge abstracts for acute care hospitalizations of Medicare beneficiaries covered under the hospital (Part A) insurance program. Thus, our analysis was restricted to inpatient procedures. For the denominator, we used the Denominator file, which contains identifier and demographic information for all Medicare enrollees. To ensure that the persons counted in the numerator corresponded to the population in the denominator, we excluded Medicare enrollees who were younger than 65 years of age (a very small, distinct population) or who were enrolled in risk-bearing HMOs (because utilization data are not reported for these patients). For this analysis, we compared spinal surgery rates across hospital referral regions (HRRs) of the United States. These regions, which represent naturally occurring market areas for tertiary health care, were created by aggregating ZIP codes according to the likelihood that residents will undergo major cardiovascular surgery and neurosurgery. This resulted in the formation of 306 HRRs nationwide. More details about the designation of HRRs and methods of small-area analysis are available in the *Dartmouth Atlas of Healthcare*[44,45] and elsewhere.[48]

We included only the discharges of patients who had a diagnosis that could have caused low back pain, sciatica, or neurogenic claudication. We excluded the discharges of patients for whom the primary diagnosis was related to the cervical or thoracic spine. For a patient to be included, the primary diagnosis of disc herniation or spinal stenosis had to be associated with at least one of three surgical procedures: discectomy, laminectomy, or spinal arthrodesis. We excluded patients with procedure codes that indicated reopening of a laminectomy site or lysis of adhesions of the spinal cord and nerve roots. We also excluded all patients with diagnosis codes that indicated neoplasm, infection of the spine, inflammatory spondylitis, fracture, or vehicular trauma. Our case selection was based on algorithms developed by the Back Pain Outcome Assessment Team and is described in detail elsewhere.[49]

Geographic Variation in Practice

From 1996 through 1997, 44,088 patients with disc herniation and 58,556 patients with spinal stenosis in the Medicare-eligible population had spinal surgery. Of these, 4543 (4.4%) were excluded from further analysis for reasons listed previously. The rate of surgery for disc herniation varied 8-fold, from 0.24 per 1000 persons in York, Pennsylvania, to 1.96 per 1000 persons in Boise, Idaho (**Figure 1**). The rate was at least 50% higher than the national average (0.64 per 1000) in 51 HRRs and more than 50% lower than the national average in 12 HRRs. The rate of surgery for spinal stenosis varied 12-fold, from 0.29 per 1000 persons in Johnson City, Tennessee, to 3.34 per 1000 persons in Bend, Oregon (**Figure 2**). The rate was at least 50% higher than the national average (0.99) in 38 HRRs and more than 50% lower than the national average in 13 HRRs. Rates of surgery for both conditions tended to be high in parts of the northwestern, mountain, midwestern, and southern states and low in the Northeast, Alaska, Hawaii, and parts of the Southwest and Central/Great Lakes region.

Compared with variations in rates of other common surgical procedures, the 8-fold variation in rates of surgery for lumbar disc herniation and the 12-fold variation in surgery for spinal stenosis are very large. For example, in the same population studied here, rates of surgery for hip fracture vary approximately 2-fold and rates of radical prostatectomy vary 8-fold.

Conclusions

What could explain this high rate of variation in rates of surgery? It is possible that 8-fold and 12-fold variations exist in the prevalence of the study conditions across HRRs, but we find this explanation implausible. Instead, we believe that the variations found in our study—like those of other "high-variation conditions"—reflect a basic lack of consensus among clinicians about the indications for these procedures. In general, the degree of geographical variation seen for a given procedure is related to the level of clinical agreement about the most appropriate methods and indications for diagnosis and treatment. For example, rates of surgery for hip fracture vary little; there is essentially no ambiguity about the diagnosis of hip fracture, and there is clinical consensus about the optimal therapy for it. In contrast, no such agreement exists about treatment for early-stage prostate cancer, and practice variation is substantial. Our literature review highlights the absence of strong evidence favoring either medical or surgical treatment for lumbar disc herniation or spinal stenosis. In the absence of outcome data to guide decision making, a high degree of practice variation is predictable. Physicians may differ in their definitions of the failure of conservative measures, in their thresholds for radiologic definitions of disease, and in how they interpret patient symptoms and physical examination findings.

Clinical decisions not only are driven by outcome data but also reflect patient preferences. To help patients make informed decisions, programs are available to educate patients about what is and what is not known about the relative efficacy and risks of surgical and medical treatments for disc herniation and spinal stenosis.[50] A study that assessed the effect of such a program on decision making found that fewer patients remained undecided about the choice between surgical and medical treatment after completion of the program (17% vs. 29%).[50] Without appropriate data and an understanding of patient preferences, it will be impossible to determine which rate is "right" (i.e., are areas with low rates of surgery doing too little, or are other areas doing too much?).

Lumbar disc herniation and spinal stenosis are common, debilitating conditions for which both medical and surgical interventions exist. Wide variation in the use of spinal surgery indicates that there is substantial room for discretion in clinical decisions about treatment for these conditions. We believe that the remarkable degree of variation reflects clinical uncertainty about the relative efficacy of medical and surgical approaches and is largely attributable to the paucity of high-quality evidence available to guide decision making. Randomized clinical trials would avoid the confounding and bias inherent in previous observational studies. Well-designed observational studies would help assess the generalizability of the results of randomized studies to the population of eligible patients. The use of reliable, valid, and sensitive outcome measures would ensure that treatments are assessed in a way that is relevant to the lives of the patients receiving them. We believe that better evidence will ultimately translate into better decisions and treatment for patients with low back pain.

Take-Home Points

- **Low back pain is second only to the common cold as a reason to seek medical attention.**
- **Although low back pain in most patients is nonspecific, about 15% have conditions (predominantly lumbar disc herniation and spinal stenosis) that may be amenable to surgery.**
- **Little evidence indicates that surgery is better than medical therapy for lumbar disc herniation and spinal stenosis.**
- **Across geographic areas in the United States, there is an 8-fold variation in rates of surgery for lumbar disc herniation and a 12-fold variation in rates of surgery for spinal stenosis.**
- **To reduce this dramatic variation, we need better data on when to operate and more patient involvement in treatment decisions.**

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