The who, what and when of surgery for the degenerative lumbar spine: a population-based study of surgeon factors, surgical procedures, recent trends and reoperation rates

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Presented as a lecture at the Canadian Spine Society Annual Meeting, Mar. 22–25, 2006, in Lake Louise, Alta.; at Spine Across the Sea (North American Spine Society, Japanese Spine Research Society), July 2006, in Maui, Hawaii; and at the Canadian Orthopaedic Association Annual Meeting, Jun. 1–3, 2007, in Halifax, NS. Presented as a poster at the International Society for the Study of the Lumbar Spine Annual Meeting, June 2006, in Bergen, Norway.

Accepted for publication Apr. 3, 2008

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Background: Degenerative disease of the lumbar spine (DLS) is a common condition for which surgery can be beneficial in selected patients. With recent surgical trends toward more focused subspecialty training, it is unclear how characteristics of the surgical consultant may impact on treatment and reoperations. Our objective was to understand the relations between surgeon factors (who), surgical procedures (what) and recent trends (when) and their influence on reoperations for DLS surgery.

Methods: We performed a longitudinal population-based study using administrative databases including all patients aged 50 years and older who underwent surgery for DLS. We collected data on surgeon characteristics (specialty, volume), index procedures (decompressions, fusions) and reoperations.

Results: We identified 6128 patients who underwent surgery for DLS (4200 who had decompressions, 1928 who had fusions). We observed an increasing proportion of fusions over decompressions while the per capita surgeon supply declined. Orthopedic specialty and higher surgical volume were associated with a higher proportion of fusions ($p < 0.001$). The overall reoperation rate was 10.6%. Reoperations were more frequent in patients who had decompressions than those who had fusions at 2 years (5.4% v. 3.8%, odds ratio 1.4, $p < 0.013$), but not over the long-term. Long-term survival analysis demonstrated that a lower surgical volume was related to a higher reoperation rate (hazard ratio 1.28, $p = 0.038$).

Conclusion: Lumbar spinal fusion rates for DLS have been increasing in Ontario. There is wide variation in surgical procedures between specialty and volume: namely high-volume and orthopedic surgeons have higer fusion rates than other surgeons. We observed better long-term survival among patients of high-volume surgeons. Referring physicians should be aware that the choice of surgical consultant may influence patients' treatments and outcomes. With increasing rates of spinal surgery, the efficacy and cost benefit of current surgical options require ongoing study.

Contexte : L'arthrose lombaire est une affection répandue qui répond bien à la chirurgie chez les patients qui sont de bons candidats. Compte tenu des tendances récentes observées en chirurgie, axées davantage sur la surspécialisation, on ignore quel impact les caractéristiques du chirurgien peuvent avoir sur le traitement et les réinterventions. Nous avions pour objectif d'explorer les liens entre les facteurs liés au chirurgien (qui), les interventions chirurgicales (quoi) et les tendances récentes (quand), et leur influence sur les réinterventions chirurgicales dans les cas d'arthrose lombaire.

Méthodes : Nous avons procédé à une étude longitudinale de population à partir de bases de données administratives regroupant tous les patients âgés de 50 ans et plus ayant subi une chirurgie pour arthrose lombaire. Nous avons recueilli les données sur les caractéristiques des chirurgiens (spécialité, volume), les interventions de départ (décompression, arthrodèse) et les réinterventions.

Résultats : Nous avons recensé 6128 patients ayant subi une chirurgie pour arthrose lombaire (4200 par décompression, 1928 par arthrodèse). Nous avons observé une proportion croissante d'arthrodèses par rapport aux décompressions à mesure du déclin des effectifs en chirurgie. On a pu établir un lien entre la spécialisation en orthopédie, un volume de chirurgies élevé et une proportion plus grande d'arthrodèses ($p < 0,001$). Le taux global de réinterventions s'élevait à 10,6 %. On est réintervenu plus souvent à 2 ans chez les patients qui avaient subi une décompression que chez ceux qui avaient subi une arthrodèse (5,4 % c. 3,8 %; rapport des cotes 1,4, $p < 0,013$), ce qui n'a pas été le cas à long terme. L'analyse de survie à long terme a montré un lien entre un volume moindre de chirurgies et un taux plus élevé de réinterventions (risque relatif 1,28, $p = 0,038$).

Conclusion : Les taux d'arthrodèses de la colonne lombaire pour arthrose ont augmenté en Ontario. On observe une grande variation quant aux interventions chirurgicales selon la spécialité et le volume, notamment les chirurgiens orthopédiques dont le volume opératoire est élevé pratiquent plus souvent des arthrodèses que les autres chirurgiens. Nous avons observé une meilleure survie à long terme chez les patients des chirurgiens qui ont un volume opératoire élevé. Tout médecin qui réfère doit savoir que le choix de l'expert peut influer sur le traitement et le pronostic des patients. Compte tenu des taux croissants de chirurgies de la colonne vertébrale, l'efficacité et le rapport coût:avantages des options chirurgicales actuelles méritent de faire l'objet d'études plus approfondies.

Degenerative disease of the lumbar spine (DLS) is a common and often disabling disorder causing back and lower extremity pain and is a common reason for people to see their general practitioners (GPs).[1–3] The prevalence of this condition is expected to rise with the aging population. Many patients with moderate to severe symptoms may be appropriate candidates for surgery.[4–12] Traditionally, patients with symptomatic nerve root compression benefit most from decompressive surgery (i.e., laminectomy). Fusion (i.e., arthrodesis) of the involved degenerative segments has shown benefit in certain circumstances.[13] Spinal fusion is often supplemented with instrumentation (i.e., pedicle screw–rod constructs) and may even include devices placed between adjacent vertebrae (i.e., interbody cages). Instrumentation may improve spinal fusion rates; however, its impact on improved patient-reported outcomes is less conclusive.[14] Owing to the variability of clinical presentations and treatment options with differing reported successes, there exists no clear consensus on the ideal surgical management for these patients despite overall improvement with surgical management.[8,13,15–18]

Surgical training has supported more subspecialization in spinal surgery, both for neurosurgeons and orthopedic surgeons.[19] Presently in Canada, there is no national standard for the formal certification of a spinal surgeon. Specialty designation as a neurosurgeon or orthopedic surgeon, with or without additional fellowship training, is generally considered to be acceptable. With advances in surgical technology, surgical decisions become even more complex. Thus, the use of surgical resources may be influenced more by surgeon factors such as surgical training and volume than by clinical factors.[20]

In Ontario, the GP serves as the "gatekeeper" to care such that specialist consultation requires a referral from a GP. For patients with DLS, the GP must not only decide who might benefit most from surgical referral but also from which specialist to request a consultation. Referral patterns in shared clinical areas such as spinal surgery may be influenced by access to or a GP's relationship with the specialist rather than a consideration for the specific surgical procedure that the patient might receive.

Over the past 2 decades, there has been a dramatic rise in the overall rates of spinal surgery whereby waiting lists for specialist consultation and surgery remain long.[21–24] Referring physicians must be vigilant in selecting the most appropriate patients for surgical referral such that patients receive the most effective care. Currently, referring physicians have little information on the patterns of surgical practice for patients with DLS on which to base their decisions. The purpose of our study was to determine the surgeon factors (who), types of surgical procedures (what) and recent surgical trends (when) influencing DLS surgery and reoperation rates in Ontario.

Methods

Using administrative databases, we conducted a longitudinal study to identify all patients aged 50 years or older who were admitted to hospital in Ontario between 1995 and 2001 for surgical treatment of DLS, including lumbar spinal stenosis, facet arthrosis, degenerative lumbar spinal disease and degenerative instability patterns. The Canadian Institute for Health Information (CIHI) database contains data from all patient–hospital encounters and includes specialist designation (e.g., neurosurgeon, orthopedic surgeon) for all physicians in Ontario. All patients in Ontario are covered under the Ontario Health Insurance Plan (OHIP), which assigns unique identifiers to patients, hospitals and physicians and can be linked to the CIHI database.[25]

We collected patient data from Apr. 1, 1995, to Dec. 31, 2001, using International Classification of Diseases, ninth revision (ICD-9) diagnostic codes and Canadian Classification of Procedures (CCP) procedural codes (Appendix 1). We included patients aged 50 years or older, and we excluded those with primary admitting diagnoses of infection, trauma, tumour, inflammatory disease or primary disc herniation (Appendix 2). Although several population-based studies evaluating trends in DLS have limited inclusion to patients aged 65 years or older,[26,27] we chose to include patients aged 50 years and older since more than 90% of patients with spinal stenosis are older than 50[28] and because degenerative instability patterns are frequently seen in patients as young as 50.[29] Furthermore, to best avoid capturing patients with primarily disc herniations, primary degenerative disc disease or isthmic spondylolisthesis, we somewhat arbitrarily chose not to include patients younger than 50. Using the 3 most common OHIP procedural codes for surgical treatment of the degenerative lumbar spine, we classified each patient as having received either decompression, noninstrumented fusion or instrumented fusion (Appendix 3). Since the rate of reoperation for surgery for DLS has been shown to be 23% over 10 years,[30] we repeated a search for relevant procedures over a 2-year "look-back" window before the date of their first identified operation to exclude patients who had recent reoperations.

We collected baseline demographic information (age, sex) and a modified Charlson–Deyo index, used to quantify comorbidity.[31,32] We calculated this validated measure of comorbidity using ICD-9 diagnostic information from the Discharge Abstracts Database within CIHI, which assigns a score from 0 to 5 for 17 different comorbid diagnoses. We then dichotomized patients into a score of 0 (no recorded Charlson–Deyo comorbidity) or greater than or equal to 1 (1 or more Charlson–Deyo comorbidities).

We identified surgeons who performed procedures on the patients in our sample using unique numbers from OHIP. Although the term "spinal surgeon" may imply a surgeon who almost exclusively performs spinal surgery, in this study, we use the term to describe any surgeon (orthopedic or neurosurgeon) who performs any spinal surgery. We determined surgeon volume by averaging the annual volume of that surgeon over the 2 years before the relevant patient's operation. We divided surgeon volumes into quartiles based on the 25th, 50th and 75th percentiles. Because fiscal years run from Apr. 1 to Mar. 31 and coding systems changed after Dec. 31, 2001, we had incomplete data on procedures performed for the fiscal year 2001/02. We therefore extrapolated our data by multiplying surgical volume by a correction factor of 4/3 to reflect the 3 of 12 incomplete months for that year. We calculated per capita surgical rates using census data for the Ontario population aged 50 years and older obtained from Statistics Canada.

We captured reoperation rates prospectively for each patient until Jun. 30, 2005. We evaluated reoperation rates at 6 weeks, 1 year, 2 years and at final follow-up.

We used the Student *t* test to compare continuous variables across categories, and we used simple linear regression to model rate changes over time. We used multivariate analysis of variance (MANOVA) to model multiple outcome rates over time simultaneously with multiple comparison adjustments. We analyzed frequency tables for count data with simple χ^2 statistics and Cochran–Mantel–Haenszel statistics. We used logistic regression and Cox proportional hazards regression to model reoperation rates at each time interval and for survival analysis until final follow-up, respectively.

Results

We identified 7585 patients who underwent spinal surgery for degenerative lumbar conditions in the province of Ontario between Apr. 1, 1995, and Dec. 31, 2001. Of those, 6136 were aged 50 years and older. Of these, we excluded 8 patients owing to their admitting diagnoses or because their surgeons were not classified as a neurosurgeon or orthopedic surgeon, leaving us with a total of 6128 patients for analysis. There were 3360 women (54.8%), the mean age of patients was 67.7 (range 50–94) years, and 4455 patients had no significant comorbidities (72.7%). There were 4200 patients who underwent decompressions only and 1928 who underwent fusions, with or without decompression (Table 1).

On average, we found no increase in overall population-based surgical rates from 1995 to 2001 (p = 0.45). Overall fusion rates increased by 63% over the study period (0.74 per 100 000 population aged ≥ 50 years per year, p = 0.006), whereas, simultaneously, rates of decompression without fusion decreased by 24% over the study period (0.91 per 100 000 population aged ≥ 50 years per year, p = 0.017). Furthermore, we identified an average of 147 surgeons

Table 1. Procedure numbers and rates among patients in Ontario who underwent surgery for degenerative disease of the lumbar spine between Apr. 1, 1995, and Dec. 31, 2001

	No. (%) of patients				Rate per 100 000 population aged ≥ 50 yr		
Year	Decompression	Noninstrumented fusion	Instrumented fusion	Total	Decompression	Total fusion	Total procedure
1995	600 (72.0)	39 (4.7)	194 (23.3)	833	21.0	8.2	29.2
1996	706 (78.3)	39 (4.3)	157 (17.4)	902	24.2	6.7	30.9
1997	633 (71.2)	30 (3.4)	226 (25.4)	889	21.0	8.5	29.5
1998	625 (69.6)	34 (3.8)	239 (26.6)	898	20.1	8.8	28.9
1999	594 (66.4)	41 (4.6)	259 (29.0)	894	18.6	9.4	28.0
2000	619 (61.9)	59 (5.9)	322 (32.2)	1000	18.9	11.6	30.5
2001	423 (59.4) 564* (59.4)*	47 (6.6) 63* (6.6)*	242 (34.0) 323* (34.0)*	712 (949)*	16.8	11.5	28.3

*Numbers and rates adjusted by 4/3.

performing operations for DLS in Ontario, which decreased on average by 14% over the study period (Fig. 1). Results

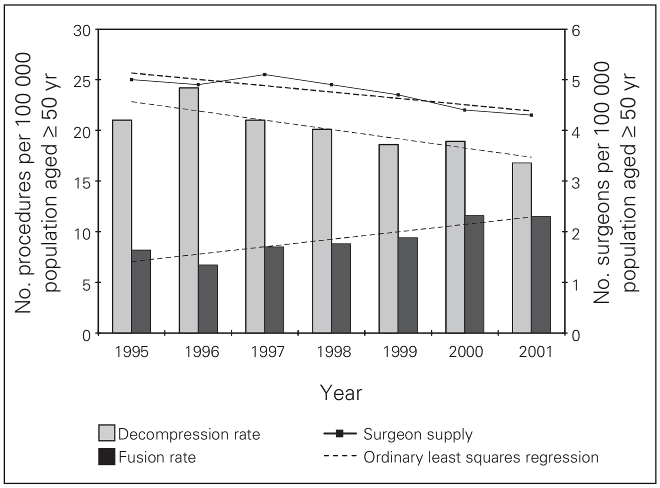

Fig. 1. Surgeon supply and surgical rates per 100 000 population aged 50 years or older.

from MANOVA show that there was an overall significant effect of decreasing surgeon supply and rates of decompressions and increasing fusions over time ($p = 0.030$, Wilks Λ).

Since the distribution of patients among surgeons with different volumes was negatively skewed such that most patients had high-volume surgeons, more central measures (i.e., mean or median) dichotomized the patient volume quite disproportionately. We therefore chose the 75th percentile cutoff to dichotomize high volume from low volume in order to balance the ratio of numbers of surgeons with numbers of patients. The 75th percentile for annual surgical volume, which dichotomized low from high volume, was 31.5 cases (range 1–176 cases/yr). Over the study period, 110 low-volume surgeons (75% of surgeons) operated on only 37.5% of the patients, whereas 37 high-volume surgeons (25% of surgeons) operated on 62.5% of patients (Table 2). We found no differences in the mean age, sex or comorbidities of patients with high- or low-volume surgeons (Table 3). Although neurosurgeons operated on older patients and more men than orthopedic surgeons

Table 2. Surgeon volumes among neurosurgeons and orthopedic surgeons who treated patients in Ontario with degenerative disease of the lumbar spine between Apr. 1, 1995, and Dec. 31, 2001

	No. (%) of surgeons			Annual surgical volume		No. (%) of patients	
Year	Low volume	High volume	Total	75th percentile	Range	Low volume	High volume
1995	105 (73.9)	37 (26.1)	142	27.5	1–201	329 (39.5)	504 (60.5)
1996	106 (74.6)	36 (25.4)	142	29.5	1–214	366 (40.6)	536 (59.4)
1997	114 (74.5)	39 (25.5)	153	30.5	1–189	324 (36.4)	565 (63.6)
1998	114 (74.5)	39 (25.5)	153	31.5	1–156	355 (39.5)	543 (60.5)
1999	113 (74.8)	38 (25.2)	151	29.5	1–151	315 (35.2)	579 (64.8)
2000	107 (74.8)	36 (25.2)	143	35.5	1–160	364 (36.4)	636 (63.6)
2001	108 (75.0)	36 (25.0)	144	36.5	1–161	242 (34.0) 323* (34.0)*	470 (66.0) 627* (66.0)*

*Numbers adjusted by 4/3.

Table 3. Demographics of patients in Ontario who underwent surgery for degenerative disease of the lumbar spine between Apr. 1, 1995, and Dec. 31, 2001, by surgeon specialty and volume

	Surgeon specialty		Surgeon volume	
Characteristic	Neurosurgery	Orthopedic	Low volume	High volume
No. of patients	2687	3441	2295	3833
Age, mean (range) yr	68 (50–92)	67 (50–94)	68 (50–94)	68 (50–91)
Female, no. (%)	1365 (50.8)	1995 (58.0)	1234 (53.8)	2126 (55.5)
Charlson ≥ 1, no. (%)	744 (27.7)	929 (27.0)	651 (28.4)	1022 (26.7)

Table 4. Surgical procedures performed on patients in Ontario who underwent surgery for degenerative disease of the lumbar spine between Apr. 1, 1995, and Dec. 31, 2001, by surgeon specialty and volume

	Decompressions, no.			Fusions, no.		
Surgeon volume	Neurosurgeons	Orthopedic surgeons	Total	Neurosurgeons	Orthopedic surgeons	Total
Low volume	1005	867	1872	66	357	423
High volume	1481	847	2328	135	1370	1505
Total	2486	1714	4200	201	1727	1928

($p < 0.001$), the age and percent female differences were small considering the study sample size (1.1 yr older, 7.2% more men). There was also no change in the ratio of procedures (i.e., decompresson v. adjunctive fusion) performed by neurosurgeons compared with orthopedic surgeons over the study period.

The number of decompressive and fusion procedures by surgical specialty and surgical volume is shown in Table 4. The odds of performing fusions over decompressions was 2.9 for higher-volume compared with lower-volume surgeons (95% confidence interval [CI] 2.5–3.2) and 12.5 for orthopedic surgeons compared with neurosurgeons (95% CI 10.6–14.6). We found heterogeneity in the odds ratios (ORs) for surgery by specialty between the low- and high-volume groups ($p < 0.001$, Breslow–Day test) such that the OR for fusions in low-volume surgeons was 6.3 (95% CI 4.7–8.3) compared with an OR in high-volume surgeons of 17.7 (95% CI 14.6–21.6).

From 1995 to 2005, there were 649 reoperations (10.6%; Table 5). The reoperation rate was higher for decompressions than fusions at 2 years (OR 1.4, 95% CI 1.1–1.8). Overall, the reoperation rate was lower for younger patients (mean difference 2.0 yr, 95% CI 1.3–2.8) and those without significant comorbidities (OR 0.7, 95% CI 0.6–0.9). We found no significant differences in long-term survival for index procedures or surgeon specialty (Fig. 2 and Fig. 3). Cox proportional hazards regression demonstrated that patients with lower-volume surgeons had a significantly higher reoperation rate after adjusting for age, comorbidity and surgeon specialty (hazard ratio 1.28, $p = 0.038$; Fig. 4).

Table 5. Reoperations among patients in Ontario who underwent surgery for degenerative disease of the lumbar spine between Apr. 1, 1995, and Dec. 31, 2001, by demographics and surgeon factors

	Reoperation; no. (%)*			
Characteristics	6 weeks	1 year	2 years	Overall
No. of patients	36 (0.6)	142 (2.3)	297 (4.9)	649 (10.6)
Age, mean (range) yr	66 (50–81)	67 (50–87)	67 (50–87)	66 (50–87)
Female sex	20 (0.6)	77 (2.3)	165 (4.9)	354 (10.5)
Male sex	16 (0.6)	65 (2.4)	132 (4.8)	295 (10.7)
Charlson = 0	24 (0.5)	108 (2.4)	227 (5.1)	506 (11.3)
Charlson ≥ 1	12 (0.7)	34 (2.0)	70 (4.2)	143 (8.6)
Index operation				
Decompression	23 (0.6)	108 (2.6)	223 (5.3)	449 (10.7)
Fusion	13 (0.7)	34 (1.8)	74 (3.8)	200 (10.4)
Surgeon volume				
Low volume	9 (0.4)	56 (2.4)	120 (5.2)	255 (11.1)
High volume	27 (0.7)	86 (2.2)	177 (4.6)	394 (10.3)
Surgeon specialty				
Neurosurgery	12 (0.5)	73 (2.7)	134 (5.0)	279 (10.4)
Orthopedic surgery	24 (0.7)	69 (2.0)	163 (4.7)	370 (10.8)

*Unless otherwise indicated.

Discussion

From 1995 to 2001 in Ontario, we observed a trend toward more spinal fusions and fewer isolated decompressions with a simultaneous decrease in overall supply of

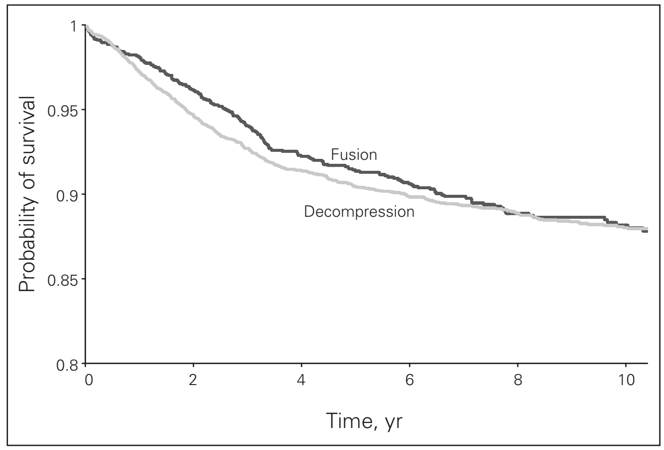

Fig. 2. Kaplan–Meier probability of reoperation-free survival, by index procedure.

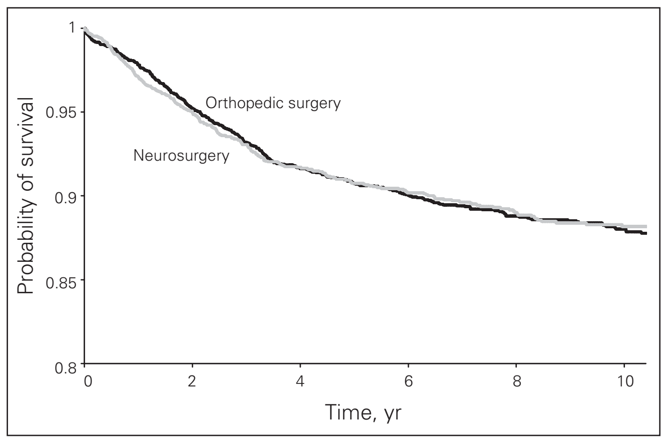

Fig. 3. Kaplan–Meier probability of reoperation-free survival, by surgeon specialty.

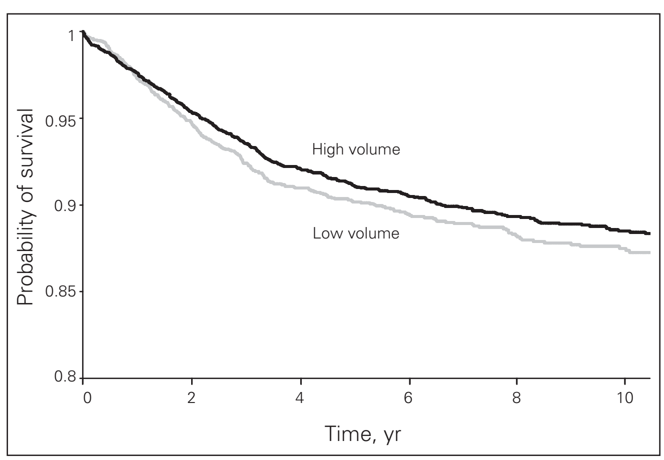

Fig. 4. Kaplan–Meier probability of reoperation-free survival, by surgeon volume.

spinal surgeons. A significantly higher proportion of fusions were performed by orthopedic surgeons than neurosurgeons and also by high- compared with low-volume surgeons, irrespective of surgical background. Whereas the reoperation rate was lower for fusions in the short-term and higher-volume surgeons in the long-term, the reoperation rate was not influenced by surgical specialty.

Although surgical rates have been increasing steadily in the United States, there is wide variation in rates across different geographical regions.[33] Because of this phenomenon, there is controversy on the appropriateness of the increasing spinal fusion rates.[34,35] However, a recent large multicentre preference trial of patients with degenerative spondylolisthesis associated with lumbar spinal stenosis suggested that those treated surgically, mostly with instrumented fusions, showed greater improvement in functional outcome than those treated nonsurgically.[17] Since there was a high rate of crossover from nonsurgical to surgical management, making an intention-to-treat analysis for the randomized arm difficult, the study demonstrated the difficulty with conducting a purely randomized trial for this condition. In a comparison of patients with focal spinal stenosis with patients receiving total joint arthroplasty, decompressive spinal procedures had functional outcomes comparable to patients receiving total joint arthroplasty.[18]

With a decline in surgeon supply but a steady overall rate of surgery, our findings suggest a trend toward spinal subspecialization, whereby dedicated spinal surgeons emanating from both specialties are spending more time performing spinal surgery exclusively. Furthermore, we found a lower reoperation rate among higher-volume surgeons, a finding that has been well established in many other areas.[36–38] In dichotomizing surgical volume by the 75th percentile, the 110 low-volume surgeons performed fewer than 31.5 operations for DLS annually, whereas the 37 high-volume surgeons performed more. Although this may appear to be a low case volume, particularly for high-volume surgeons, this rate was based solely on the top 3 OHIP procedural codes for the surgical treatment of DLS (Appendix 3) and may not reflect a surgeon's true procedural volume.

It is because neurosurgeons and orthopedic surgeons have different training experiences that decision-making surrounding spinal surgery is varied.[16,39–41] It is, therefore, not surprising that neurosurgeons perform mostly decompressions whereas orthopedic surgeons perform more fusions. Thus, the surgical procedure performed depends on the surgeon seen, despite reoperation rates being similar across surgical specialties.

One possible explanation for interspecialty variation may be that referring physicians are appropriately identifying patients at the time of consultation such that those needing isolated decompressive procedures as opposed to fusions are being appropriately referred. Another explanation is that referring physicians will consult the specialist with whom they have the closest relationship, and, subsequently, that consultant determines the surgical procedure. In this scenario, the GP's role in initiating referral for consultation may be more than simply the "gatekeeper" to care. The GP may also be acting as the "switch-operator" whereby the patient's treatment may be dictated by the type of surgeon from whom the GP has requested consultation. Nonetheless, it is reassuring that reoperation rates, although lower for higher-volume surgeons, are not related to surgeon specialty.

To our knowledge, our study represents the first attempt to relate the surgical procedures performed for patients with DLS to surgeon factors using a large administrative database. Study limitations include those inherent in administrative database research, including the type and quality of the data. First, with a lack of patient-oriented outcome measures available, reoperation following spinal surgery, our primary outcome measure, may not truly reflect a poor outcome. Second, there may have been coding inaccuracies; however, procedural and demographic data from the databases we used have been shown to be accurate.[25] Third, by using a 2-year "look-back" window to exclude patients having had recent reoperations, we may have misclassified some reoperations as index procedures. Several population-based studies investigating reoperation rates in spinal surgery have previously neglected to use a "look-back" window at all.[42,43] Studies that have used a "look-back" window used a timeframe of 2–3 years, similar to our study.[32,44] Fourth, patients included in our analysis and the follow-up were limited to those who received care in Ontario. Finally, since our study was observational, it was subject to other biases that we could not adequately control: namely, the patient's preference in referral.

Our study was confined to surgical trends in Ontario from 1996 to 2001, and our results may not necessarily generalize to other jurisdictions. However, our findings are worth consideration for referring physicians. Additionally, our findings are important where physicians have an opportunity to discuss treatment options with their patients. Even in health systems with self-referral, these findings may help policy-makers with further cost-effectiveness analyses such that understanding differences in practice among specialists and their associated financial impact can help plan resource use.

In conclusion, rates of lumbar spinal fusion to treat DLS are increasing while the number of spinal surgeons is decreasing. Spinal subspecialization and higher surgical volumes among both neurosurgeons and orthopedic surgeons may lead to improved outcomes and reduced complications, thus improving the care for patients with DLS. Despite there being no difference in reoperation rates between neurosurgeons and orthopedic surgeons, GPs should be aware that the specialist to whom they refer their patients is likely to influence the procedures their patients will have. High-quality clinical trials may still provide the best scientific evidence for the efficacy of spinal fusion surgery in the treatment of degenerative conditions of the lumbar spine.

Competing interests: None declared.

Contributors: Each author contributed to study design and article review and gave final approval for publication. Dr. Bederman acquired the data and wrote the article. Drs. Bederman and Weller analyzed the data.

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Appendix 1. Patient identification

Diagnostic codes (ICD-9)

721.3 Lumbosacral spondylosis without myelopathy (lumbar or lumbosacral: arthritis, osteoarthritis, spondylarthritis)

724.0 Spinal stenosis, other than cervical

00 Spinal stenosis, unspecified region

02 Spinal stenosis, lumbar region

724.2 Lumbago (low back pain, low back syndrome, lumbalgia)

724.3 Sciatica (neuralgia or neuritis of sciatic nerve)

724.4 Thoracic or lumbosacral neuritis or radiculitis, unspecified (radicular syndrome of lower limbs)

724.5 Backache, unspecified (vertebrogenic pain syndrome NOS)

724.6 Disorders of sacrum (ankylosis or instability, lumbosacral or sacroiliac)

724.9 Other unspecified back disorders (ankylosis of spine NOS, compression of spinal nerve root NOS, spinal disorder NOS)

738.4 Acquired spondylolisthesis (degenerative spondylolisthesis, spondylolysis acquired)

738.5 Other acquired deformity of back or spine (deformity of spine NOS)

Procedural codes (CCP)

16.09 Other explorations and decompression of spinal canal (decompression: laminectomy, laminotomy; exploration of spinal nerve root; fomraminotomy)

92.31 Excision of intervertebral disc

93.03 Dorsal spinal fusion

93.04 Dorsolumbar spinal fusion with Harrington rod

93.05 Other dorsolumbar spinal fusion

93.06 Lumbar spinal fusion

93.07 Lumbosacral spinal fusion

CCP = Canadian Classification of Procedures; ICD-9 = International Classification of Diseases, ninth revision; NOS = not otherwise specified.

Appendix 2. Exclusion criteria (ICD-9)

170.2 Malignancy of bone and articular cartilage (vertebral column)

213.2 Benign neoplasm of bone and articular cartilate (vertebral column)

720 Inflammatory spondylopathies

722 Disc disorders

730 Infection

805-806 Fracture of vertebral column

ICD-9 = International Classification of Diseases, ninth revision.

Appendix 3. Classification of procedures

Instrumented fusion

Any code with R371

R371 – instrumentation – deformities – segmental procedure – with fusion

Noninstrumented fusion

Any code with E567 and no R371

E567 – arthrodesis – fusion with other procedure(s)

Decompression

Any code with N185 without R371 or E567

N185 – decompression – posterior – posterior laminectomy 1 or 2 levels, cervical, thoracic, lumbar