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Physician-Specific Variability in Spine Fusion Patients

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ABSTRACT

Background: It is often assumed that each surgeon's patient population is similar to that of his or her peers. Differences in patient characteristics naturally may lead to diverse outcomes. To date, the variability of individual surgeons' patient populations has not been adequately characterized. The purpose of this study is to describe the variation in physician-specific patient characteristics among surgeons performing spine fusion surgery at a large, urban academic medical center.

Methods: We analyzed administrative data from a single institution for spine fusion surgery from 2009 to 2013. There were 6585 primary and 362 revision cases of spine fusion performed within this time period. Variability between surgeons and their respective patient populations was compared using descriptive statistics.

Results: The mean annual percentage of primary fusion patients with diabetes mellitus ranged from 0 to 16.17% (mean ± SD, 7.79% ± 3.96%) but constituted anywhere from 0 to 41.58% (mean ± SD, 8.15% ± 12.09%) of revision fusions. The mean annual percentage of primary fusion patients who were obese ranged from 0 to 9% (mean ± SD, 2.95% ± 2.7%), and 0 to 25% in revision cases (mean ± SD, 3.43% ± 6.43%). The annual mean percentage of patients with American Society of Anesthesiologists (ASA) scores greater than 3 ranged from 8.8% to 44.43% (mean ± SD, 20.42% ± 8.85%) in primary fusions and 0 to 100% (mean ± SD, 32.79% ± 23.47%) in revision fusions.

Conclusion: There was a large amount of variability among surgeons' patient populations when looking at characteristics such as obesity, diabetes, and ASA scores >3. These factors have been shown to impact patient outcomes. The variability in the patient populations of individual surgeons' practices even within the same medical center must be taken into account when evaluating physician specific outcomes and quality of care.

Other & Special Categories

Keywords: patient variability, risk adjustment, spine fusion, physician outcomes

INTRODUCTION

The incidence of spine fusion surgery in the United States is rapidly increasing and has more than doubled from 1998,[1,2] outstripping growth in other common orthopaedic procedures, such as hip and knee arthroplasty. Spine fusion surgery also incurs increasingly high financial costs[2,3] and is associated with complications such as infection, pseudarthrosis, and adjacent-level disease, which significantly impact patient outcomes and cost.[4–7] In particular, risk factors for infection include diabetes mellitus, obesity, and worse comorbidity burden.[8,9] The presence of these risk factors for infection may vary across different surgeons' practices, and little research has been done to explore these potential differences. It is important to understand the risk factors for infection that impact patient outcomes, both for appropriate patient counseling and for fair comparison of quality performance among different surgeons. The prevalence and importance of physician performance evaluation have increased in recent years, and perhaps most notably, the Medicare Access and CHIP Reauthorization Act will soon tether value to provider reimbursement for the Medicare population.[10] The purpose of this study was to compare the practice compositions of different surgeons from a single, large academic medical center to determine whether there is significant variation in patient characteristics for individual surgeon practices.

MATERIALS AND METHODS

We retrospectively analyzed cross-sectional data from an institutional database. Our study consisted of 6585 cases of primary spine fusion and 362 cases of revision spine fusion performed by 22 and 24 surgeons, respectively, in our single-specialty institution during a 5-year time frame (2009–2013). The

Table 1. Variable factors in health care delivery.

Patient	Age, commercial insurance, Medicaid insurance, Medicare insurance, diabetes mellitus, body mass index >30, tobacco users, same-day admission, American Society of Anesthesiologists score
Perioperative	Operative time, packed red blood cells used, >9 spine levels fused, lower levels fused

factors that constituted variability were divided into patient and perioperative considerations (Table 1).

Variability among surgeons and their respective patient populations was illustrated using descriptive statistics (mean, range, standard deviation, maximum, minimum).

RESULTS

We analyzed a total of 6585 cases of primary spine fusion and 362 cases of revision spine fusion performed by 22 and 24 surgeons, respectively, in our single-specialty institution during a 5-year time frame (2009–2013). The mean annual ages across each surgeon's patient population for primary and revision fusion ranged from 14.01 to 57 years (mean ± SD, 44.84 ± 10.72 years) and 14 to 69 years (55.36 ± 10.8 years), respectively. The mean annual percentage of primary fusion patients with commercial insurance (29.32% ± 18.9%) was an overwhelmingly larger percentage than those with Medicaid (0.76% ± 1.37%) or Medicare (7.41% ± 7.94%). Revision fusion data showed a large proportion of commercial insurance (34.83% ± 29.23%) and Medicare patients (19.75% ± 25.33%), and no Medicaid patients (0 ± 0). The mean annual percentage of primary fusion patients with diabetes mellitus ranged from 0 to 16.17% (7.79% ± 3.96%), and patients with diabetes constituted anywhere from 0 to 41.58% (8.15% ± 12.09%) of revision fusions. The mean annual percentage of primary fusion patients who were obese ranged from 0 to 9% (2.95% ± 2.7%), and obesity ranged from 0 to 25% in revision cases (3.43% ± 6.43%), while tobacco users comprised 0 to 19.95% of surgeons' average annual patient populations (10.17% ± 6.1%) in primary fusions and 0 to 50% in revision fusions (12.79% ± 13.63%). Same-day admissions constituted almost all primary and revision spine fusion surgeries and ranged from 88% to 100% (91.9% ± 3.57%) and 60% to 100% (90.16% ± 11.51%) of surgeons' mean annual percentages, respectively. The annual mean percentage of patients with American Society of Anesthesiologists (ASA) scores >3 ranged from 8.8% to 44.43% (20.42% ± 8.85%) in primary fusions and 0 to 100% (32.79% ± 23.47%) in revision fusions.

Perioperative Variability

Perioperative variables were analyzed to characterize differences in surgeon practices in the operating room. The mean annual operating time ranged from 145.66 to 495.91 minutes (255.94 ± 105.03 minutes) in primary fusions and 231 to 1204 minutes (469.79 ± 251.88 minutes) in revision cases. The mean annual percentage of primary surgeries in which packed red blood cells (pRBCs) were used ranged from 0 to 27.54% (8.92% ± 8.25%), whereas the average units of pRBCs used in such instances ranged from 0 to 2.89 (1.53 ± 0.85 units). Revision surgeries required more frequent use and greater quantities of blood transfusions, because pRBC use ranged from 0 to 100% (29.63% ± 29.18%), whereas the average units of pRBCs used in such instances ranged from 0 to 8 (1.98 ± 2.07 units). The mean annual percentage of greater than 9 spine levels fused ranged from 0 to 57.18% (10.09% ± 15.96%) in primary cases and 0 to 100% (16.09% ± 29.28%) in revision cases. The percentage of patients who required lower-level spine fusions ranged from 11.91% to 64% (36.7% ± 12.1%) in primary cases and 33% to 100% (82.56% ± 17.77%) in revision cases.

DISCUSSION

Performance has been evaluated at the institutional level, and public reporting of quality data has become increasingly prevalent. However, there has been little effort to characterize any potential existing variability in patient populations at the physician level. From a provider perspective, it has been shown that quality increases after performance is evaluated and disseminated publicly or only among physicians.[11–15] However, there remain concerns on the fairness of public reporting of individual physicians' performance, as the recent ProPublica Surgeon's Report Card has reinforced.[16] Obstacles that have prevented the fair and accurate measurement of physician performance include poor measure reliability and limited or incomplete data for adequate risk adjustment at the physician level.[1,17] This study demonstrates that variation in patients' infection risk factors for different surgeons

Table 2. Primary spine fusion data (per year).

Variability Type and Factor	Mean	Minimum	Maximum	Range	Standard Deviation
Patients					
Mean age, y	55.36	14	69	55	10.8
Commercial, %	34.83	0	100	100	29.23
Medicaid, %	0	0	0	0	0
Medicare, %	19.75	0	100	100	25.33
Diabetes, %	8.15	0	41.58	41.58	12.09
Body mass index >30, %	3.43	0	25	25	6.43
Tobacco users, %	12.79	0	50	50	13.63
Same-day admissions, %	90.16	60	100	40	11.51
ASA scores >3, %	32.79	0	100	100	23.47
Perioperative					
Mean operation time, min	469.79	231	1204	973	251.88
Mean operation time, min	470.44	188.73	1204	1015.27	264.24
pRBCs, %	29.63	0	100	100	29.18
Mean units of pRBCs	1.98	0	8	8	2.07
>9 spine levels, %	16.09	0	100	100	29.28
Lower levels, %	82.56	33	100	67	17.77

Abbreviations: ASA, American Society of Anesthesiologists; pRBCs, packed red blood cells.

that may impact quality measurement and reporting exist. The characterization of intersurgeon variability in patient risk factors associated with postoperative complications is an important step in evaluating future metrics of physician-level quality assessment.[11–15,18–21] The demonstration of variability and efforts to reduce this variability where appropriate may be one strategy for improving patient outcomes.

There is great variation in the complexity of spine surgery and in infection risk factors for individual physician practices at a single urban academic medical center. In our single-institution data set, we demonstrated significant variability among physician patient populations.

The incidence of diabetic patients among surgeons varied from 0 to 16.17% in the primary fusion cohort (Figure 1 and Table 2) and from 0 to 25% in the revision fusion cohort (Figure 2 and Table 3). In 4 of the 22 surgeons performing primary fusions, diabetic patients constituted only 4% or less of their patient populations. Diabetes is a strong risk factor for developing postsurgical infections and delayed healing, which could partially contribute to the apparent reluctance of many surgeons in our cohort to perform spine fusions.[22–25] However, even in spite of the 6- to 8-fold increased risk of developing surgical site infections reported in the literature, diabetic patients constituted more than 10% of 5 surgeons' patient populations in the primary fusion cohort.

Obesity in surgeons' populations seemed to be clustered around a bimodal distribution in the primary fusion group, with 5 surgeons' patient populations comprising 6% to 9% obese patients and the other 17 having less than 4% (Figure 1 and

Table 3. Revision spine fusion data (per year)

Variability Type and Factor	Mean	Minimum	Maximum	Range	Standard Deviation
Patient					
Mean age, y	44.84	14.01	57	42.99	10.72
Median age, y	45.2	14.05	65.38	51.33	13.71
Commercial, %	29.32	0	77.51	77.51	18.9
Medicaid, %	0.76	0	5.51	5.51	1.37
Medicare, %	7.41	0	29.78	29.78	7.94
Diabetes, %	7.79	0	16.17	16.17	3.96
Body mass index >30, %	2.95	0	9	9	2.7
Tobacco users, %	10.17	0	19.95	19.95	6.1
Same-day admissions, %	91.9	88	100	12	3.57
ASA scores >3, %	20.42	8.8	44.43	35.63	8.85
Perioperative					
Mean operation time, min	255.94	145.66	495.91	350.25	105.03
Median operation time, min	206.8	100.09	502.09	402	108.42
pRBCs, %	8.92	0	27.54	27.54	8.25
Mean units of pRBCs	1.53	0	2.89	2.89	0.85
>9 spine levels, %	10.09	0	57.18	57.18	15.96
Lower levels, %	36.7	11.91	64	52.09	12.1

Abbreviations: ASA, American Society of Anesthesiologists; pRBCs, packed red blood cells.

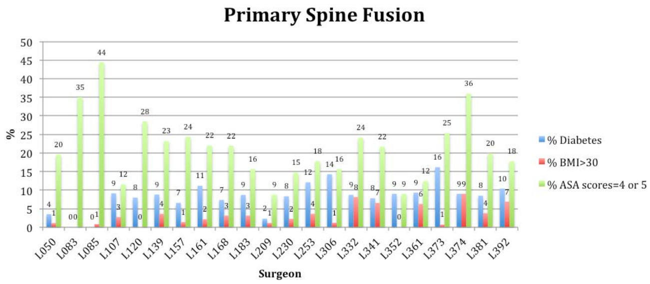

Figure 1. Surgeon case-mix (primary spine fusion). Abbreviations: BMI, body mass index; ASA, American Society of Anesthesiologists.

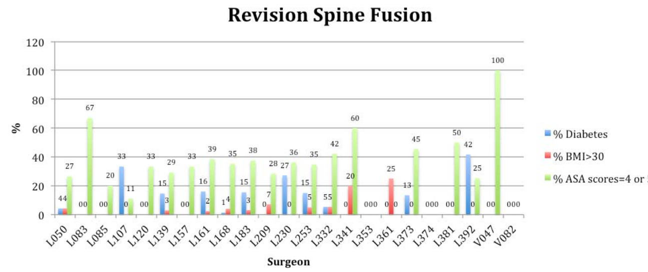

Figure 2. Surgeon case-mix (revision spine fusion). Abbreviations: BMI, body mass index; ASA, American Society of Anesthesiologists.

Table 2). Obesity was even less commonly found in revisions, because 13 of the 23 surgeons did not perform surgery on obese patients in a revision setting (Figure 2 and Table 3). However, obese patients constituted 20% or more of 2 of the surgeons' populations in the revision cohort. Patients who reported tobacco use ranged from 0 to 19.95% in the primary fusion cohort (Figure 1 and Table 2) and from 0 to 50% in the revision fusion cohort (Figure 2 and Table 3). A total of 5 of the 22 surgeons performing primary fusions performed less than 5% of their procedures on tobacco users, whereas 8 surgeons operated on tobacco users more than 15% of the time. The revision cohort showed a greater spread, because 9 surgeons did not perform spine fusions on tobacco users at all, whereas tobacco use was prevalent in more than 15% of procedures in 10 of the surgeons' populations. Obesity and tobacco use have been associated with an increased risk of developing surgical site infections, higher hospital costs, and other complications, making them clinically relevant risk factors that must be evaluated in the context of performance assessment.[24–27]

A large variation, ranging from 7% to 44%, of patient populations with ASA scores >3 was seen among the 22 surgeons performing primary fusions (Figure 1 and Table 2). Revision fusion patient populations evidenced a higher proportion of ASA scores >3 than primary fusion populations (Figure 2 and Table 3), possibly reflecting the inherently greater baseline risk in this patient population. Higher ASA scores have been correlated with increased cost and likelihood of developing major complications after spine fusion.[25,28]

The characterization of intersurgeon variability in patient risk factors associated with postoperative complications is an important step in minimizing the likelihood that a physician will be held accountable for aspects of care beyond his or her control in future metrics of physician-level quality assessment. Proper risk adjustment involves accounting for variation in patient characteristics, or case-mix bias, so that physicians who treat sicker patients do not appear to provide a lower quality of care compared with their peers. It is imperative that this variation be accounted for in order to more accurately represent a physician's performance. This is especially true for spine surgeons because there is great variability in spinal fusion procedures. This variability includes the number of levels fused and revision versus nonrevision surgery. Each of these types of fusions carries a different risk of complications. For example, adult spinal deformity surgery has especially proven to be associated with high complication rates and costly hospital stays and will be difficult to incorporate into a bundled payment program.[29] In a single-center retrospective analysis of 448 consecutive adult spinal deformity surgeries from 2005 to 2011, McCarthy et al.[30] found an average cost of $103,143 per patient during primary hospital stays. Additionally, many complications in spine surgery do not lead to clinically significant differences in outcome, as put forth by Smith et al,[31] and it will be important to isolate variables that have clinically significant impacts on long-term outcomes.

The ramifications of appropriately characterizing the risk characteristics of patient populations are compelling. Surgeons who operate on the most severely ill patients may appear to provide poorer-quality care compared with their colleagues who take on patients with an average risk profile. Such a misrepresentation misleads consumers, results in inappropriate payment allocation in quality-based payment programs, and misguides policy efforts towards quality improvement.[32,33] Because we know that there are certain risk factors associated with an increase in surgical site infection rate and other negative outcomes,[22,24] some surgeons who operate on patients outside an acceptable range of risk

should be more judicious about on whom they perform fusions or focus more on optimizing the patient, when able.

In our study we were able to display the case-mix of each surgeon individually, data that have not been shown before in the literature. However, one limitation is that surgical outcomes were not investigated and further follow-up studies to further delineate the association between case-mix and outcomes are needed. Selection bias is also a significant limitation in our study, as our purpose was to emphasize the variability in case-mix among surgeons all operating in the same institution. Future studies should include a large set of surgeons across a multiplicity of hospitals from various locations and practice settings to minimize this effect.

CONCLUSION

Significant variation of individual spine practices and patient populations within a single institution appears to exist. These differences can potentially be used to help surgeons improve patient outcomes. Quality assessment and reporting programs should make efforts to stratify and separately analyze outcomes and complications in cases involving revision surgery and patients with comorbidities associated with higher complications. Further investigation to evaluate the etiology of the variation in patient populations of different surgeons within the same urban academic medical centers is needed.

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