



Inferior Clinical Outcomes for Patients with Medicaid Insurance After Surgery for Degenerative Lumbar Spondylolisthesis: A Prospective Registry Analysis of 608 Patients

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■ **BACKGROUND:** It remains unclear how type of insurance coverage affects long-term, spine-specific patient-reported outcomes (PROs). This study sought to elucidate the impact of insurance on clinical outcomes after lumbar spondylolisthesis surgery.

■ **METHODS:** The prospective Quality Outcomes Database registry was queried for patients with grade 1 degenerative lumbar spondylolisthesis who underwent single-segment surgery. Twenty-four-month PROs were compared and included Oswestry Disability Index, Numeric Rating Scale (NRS) back pain, NRS leg pain, EuroQoL-5D, and North American Spine Society Satisfaction.

■ **RESULTS:** A total of 608 patients undergoing surgery for grade 1 degenerative lumbar spondylolisthesis (mean age, 62.5 ± 11.5 years and 59.2% women) were selected. Insurance types included private insurance ($n = 319$; 52.5%),

Medicare ($n = 235$; 38.7%), Medicaid ($n = 36$; 5.9%), and Veterans Affairs (VA)/government ($n = 17$; 2.8%). One patient (0.2%) was uninsured and was removed from the analyses. Regardless of insurance status, compared to baseline, all 4 cohorts improved significantly regarding ODI, NRS-BP, NRS-LP, and EQ-5D scores ($P < 0.001$). In adjusted multivariable analyses, compared with patients with private insurance, Medicaid was associated with worse 24-month postoperative Oswestry Disability Index ($\beta = 10.2$; 95% confidence interval [CI], 3.9–16.5; $P = 0.002$) and NRS leg pain ($\beta = 1.3$; 95% CI, 0.3–2.4; $P = 0.02$). Medicaid was associated with worse EuroQoL-5D scores compared with private insurance ($\beta = -0.07$; 95% CI -0.01 to -0.14 ; $P = 0.03$), but not compared with Medicare and VA/government insurance ($P > 0.05$). Medicaid was associated with lower odds of reaching ODI minimal clinically important difference (odds ratio, 0.2; 95%

Key words

- Insurance
- Lumbar
- Medicaid
- Medicare
- Patient-reported outcomes
- Quality outcomes database
- Spondylolisthesis

Abbreviations and Acronyms

- CI:** Confidence Interval
EQ-5D: EuroQoL-5D
MCID: Minimal Clinically Important Difference
NASS: North American Spine Society
NRS-BP: Numeric Rating Scale Back Pain
NRS-LP: Numeric Rating Scale Leg Pain
ODI: Oswestry Disability Index
PRO: Patient-reported outcome
QOD: Quality Outcomes Database
VA: Veterans Affairs

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CI, 0.03–0.7; $P = 0.02$) compared with VA/government insurance. NRS back pain and North American Spine Society satisfaction did not differ by insurance coverage ($P > 0.05$).

■ **CONCLUSIONS:** Despite adjusting for potential confounding variables, Medicaid coverage was independently associated with worse 24-month PROs after lumbar spondylolisthesis surgery compared with other payer types. Although all improved postoperatively, those with Medicaid coverage had relatively inferior improvements.

INTRODUCTION

Lumbar spondylolisthesis is a common cause of low back pain and lumbar radiculopathy in the United States, affecting approximately 2.4 million patients annually in the United States and Canada.¹ Lumbar spondylolisthesis is one of the most common indications for lumbar surgery and is effective in reducing pain and improving quality of life.^{2,3} However, not all patients experience improvement after surgery, and a subset of patients may even require further surgery to address their symptoms.^{4,5}

Although clinical factors such as comorbidities and radiographic parameters have traditionally been used to predict surgical outcomes,⁶ recent work has recognized the usefulness of socioeconomic factors to determine which patients will benefit from surgery. In particular, several retrospective studies have suggested that a patient's type of insurance has an independent association with surgical outcomes and recovery after neurosurgical procedures. In the United States, patients have access to various types of insurance depending on their eligibility. Private insurance is, inherently in the name, health insurance provided via a private company to which the insured or their employer pays a monthly premium. Employer-sponsored health insurance covers approximately 55% of Americans.⁷ Once an individual turns 65 years of age, they are eligible for Medicare, a U.S. government program that covers most medical care but can be supplemented either by private insurance or with Medicaid. Medicaid is a federal program that is administered by individual states and has both income and asset requirements, ensuring it is available only to those below a certain socioeconomic cutoff (which varies by state). Insurance provided by the Veterans Affairs (VA)/government are only for individuals with a previous employment history with the U.S. military or other governmental agencies. Insurance status was shown to correlate with patient-reported outcomes (PROs) for brain tumors,⁸ spinal tumors,⁹ cervical spondylosis,¹⁰ and lumbar spinal decompression.¹¹ Although these results suggest that insurance is linked to PROs, most of these studies use large retrospectively collected datasets to demonstrate this association.

Prospective registries specifically designed to collect data for spondylolisthesis offer an opportunity to show how payer status influences outcomes after lumbar spondylolisthesis surgery. Strengths of prospective registries include the higher levels of evidence provided compared with other national databases, the

increased granularity of the evidence collected, and the spine outcome—specific nature of the registry. Higher levels of evidence, increased granularity, and spine patient—relevant long-term outcomes are important in assessing the association of payer status on postoperative recovery after lumbar spondylolisthesis surgery. To this end, the largest prospective registry study investigating how payer status influences surgical outcomes after lumbar spondylolisthesis surgery is presented.

METHODS

Data Source

The Quality Outcomes Database (QOD) is a prospective, multi-center, multidisciplinary registry that contains demographic, clinical, and PRO data to assess the safety and quality of spinal surgery.¹² The multidisciplinary nature of the registry, containing operative data from both orthopedic and neurosurgical spine surgeons, permits greater generalizability of observed findings. The lumbar spondylolisthesis module was created by curating a focused study group of 12 of the highest-enrolling QOD sites. The inclusion criteria for this lumbar spondylolisthesis module included patients with Meyerding grade 1 degenerative lumbar spondylolisthesis who underwent elective single-segment surgical management. Grade 1 lumbar spondylolisthesis was confirmed by surgeons at participating sites along with a neuroradiologist independent of the study group by evaluation of preoperative standing or dynamic plain radiographs.^{13–19} Patients must have undergone surgery at the index level of lumbar spondylolisthesis.²⁰ (Patients were excluded from the cohort if they had 1) grade 2 or higher spondylolisthesis or 2) surgery that involved >1 disc level. Institutional review board approval was obtained (University of California, San Francisco, IRB 16–20085).

Baseline characteristics, medical comorbidities, and clinical and surgical characteristics were collected at baseline. Socioeconomic variables collected included form of primary insurance (uninsured, Medicare, Medicaid, VA/government, or private), patient education level, use of workers' compensation, and employment status. One patient was uninsured and was removed from the analysis. Outcomes collected at 24 months included Oswestry Disability Index (ODI), ODI minimal clinically important difference (MCID), Numeric Rating Scale (NRS) back pain (NRS-BP) score, NRS leg pain (NRS-LP) score, and EuroQol-5D (EQ-5D) score. ODI MCID was defined as an improvement in ODI by 14.3 at 24 months follow-up.¹³ Patient satisfaction was also assessed at the 24-month postoperative time point via the North American Spine Society (NASS) satisfaction scale, scored 1–4, respectively: 1) surgery met my expectations; 2) I did not improve as much as I had hoped but I would undergo the same operation for the same results; 3) surgery helped but I would not undergo the same operation for the same results; 4) I am the same or worse as compared to before surgery. Three-month readmission and cumulative reoperation rates were recorded. Complication rates were recorded at 30 days and included 1) deep venous thrombosis/pulmonary embolism, 2) new motor deficit, 3) myocardial infarction, 4) urinary tract infection, 5) surgical site infection, 6) postoperative hematoma, 7) cerebrovascular accident, 8) durotomy, and 9) pneumonia. QOD complication data were audited and verified independently

by each study site. Baseline and 24-month radiologic measurements and adjudication of radiographic fusion were evaluated with plain radiographs by a board-certified neuroradiologist independent of the study group.

Statistical Analysis

Univariate analyses used a paired t test, a 2-sample t test, and a Pearson χ^2 test where appropriate. The Yates correction for continuity was used where appropriate. For categorical tests in which a cell had an expected frequency <1 , a Fisher exact test was used. Multivariable linear regression models were constructed to assess the impact of insurance type on PROs. Each model was adjusted for demographic, clinical, surgical, and socioeconomic variables that reached a P value <0.20 in univariate analysis of the cohort groups by insurance type. For NASS satisfaction, an ordinal logistic regression model was constructed in a similar fashion to the multivariable linear regression models. All analyses were conducted using R version 2.15.2 (R Foundation for Statistical Computing, Vienna, Austria). Missing values in the data were imputed using the missForest R package. P values were 2-tailed and a significance level of $\alpha = 0.05$ was used.

RESULTS

From July 1, 2014 to June 30 2016, 608 patients underwent single-segment spinal surgery for Meyerding grade 1 degenerative lumbar spondylolisthesis. Baseline characteristics of this cohort are described in detail in [Table 1](#). The overall mean age of the cohort was 62.5 ± 11.5 years and 59.2% were women. Forms of payment included 319 patients with private insurance (52.5%), 235 with Medicare (38.7%), 36 with Medicaid (5.9%), 17 with VA/governmental (2.8%), and 1 who was uninsured (0.2%). The single uninsured patient was removed from the further analysis. There were significant differences in age ($P < 0.001$), dominant symptom ($P < 0.001$), American Society of Anesthesiologists grade ($P < 0.001$), surgical approach ($P = 0.02$), and use of fusion procedures ($P < 0.001$) among the various payer types. In addition, there was a higher frequency of depression in the Medicaid group (36%) than in both the Medicare (17%; $P = 0.01$) and the private insurance group (19%; $P = 0.02$). PROs were similar among all payer cohorts at baseline ($P > 0.05$). Twenty-four months follow-up rates were similar across insurance types ($P = 0.59$). [Table 2](#) compares the perioperative and surgical parameters for the cohorts. Estimated blood loss, perioperative complication rates, and postoperative length of stay were similar among insurance types. However, operative time was longer in patients in the Medicaid (206.4 minutes) cohort compared with the other insurance types ($P = 0.048$) ([Table 2](#)). Rates of discharge to home were different ($P = 0.004$), with those using private insurance having the highest rate (94.6%) of discharge to home.

[Table 3](#) shows the clinical outcomes for the cohorts. Regardless of insurance status, compared to baseline, all 4 cohorts improved significantly regarding ODI, NRS-BP, NRS-LP, and EQ-5D scores ($P < 0.001$). In addition, similar proportions of each insurance cohort reached ODI MCID ($P = 0.25$). In the univariate analysis, payer type had a significant association with the distribution of 24-

month NASS satisfaction scores ([Table 3](#); $P = 0.02$). This association was driven by the 2-fold lower number of patients in the NASS 1 satisfaction cohort (representing the patients who perceived their surgical results to have met their expectations) in the Medicaid cohort (27.8%), compared with Medicare (54.5%), VA/government (58.8%), and private insurance (50.5%) cohorts.

To adjust for baseline differences in the cohorts, we conducted multivariable analyses. In these adjusted analyses ([Table 4](#)), compared with private insurance, Medicaid coverage was associated with worse ODI ($\beta = +10.2$; 95% confidence interval [CI], +3.9 to +16.5; $P = 0.002$). When adjusting for other factors, Medicaid insurance was associated with a 10.2-point higher mean ODI at 24 months compared with private insurance. Similarly, compared with private insurance, Medicaid coverage was associated with worse NRS-LP ($\beta = +1.3$; 95% CI +0.3 to +2.4; $P = 0.02$). Similar findings for postoperative ODI and NRS leg pain were observed for patients using Medicaid compared with Medicare and VA/government insurance ([Table 4](#)). Medicaid coverage was associated with worse EQ-5D compared with private insurance ($\beta = -0.07$; 95% CI, -0.01 to -0.14; $P = 0.03$), but not compared with Medicare and VA/government insurance ($P > 0.05$). Medicaid coverage was associated with a significantly smaller proportion reaching ODI MCID compared with VA/government (adjusted odds ratio, 0.2; 95% CI, 0.03–0.7; $P = 0.02$), but not compared with Medicare and private insurance ($P > 0.05$). Medicaid was not associated with significantly different NRS-BP and NASS satisfaction compared with other forms of coverage ($P > 0.05$).

DISCUSSION

The prospective QOD database was used to investigate the impact of payer status on outcomes after surgical treatment for grade I degenerative lumbar spondylolisthesis. Even after accounting for confounding variables, an association between insurance type and outcomes was identified. Specifically, although Medicaid patients had high preexisting rates of comorbidities and depression, multivariable modeling demonstrated an independent association between insurance type and PROs after surgery.

Previous retrospective data have suggested that insurance payer type influences outcomes after lumbar surgery,²¹ but most of these studies have used large administrative data sets that often limit findings to short-term index-hospitalization safety outcomes.^{21–25} Patient-centered, long-term clinical outcome metrics may be more reflective of care received because the patient is the arbiter of success. This study also implicates insurance type as a major source of variability for long-term patient-centered outcomes. This finding is supported by the significantly lower proportion reaching ODI MCID in the Medicaid cohort.¹³ Still, these data should not be interpreted to dissuade surgeons from operating on patients with Medicaid, because many still obtain a clinically meaningful result. More than 50% of Medicaid patients still reached ODI MCID. In this light, it is important to note the low proportion of individuals with Medicaid (6%) included in this study. Although the exact cause of this phenomenon is unclear, it may suggest a lack of access to care for this population regarding spinal surgery,²⁶ especially given that Medicaid covers nearly 20% of

Table 1. Characteristics of Patients Undergoing Surgery for Grade 1 Lumbar Spondylolisthesis

Characteristic	Medicaid (n = 36)	Medicare (n = 235)	Private (n = 319)	Veterans Affairs/Government (n = 17)	P Value
Age (years), mean \pm SD	52.1 \pm 11.0	71.1 \pm 8.7	57.1 \pm 10.0	55.4 \pm 14.0	<0.001
Female, n (%)	17 (47.2)	142 (60.4)	180 (56.4)	11 (64.7)	0.41
Body mass index (kg/m ²), mean \pm SD	32.5 \pm 7.6	29.6 \pm 5.4	30.7 \pm 6.8	31.1 \pm 6.7	0.03
Smoker, n (%)	11 (30.6)	24 (10.2)	32 (10.0)	4 (23.5)	0.001
Comorbidities, n (%)					
Diabetes mellitus	9 (25.0)	49 (20.9)	39 (12.2)	4 (23.5)	0.02
Coronary artery disease	5 (13.9)	36 (15.3)	25 (7.8)	2 (11.8)	0.048
Anxiety	11 (30.6)	40 (17.0)	51 (16.0)	6 (35.3)	0.04
Depression	13 (36.1)	40 (17.0)	61 (19.1)	9 (52.9)	<0.001
Osteoporosis	2 (5.6)	19 (8.1)	14 (4.4)	3 (17.6)	0.07
Dominant presenting symptom, n (%)					<0.001
Back pain dominant	15 (41.7)	81 (34.5)	128 (40.1)	6 (35.3)	
Leg pain dominant	1 (2.8)	74 (31.5)	50 (15.7)	6 (35.3)	
Back pain = leg pain	20 (55.6)	80 (34.0)	141 (44.2)	5 (29.4)	
Motor deficit present at presentation, n (%)	8 (22.2)	63 (26.8)	63 (19.7)	5 (29.4)	0.24
Independently ambulatory, n (%)	29 (80.6)	204 (86.8)	287 (90.0)	16 (94.1)	0.26
Symptom duration, n (%)					0.25
<3 months	0 (0)	10 (4.3)	5 (1.6)	0 (0)	
>3 months	36 (100)	218 (92.8)	300 (94.0)	16 (94.1)	
American Society of Anesthesiologists grade, n (%)					<0.001
1 or 2	13 (36.1)	127 (54.0)	210 (65.8)	11 (64.7)	
3 or 4	23 (63.9)	108 (46.0)	109 (34.2)	6 (35.3)	
Ethnicity, n (%)					
Hispanic or Latino	3 (8.3)	8 (3.4)	18 (5.6)	0 (0)	0.34
Education level, n (%)					
\geq 4 years of college education	3 (8.3)	96 (40.9)	130 (40.8)	2 (11.8)	<0.001
Employment status, n (%)					
Employed or employed and on leave	6 (16.7)	50 (21.3)	221 (69.3)	7 (41.2)	<0.001
Use of workers' compensation, n (%)	1 (2.8)	5 (2.1)	20 (6.3)	1 (5.9)	0.34
ODI, baseline, mean \pm SD	61.9 \pm 17.0	43.1 \pm 16.1	47.2 \pm 16.9	52.5 \pm 17.7	0.32
NRS back pain, baseline, mean \pm SD	8.8 \pm 1.4	6.0 \pm 3.0	7.0 \pm 2.5	6.2 \pm 3.2	0.91
NRS leg pain, baseline, mean \pm SD	7.9 \pm 2.8	6.5 \pm 2.8	6.5 \pm 2.9	6.5 \pm 2.6	0.55
EuroQol-5D, baseline, mean \pm SD	0.33 \pm 0.24	0.58 \pm 0.21	0.53 \pm 0.21	0.48 \pm 0.26	0.40
Surgery performed					<0.001
Decompression alone, n (%)	1 (2.8)	83 (35.3)	55 (17.2)	1 (5.9)	
Decompression and fusion, n (%)	35 (97.2)	152 (64.7)	264 (82.8)	16 (94.1)	
Use of MIS technique, n (%)	13 (36.1)	108 (46.0)	134 (42.0)	3 (17.6)	0.11
Values do not add up to 100% where there are missing data. P values < 0.05 are significant. SD, standard deviation; ODI, Oswestry Disability Index; NRS, Numeric Rating Scale; MIS, minimally invasive surgery.					
Continues					

Table 1. Continued

Characteristic	Medicaid (n = 36)	Medicare (n = 235)	Private (n = 319)	Veterans Affairs/Government (n = 17)	P Value
Surgical approach					0.02
Posterior only, n (%)	29 (80.6)	226 (96.2)	287 (90.0)	17 (100)	
Anterior only, n (%)	1 (2.8)	5 (2.1)	11 (3.5)	0 (0)	
Lateral only, n (%)	1 (2.8)	1 (0.4)	5 (1.6)	0 (0)	
Two-stage procedure, n (%)	5 (13.9)	3 (1.3)	16 (5.0)	0 (0)	
24 months follow-up, n (%)	30 (83.3)	205 (87.2)	271 (85.0)	13 (76.5)	0.59

Values do not add up to 100% where there are missing data. *P* values < 0.05 are significant.
SD, standard deviation; ODI, Oswestry Disability Index; NRS, Numeric Rating Scale; MIS, minimally invasive surgery.

Americans.²⁷ This disparity has been discussed previously in the literature in the context of deep brain stimulation, neuro-oncologic care, spinal surgery, vascular surgery, and cardiothoracic surgery.^{26,28-31} Despite the low proportion of individuals with Medicaid coverage, rather than suggesting that Medicaid insurance itself is a harbinger of poor outcomes, it should be explicitly stated that Medicaid is likely a surrogate for other factors that may affect outcomes.

The factors contributing to the poorer outcomes seen in patients with Medicaid remain incompletely defined. Several studies have shown that differences in ethnic background and a variety of other socioeconomic factors play a role in outcomes after spinal surgery.^{4,32-35} However, we did not observe any association between ethnic background and payer type. Another socioeconomic factor that has been associated with poorer outcomes after any surgical intervention is patient education level.³⁶⁻⁴³ In this study,

patients with Medicaid were found to have completed a college degree at a significantly lower rate than those with other insurance types. The likely reason is that poverty, which is highly represented in a Medicaid cohort, correlates with outcome in spine surgery.⁴⁴ The associations between poverty and health care use are well documented.^{45,46}

Beyond these factors, it is likely that payer type influences spinal care on several levels.⁶ First, regular visits with the general practitioner before surgery may be less likely for Medicaid patients.⁴⁷ Similarly, the low fee-for-service reimbursement and narrow networks within Medicaid managed care may lead to delays in the provision of timely operative intervention.^{48,49}

Second, insurance type dictates the number and types of opportunities for postoperative rehabilitation, both with brief stays in acute rehabilitation as well as home visits with physical and occupational therapy.^{10,50} This study showed that patients with

Table 2. Surgical and Perioperative Parameters of Patients Undergoing Surgery for Grade 1 Lumbar Spondylolisthesis

Characteristic	Medicaid (n = 36)	Medicare (n = 235)	Private (n = 319)	Veterans Affairs/Government (n = 17)	P Value
Estimated blood loss (mm), mean ± SD	268.1 ± 265.4	178.8 ± 205.5	179.4 ± 186.6	240.9 ± 195.9	0.58
Operative time (minutes), mean ± SD	206.4 ± 87.1	157.5 ± 79.1	186.7 ± 88.4	169.1 ± 68.5	0.048
Length of hospitalization (days), mean ± SD	2.9 ± 1.1	2.6 ± 1.9	2.8 ± 1.8	3.2 ± 1.5	0.81
Discharge disposition, n (%)					
Home or home health care, n (%)	31 (86.1)	202 (85.9)	302 (94.6)	15 (88.2)	0.004
Overall complication rate, n (%)	1 (2.8)	16 (6.8)	21 (6.6)	1 (5.9)	0.831
Deep venous thrombosis or pulmonary embolism	0 (0)	1 (0.4)	0 (0)	0 (0)	0.663
New neurologic deficit	0 (0)	3 (1.3)	4 (1.3)	0 (0)	0.878
Myocardial Infarction	0 (0)	1 (0.4)	1 (0.3)	0 (0)	0.970
Urinary tract infection	0 (0)	3 (1.3)	3 (0.9)	0 (0)	0.865
Surgical site infection	1 (2.8)	1 (0.4)	8 (2.5)	0 (0)	0.242
Hematoma	0 (0)	1 (0.4)	3 (0.9)	0 (0)	0.817
Durotomy	1 (5.9)	7 (3.0)	4 (1.3)	1 (5.9)	0.247

P values < 0.05 are significant.
SD, standard deviation.

Table 3. Clinical Outcomes of Patients Undergoing Surgery for Grade 1 Lumbar Spondylolisthesis

Outcome	Medicaid (n = 36)	Medicare (n = 235)	Private (n = 319)	Veterans Affairs/Government (n = 17)	P Value
ODI 24 months, mean ± SD	40.7 ± 23.8	21.6 ± 19.6	21.0 ± 18.9	24.8 ± 19.5	0.58
ODI 24-month change, mean ± SD	-21.1 ± 23.8	-21.1 ± 19.3	-25.1 ± 20.8	-29.8 ± 19.0	0.99
ODI MCID, n (%)	n = 30	n = 203	n = 270	n = 13	0.25
MCID achieved	17 (56.7)	130 (64.0)	184 (68.1)	11 (84.6)	
MCID not achieved	13 (43.3)	73 (36.0)	86 (31.9)	2 (15.4)	
NRS-BP (24 months), mean ± SD	4.7 ± 3.1	3.1 ± 2.9	3.3 ± 3.1	4.4 ± 3.2	0.63
NRS-BP 24-month change, mean ± SD	-4.4 ± 3.2	-2.9 ± 3.6	-3.6 ± 3.3	-2.0 ± 2.1	0.63
NRS-LP (24 months), mean ± SD	5.1 ± 3.4	2.2 ± 3.0	2.7 ± 3.2	2.6 ± 3.4	0.44
NRS-LP 24-month change, mean ± SD	-2.7 ± 4.5	-4.1 ± 3.7	-3.7 ± 3.8	-3.7 ± 4.2	0.71
EuroQol-5D					
EuroQol-5D (24 months), mean ± SD	0.60 ± 0.24	0.78 ± 0.19	0.77 ± 0.21	0.65 ± 0.32	0.47
EuroQol-5D 24-month change, mean ± SD	+0.27 ± 0.23	+0.19 ± 0.24	+0.23 ± 0.23	+0.19 ± 0.37	0.74
North American Spine Society Satisfaction, n (%)					0.02
1	10 (27.8)	128 (54.5)	161 (50.5)	10 (58.8)	
2	12 (33.3)	38 (16.2)	52 (16.3)	1 (5.9)	
3	2 (5.6)	9 (3.8)	26 (8.2)	1 (5.9)	
4	5 (13.9)	25 (10.6)	21 (6.6)	1 (5.9)	
30-day readmission	0 (0)	6 (2.6)	7 (2.2)	1 (5.9)	0.59
Cumulative reoperation	2 (5.6)	14 (6.0)	24 (7.5)	3 (17.6)	0.31

Values do not add up to 100% where there are missing data. P values < 0.05 are significant.
ODI, Oswestry Disability Index; SD, standard deviation; MCID, minimal clinically important difference; NRS, Numeric Rating Scale; BP, back pain; LP, leg pain.

Medicaid were less likely to be discharged home or with home health care (compared to those with private insurance) and were instead discharged to other postacute facilities. Access to postacute care services in Medicaid varies by state, although there are some federal minimum standards that must be met.⁵¹ Insurance status has been implicated in choice of surgery for patients and this study showed that most patients with Medicaid were offered a decompression with fusion. The retrospective nature of this study prevents ascertaining the exact reason for this phenomenon but one hypothesis is that patients with Medicaid may present with more advanced radiographic disease and thus require more extensive surgery. This phenomenon has been observed in patients with lower educational status.³⁶⁻⁴³ Our cohort of Medicaid patients showed lower rates of college-level education compared with other payer types. However, on the other hand, several studies have shown that higher rates of fusion portend better outcomes in the postoperative period.^{2,16,52} Thus, the independent worsening of outcomes in these Medicaid patients is even more notable. Furthermore, decreased hospital margins and reimbursement for Medicaid procedures may lead to alterations in the delivery of perioperative care for these patients.^{53,54} For example, multiple studies have found an increased odds of postoperative readmission for Medicaid patients after lumbar spine surgery.²²⁻²⁴

Third, Medicaid insurance may be a proxy for poorer health literacy,⁵⁵ which affects preoperative optimization, expectation setting, and postoperative rehabilitation. Another point highlighted by this study is the impact of insurance status on various perioperative outcomes such as surgical case length and complication rates. Although this study showed that patients with Medicaid have a longer surgical operative case duration, this was not accompanied by an increased rate of surgical complications, intraoperative blood loss, or postoperative hospital length of stay. The increased operative time seen in this Medicaid cohort may be a result of the higher frequency of fusion procedures and 2-stage spinal procedures conducted in the Medicaid cohort compared with those of other payer types. However, it is reassuring that patients with Medicaid did not experience an increased rate of intraoperative complications despite the increased operative time and increased rate of fusion procedures and 2-stage procedures. More research is needed to precisely identify the factors mediating worse long-term clinical outcomes based on insurance payer type.

Although this study informs the reader of a strong association between Medicaid insurance and inferior long-term clinical outcomes after spondylolisthesis surgery, which itself has usefulness in increasing awareness,⁵⁶ both the patient and surgeon are understandably left with a desire for a clinical ramification for such a report. Still, payers are increasingly tying reimbursement

Table 4. Multivariable Analysis of the Impact of Medicaid Insurance Use on Clinical Outcomes, Compared With Private Insurance

Outcome	Adjusted β Coefficients (95% CI)*	Adjusted OR (95% CI)*	P Value
Compared with private insurance			
ODI, 24 months	+10.2 (+3.9 to +16.5)		0.002
NRS back pain, 24 months	+0.5 (−0.6 to 1.5)		0.38
NRS leg pain, 24 months	+1.3 (+0.3 to +2.4)		0.02
EQ-5D, 24 months	−0.07 (−0.01 to −0.14)		0.03
ODI MCID, 24 months		0.5 (0.2–1.1)	0.09
NASS Satisfaction†, 24 months		1.8 (0.9–3.6)	0.10
Compared with Medicare			
ODI, 24 months	+8.0 (+1.3 to +14.8)		0.02
NRS back pain, 24 months	+0.6 (−0.5 to +1.6)		0.31
NRS leg pain, 24 months	+1.6 (+0.5 to +2.8)		0.006
EQ-5D, 24 months	−0.05 (−0.12 to +0.01)		0.14
ODI MCID, 24 months		0.5 (0.2–1.2)	0.10
NASS Satisfaction†, 24 months		1.8 (0.8–3.9)	0.13
Compared with Veterans Affairs/government			
ODI, 24 months	+12.6 (+2.6 to +22.6)		0.01
NRS back pain, 24 months	+0.15 (−1.5 to +1.8)		0.85
NRS leg pain, 24 months	+1.8 (+0.1 to +3.5)		0.04
EQ-5D, 24 months	−0.05 (−0.15 to +0.06)		0.36
ODI MCID, 24 months		0.2 (0.03–0.7)	0.02
NASS Satisfaction†, 24 months		4.0 (0.95–19.5)	0.06
<p>β coefficients are reported such that a negative value for ODI, NRS back pain, and NRS leg pain and a positive value for EQ-5D represent more favorable outcomes at 24 months. ORs are reported such that an OR < 1.0 for NASS Satisfaction represents greater satisfaction at 24 months. <i>P</i> values < 0.05 are significant.</p> <p>CI, confidence interval; ODI, Oswestry Disability Index; NRS, Numeric Rating Scale; EQ-5D, EuroQol-5D; OR, odds ratio; MCID, minimal clinically important difference; NASS, North American Spine Society.</p> <p>*Multivariable models adjusted for 1) factors with <i>P</i> < 0.20 on univariate comparisons of cohorts groups by type of insurance and 2) each respective baseline patient-reported outcome value for models for ODI, NRS back pain, NRS leg pain, and EQ-5D. Specifically, the factors reaching <i>P</i> < 0.20 on univariate comparisons included were age, body mass index, smoking status, American Society of Anesthesiologists grade, presence of comorbidities (diabetes, coronary artery disease, anxiety, depression, osteoporosis, dominant presenting symptom, level of education, employment status, surgical approach, whether the procedure included an arthrodesis, whether minimally invasive techniques were used, and operative time).</p> <p>†OR < 1.0 represents an increased odds of greater satisfaction after surgery.</p>			

to patient-centered outcomes, which could have the unintended consequence of disincentivizing surgery on Medicaid patients. It is important to distribute this information so that payers remain informed. There is already evidence that pay-for-performance programs disproportionately punish hospitals that treat socio-economically disadvantaged patients.^{57,58}

Future studies may link such an analysis to pre-index and post-index case claims to help determine if the intensity of intervention specific to adjunctive surgical therapies differs between Medicaid and Medicare populations. Such investigation will more clearly elucidate the specific factors driving the relationship between form of payment and spine surgical outcomes.

Limitations

Aside from the limitations associated with a retrospective analysis of a prospective registry, there were additional limitations that

should be discussed. First, it was not possible to ascertain why certain insurance carriers were selected over others. This point is important because differences in income, experience with the medical system, and regular primary care appointments may bias insurance selection and have an influence on outcome as well.⁶ Second, even although the study was multi-institutional, it is possible that the results are biased toward high-volume centers, which make up most QOD sites. This is noteworthy regarding generalizing the results to low-volume centers that often provide care to Medicaid patients.⁵⁹

In a similar vein, the geographic variations that make up the data set could affect the results. Rules and regulations for referrals and previous authorizations differ from state to state. Biases could be introduced if the dataset is biased to particular regions or states. Insurance rules based on geographic variances may affect results because studies have shown that insurance may influence

which specialty initially manages the symptoms of spondylolisthesis (e.g., back pain) (mediated partially by different needs for referrals), which has recently been associated with outcomes.^{50,60} In addition, our registry does not include several variables with respect to patient, surgeon, and operative characteristics. Factors such as type of patient employment, lifestyle and baseline patient activity level, experience level of a performing surgeon, and differential use of surgical implants (if associated with payor type) could influence outcomes. Furthermore, as a registry, our results may be influenced by selection bias. Reasons for surgical approach selection (e.g., decompression with fusion vs. decompression alone and posterior vs. nonposterior-only approach) are unknown.

Nonetheless, the data provide evidence that Medicaid insurance compared with other types shows a strong association with

relatively inferior 2-year clinical outcomes after surgery for grade I degenerative lumbar spondylolisthesis.

CONCLUSIONS

In a prospective registry study of 608 patients undergoing single-segment surgery for grade I degenerative lumbar spondylolisthesis, Medicaid coverage was independently associated with worse 24-month outcomes for disability, leg pain, and quality of life compared with private coverage. Regardless of form of payment, all cohorts improved after surgery, but those with Medicaid coverage had relatively inferior outcomes compared with those with Medicare, Private, or VA/government coverage. The specific factors driving this association require further investigation.

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