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# Outcomes and Cost-Effectiveness of Hospital Outpatient Versus Ambulatory Surgery Center Lumbar Decompression Surgery

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## Abstract

**Study Design:** Retrospective Chart Review.

**Objectives:** Outpatient spinal surgeries in Ambulatory Surgery Centers (ASCs) have gained traction due to their potential cost efficiencies and improved perioperative processes. This study aims to compare the cost-effectiveness and patient outcomes of lumbar laminectomies performed in hospital settings vs ASCs.

**Methods:** A retrospective analysis was conducted on 771 patients who underwent 1 or 2-level outpatient laminectomy between 2019 and 2023. Patient demographics, 90-day and one-year clinical and patient-reported outcomes (PROs), and one-year episode of care costs were evaluated. A one-year cost-effectiveness analysis was performed using the EQ-5D to measure quality-adjusted life years (QALYs).

**Results:** ASC patients demonstrated lower body mass index and American Society of Anesthesiologists (ASA) scores, with a higher prevalence of 1-level laminectomies compared to hospital patients. ASC-based laminectomy was associated with lower initial surgery cost and one-year episode of care costs ($5662 ± 4748 vs $10229 ± 9202, $P < 0.001$), with similar rates of complications and postoperative resource utilization. These trends remained after controlling for patient demographics, comorbidities, and number of levels treated. In patients completing baseline and 1-year EQ-5D scores, ASC-based laminectomy was over twice as cost-effective as hospital procedures ($64873/QALY gained vs $152630).

**Conclusions:** The findings support the safety and one-year cost effectiveness of ASCs for appropriately selected patient populations undergoing lumbar laminectomy. Additional studies are needed to replicate these findings across institutions, and to assess the cost effectiveness of ASC-based laminectomy beyond one-year postoperatively.

## Keywords

laminectomy, ambulatory surgical center, decompression, EQ-5d, quality-adjusted life years, patient reported outcomes

## Introduction

In the midst of rapid healthcare reform, prioritizing value has become essential. Among the various options in surgical care, outpatient operations, particularly those performed in Ambulatory Surgery Centers (ASCs), have emerged as an attractive alternative to hospital-based procedures. ASCs offer cost efficiencies through specialized care, smaller size, and the ability to implement perioperative process improvements swiftly. Recent literature confirms these advantages, with

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studies showing that outpatient facility charges for lumbar discectomies are less than 50% of inpatient charges.[1] Badlani et al. report that both patients and physicians benefit from ASCs. Patients prefer outpatient procedures due to increased convenience and perceived quality of care, while physicians appreciate the efficiencies of the outpatient setting and the potential for financial ownership of ambulatory centers.[2]

Prior publications have scrutinized the rising cost and overall burden of spinal surgery, identifying it as a major contributor to high healthcare costs.[3-5] Among spine surgeries, lumbar laminectomy for the treatment of spinal stenosis and intervertebral disc herniations is one of the most commonly performed procedures.[6] Multiple prior studies have found that decompressive laminectomy procedures are cost-effective treatments for these conditions.[7-9] Further, a growing body of evidence suggests multiple spine surgeries, including laminectomies, can be safely performed in the ASC setting. However, to date a paucity of evidence comparing the cost-effectiveness of laminectomies performed in the ASC and hospital outpatient settings exists. To address this gap, the purpose of this study was to compare the costs and outcomes of ASC vs hospital outpatient laminectomies, and to conduct a cost-effectiveness evaluating the value of surgery performed in these settings.

## Materials and Methods

This study was deemed exempt as a retrospective review of existing medical records by the institutional review board.

### Study Population

A retrospective review of 771 patients undergoing a 1 or 2 level laminectomy for lumbar spinal stenosis or disc herniation from July 3, 2019, to May 22, 2023 with 2 fellowship-trained spine surgeons was performed. 367 procedures were performed by surgeon 1 and 404 were performed by surgeon 2. 354 (45.9%) patients had their laminectomy performed as an outpatient at a single acute-care hospital while 417 (54.1%) patients had their laminectomy performed outpatient at a single hospital-owned ASC. All patients included in the study were discharged on the day of surgery from the post-anesthesia care unit (PACU). Patients staying overnight in the PACU or for 24-hour observation were excluded.

### ASC Selection Criteria and Procedures Performed

At our institution, the selection criteria for performance of laminectomy in the ASC include: age <75 years, body mass index (BMI) < 45 kg/m$^2$, presence of a caregiver in the home, and the absence of major cardiac disease, pulmonary disease, or obstructive sleep apnea. The final decision for ASC-based surgery is made by the surgeon in collaboration with the patient and their caregiver. Patients included in the study underwent partial or total laminectomy via either a mini-open posterior midline incision or minimally invasive tubular approach. Concomitant facetectomies and forminotomies were performed as required. No endoscopic decompression procedures were performed. Prior to discharge at either the hospital or ASC, all patients were required to have adequate pain control using oral medications, stable vital signs, ambulate, tolerate food, void, and have a postoperative pain medication prescription. Post-discharge protocols were the same for procedures performed in either the hospital or ASC setting.

### Study Outcomes

The outcomes of interest included 90-day ED returns and readmissions, and 1-year reoperations, clinic visits, imaging encounters, and injections. Costs for the index surgery and all postoperative outcomes were calculated. For a subset of patients who completed both preoperative and 1-year post-operative patient reported outcomes surveys, a cost-effectiveness analysis was conducted. Quality adjusted life years (QALYs) were assessed using EQ-5D scores calculated from conversion of PROMIS-Global Health scores using the methodology by Revicki et al.[10] Cost-effectiveness was measured as the cost per QALY gained over the one-year postoperative period.

### Cost Determinations

All cost analysis was performed from the payer perspective. Surgery cost was comprised of the facility fee, professional surgeon and anesthesia fee. The facility fee was estimated using the 2023 Centers for Medicare and Medicaid Services (CMS) Medicare allowed amounts for Current Procedural Terminology (CPT) code 63047. The facility fee for the ASC was $3137.69 and the facility fee for the hospital was $6614.63. The surgeon fee was modeled as the 2023 CMS Medicare allowed amount for MAC locality 1230201 Baltimore/Surrounding counties for CPT 63047 (1 level laminectomy) and 63047 and 63048 (2 level laminectomy). The anesthesia fee was calculated as the CMS Medicare allowed amount for 8 base units plus number of 15-minute time block units multiplied by 22.22 conversion factor for the MAC locality.

ED/Readmission cost was the actual allowed amount for the facility fee and did not include professional fees or reoperation cost if the reoperation was during the ED/readmission. One-year reoperation cost was the actual allowed amount for the facility fee. Office visits were all other visits within 365 days and were calculated as the CMS Medicare allowed amounts (non-facility) for the CPT codes billed using the MAC locality rate. Imaging costs were calculated using the Medicare allowed amount (both technical and professional components) for the MAC locality based on the CPT code billed. Computed tomography, magnetic resonance, and radiographic imaging was performed. Postoperative injection cost was modeled as the Medicare allowed

**Table 1.** Patient Demographics, Levels Decompressed and Payor Information.

| | Hospital (n = 354) | ASC (n = 417) | *P* -Value |
|---|---|---|---|
| Demographics | | | |
| Age | 58.0 ± 16.2 | 56.8 ± 14.5 | 0.300 |
| Female | 153 (43.2) | 173 (41.5) | 0.680 |
| BMI | 30.9 ± 6.95 | 29.2 ± 5.05 | **<0.001** |
| ASA | 2.39 ± 0.61 | 2.26 ± 0.56 | **0.003** |
| Levels | | | **<0.001** |
| % 1 level | 293 (82.8) | 414 (99.3) | |
| % 2 level | 61 (17.2) | 3 (0.7) | |
| Payor | | | 0.656 |
| % medicare | 105 (29.7) | 120 (28.8) | |
| % commercial | 241 (68.1) | 291 (69.8) | |
| % other | 8 (2.3) | 6 (1.4) | |

*p*-values <0.05 in bold.

amount (ASC facility and facility professional fee) for the various types of epidural, facet, and block injections performed.

### *Statistical Analysis*

Univariate analyses including chi-square tests and independent sample t-tests were performed to determine differences in demographics, number of operative levels, payor types, postoperative utilization trends and cost between those who underwent laminectomy in the hospital vs the ASC. The details of reasons for ED visits, readmissions, and reoperations were also compared between groups. Multivariate linear and logistic regression were used to assess the relationship between ASC and postoperative utilization and cost, controlling for age, sex, BMI, ASA score and number of levels. For the subset of patients with both preoperative and one-year postoperative EQ-5D scores available, univariate analyses were conducted to compare costs and outcomes between ASC and hospital patients. All statistical analyses were performed using R Studio (Version 4.2.2 © 2009-2023 RStudio, PBC). Statistical significance was assessed at $P < 0.05$.

## Results

In comparison to patients undergoing laminectomy at the hospital, ASC patients had a lower body mass index (BMI) (29.2 ± 5.05 vs 30.9 ± 6.95; $P < 0.001$), lower American Society of Anesthesiologist (ASA) score (2.26 ± 0.56 vs 2.39 ± 0.61; $P = 0.003$) and more patients with a 1-level laminectomy (99.3% vs 82.8%; $P < 0.001$). There were no differences in age, sex or payor mix between the two groups (Table 1).

In the 90-day postoperative period, no statistically significant differences in rates of ED return or readmissions were observed between groups. Over the one-year postoperative period, no differences in reoperation rates, clinic follow-up rates or number of follow-up visits, or injection utilization rates and number of injections performed was observed between groups. While no difference in the rate of postoperative imaging utilization was observed, patients undergoing laminectomy in the hospital did require more imaging encounters when they were performed (1.88 ± 1.50 vs 1.47 ± 0.83; $P = 0.019$). The cost of the initial laminectomy was significantly less at the ASC than the hospital ($4529 ± 41 vs $8060 ± 107; $P < 0.001$). Additionally, the average cost of reoperation for ASC patients was less than the cost of reoperation for hospital patients ($13,709 ± 13,591 vs $25,506 ± 23,583; $P = 0.037$). Overall, the total 1-year cost of the ASC patients was less than total 1-year cost of the hospital patients ($5662 ± 4748 vs $10,229 ± 9202; $P < 0.001$) (Table 2).

The distribution of reasons for ED visits, readmissions and reoperations did not significantly differ between ASC and hospital-based laminectomy patients. The most common reasons for ED visits were radiculopathy, other medical issues and other pain, while hematoma/seroma and other medical issues were the leading causes of readmission. Over the one-year postoperative period, 49 patients (6.4%) underwent reoperations. The leading reasons for reoperation were conversion to lumbar fusion (17 patients) and revision laminectomy (23 patients) (Table 3).

After controlling for patient demographics, comorbidities, and number of levels treated, there were no differences in 90-day ED return, 90-day readmission, 1-year reoperation, number of 1-year spine visits, or number of 1-year imaging encounters between those who had surgery in the ASC and those who had surgery in the hospital. The initial surgery cost (β: −3495.4, 95% CI: −3510.5 to −3480.4, $P < 0.001$), 1-year postoperative care cost (β: −1125.1, 95% CI: −2210.5 to −39.6; $P = 0.042$) and total 1-year cost (β: −4610.7, 95% CI: −5696.4 to −3524.9; $P < 0.001$) were significantly less for ASC patients (Table 4).

A subset of 117 patients (hospital n = 41, ASC n = 76) completed patient-reported outcomes surveys both preoperatively and at 1-year postoperatively and were included in the cost-effectiveness analysis. In this cohort, ASC patients incurred significantly lower costs for the index surgery ($4527 ± 37 vs $8089 ± 122; $P < 0.001$) and overall total costs over the one-year period ($7136 ± 7185 vs $15,263 ± 18,375; $P = 0.009$). Both ASC and hospital patients had similar EQ-5D scores at baseline and one year postoperatively, resulting in similar improvements in QALYs over the one-year period (Hospital: 0.10 ± 0.13 vs ASC: 0.11 ± 0.10, $P = 0.671$). ASC patients had more favorable costs per QALY gained ($64,873 vs $152,630) as they incurred lower overall costs while experiencing similar improvements in quality-adjusted life years (Table 5).

## Discussion

The results of the current study add to a growing body of literature supporting the safety and cost-savings of performing spinal decompression procedures in the ASC setting.[2,11-13] In

**Table 2.** Surgical Cost and Postoperative Utilization and Cost.

| | Hospital (n = 354) | ASC (n = 417) | *P* -Value |
|---|---|---|---|
| Surgery cost | $8060 ± 107 | $4529 ± 41 | **<0.001** |
| 90-Day ED/Readmission | | | |
| ED return (%) | 22 (6.2) | 18 (4.3) | 0.307 |
| Readmission (%) | 4 (1.1) | 8 (1.9) | 0.555 |
| ED return/readmission cost | $2515 ± 2337 | $3380 ± 4032 | 0.399 |
| 1-Year reoperation | | | |
| Reoperation (%) | 25 (7.1) | 24 (5.8) | 0.553 |
| Reoperation cost | $25,506 ± 23,583 | $13,709 ± 13,591 | **0.037** |
| 1-Year spine visit | | | |
| Spine visits (%) | 176 (49.7) | 202 (48.4) | 0.779 |
| # Visits | 1.72 ± 1.12 | 1.54 ± 0.93 | 0.099 |
| Visit cost | $192 ± 130 | $167 ± 114 | 0.056 |
| 1-Year imaging encounter | | | |
| Imaging encounters (%) | 100 (28.2) | 92 (22.1) | 0.058 |
| # Imaging encounters | 1.88 ± 1.50 | 1.47 ± 0.83 | **0.019** |
| Imaging cost | $235 ± 191 | $190 ± 141 | 0.060 |
| 1-Year injections | | | |
| Injections (%) | 26 (7.3) | 31 (7.4) | 1 |
| # Injections | 1.38 ± 0.70 | 1.26 ± 0.51 | 0.447 |
| Injection cost | $669 ± 436 | $681 ± 360 | 0.908 |
| 1-Year postoperative care cost | $2168 ± 9202 | $1133 ± 4747 | 0.056 |
| Total 1- year cost | $10,229 ± 9202 | $5662 ± 4748 | **<0.001** |

*p*-values <0.05 in bold.

the current study, we found that the performance of laminectomies in the ASC setting reduced the cost of surgery and overall one-year episode of care costs by 44% and 53.2%, respectively, while maintaining high levels of safety and efficacy when compared to outpatient procedures performed in the hospital setting. Further, when pairing these results with improvements in QALYs over the one-year period, our study demonstrates that the performance of laminectomies in the ASC setting is over twice as cost-effective as in the hospital outpatient setting. This finding is notable, as it is the first direct comparison of cost-effectiveness between hospital and ASC-based laminectomies, to the authors' knowledge. While these results support the continued shift of lumbar decompression surgery to the ASC setting, it is critical that patient selection criteria and risk profiles continue to be considered in both clinical and payor coverage decisions to ensure hospital outpatient surgery remains an available option for appropriate patients.

A wealth of evidence from multiple studies supports the notion that ASCs can reduce costs without compromising patient safety for multiple spine surgeries. A comprehensive review of the available literature by Sivaganesan et al. revealed substantial evidence supporting the safety and effectiveness of outpatient cervical and lumbar surgery.[11] Similarly, Purger et al. demonstrated that anterior cervical discectomy and fusion (ACDF) can be performed in an ambulatory setting with comparable morbidity and readmission rates while also achieving lower costs compared to inpatient procedures.[13] In an evaluation of single-level decompression procedures specifically, Azeem et al found that performance of surgery in an ASC resulted in significant cost savings of approximately $2000 to $3500 per case over the 90-day perioperative period when compared to hospitals. Importantly, these cost savings did not lead to any statistically significant impact on complication or readmission rates.[14] The results of the current study build upon those of Azeem et al, demonstrating that even more significant cost savings may result over the one-year postoperative period, as we observed an average cost reduction of $4610 over this time horizon, after controlling for patient characteristics and the number of levels treated. In our risk adjusted models, approximately $3495 (76%) of this savings was driven by lower initial surgery costs, as a result of lower facility fees in the ASC setting. In alignment with Azeem et al.'s findings we also observed no increased risk of complications in ASC-based laminectomies. Collectively, these studies demonstrate that ASCs can effectively reduce costs while maintaining patient safety, making them a valuable option for various spine surgeries, including laminectomy.

While the aforementioned studies evaluated both the cost and safety of spine surgery in ASCs, an even larger body of literature supports the notion that similar or improved clinical outcomes can be achieved in the ASC setting. Durand et al conducted a study involving 202,202 patients who underwent outpatient spine surgery and examined the 90-day postoperative period, finding that a total of 22,198 ED visits were recorded.

**Table 3.** Emergency Department, Readmission and Reoperation Details.

| | Hospital | ASC | *P* -Value |
|---|---|---|---|
| Emergency department visit reason | (n = 22) | (n = 18) | 0.085 |
| Chest pain | 1 (4.5) | 3 (16.7) | |
| DVT/PE | 0 (0) | 2 (11.1) | |
| Infection | 1 (4.5) | 1 (5.5) | |
| Fever | 0 (0) | 2 (11.1) | |
| Hematoma/seroma | 2 (9.1) | 2 (11.1) | |
| Radiculopathy | 3 (13.6) | 4 (22.2) | |
| Non-spine fracture | 0 (0) | 1 (5.5) | |
| Other medical | 10 (45.5) | 2 (11.1) | |
| Other pain | 5 (22.7) | 1 (5.5) | |
| Readmission reason | (n = 4) | (n = 8) | 0.700 |
| CVA | 0 (0) | 1 (12.5) | |
| Fever | 0 (0) | 1 (12.5) | |
| Hematoma/seroma | 1 (25.0) | 2 (25.0) | |
| Infection | 2 (0.0) | 1 (12.5) | |
| Radiculopathy | 0 (0) | 1 (12.5) | |
| Other medical | 1 (25.0) | 2 (25.0) | |
| Reoperation procedure | (n = 25) | (n = 24) | 0.112 |
| I&D | 4 (16.0) | 4 (16.7) | |
| Evacuation hematoma | 1 (4.0) | 0 (0) | |
| Lumbar fusion | 12 (48.0) | 5 (20.8) | |
| Revision laminectomy | 8 (32.0) | 15 (62.5) | |

After adjusting for age, sex, and comorbidity index, the study found that patients who received surgery at hospitals had higher odds of having at least one ED visit compared to those who underwent surgery at ASCs.[15] Hirsch et al. explored the outcomes of patients undergoing revision minimally invasive lumbar decompression (MIS LD) in ASCs compared to Hospital-Based Centers (HBCs). The study demonstrated that patients undergoing revision MIS LD in an ASC exhibited similar perioperative outcomes when compared to those undergoing the procedure in an HBC.[16] Cuellar et al investigated spine surgery readmission rates, complications, and reoperation rates at ambulatory outpatient vs inpatient hospital. They found that the 90-day readmission rates were lower for outpatients, indicating better postoperative recovery and management. They also found complication and reoperation rates to be similar between the two groups, comparable to what we saw in our study.[17] In summary, the evidence from these studies aligns with our results demonstrating similar or improved clinical outcomes in the ASC setting.

While ASCs present a seemingly secure option for hospital-based laminectomy alternatives, the suitability of patients with specific medical conditions requires meticulous assessment. Commonly cited criteria for appropriate ASC candidacy encompass age, BMI, ASA score, and certain comorbidities like obstructive sleep apnea (OSA), diabetes, and cardiac ailments.[18–22] Additionally, factors such as smoking status and familial assistance, though less frequently mentioned, might influence patient selection. Noteworthy is the increased complication risk such as bronchospasm for high-BMI patients in both hospital and ambulatory settings, though select morbidly obese cases could still safely undergo ASC procedures.[18,23-25] Several studies have delved into the impact of ASA classification and comorbidities on outcomes.[24,26,27] Helseth et al.'s research, involving 1449 outpatient spine procedures, recommended specific criteria like ASA class 1 or 2, age under 70, and single-level lumbar or cervical operations, advising against ASC use for ASA class 3 or higher patients.[26] This caution extends to OSA patients, particularly those with unmanaged comorbidities, who face elevated respiratory intervention and perioperative mortality risks.[28] Cardiac risk factor assessment is equally critical, as highlighted by Siow et al.'s findings of coronary artery disease's impact on orthopedic ASC exclusions.[22] Comorbidity scores, demonstrated by Zuckerman et al, reveal specific thresholds linked to lower complication risks, underlining cardiac evaluation's significance in outpatient spine surgery.[21] Similarly, conditions like diabetes and smoking correlate with heightened readmission risk compared to inpatient cases.[29] Despite indications of safe ASC potential within specific populations, comprehensive evaluation of health conditions and risk factors remains imperative to ensure positive surgical outcomes while minimizing complications.

A novel aspect of the current study is its inclusion of a formal cost-effectiveness analysis. While others have demonstrated that laminectomy in the ASC setting can be performed safely at lower cost than in the hospital, no prior studies have directly compared the cost-effectiveness of ASC and hospital-based laminectomies, to the authors' knowledge. Assessment of cost-effectiveness, as measured by cost per QALY gained over a specific time horizon is widely used to assess the value of various medical interventions.[30] In the United States, as well as in many other countries, medical intervention is generally deemed cost-effective if the cost per QALY gained remains below a certain threshold, commonly set at $50,000-$100,000.[3,31-33] Prior evaluations yield variable results regarding the cost-effectiveness of laminectomy procedures, depending on the population assessed, comparison group, time horizon, and cost perspective used. In a prospective, 2-year cost-effectiveness analysis of patients in the Spine Patient Outcomes Research Trial (SPORT), Tosteson et al. found that decompression for spinal stenosis yielded a cost per QALY gained of $47,900 (95% CI: $28,200 - $73,600) in 2004 US dollars (USD) relative to nonoperative treatment,[34] making it a cost-effective intervention. In the lumbar disc herniation arm of the same trial, the authors found decompression surgery resulted in a cost of $69,403/QALY gained (95%CI: $49,523, $94,999) in comparison to nonoperative treatment over the 2-year time horizon, again making the intervention cost-effective at the $100,000/QALY-gained threshold.[7] Using a Markov model to evaluate cost-effectiveness of various interventions for 1 and 2-level lumbar spinal stenosis, Parker et al. found decompression surgery resulted in a cost per QALY gained of $48,131 in 2014 USD.[35] The results of the current study build upon those previously presented by demonstrating that the

**Table 4.** Multivariate Regression: ASC Utilization and Postoperative Care and Cost.

| | ASCOR/β | 95% Confidence Interval | p -Value |
|---|---|---|---|
| Surgical cost (β) | −3495.4 | −3510.5 to −3480.4 | **<0.001** |
| 90-Day ED return (OR) | 0.62 | 0.31 to 1.21 | 0.163 |
| 90-Day readmission (OR) | 2.09 | 0.61 to 8.54 | 0.260 |
| 1-Year reoperation (OR) | 0.75 | 0.41 to 1.40 | 0.367 |
| # Of 1-year spine visit (β) | −0.17 | −0.39 to 0.06 | 0.141 |
| # Of 1-year imaging encounters (β) | −0.36 | −0.73 to 0.02 | 0.061 |
| 1-Year postoperative care cost (β) | −1125.1 | −2210.5 to −39.6 | **0.042** |
| Total 1-year cost (β) | −4610.7 | −5696.4 to −3524.9 | **<0.001** |

Controlling for age, sex, ASA, BMI and # of levels.
*p*-values <0.05 in bold.

**Table 5.** Cost Utility Analysis.

| Cost Utility | Hospital (n = 41) | ASC (n = 76) | *P*-Value |
|---|---|---|---|
| Surgery cost | $8089 ± 122 | $4527 ± 37 | **<0.001** |
| Postoperative care cost | $7174 ± 18,371 | $2609 ± 7183 | 0.133 |
| Total cost | $15,263 ± 18,375 | $7136 ± 7185 | **0.009** |
| Baseline EQ-5D | 0.58 ± 0.10 | 0.59 ± 0.10 | 0.890 |
| 1-Year EQ-5D | 0.68 ± 0.11 | 0.69 ± 0.11 | 0.557 |
| Δ QALY | 0.10 ± 0.13 | 0.11 ± 0.10 | 0.671 |
| Total Cost/QALY gained | $152,630 | $64,873 | |

*p*-values <0.05 in bold.

performance of laminectomy in the ASC setting should be considered the dominant strategy over hospital-based surgery, as it resulted in statistically similar (but slightly greater) improvements in QALYs at a lower cost over the one-year time horizon. At $64,873/QALY gained, we found laminectomy in the ASC to be cost-effective at the $100,000/QALY gained threshold, while hospital-based procedures were not at $152,630/QALY gained. However, caution must be used when interpreting the results of cost-effectiveness analyses and comparing across studies, given the significant variability in methodologies. This is reflected by the findings of Chang et al.'s recent systematic review of cost-effectiveness studies in U.S. spine surgery, which concluded that while the majority of studies find surgery for lumbar disc herniation and spinal stenosis to be cost-effective, obscure costing methodologies and inconsistent reporting of incremental cost-effectiveness ratios makes results largely incomparable.[9]

While our findings suggest performance of laminectomy procedures in the ASC setting is both safe and cost-effective, there are potential limitations to ASCs that warrant consideration. As surgeons transition toward the performance of cases in multiple settings, it is critical that standardized protocols be adhered to and appropriate support resources such as nurse navigators or care coordinators be leveraged to minimize the potential fragmentation of care. As health systems attempt to standardize care and improve outcomes across settings, a coordinated approach such as the Ambulatory Surgery Coordinating Council implemented at Johns Hopkins Medicine may hold value.[36] Additionally, as younger, healthier patients transition to ASCs, more complex and costly procedures will be increasingly performed in the hospital setting. In addition to the financial pressure this shift places on hospitals,[37] its potential adverse effect on access to care for medically complex patients not eligible for ambulatory surgery must be considered. We therefore emphasize that while our results highlight the potential benefits of performing laminectomies in the ASC setting, adequate reimbursement for hospital-based procedures must continue to avoid these negative consequences.

Our findings should be interpreted considering several significant limitations. First, as a single institution study, our findings may not be generalizable to the broader population of patients undergoing lumbar laminectomy. Second, the study was conducted retrospectively, which inherently introduces limitations in data collection and may lead to potential selection biases. Notably, patients undergoing surgery in the ASC had statistically lower BMIs and ASA scores on average, although we suggest the clinical significance of these differences is debatable. It is also possible that other unmeasured confounding differences between the ASC and hospital-based patients existed that influenced surgeon selection of appropriate ASC candidates. Although our use of multivariate analysis controlling for age, sex, BMI, ASA scores, and number of levels treated mitigates the impact of this bias to an extent, it is likely that residual differences between the hospital and ASC populations influenced our results. In addition,

the study contains a mixed cohort of patients undergoing laminectomy for degenerative spinal stenosis and disc herniations; given the relatively small sample size, we did not stratify our results between these groups. Further, detailed aspects of each case, such as the degree and location of stenosis, size of disc herniations, and specific technical aspects of the decompressive procedures performed, were not assessed. A third important limitation is that the majority of costs presented in the study are estimated based on Medicare allowed amount fee schedules. While this is common practice among cost-effectiveness studies, it merits noting, given that actual costs may have varied from those presented based on case-specific factors. Additionally, we elected to use the Medicare fee schedules for all modeled costs, regardless of whether patients were covered by Medicare or commercial insurers. This was purposefully done for two reasons. First, the distribution of payers was similar between groups, thus mitigating the impact of the payer mix. Second, the aim of the study was to assess how differences in utilization patterns between ASC and hospital patients affect cost rather than differences in pricing based on payer type. Given that commercial rates are not publicly available, and are often double those of Medicare,[38] we elected to use a consistent fee schedule to mitigate this impact on the analysis. It is, therefore, likely that overall actual costs incurred were higher than those presented. Finally, the cost-effectiveness analysis presented is limited by the fact that only a subset of patients completed patient-reported outcomes at both baseline and 1-year follow-up and was available for assessment of QALYs. It is possible that significant differences in outcomes existed between those who completed these measures and those who did not, which may bias our results. Additional studies evaluating the cost effectiveness of ASC-based laminectomy procedures over longer follow-up periods are needed to determine whether differences in cost effectiveness remain beyond the one-year postoperative time horizon. Despite these limitations, our study makes a valuable contribution to the expanding literature on the cost-effectiveness and safety of laminectomies in ambulatory settings.

## Conclusion

Laminectomy for lumbar spinal stenosis and disc herniations appears to be more cost-effective over the one-year time horizon when performed in the ASC rather than hospital outpatient setting. ASC patients benefited from lower surgery and postoperative care costs while experiencing similar rates of complications and improvements in quality of life over the one-year postoperative period. Additional studies are needed to replicate these findings across institutions, and to assess the cost effectiveness of ASC-based laminectomy beyond one-year postoperatively.

### Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Chad Patton, MD receives consulting payments from Medtronic, unrelated to the current study. No other authors have conflicts of interest to report.

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### IRB Statement

Patient consent was not required for the study as it was deemed exempt as a review of existing medical records by the institutional review board.

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