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Effect of Surgical Setting on Cost and Hospital Reported Outcomes for Single-Level Anterior Cervical Discectomy and Fusion

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ABSTRACT

Background: Hospitals seek to reduce costs and improve patient outcomes by decreasing length of stay (LOS), 30-day all-cause readmissions, and preventable complications. We evaluated hospital-reported outcome measures for elective single-level anterior cervical discectomy and fusions (ACDFs) between tertiary (TH) and community hospitals (CH) to determine location-based differences in complications, LOS, and overall costs.

Methods: Patients undergoing elective single-level ACDF in a 1-year period were retrospectively reviewed from a physician-driven database from a single medical system consisting of 1 TH and 4 CHs. Adult patients who underwent elective single-level ACDF were included. Patients with trauma, tumor, prior cervical surgery, and infection were excluded. Outcomes measures included all-cause 30-day readmissions, preventable complications, LOS, and hospital costs.

Results: A total of 301 patients (60 TH, 241 CH) were included. CHs had longer LOS (1.25 ± 0.50 versus 1.08 ± 0.28 days, $P = .01$). There were no differences in complication and readmission rates between hospital settings. CH, orthopaedic subspecialty, female sex, and myelopathy were predictors for longer LOS. Overall, costs at the TH were significantly higher than at CHs (\$17 171 versus \$11 737; $\Delta\$ = 5434 \pm 3996$; $P < .0001$). For CHs, the total costs of drugs, rooms, supplies, and therapy were significantly higher than at the TH. TH status, orthopaedic subspecialty, and myelopathy were associated with higher costs.

Conclusion: Patients undergoing single-level ACDFs at CHs had longer LOS, but similar complications and readmission rates as those at the TH. However, cost of ACDF was 1.5 times greater in the TH. To improve patient outcomes, optimize value, and reduce hospital costs, modifiable factors for elective ACDFs should be evaluated.

Level of Evidence: 3.

Cervical Spine

Keywords: health care costs, surgical outcomes, value-based care, tertiary hospitals, community hospital, anterior cervical discectomy and fusion

INTRODUCTION

Health care systems are shifting to valued-based models that require cost reduction while maintaining or improving patient-centered outcomes.[1–3] Value has been defined as patient health outcomes obtained relative to the cost.[4] In an effort to shift to quality-based bundled payment models, the US Centers for Medicare and Medicaid Services (CMS) changed to a merit-based incentive payment system.[3] Furthermore, health care spending is evaluated in the context of patient outcomes and patients' care-experience surveys.[5]

Hospitals and payers are using data-driven methods to identify and measure the extent of wasteful spending.[6] To improve value and reduce costs, quantifiable metrics such as patient length of stay (LOS), in-hospital complications, and 30-day all-cause readmissions rates are being targeted by the hospitals as well as CMS.[7] The Medicare Hospital Readmissions Reduction Program penalizes hospitals for having higher than expected 30-

day readmission rates.[7,8] Because of the pressure to increase value while decreasing costs, institutions are interested in evaluating the factors that drive costs, complications, and readmissions.

Variations in costs and outcomes after spine surgery are shown to be associated with different treating subspecialties, hospital settings, geographic locations, and time of year.[9–14] Feinberg et al[14] compared outcomes between teaching and non-teaching hospitals and found that teaching hospitals had longer hospital stays and increased costs. Other studies have identified differences in management and patient outcomes among neurosurgeons and orthopaedic surgeons.[10,11,15] Standardization of costs and outcomes across surgical subspecialties and hospital settings will improve the overall value of care provided. To date, the combined impact of hospital setting, surgical subspecialty, and operative characteristics on the cost and outcomes of anterior cervical discectomy and fusion (ACDF) has not been investigated. Our objective was to evaluate hospital-reported outcomes measures between tertiary hospitals (TH) and community hospitals (CH) within the same hospital system. We aimed to determine differences in LOS, complications, readmissions, and costs for elective single-level ACDF procedures performed at tertiary versus community hospitals.

METHODS

Patient Population

After obtaining institutional review board approval (University of Maryland, Baltimore Institutional Review Board, HP-00082698), we performed a retrospective review of a physician-driven database from a single medical system consisting of 1 TH (757 beds) and 4 CHs (110–320 beds). The TH is in an urban US city, and the CHs are in suburban settings within 16.1 to 112.7 km (10 to 70 miles) of the TH. In general, THs are large, often academic, hospitals with full specialty and subspecialty services. CHs are usually stand-alone hospitals with the primary aim to care for local patients, and often refer highly complex and patients with acute needs to THs. Eight orthopaedic spine surgeons (TH, n = 4; CH, n = 4) and 10 neurosurgeons (TH, n = 2; CH, n = 8) performed elective ACDF between January 1, 2015, and January 1, 2016. Surgeon experience ranged from 6 to 33 years of practice. The use of interbody cages, fixation plate, and surgical decompression techniques varied among surgeons.

Adult patients (ages 18–90 years) who underwent elective single-level ACDF for treatment of cervical degenerative disc pathology, including cervical disc herniation, spondylosis, and spinal stenosis, were included. Patients who underwent ACDF for traumatic, neoplastic, or infectious causes, or had incomplete hospital records or previous cervical spine surgery were excluded.

Data Collection

Patient characteristics were obtained from chart review and electronic billing database from both the TH and CHs. The metrics obtained included age, sex, race, primary insurance provider, comorbid conditions, and surgeon subspecialty (orthopaedic spine or neurosurgery). A medical billing database was used to obtain the ICD-9 codes for comorbidities. A published list of ICD-9 codes was used to develop Charlson comorbidity index.[16] The ICD-9 codes for the Charlson comorbidity index were weighed according to published literature.[17] Preoperative comorbid conditions: myelopathy, smoking status, and obesity (body mass index $\geq$ 30 kg/m^2) were also collected.

Outcomes Measures

Outcomes measures included baseline patient and surgical characteristics, in-hospital LOS, the rates of complications and 30-day readmissions, discharge disposition to home versus a facility (inpatient rehabilitation or skilled nursing facility), and hospital costs. For patients who required readmission or had a complication, the complication or reason for readmission was identified based on chart review. Readmission rates included 30-day all-cause, all-payer readmissions to the same hospital at which the index surgery had been performed. The logic follows the same algorithm as CMS all-condition, hospital-wide readmission measure but includes all payers.[18]

Hospital costs, rather than charges, were obtained from the billing database from a single medical system for single-level ACDF. Costs were derived directly from our billing database, which is consistent across all hospitals within our single medical system. Items or services are billed according to similar "charge buckets" for each hospital, creating consistency in billing. The itemized list of supplies and services are then billed to the insurance as charges. Payment to the hospital from the insurance payer is defined as the cost. Costs were

Table 1. Patient demographics and surgical characteristics of patients undergoing elective anterior cervical discectomy and fusion at tertiary and community hospitals.

Patient Characteristics	Total (n = 301)	TH (n = 60)	CH (n = 241)	*P*
Age, mean ± SD, y	50.1 ± 11.4	50.1 ± 10.8	51.1 ± 11.6	.51
Sex, male, n (%)	135 (45)	23 (38)	112 (46)	.31
Race, n (%)				.13
White	245 (81)	44 (73)	201 (83)	
Black	42 (14)	11 (18)	31 (13)	
Other	14 (5)	5 (8)	9 (4)	
CCI, mean ± SD	0.31 ± 0.72	0.26 ± 0.14	0.32 ± 0.61	.09
Myelopathy, n (%)	109 (36)	20 (33)	89 (37)	.65
BMI ≥ 30 kg/m^2, n (%)	65 (22)	6 (10)	59 (24)	.01[a]
Smoker, n (%)	46 (15)	6 (10)	40 (17)	.23
Insurance, n (%)				.29
Private	213 (71)	38 (63)	175 (73)	
Medicare/Medicaid	71 (23)	17 (28)	54 (22)	
Workers Compensation	17 (6)	5 (8)	12 (5)	

Abbreviations: BMI, body mass index; CCI, Charlson comorbidity index; CH, community hospital; TH, tertiary hospital.
[a]Statistical significance was determined with a *P* value < .05.

Table 2. Surgical characteristics for patients undergoing elective anterior cervical discectomy and fusion at tertiary and community hospitals.

Surgical Characteristics	Total (n = 301)	TH (n = 60)	CH (n = 241)	*P*
Specialty, n (%)				<.0001[a]
Orthopaedic	170 (56)	53 (31)	117 (69)	
Neurosurgery	131 (44)	7 (5)	124 (95)	
Levels fused, n (%)				.34
C2-C3	1 (0)	0 (0)	1 (0)	
C3-C4	45 (15)	11 (18)	34 (14)	
C4-C5	40 (13)	11 (18)	29 (12)	
C5-C6	107 (36)	16 (27)	91 (38)	
C6-C7	99 (33)	19 (32)	80 (33)	
C7-T1	9 (3)	3 (5)	6 (2)	
Instrumentation plate, n (%)	190 (63)	53 (88)	137 (57)	<.0001[a]
Cage, n (%)	180 (60)	15 (25)	165 (68)	<.0001[a]

Abbreviations: CH, community hospital; TH, tertiary hospital.
[a]Statistical significance was determined with a *P* value < .05.

broken down into following categories: total, drug, laboratory, operating room, imaging, patient room, supply (including implant), therapy (physical and occupational), and other (including intraoperative neurophysiological monitoring [IONM]) costs. Each cost category was further stratified by the fixed costs, which are those related to the infrastructure and overhead to run the facility where the procedure was performed.

Statistical Analysis

All data were collected and audited in Microsoft Excel (Microsoft Office Professional Plus 2016, Microsoft Corporation, Redmond, Washington). JMP® Pro (Version 13.0.0, 1987–2007, SAS Institute Inc., Cary, North Carolina) was used for descriptive statistics. All tests were 2-tailed, and the significance level was .05 unless otherwise stated. Continuous variables were tested for normality with the Shapiro-Wilk test. An unpaired *t* test was used for continuous variables that were normally distributed (age). A Mann-Whitney *U* test was used for continuous variables that were not normally distributed (LOS and costs). Because of the small sample size, the Fisher exact test was used for all nominal variables. The ordinal variable (Charles comorbidity index) was summarized with mean and standard deviation, but the Mann-Whitney *U* test was used to assess statistical significance. All independent variables that could have affected cost and LOS were included in the multivariate analysis. Variables with a *P* value of .10 or less were then included in the multivariable linear regression analysis. Using an alpha error of .10, variables at or below this level of significance were included in the multivariable stepwise linear regression model.

RESULTS

A total of 301 patients (60 TH, 241 CH) were included in the study. Table 1 details differences in baseline patient characteristics based on hospital settings. The patient populations treated at the 3 different hospital settings were similar with respect to age, sex, race, comorbidities, and insurance status. Patients at CHs were more likely to be obese than patients at the TH (24% versus 10%; $P = .01$). Relative to neurosurgeons, orthopaedic surgeons were more likely to be the operating surgeons at the TH (31% versus 5%; $P < .0001$). Instrumentation plate was more commonly utilized at the TH (88% versus 57%; $P < .0001$) whereas cages were more common at CHs (68% versus 25%; $P < .0001$) (Table 2).

The CHs had significantly longer LOS compared to the TH (1.25 ± 0.50 versus 1.08 ± 0.28 days, $P = .01$). There were no differences in complications and readmissions rates between hospital settings (Table 3). There were no complications reported during

Table 3. Outcomes of elective anterior cervical discectomy and fusion at tertiary and community hospitals.

Postoperative Outcomes	TH (n = 60)	CH (n = 241)	*P*
LOS, mean ± SD, d	1.08 ± 0.28	1.25 ± 0.50	.01[a]
Complications, n (%)	0 (0)	0 (0)	. . .
Readmissions, n (%)	0 (0)	1 (0.41)	1.00
Discharge, n (%)			.0004[a]
Home	60 (100)	207 (86)	
Facility	0 (0)	34 (14)	

Abbreviations: CH, community hospital; TH, tertiary hospital.
[a]Statistical significance was determined with a *P* value < .05.

Table 4. Multivariate analysis for predictors of length of stay. Beta weights were obtained using a multivariate regression model for length of stay in days. Adjusted $R^2 = 0.24$; Model fit $P \leq .0001$.

	β	*P*	95% CI Lower	95% CI Upper	VIF
Intercept	1.20	<.0001	1.13	1.28	...
Tertiary hospitals	−0.10	.01	−0.17	−0.03	1.38
Specialty, orthopaedics	0.11	.001	0.06	0.17	1.49
Instrumentation plate	−0.13	<.0001	−0.19	−0.07	1.49
Sex, female	0.04	.09	−0.01	0.09	1.01
Myelopathy	0.11	<.0001	0.06	0.16	1.07

Abbreviations: CI, confidence interval; LOS, length of stay; VIF, variance inflation factor.
[a]Statistical significance was determined with a *P* value < .05.

hospital stays. One person was readmitted at a CH due to acute postoperative neck pain. All of the patients from the TH were discharged home whereas 14% of patients from CHs were discharged to a rehabilitation facility ($P = .0004$). Multivariate regression for LOS showed that CHs, orthopaedic subspecialty, female sex, and myelopathy were predictors for longer LOS (Table 4).

Overall, TH total costs were significantly higher when compared to CHs ($17 171 versus $11 737; *Δ*$ = $5434 ± 3996; $P < .0001$). For the CHs, the drug, patient room, supply, and therapy costs were significantly higher (Table 5). The largest net difference between the TH and CHs was observed for operating room costs ($6987 ± 2103 versus $3121 ± 799; *Δ*$ = $3866 ± 1942; $P < .0001$), followed by other costs ($1819 ± 1029 versus $295 ± 433; *Δ*$ = $1524 ± 854; $P < .0001$). The higher operating room costs were largely due to higher fixed costs at the TH ($4667 ± 1646 versus $2158 ± 609; *Δ*$ = $2509 ± 1356; $P < .0001$). The other costs were also largely due to higher fixed costs ($1544 ± 773 versus $193 ± 262; *Δ*$ = $1351 ± 682; $P < .0001$), but also due to higher IONM costs ($1421 ± 314 versus $96 ± 296; *Δ*$ = $1325 ± 609; $P < .0001$) at the TH. The laboratory costs were also significantly greater at the TH ($1361 ± 1378 versus $129 ± 164; *Δ*$ = $1231 ± 798; $P < .0001$), despite the TH ordering 1.4 fewer laboratory tests than the CHs (mean, 4.2 ± 4.3 versus 5.6 ± 5.5 tests; $P = .032$). The fixed costs were responsible for 49.5%–88.6% of the cost differences across cost categories and accounted for 72.6% of the difference in total costs between the TH and CHs. The multivariate regression model for the cost of performing an ACDF showed the TH, orthopaedic surgeon specialty, presence of myelopathy, and a longer LOS were associated with higher costs. The use of an instrumentation plate and discharge to home were associated with lower costs (Table 6).

DISCUSSION

Optimizing the value of health care requires institutions to constantly evaluate resource utilization and clinical outcomes. Better clinical outcomes

Table 5. Cost in US dollars of elective single-level anterior cervical discectomy and fusion at tertiary and community hospitals.

	TH, mean ± SD (n = 60)	CH, mean ± SD (n = 241)	Net Difference, mean ± SD (*Δ*$ = TH − CH)	ΔFixed[a]/ΔTotal Cost (%)[b]	*P*[c]
Drugs	522 ± 173	742 ± 581	−219 ± 532	...	<.0001[c]
Fixed	203 ± 80	394 ± 254	−191 ± 242	86.9	<.0001[c]
Laboratory	1361 ± 1378	129 ± 164	1231 ± 798	...	<.0001[c]
Fixed	1113 ± 1150	77 ± 111	1036 ± 665	84.1	<.0001[c]
OR	6987 ± 2103	3121 ± 799	3866 ± 1942	...	<.0001[c]
Fixed	4667 ± 1646	2158 ± 609	2509 ± 1356	64.9	<.0001[c]
Imaging	325 ± 62	214 ± 100	111 ± 103	...	<.0001[c]
Fixed	230 ± 43	141 ± 68	89 ± 73	80.5	<.0001[c]
Patient room	391 ± 931	1025 ± 1302	−633 ± 1261	...	<.0001[c]
Fixed	235 ± 570	687 ± 870	−452 ± 838	71.3	<.0001[c]
Supply total	5733 ± 2198	5941 ± 2054	−208 ± 2081	...	.27
Fixed	1073 ± 418	1351 ± 651	−278 ± 621	74.9	.0001[c]
Implants	4085 ± 1914	3933 ± 2633	152 ± 2504	...	.86
Therapy	33 ± 116	271 ± 232	−237 ± 233	...	<.0001[c]
Fixed	13 ± 47	131 ± 109	−118 ± 110	49.5	<.0001[c]
Other costs	1819 ± 1029	295 ± 433	1524 ± 854	...	<.0001[c]
Fixed	1544 ± 773	193 ± 262	1351 ± 682	88.6	<.0001[c]
IONM	1421 ± 314	96 ± 296	1325 ± 609	...	<.0001[c]
Total cost	17 171 ± 3734	11 737 ± 3260	5434 ± 3996	...	<.0001[c]
Fixed	9078 ± 2270	5131 ± 1497	3947 ± 2302	72.6	<.0001[c]

Abbreviations: CH, community hospital; IONM, intraoperative neuromonitoring; OR, operating room; TH, tertiary hospital.
[a]Fixed costs are those related to the infrastructure and overhead to run the facility where the procedure was performed.
[b]The proportion of total costs attributed to the fixed costs is presented as the difference between fixed costs divided by the difference in total costs between the TH and CH.
[c]Statistical significance was determined with a *P* value <.05.

Table 6. Multivariate analysis for predictors of costs of anterior cervical discectomy and fusion. Beta weights were obtained using a multivariate regression model for length of stay in days. Adjusted $R^2 = 0.57$; model fit $P \leq .0001$.

	β	P^a	95% CI Lower	95% CI Upper	VIF
Intercept	10 778.08	<.0001	8949.09	12 607.07	...
Age	26.32	.05	0.02	52.62	1.02
Tertiary hospitals	2847.41	<.0001	2397.63	3297.19	1.44
Specialty, orthopaedics	398.00	.04	18.65	777.36	1.62
Myelopathy	550.47	.001	221.08	879.86	1.15
Instrumentation plate	−525.53	.01	−918.49	−132.57	1.64
Length of stay	2446.84	<.0001	1683.01	3210.67	1.47
Home discharge	−552.26	.05	−1110.32	5.80	1.45

Abbreviations: CI, confidence interval; VIF, variance inflation factor.
[a]Statistical significance was determined with a P value < .05.

with efficient resource utilization lead to higher value of care. To improve value, hospital systems are merging with or acquiring other hospitals to build larger hospital systems that span both urban and suburban geographies. The larger hospital systems aim to utilize economies of scale to decrease cost and improve clinical outcomes.[19] Our study investigated the costs and outcomes of elective single-level ACDFs in a large hospital system across 2 different types of hospital settings: tertiary and community hospitals.

Comparing the 2 hospital settings highlighted key differences that can be targeted for further optimization of care and resource utilization. While similar patient populations were treated in both settings, patients in CHs had a longer hospital stay and were more likely to get discharged to a rehabilitation facility. The cost analysis showed that single-level ACDFs performed at the TH were significantly more costly than those performed at the CHs. Differences in operating room, other (including IONM), and laboratory costs were the primary drivers of the difference observed.

The complexity of patients can often dictate the clinical outcomes. Our analysis did not find any differences in patient characteristics. While the TH is located in an urban setting, the percentage of patients with Medicare/Medicaid or workers compensation was not different between the 2 hospital settings. These findings contrast with reports showing that THs treat more complex patients with lower access to healthcare.[20–22] The populations in our 2 hospital settings were uneven (241 CH versus 60 patients in TH), which could have masked potential differences. Additionally, the analysis only included elective single-level ACDF patients. The surgeons at our hospital system have established guidelines for ideal surgical candidates. Therefore, the similar patient cohorts could be a function of pre-established guidelines for surgical candidates within the hospital system. The similarity of the patient groups, however, is valuable to the outcomes analysis. The outcomes—LOS, complications, readmissions, and costs—can be directly compared against each other without concern for confounding due to differences in patient characteristics.

Hospital systems and governing bodies such as CMS evaluate complications associated with a procedure to derive the quality and value of services provided. LOS, complications, and readmissions are 3 metrics critical to the value-based health care equation. CHs had significantly longer hospital stays and discharged more patients to rehabilitation facilities relative to the TH. Multivariate analysis showed that orthopaedic subspecialty, CHs, not using an instrumentation plate, and myelopathy were independent risk factors for a longer LOS. While each of these variables was significantly associated with a longer LOS, the mean difference of a 0.17-days (4.1-hour) longer LOS at the CHs and beta weights ranging from 0.10 to 0.13 days (2.4 to 3.1 hours) are unlikely to be clinically important given they are less than 1 day. Myelopathy has not been reported in earlier studies as an independent risk factor for prolonged LOS.[23–26] Given the potential of neurological injury associated with myelopathy, providers likely observe patients longer to ensure that the neurologic exam is stable. Arnold et al[26] determined old age (>50 years), female sex, and cardiac, urinary, and pulmonary complications were predictors for prolonged LOS after ACDF. Other factors such as perioperative nutrition status have also shown to be associated with a prolonged LOS.[27] While a greater proportion of CH patients were obese, obesity was not a predictor of LOS in the multivariate analysis, consistent with prior research.[28] Finally, the use of a plate was associated with a 0.13-day (3.1-hour) shorter LOS. This is consistent with prior research showing a marginally shorter (1.4-hour) LOS in patients undergoing plate fixation for single-level ACDFs.[29] The multivariate regression in our study only accounted for 24% of the variability in LOS. Therefore, other factors not directly evaluated in the study could have also contributed to longer LOS at CHs. In addition to the quantifiable factors, individual physician choices, ancillary staff training, and patient characteristics could all impact patient LOS.

The single most important factor that could influence peri-operative and postoperative outcomes for patients is the surgeon performing the surgery. Our study evaluated ACDFs performed by both orthopaedic surgeons and neurosurgeons. We found that ACDFs performed by an orthopaedic surgeon were associated with longer LOS; however, this finding does not necessarily implicate orthopaedic surgeons as the cause of longer LOS. Additionally, the 0.11-day (2.6-hour) LOS difference for orthopaedic surgeons is unlikely clinically important. Hijji et al[15] similarly showed no significant differences in LOS for patients undergoing single-level ACDFs by orthopaedic and neurosurgeons. The same disease can be managed very differently by different subspecialties.[9–12] Studies have compared the clinical decision making of orthopaedic surgeons and neurosurgeons and found that factors such as surgeon age, geographic location, and experience can all influence clinical decision making.[9,10,12] Therefore, the impact of surgical subspecialty on LOS is variable and it is one of the many factors that influences LOS.

In addition to LOS, complications and readmissions are also evaluated by CMS to determine the value of health care. No complications were reported and only 1 readmission was reported for the patients in our cohort. The complication and readmission rates are lower than those reported in prior literature.[30–32] The low complication and readmission rates in our study are largely due to coding according to the CMS provider-preventable conditions and 30-day all-cause, all-payer readmissions to the same hospital. Since we aimed to determine the effect of hospital setting on hospital-reported outcomes that affect hospital reimbursement, our complication and readmission rates may not be directly compared to studies with different criteria for identifying complication and readmission rates. For example, dysphagia is a potential complication of ACDF and would be reportable in a study evaluating ACDF complications. CMS, however, categorizes those complications that require a return to the operating room during the same hospital stay (a provider-preventable condition) or those that would require a readmission and possible return to the operating room within 30 days (a readmission). Both events would significantly affect the cost of the perioperative course, and are reportable to CMS, affecting hospital reimbursement. Therefore, we expect lower complication and readmission rates in our study.

Standardization across hospital systems improves system-level outcomes and decrease costs. The costs of performing the same procedure in 2 different hospital setting were significantly different. Although there were no differences in complications and readmissions, the cost of an ACDF at the TH was nearly 1.5 times ($5434) higher than at the CHs. Operating room, other (including IONM), and laboratory costs were the biggest contributors to the cost differentials between the TH and CHs. The higher costs were largely due to the fixed costs associated with running a large tertiary referral center, where 49.5%–88.6% of the cost difference was attributed to higher fixed costs. The difference in fixed costs accounted for 64.9% of the operating room and 84.1% of the laboratory cost variability. Despite ordering 1.4 fewer tests at the TH, the laboratory costs were still significantly higher due to the overhead costs of running a large tertiary facility. The significantly higher other costs were due to higher fixed costs, but also due to greater use of IONM at the TH. The use of IONM is a surgeon preference and is likely used more in the TH where residents and fellows play a greater role in the surgery. Prior studies, however, have not shown a reduction in neurologic injury rates with routine use of IONM in patients undergoing ACDF.[33] Interestingly, the supply costs were not significantly different between hospital settings, nor were the implant costs, likely due to similar contracts with medical device companies within the single hospital system. Multivariate analysis showed the older age, TH, orthopaedic specialty, myelopathy, and LOS were associated with higher costs, while use of an instrumentation plate and home discharge were associated with lower costs. To reduce costs while maintaining quality, hospitals systems will need to focus on modifiable and nonmodifiable factors. This analysis highlights discharge destination, LOS, differences in subspecialty, and hospital settings as potential modifiable factors.

Limitations

The study has several limitations. Although, we aimed to identify differences in clinical outcomes and costs between surgical settings, conclusions for hospital-reported and cost outcomes should be made with caution. Our readmission rates may be underreported because patients may have sought care at another hospital. Missing readmissions were minimized by encouraging patients to contact our call center if they experienced postoperative problems, and multiple hospitals in our medical system provided a larger catchment area for readmissions. Using multiple hospitals in our cost assessment increased the variability of how certain items were categorized, but this variability was reduced by analyzing information within a single medical system. Surgical specialty is also another potential limitation to our study, as different surgical techniques and choice of implants may introduce variability into our results. Ultimately, we used cost rather than charges, which was more accurate and consistent between payers within our geographic location. However, this can vary between health care institutions, as they may have different financial agreements with payers. Additionally, the results of this study may not be applicable to all surgeons or hospital systems. The decision of where to perform a single-level ACDF will depend on patient comorbidities, the resources of the hospital system, and the privileges of the surgeon. Finally, additional variables may be associated with cost differences between surgical settings. This study did not specifically address the influence of surgical time or the involvement of residents and fellows. Prior studies, however, have shown no differences in operating room time and short-term outcomes when residents and fellows are involved in spine surgery.[34] We further controlled for operating room time by only including patients undergoing elective single-level ACDF procedures.

CONCLUSION

In summary, we compare hospital-reported outcomes and costs at a TH and CHs within a single medical system for patients undergoing primary, elective, single-level ACDF. Despite the different geographical locations of the 2 hospital settings (suburban versus urban), the patients had similar baseline demographics. Complication and readmission rates were similar, but LOS was significantly longer at CHs. The significantly longer LOS, however, is unlikely clinically important given it was less than 1 day**.** The cost analysis showed the cost of performing an ACDF was significantly higher at the TH, primarily due to differences in fixed costs associated with running the hospital. We identify modifiable factors such as surgical subspecialty, hospital setting, and discharge destination as potential targets to reduce hospital costs across the system.

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