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Does the Day of the Week Affect Length of Stay and Hospital Charges Following Anterior Cervical Discectomy and Fusion?

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ABSTRACT

Background: To reduce the economic impact of excessive costs, risk factors for increased length of stay (LOS) must be identified. Previous literature has demonstrated that surgeries later in the week can affect the LOS and costs following joint arthroplasty. However, few investigations regarding the day of surgery have been performed in the spine literature. The present study attempts to identify the association between day of surgery on LOS and hospital charges following anterior cervical discectomy and fusion (ACDF) procedures.

Methods: A prospectively maintained surgical database of primary, level 1-2 ACDF patients between 2008 and 2015 was retrospectively reviewed. Patients were stratified by surgery day: early week (Tuesday) or late week (Friday) ACDF. Differences in patient demographics and preoperative characteristics were compared between cohorts using chi-square analysis or Student *t* test for categorical and continuous variables, respectively. Direct hospital costs were obtained using hospital charges for each procedure and subsequent care prior to discharge. Associations between date of surgery and costs were assessed using multivariate linear regression controlled for.

Results: Two hundred and ninety-five patients were included in the analysis. One hundred and fifty-three patients underwent early week ACDF, and 142 underwent late week ACDF. Surgery day cohorts reported similar baseline characteristics. There were no differences in operative characteristics or hospital LOS between cohorts. Additionally, no differences in total or subcategorical hospital costs were identified between surgery day cohorts.

Conclusions: Patients undergoing ACDF later in the week exhibit similar LOS and hospital costs compared to those undergoing ACDF early in the week. These results suggest that outpatient procedures with short postoperative stays are likely not affected by the changes in hospital work efficiency that occur during the transition to the weekend. As such, hospitals should not restrict outpatient procedures to specific days of the week.

Level of Evidence: 3.

Cervical Spine

Keywords: anterior cervical discectomy and fusion, length of stay, day of surgery, hospital direct costs, hospital charges

INTRODUCTION

The current predominant payment system for physician reimbursement is the fee-for-service model. This model has previously been scrutinized for not taking into account the cost, quality, or outcomes of the service provided.[1] As a result, the bundled payment model has gained popularity through recent initiatives such as the Affordable Care Act.[2,3] Emphasis on value-based care has resulted in the increased responsibility of health care providers to control costs of medical procedures.[1] Interventions specifically related to spine care in the United States are among the most expensive, reported at an annual cost exceeding $100 billion.[4] In a bundled payment model, these costs can be excessive and must be addressed in a manner that improves cost containment while improving quality of care and patient-centered outcomes.

Recently, studies have shown that prolonged hospital stays can significantly contribute to greater health care costs.[5,6] In order to minimize excess health care expenditure, it is necessary to identify risk factors that contribute to prolonged hospital stays. Previous studies in the orthopedic literature have indicated that procedures performed later in the week can extend the length of postoperative hospital stay and costs due to reduced hospital staff and work efficiency on weekends.[7–10]

Although previous studies have analyzed factors affecting length of stay (LOS) after spinal surgery, few investigations regarding the effect of day of surgery have been performed.[11,12] The purpose of this study is to identify any differences in length of hospital stay and costs between patients who underwent anterior cervical discectomy and fusion (ACDF) procedures earlier in the week compared to those who had the procedure later in the week.

MATERIALS AND METHODS

Patient Population

Institutional review board approval was obtained for this study (ORA# 14051301). A prospective database of surgical patients treated by a single surgeon at a single academic institution between 2008 and 2015 was retrospectively reviewed. Patients who underwent primary, level 1-2 ACDF for degenerative spinal pathology were included in this study. All procedures were performed in an inpatient hospital setting. Patients were excluded if they underwent ACDF for nondegenerative pathology, such as deformity, trauma, or infection. Additionally, 1 patient experienced an intraoperative dural tear and was excluded from the analysis in order to limit influences on LOS or direct hospital costs unrelated to the day of surgery. Discharge readiness was determined based on the clinical judgment of the treatment team with adequate pain management and voluntary bladder control being the primary requirements.

Data Collection

Patients were grouped by the day of their surgical procedure. The early group underwent surgery on Tuesday, and the late group underwent surgery on Friday. No procedures were performed on Monday, Wednesday, Thursday, Saturday, or Sunday. Surgery dates were scheduled based on patient preferences.

Demographic variables were collected from the patient's medical records and included age, sex, body mass index (BMI), smoking status, Charlson Comorbidity Index (CCI), and presence of neuropathy. A modified CCI with the age component removed was used in order to assess age and CCI separately in subsequent analyses. Perioperative variables were recorded for each patient, including operative time, estimated intraoperative blood loss, postoperative length of hospital stay, number of operative levels, and postoperative complications. Direct hospital costs were determined for each patient's surgical encounter and perioperative hospital stay through review of hospital financial records. Total costs were also subcategorized by charges for blood services, cardiology, radiology, laboratory, nursing unit, intensive care unit, pharmacy, physical/occupational/speech therapy, and surgical services.

Statistical Analysis

Statistical analysis was performed using Stata/MP 13.1 for Mac (StataCorp LP, College Station, Texas). Differences in patient demographics and operative characteristics were compared between cohorts using chi-square analysis or Student t test for categorical and continuous variables, respectively. Associations between date of surgery and direct hospital costs were assessed using multivariate linear regression controlled for age, sex, BMI, smoking status, modified CCI, number of operative levels, and presence of neuropathy. Statistical significance was set at $P < .05$.

RESULTS

A total of 295 patients were included in the analysis. Of these, 153 (51.8%) underwent surgery on Tuesday (early surgery), and 142 (48.2%) underwent surgery on Friday (late surgery). Table 1 details demographic information for both cohorts. There were no statistically significant differences between cohorts in terms of age, sex, BMI, smoking status, CCI, or presence of neuropathy ($P > .05$ for each).

Table 2 details perioperative variables for both cohorts. A majority of patients underwent single-level ACDF in both early and late surgery cohorts (51.6% versus 54.9%, $P = .109$). There were no significant differences in operative time or estimated blood loss identified between cohorts ($P > .05$ for each). Additionally, there were no differences in postoperative complication rates between groups (early: 11.8% [18]; late: 9.9% [14]; $P = .599$). Regarding LOS, no differences were reported between surgical day cohorts (early: 30.1 hours; late: 30.5 hours; $P = .819$).

Table 3 presents information on direct hospital costs. No differences in total direct hospital costs were demonstrated between cohorts (early: $8157; late: $7985; $P = .496$). Additionally, patients in both

Table 1. Demographics.

	Early Surgery (N = 153)	Late Surgery (N = 142)	*P* Value[a]
Age (mean ± SD, years)	50.7 ± 9.1	50.1 ± 10.5	.637
Sex, % (n)			.366
Female	39.9 (61)	45.1 (64)	
Male	60.1 (92)	54.9 (78)	
Body mass index, % (n)			.757
<30 kg/m^2	58.8 (90)	57.0 (81)	
≥30 kg/m^2	41.2 (63)	43.0 (69)	
Insurance status, % (n)			.946
WC	68.0 (104)	67.6 (96)	
Non-WC	32.0 (49)	32.4 (46)	
Smoking status, % (n)			.964
Nonsmoker	79.1 (121)	78.9 (112)	
Smoker	20.9 (32)	21.1 (30)	
Modified CCI (mean ± SD)	1.7 ± 1.2	1.6 ± 1.3	.424
Presence of neuropathy, % (n)			.773
None	5.2 (8)	3.5 (5)	
Radiculopathy	30.7 (47)	31.7 (45)	
Myelopathy	64.1 (98)	64.8 (92)	

Abbreviations: WC, workers' compensation; CCI, Charlson Comorbidity Index.
[a]*P* value calculated using chi-square analysis (categorical) or Student *t* test (continuous).

cohorts exhibited similar costs for all subcategories ($P > .05$ for each).

DISCUSSION

In recent years, health care delivery in the United States has shifted away from fee-for-service in favor of value-based medical care.[13,14] This transition has contributed to an increased effort to identify cost-saving measures in spine surgery.[14] While numerous studies have demonstrated patient and perioperative characteristics that influence LOS,[11,15–19] a paucity of literature exists regarding the effect of surgical scheduling on LOS and direct medical costs following ACDF. As such, the current study aimed to investigate if a day of surgery was associated with greater LOS and direct hospital costs following primary, level 1-2 ACDF.

The present study identified patients undergoing ACDF exhibited similar LOS independent of their scheduled day of surgery. This finding has been corroborated by previous reports in the orthopedic literature. In a retrospective analysis of 343 patients undergoing elective total ankle replacement or ankle arthrodesis, Pakzad et al[20] investigated risk factors for prolonged hospital stay. The authors determined that patients undergoing surgery on Friday did not demonstrate a greater risk for prolonged LOS as compared to patients undergoing a procedure earlier in the week ($P = .510$). Similarly, Rathi et al[10] retrospectively investigated the effect of surgery day on LOS following total hip arthroplasty (THA) in 273 patients. The authors reported that patients undergoing THA later in the week did not have significantly greater LOS than patients undergoing THA early in the week (Friday: 3.8 days versus Monday: 3.7 days; $P = .496$).

In contrast to the present study, previous studies have also described a significant association between day of surgery and LOS.[8,9,21–23] In a retrospective analysis of 580 patients, Keswani et al[8] investigated

Table 2. Perioperative variables.

	Early Surgery (N = 153)	Late Surgery (N = 142)	*P* Value[a]
Operative time (mean ± SD, min)	58.7 ± 20.2	54.7 ± 17.9	.078
Estimated blood loss (mL)	44.2 ± 18.9	44.0 ± 25.9	.969
Length of hospital stay (hours)	30.1 ± 14.9	30.5 ± 19.8	.819
Operative levels, % (n)			.571
Level 1	51.6 (79)	54.9 (78)	
Level 2	48.4 (74)	45.1 (64)	
Postoperative complications, % (n)	11.8 (18)	9.9 (14)	.599
Transient urinary retention,[b] % (n)	11.1 (17)	9.2 (13)	.579
Reintubation,[c] % (n)	0.0 (0)	0.7 (1)	.298
Altered mental status, % (n)	0.7 (1)	0.0 (0)	.335

[a]*P* value calculated using chi-square analysis (categorical) or Student *t* test (continuous).
[b]Transient urinary retention requiring recatheterization.
[c]Respiratory depression requiring reintubation.

Table 3. Direct costs.

	Early Surgery, $ (N = 153)	Late Surgery, $ (N = 142)	*P* Value[a]
Total costs, mean ± SD	8157 ± 1388	7985 ± 1583	.496
Blood	0 ± 4	1 ± 7	.401
Cardiology	6 ± 38	10 ± 99	.504
Radiology	157 ± 31	160 ± 44	.745
Laboratory	19 ± 17	18 ± 20	.744
Nursing unit	672 ± 430	681 ± 721	.773
Intensive care unit	0 ± 0	10 ± 118	.317
Pharmacy	369 ± 156	400 ± 163	.143
PT/OT/speech therapy	72 ± 51	69 ± 68	.653
Surgical services	6822 ± 1185	6602 ± 1152	.111

Abbreviations: PT, physical therapy; OT, occupational therapy.
[a]*P* value calculated using multivariate linear regression adjusted for age, sex, body mass index, smoking status, modified Charlson Comorbidity Index, number of operative levels, and presence of neuropathy.

the effect of surgical scheduling on clinical outcomes following THA. The authors reported patients undergoing THA on Thursday or Friday exhibited a longer LOS compared to patients undergoing surgery on Monday or Tuesday (3.7 versus 3.4 days; $P = .03$). In another retrospective study, Muppavarapu et al[23] demonstrated patients undergoing total joint arthroplasty early in the week exhibited significantly shorter hospital stays as compared to patients undergoing surgery later in the week ($P < .050$ for each). Additionally, no differences in LOS were identified between patients undergoing surgery on Monday and Tuesday ($P = .690$) and Thursday and Friday ($P = .890$).

The correlation between day of surgery and LOS demonstrated in previous studies has been attributed to differences in hospital staffing between weekdays and the weekend.[9] On weekend days, there are often fewer nonphysician staff available, such as physical therapists and nurses, which may delay patient mobilization and inhibit discharge readiness.[8] Additionally, other staff members, such as case managers or social workers, are often not available on weekends, which can lead to delays in discharge, particularly for patients who require transfer to a nursing or rehabilitation facility.

In the ACDF population, day of surgery may not have as significant of an effect on LOS as it may have in other populations. In comparison to total joint arthroplasty, ACDF procedures require fewer resources in the postoperative period. ACDF procedures do not require significant postoperative physical therapy interventions, such as those required following arthroplasty. Additionally, ACDF procedures can be performed on an outpatient basis and as such are less likely to be affected by changes in staffing over weekends.[24] These patients do not typically require transfer to rehabilitation or nursing facilities and therefore may not require the same level of involvement from care team members when planning discharge. Furthermore, the institution in which the present study was conducted uses a discharge protocol in order to complete social work and discharge documents prior to the weekend for patients having surgery later in the week. This may also limit delays in discharge associated with discharge coordination and paperwork. To better elucidate the effect of specific discharge protocols on LOS following ACDF, additional studies comparing institutional policies are required.

The present study did not identify any differences in direct hospital costs between surgery cohorts. The effect of surgery day direct hospital costs has been previously studied in the total joint population. In a retrospective review of 14 800 THA and total knee arthroplasty (TKA) patients, study, Newman et al[9] determined that patients undergoing surgery on Thursday or Friday were identified to stay 0.358 days longer in the hospital than patients undergoing surgery on Monday or Tuesday (95% confidence interval: 0.29–0.425, $P < .001$).[9] When analyzing hospital costs, the authors reported mixed findings between surgical cohorts. Only patients undergoing TKA later in the week were identified to have greater direct hospital costs ($44 175 versus $42 772; $P < .001$). The authors attributed this finding to the greater LOS reported in TKA patients (0.411 days) as compared to THA patients (0.281 days). In the current study, patients undergoing surgery late in the week stayed less than half an hour longer than those undergoing surgery early in the week. This, in part, provides explanation for the similar direct hospital costs incurred by both cohorts. Additionally, differences in operative time and intraoperative blood loss were not identified. Surgical service costs are the largest component of

total costs following ACDF and are determined by surgical supplies and labor, such as operative time and supply usage. Therefore, the similar operative characteristics between cohorts likely prevented significant differences in surgical service costs and subsequent total direct costs. In addition, the similar LOS between groups likely minimized any variations in therapy or nursing unit costs. These findings suggest that the scheduling of ACDF procedures does not need to be limited to particular days of the week.

Our investigation did not identify any difference in postoperative complication rates between both cohorts ($P = .599$). Specifically, our sample of patients collectively experienced, transient urinary retention (early: 11.1%; late: 9.2%; $P = .579$), respiratory depression requiring reintubation (early: 0.0%; late: 0.7%; $P = 0.298$), and altered mental status (early: 0.7%; late: 0.0%; $P = .335$). While these results were distinct to our investigation, it is important to note that severe postoperative complications following ACDF may occur, such as dysphagia, dysphagia, hoarseness, vocal cord paresis, esophageal injury, postoperative hematoma, superficial wound infection, worsening of myelopathy/radiculopathy, pulmonary complications, and others.[25–27] These complications are considerations surgeons must note during patient preoperative screening to weight risks and benefits while scheduling patients for later surgery days.

The current study has both strengths and weaknesses. As the investigation involved a single surgeon at a single academic medical center, the variability in LOS and costs was minimized. However, the retrospective nature of this study may introduce an element of selection and reporting bias. Additionally, the discharge planning at our institution may not be reflective of discharge protocols used at other institutions. Finally, as our investigation was limited to the inpatient stay, complications after discharge and long-term outcomes were not assessed in the present study. Future investigations on the effect of day of surgery on these outcomes following ACDF are necessary.

CONCLUSIONS

Patients undergoing ACDF later in the week exhibit similar LOS and hospital costs compared to those undergoing ACDF early in the week. These results suggest that elective procedures with short postoperative stays are likely not affected by the changes in hospital work efficiency that occur during the transition to the weekend. As such, hospitals should not restrict outpatient procedures to specific days of the week at our institution. However, future studies at other institutions are needed before generalizing our findings to a larger population. In addition, scheduled follow-up is necessary in order to identify and address complications. Further assessment of spinal procedures that require longer inpatient stays (eg, lumbar operations) and greater involvement of hospital staff postoperatively is necessary to elucidate the effect of day of surgery date on hospital costs and LOS.

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