

Clinical Studies

Emergency department visits within 90 days of single-level anterior cervical discectomy and fusion[☆]

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ABSTRACT

Background: Postoperative readmissions are a commonly used metric for quality-of-care initiatives, but emergency department (ED) visits have received far less attention despite their substantial impact on patient satisfaction and healthcare spending. The current study described the incidence and timing of ED visits following single-level ACDF, determined predictive factors and reasons for ED utilization, and compared reimbursement for patients with and without ED use.

Methods: Single-level ACDF procedures from 2010-2020 were identified in PearlDiver using CPT codes. Patients' age, sex, Elixhauser comorbidity index (ECI) score, region of the country, and insurance coverage were extracted. The incidence, timing, and primary diagnoses for 90-day ED visits and readmissions were determined, as well as total 90-day reimbursement. Variables were compared using univariate analysis and multivariate logistic regression.

Results: Out of 90,298 patients, 90-day ED visits were identified for 10,701 (11.9%), with the greatest incidence in postoperative weeks 1-2. Readmissions were identified for 3,325 (3.7%) patients. Independent predictors of ED utilization included younger age (OR 1.25 per 10-year decrease, $p < 0.001$), greater ECI score (OR 1.40 per 2-point increase, $p < 0.001$), and insurance type (relative to Medicare, Medicaid [OR 2.15, $p < 0.001$] and commercial plans [OR 1.14, $p = 0.004$]). In postoperative weeks 1-2, 51% of primary ED diagnoses involved the surgical site, while 23% involved the surgical site in weeks 3-13. Compared to patients without ED visits, those who visited the ED had 65% greater mean 90-day reimbursement ($p < 0.001$).

Conclusions: More than three times as many patients in the current study were found to present to the ED than be readmitted within ninety days of surgery. The identified predictive factors and reasons for ED visits can direct attention to high-risk patients and common postoperative issues. Additional postoperative counseling and integrated care pathways may reduce ED visits, thereby improving patient care and reducing healthcare spending.

Introduction

Anterior cervical discectomy and fusion (ACDF) is one of the most commonly performed spine procedures [1]. More than 150,000 procedures were performed in 2020, and the rates are predicted to continue growing over time [2]. Due to the increasing volume and potential morbidity associated with ACDF, optimizing patient experience and reducing cost have been identified as priorities for patients, healthcare systems, and insurance carriers [3-5].

In 2013, the Centers for Medicare and Medicaid Services (CMS) introduced bundled payments in an attempt to contain costs and improve outcomes by altering reimbursement strategies from point of service to

quality of care [6]. With this, hospital readmissions have become a targeted metric [7]. Many studies have assessed hospital readmissions after ACDF, with the 90-day readmission rate of all-level procedures reported to be 3.9-7.7% [4,8-11].

Postoperative emergency department (ED) visits have been correlated with reduced Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) scores following spine surgery [12,13]. In addition to adversely affecting patient experience, the average cost per ED visit is more than \$500, and ED episodes of care account for more than 10% of total healthcare payments [14,15]. Interestingly, however, ED visits after surgeries in general have received much less attention than hospital readmissions.

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Based on the above considerations, the current study used insurance claims data from a US national sample to characterize the incidence, timing, risk factors, reasons, and cost of ED visits in the ninety days following single-level ACDF. Answers to these questions may help surgeons provide additional postoperative counseling and integrated care pathways to reduce postoperative acute care usage, thereby improving patient care and reducing healthcare expenditure.

Methods

Study cohort

The current study utilized data from 2010 through 2020 Q3 in the M91Ortho PearlDiver dataset. This is a national multi-insurance database with deidentified information on inpatient and outpatient claims and healthcare expenditures in the United States. M91Ortho contains this information for approximately 91 million orthopedic patients. Because the data is de-identified and aggregated, our Institutional Review Board (IRB) has granted exemption for studies utilizing the database.

Patients were included in the study if they underwent single-level ACDF, as identified by Current Procedural Terminology (CPT) code CPT-22551. Patients were excluded if their records included the following codes: CPT-22552 (ACDF additional level), CPT-63081 (cervical corpectomy), or CPT-22846 (anterior instrumentation 4–7 segments). Patients were also excluded if cases were performed for trauma, infection, or tumor, or if their healthcare data did not extend past the 90-day follow-up period. These criteria resulted in a cohort of 90,298 single-level ACDF patients.

The following patient characteristics were extracted: age, sex, Elixhauser comorbidity index (ECI) score, region of the country (Northeast, Midwest, West, or South based on US Census Bureau definitions), and insurance coverage (Medicare, Medicaid, Commercial).

ED visits / readmissions

Postoperative visits to the ED were identified by the occurrence of one of five CPT codes (CPT-99281, CPT-99282, CPT-99283, CPT-99284, CPT-99285) within ninety days of single-level ACDF. These codes correspond to varying levels of care in the ED and were used to determine total and weekly incidence of ED visits following surgery.

Noting that this was a large study cohort with an expected basal rate of ED visits, the weekly occurrence of ED visits at 1-year status post single-level ACDF was determined using the average weekly incidence at 52–56 weeks. To ensure that insufficient database tracking time did not influence the result, this calculation was made based only on patients with at least 56 weeks of records in the database following ACDF.

The number of patients readmitted was determined based on the presence of any inpatient code within ninety days of surgery. The number of patients who were readmitted from the ED was determined based on the presence of any inpatient code within one day of the CPT code for an ED visit.

The primary International Classification of Diseases (ICD) diagnosis codes associated with ED visits were obtained to determine common reasons for ED utilization. Using PearlDiver’s DIAGTRACK function, ICD diagnosis codes and the number of ED visits with each code listed as the primary diagnosis were extracted. These codes were manually categorized as directly involving the surgical site or not involving the surgical site. Surgical site diagnoses were further categorized as pain, neurological, infection, dysphagia, wound issues/care, swelling, and other/unspecified. Diagnoses not involving the surgical site were categorized as CNS/psychiatric, cardiovascular, non-surgical site infection, gastrointestinal, respiratory, other musculoskeletal, genitourinary, and other. Reasons for diagnoses were analyzed separately for the first two weeks and for the remaining weeks. This was done to provide ad-

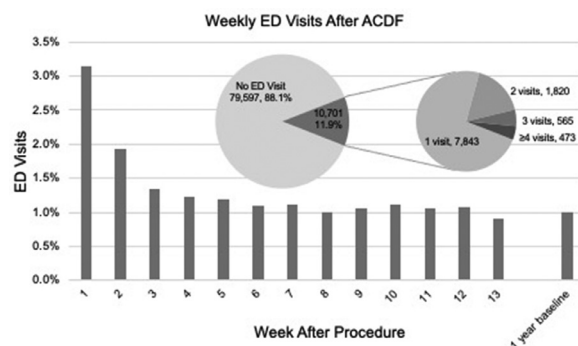


Fig. 1. Number of patients with ED visits and with no ED visit (pie chart). Incidence of ED visits in each week following single-level ACDF (bar graph). Baseline rate of weekly ED visits was determined by averaging weekly incidence for five weeks at one year after surgery. Weekly incidences are within 0.50% of baseline by week three.

ditional insight into potential differences in reasons for ED visits during the time of greatest increase relative to the following weeks.

Total reimbursement for 90-days following surgery was determined using PearlDiver’s TOTALCOST function, which sums all reimbursements over a specified period. Average reimbursement was calculated for patients with and without 90-day ED utilization.

Data analysis

ED visits were tabulated and plotted by week. Multiple ED visits associated with a single patient were represented separately in these data. Patient characteristics (age, sex, ECI score, region of the country, and insurance plan) were tabulated for the entire study population and those with and without postoperative ED visits.

Univariate statistical tests compared patients who did and did not visit the ED: Welch’s T-test for continuous variables and chi-squared test for categorical variables. The relative effects of patient characteristics (age, sex, ECI, region of the country, and insurance plan) on ED utilization were then determined using multivariate logistic regression modeling. Mean reimbursement was compared used Welch’s T-test. All statistical analyses were performed within PearlDiver with p-values less than 0.05 defined as significant.

Results

Within ninety days of single-level ACDF, at least one ED visit was noted for 10,701 (11.9%) patients (Fig. 1). One ED visit was noted for 7843, two ED visits were noted for 1820, three ED visits were noted for 565, and more than three ED visits were noted for 473. This accounted for a total of 15,578 ED visits within ninety days of surgery.

ED visits were noted in postoperative week one for 3.14% of the study cohort and in postoperative week two for 1.94% of the study cohort. By week three, ED visits were within 0.5% of the baseline weekly incidence of ED visits recorded for this population at one year post-surgery. For comparison, 90-day readmissions occurred for 3325 (3.7%) of the study cohort. Out of the total 15,578 ED visits, 335 (2.2%) resulted in readmissions.

Patient characteristics of the study cohort are shown in Table 1. Univariate analysis showed patients who visited the ED in the ninety days postoperatively were more likely to be younger, be female, have a greater comorbidity burden, be from the Midwest or Northeast, and have Medicaid insurance ($p < 0.001$).

Multivariate analysis of patient factors associated with 90-day postoperative ED visits is shown in Table 2. Independent predictors of ED utilization included: younger age (OR 1.25 per 10-year decrease, $p < 0.001$),

Table 1
Characteristics of single-level ACDF patients by occurrence of ninety-day ED visit.

	All Patients	No ED Visit	ED Visit	p-value
N	90,298 (100%)	79,597 (88.1%)	10,701 (11.9%)	
Age (mean ± st dev)	53.5 ± 11.8	53.7 ± 1.7	52.4 ± 12.2	<0.001
<40	10,852 (12%)	9159 (11.5%)	1683 (15.7%)	
40–49	23,462 (26%)	20,558 (25.8%)	2904 (27.1%)	
50–59	28,310 (31.4%)	25,183 (31.6%)	3127 (29.2%)	
>59	27,668 (30.6%)	24,691 (31%)	2977 (27.8%)	
Sex				<0.001
Male	41,266 (45.7%)	42,906 (53.9%)	4575 (42.8%)	
Female	49,032 (54.3%)	36,691 (46.1%)	6126 (57.2%)	
ECI (mean ± st dev)	3.6 ± 3.1	3.4 ± 3.0	5.5 ± 3.8	<0.001
0–1	26,550 (29.4%)	24,863 (31.2%)	1360 (12.7%)	
2–3	26,408 (29.2%)	23,751 (29.8%)	2467 (23.1%)	
4–5	17,359 (19.2%)	15,079 (18.9%)	2371 (22.2%)	
>5	19,981 (22.1%)	15,904 (20%)	4503 (42.1%)	
Region				<0.001
South	41,443 (45.9%)	36,852 (46.3%)	4596 (42.9%)	
West	10,482 (11.6%)	9286 (11.7%)	1191 (11.1%)	
Midwest	23,670 (26.2%)	20,637 (25.9%)	3033 (28.3%)	
Northeast	14,376 (15.9%)	12,536 (15.7%)	1840 (17.2%)	
Insurance				<0.001
Commercial	69,015 (76.4%)	61,214 (76.9%)	7801 (72.9%)	
Medicaid	5128 (5.7%)	3940 (4.9%)	1188 (11.1%)	
Medicare	13,058 (14.5%)	11,709 (14.7%)	1349 (12.6%)	

Table 2
Predictive factors for ED utilization.

N = 90,298	OR (95% CI)	p-value
Age (per 10-year decrease)	1.25 (1.22, 1.27)	<0.001
Sex		
Male (referent)		
Female	1.03 (0.99, 1.07)	0.165
ECI (per 2-point increase)	1.40 (1.39, 1.42)	<0.001
Region		
West (referent)		
South	0.93 (0.87, 1.00)	0.051
Northeast	1.00 (0.93, 1.09)	0.921
Midwest	1.06 (0.98, 1.14)	0.146
Insurance		
Medicare (referent)		
Commercial	1.14 (1.06, 1.22)	<0.001
Medicaid	2.15 (1.96, 2.36)	<0.001

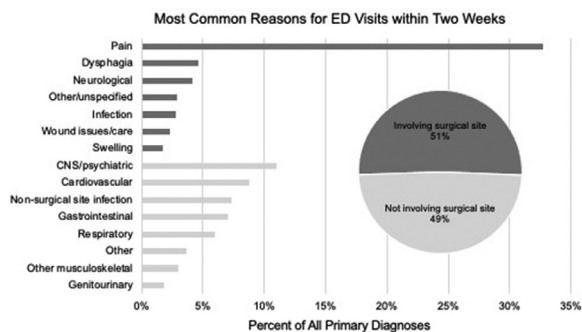


Fig. 2. Most common primary diagnoses for ED visits within two weeks of single-level ACDF.

greater ECI (OR 1.40 per 2-point increase, $p < 0.001$), and insurance type (relative to Medicare, Medicaid [OR 2.15, $p < 0.001$] and commercial plans [OR 1.14, $p = 0.004$]).

The most common reasons for ED visits within two weeks of single-level ACDF are shown in Fig. 2. During that time, 51% of diagnoses were categorized as involving the surgical site — most commonly pain (32.8% of all two-week primary diagnoses), dysphagia (4.6%), and neu-

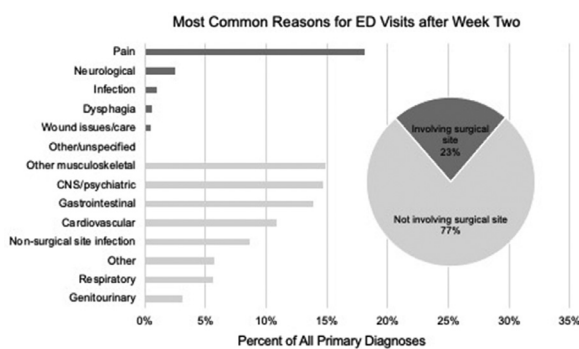


Fig. 3. Most common primary diagnoses for ED visits after postoperative week two.

rological issues (4.1%) — and 49% of diagnoses did not involve the surgical site, with the most common being CNS/psychiatric (11.0%), cardiovascular (8.8%), and non-surgical site infections (7.3%).

The primary diagnoses for ED visits for week three to ninety days after single-level-ACDF are shown in Fig. 3. During that time, 23% of diagnoses were considered to involve the surgical site — most commonly pain (18.1% of all primary diagnoses between weeks three and thirteen), neurological issues (2.5%), and surgical site infection (0.9%) — and 77% involved the surgical site, with the most common being other musculoskeletal (14.9%), CNS/psychiatric (14.6%), and gastrointestinal (13.9%).

The mean 90-day reimbursement for patients with ED utilization was \$18,426 ± \$26,101 (mean ± standard deviation), while the mean reimbursement for patients without ED use was \$11,180 ± \$17,717. Reimbursement for patients with ED visits was significantly greater than those without ($p < 0.001$).

Discussion

While postoperative readmissions after procedures such as ACDF have received significant attention, less attention has been given to postoperative ED visits despite the fact that they are very common, are indicators of poor patient experience, and place a major financial burden on

healthcare systems [16]. Of all patients undergoing single-level ACDF, 11.9% visited the ED at least once in the ninety days following their surgery, while only 3.7% were readmitted. The gap between ED visits and readmissions in the current study aligns with those for other procedures and highlights the need for the current study [17,18].

The peak incidence of postoperative ED visits occurred within two weeks of surgery. The similarity between the remaining weeks and the 1-year baseline numbers (within 0.50%) indicates that the patients had returned to a near-baseline rate of ED visits around postoperative week 3. This suggests that the first few weeks are the most important to analyze and target for quality improvement measures.

Several patient factors were independently associated with odds of ED utilization. Younger individuals had greater odds of visiting the ED postoperatively. This was found in a previous study of general ED use [19]. One reason for this association may be lower tolerance for issues due to better baseline health than older patients, as another study found that postoperative ED visits for pain were shown to be more common in younger patients [20]. Another possible explanation is that younger patients are less likely to be connected regularly with a primary care provider to whom they can contact regarding postoperative issues.

Patients with greater comorbidity burden (higher ECI score) had greater odds of postoperative ED use. This relationship makes intuitive sense and has been demonstrated following other procedures [21,22]. Insurance coverage was also an independent predictor of postoperative ED use. Patients with Medicaid were more than twice as likely as those with Medicare to visit the ED following surgery. This is in line with other literature describing increased ED usage among those with Medicaid coverage [21,23]. While this association is also likely multifactorial, accessing medical care in other settings may again be a contributing variable [24,25].

Regarding reasons for ED visits, pain was by far the most common diagnosis, which is similar to results following other non-spine surgeries [26]. This indicates that pain management may be critical for reducing postoperative acute care utilization. In the first two postoperative weeks, about half (51%) of visits were for complaints involving the surgical site. After week two, only 23% of ED visits involved the surgical site. Pain was still very common in the latter timeframe, but other diagnoses such as CNS/psychiatric, cardiovascular, gastrointestinal, and infections outside the surgical site played a more important role than previously. Consistent with what one might expect, this suggests that a focus on surgical site issues may be critical for reducing early postoperative acute care utilization, while attention must shift to other body systems later in the postoperative period.

Compared to those who did not utilize the ED following surgery, patients who visited the ED had mean 90-day reimbursement 165% of those who did not. Many factors contribute to cost of care, but this association highlights that postoperative ED visits may have impacts far beyond the patient experience itself [12]. Reducing postoperative ED visits may meaningfully impact postoperative cost of care, and accurate determination of cost is becoming increasingly important as 90-day bundled payments gain traction as a method of reimbursement. Future investigations should further describe the costs associated with postoperative ED visits.

Because the current study examined a large multi-insurance cohort from all regions of the country, we believe the results are generalizable and can provide direction for future institutional interventions to reduce postoperative ED visits, which would have to be studied prospectively to determine efficacy. For example, the risk of an individual visiting the ED after ACDF could be estimated using strong predictive factors, an approach that has been described for joint replacements [27]. High-risk patients could be directed to integrated care pathways for addressing issues in a non-acute outpatient setting, thus reducing ED utilization and the associated high costs [28,29]. Also, because pain represents such a large proportion of ED complaints, setting expectations for postoperative pain and providing additional guidance for pain management may substantially reduce postoperative ED use.

The current study has several limitations. First, as with any study of administrative data, it is limited by the coding and aggregated nature of the data. Nonetheless, with ED visits being billed for dichotomous events (the events happened or did not), we do not expect this to be a major source of error for the main endpoints of the study. Second, the reasons for postoperative ED visits may be multifactorial and not definitively captured. Additionally, the cost data may be multifactorial and largely variable, but the administrative nature of the data captures expenditures and is an important consideration.

In conclusion, ED visits without readmission are common following single-level ACDF. Comorbidity burden and insurance type are important factors in determining which patients are most likely to visit the ED, and complaints of surgical site pain were by far the most common reason for visits. This information may be valuable for directing clinical interventions to reduce postoperative acute care utilization, with the goal of reducing unnecessary healthcare costs and improving patient experiences.

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Declaration of Competing Interest

None.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.xnsj.2022.100122.

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