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Outpatient Anterior Cervical Discectomy and Fusion: An Analysis of Readmissions from the New Jersey State Ambulatory Services Database

Shearwood McClelland III MD, Peter G Passias MD, Thomas J Errico MD, R Shay Bess MD, Themistocles S Protopsaltis MD
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Abstract

Background
Anterior cervical discectomy and fusion (ACDF) performed as an outpatient has become increasingly common for treating cervical spine pathology. Few reports have attempted to assess readmissions following outpatient ACDF. This study was performed to address this issue using population-based databases.

Methods
The State Ambulatory Services Database (SASD) for New Jersey (NJ) from 2003-2012 was used for analysis. Patients receiving ACDF (defined as anterior cervical fusion (ICD-0 code=81.02) + excision of intervertebral disc (80.51)) were extracted; those with three or more levels fused (ICD-9 codes 81.63-81.64), cancer (ICD-9 codes 140-239), or trauma (ICD-9 codes=805.0-806.9) were excluded. A series of perioperative complications including durotomy, red blood cell transfusion, acute posthemorrhagic anemia, paraplegia (weakness), and mortality were examined. Propensity score matching (PSM) was used to adjust the analysis for patient age, race, sex, primary payer for care, and number of diagnoses. The NJ SASD defined readmission as admission to the same facility within seven days of initial discharge.

Results
Two thousand sixteen (2,016) patients were found, 1,528 of whom had readmission data. Of these 1,528 patients, 83 (5.4%) required readmission. PSM was performed prior to comparing readmission versus non-readmission. While there was no difference in perioperative complications between the two groups, the small sample size of the readmission cohort prevented this analysis from having sufficient power. No patient requiring readmission had an initial length of stay greater than one day.

Conclusion
Based on a 10-year outpatient analysis, fewer than 6% of outpatient 1-2 level ACDFs require readmission. Future studies involving outpatients from several states will be necessary to determine whether these results of outpatient ACDF are applicable nationwide.

Introduction
Anterior cervical discectomy and fusion (ACDF) performed as an outpatient has become increasingly common for treating cervical spine pathology. The typical patient receiving outpatient ACDF is a healthy male 43-50 years of age with a BMI of 27-29 and ≤ 2 medical co-morbidities (most likely hypertension, diabetes, hypercholesterolemia or depression) who has a cervical disc herniation and receives a single-level ACDF.1-5 The relative good preoperative health of such patients has contributed greatly to the excellent reported outcomes of outpatient ACDF.6,7 These outcomes, in combination with the potential savings in cost compared with inpatient ACDF have recently led to the rise of ACDF being performed on an outpatient basis.5,6-8
Few reports have attempted to assess readmissions following outpatient ACDF\(^2,4,5\). Of the limited previous reports, readmissions have typically resulted from postoperative neck swelling/hematoma, which has the potential to be life-threatening if not promptly evacuated.\(^4,5\) This retrospective cohort study was performed to address readmissions following outpatient ACDF using the State Ambulatory Surgery and Services Database (SASD), a large multicenter population-based database which has been recently used in the peer-reviewed literature.\(^9,10\)

For this study, the SASD for the state of New Jersey (overview available at https://www.hcup-us.ahrq.gov/sasdoverview.jsp) encompassing the years 2003 through 2012 was obtained from the Health Care Cost and Utilization Project, Agency for Healthcare Research and Quality (Rockville, MD).\(^11\)

**Methods**

**Data Source**

The SASD includes encounter-level data for ambulatory surgery and other outpatient services from hospital-owned facilities, with the specific types of ambulatory surgery and outpatient services varying by state and data year. The SASD from each state includes encounter-level outpatient data that are translated into a uniform format to facilitate multistate comparisons and analyses, and contains a core set of uniform clinical and nonclinical information on all patients, regardless of payer, including those covered by Medicare, Medicaid, private insurance, and the uninsured. Some SASD states include additional patient demographic information such as race. Presently, 34 states participate in the SASD.

For the state of New Jersey, the SASD defines readmission as admission to the same facility from which the patient was discharged within the previous seven days. The SASD contains no information on the details of the readmission such as the reasons for the readmission or the length of stay in the second admission.

**Inclusion and Exclusion Criteria**

Using the International Classification of Diseases, Ninth Revision, Clinical Modification diagnosis and treatment codes, discharges were identified for those patients undergoing ACDF (defined as anterior cervical fusion [ICD-0 code=81.02] + excision of intervertebral disc [80.51]). Patients with three or more levels fused (ICD-9 codes 81.63-81.64), cancer (ICD-9 codes 140-239), or trauma (ICD-9 codes=805.0-806.9) were excluded. Additionally, any patient with any missing data for age, sex, total hospital cost, in-hospital mortality, hospital length of stay, and number of diagnoses was excluded. Mortality data was reported using methodology consistent with the Health Care Cost and Utilization Project (HCUP) family of databases well-represented in the peer-reviewed literature, including the Nationwide Inpatient Sample, the Kids’ Inpatient Database, and the State Inpatient Databases.\(^11\)

**Data Collection**

Demographic data for age, race, gender, primary payer, hospital length of stay (LOS) and readmission were analyzed in this study (Table 1). A total of 14 postoperative variables were analyzed to compare readmissions versus non-readmissions for outpatient ACDF (Table 2). These variables were selected based on previous work involving population-based databases to conduct postoperative analyses and known perioperative ACDF complications (McGirt et al., 2015).

**Statistical Analysis**

Statistical analysis was performed using SPSS version 17 (IBM Corporation, Armonk, New York). The

<table>
<thead>
<tr>
<th></th>
<th>No Readmission</th>
<th>Readmission</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>47.8</td>
<td>45.4</td>
<td>0.021</td>
</tr>
<tr>
<td>Female sex</td>
<td>47%</td>
<td>45%</td>
<td>0.660</td>
</tr>
<tr>
<td>Caucasian race</td>
<td>75%</td>
<td>80%</td>
<td>0.302</td>
</tr>
<tr>
<td>Medicaid as Primary Payer</td>
<td>0.01%</td>
<td>0%</td>
<td>0.351</td>
</tr>
<tr>
<td>Hospital Length of Stay (days)</td>
<td>0.17</td>
<td>0.11</td>
<td>0.114</td>
</tr>
<tr>
<td>Number of Diagnoses</td>
<td>2.82</td>
<td>2.22</td>
<td>0.006</td>
</tr>
<tr>
<td>Number of Procedures Performed</td>
<td>3.98</td>
<td>3.89</td>
<td>0.410</td>
</tr>
<tr>
<td>Plate Implanted with ACDF (percentage of patients)</td>
<td>63%</td>
<td>58%</td>
<td>0.374</td>
</tr>
</tbody>
</table>

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characteristics of patients, providers and hospitals
were summarized by descriptive statistics and ana-
yzed using independent samples t-tests. Propensity
score matching (PSM) was performed on all patients
using R 3.2.3 (R Foundation for Statistical Comput-
ing, Vienna, Austria) assisted by MatchIt, rgenoud,
and Matching packages to adjust for age, race, sex,
primary payer of care, and number of diagnoses.12-15
Following PSM, postoperative variables were ana-
yzed using chi-square testing, with significance de-
efined as a P value less than 0.05. Sample size calcula-
tions were performed using MapleTech online soft-
ware (http://www.calculator.net/sample-size-
calculator.html).

Results

From 2003 through 2012, the New Jersey SASD
contained 4,194,207 outpatients, of whom 2,016 re-
ceived ACDF. 1,528 of these 2,016 patients (75.8%)
had readmission data. Demographics of readmission
versus non-readmission patients are listed in Table 1.
Differences between the two cohorts in age and num-ber of diagnoses necessitated PSM (Table 1).

Of the 1,528 ACDF patients, 83 (5.4%) required read-
mismission. Following PSM, comparisons between the
readmission and non-readmission cohorts were
made, which revealed no difference in perioperative
complications (listed in Table 2). However, sample
size calculations revealed that a minimum of 384
readmission patients would be required to provide
sufficient power, which was significantly larger than
the 83 patients in this study.

No patient who required readmission had an initial
hospital length of stay longer than one day; only nine
of the 83 patients who required readmission (10.8%)
required hospital stay of a single day; the remaining
74 (89.2%) patients required no hospital stay. Overall,
99.8% of patients in our study (1,525 of 1,528) had
hospital LOS of 0 or 1 days. There was no mortality
among the 1,528 patients with readmission data.

Further examination revealed that 1,283 of the 1,528
patients (84%) had LOS of zero days (= same-day dis-
charge), including 1,209 of the 1,445 patients who
did not require readmission. For outpatient ACDFs
who had same-day discharge, the readmission rate
was 5.8% (74 of 1,283).

Discussion

The increasing popularity of outpatient ACDF as a
means of cost savings compared with inpatient
ACDF has resulted in increased interest in the safety
of outpatient ACDF. One of the greatest threats to
both the cost savings and safety associated with out-
patient ACDF is the potential for an unacceptable
rate of readmissions. This study was performed to
assess readmissions in outpatient ACDF using a
large 10-year ambulatory surgery database, comprising
a total of 1,528 outpatient 1-2 level ACDF cases
with known readmission data.

Our results indicate that the incidence of readmis-
sion following outpatient ACDF is 5.4%. Unfortu-
nately, due to the definition of the NJ SASD of read-

Table 2. Description of the 14 postoperative complications assessed in this
NIS analysis to examine the impact of readmission on outpatient ACDF.

<table>
<thead>
<tr>
<th>Postoperative Complication</th>
<th>Required Readmission</th>
<th>Did Not Require Readmission</th>
<th>P value</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durotomy</td>
<td>0/83</td>
<td>1/1,445</td>
<td>1.000</td>
<td>N/A</td>
</tr>
<tr>
<td>Arm Paralysis</td>
<td>0/83</td>
<td>0/1,445</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Leg Paralysis</td>
<td>0/83</td>
<td>0/1,445</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Paraplegia</td>
<td>0/83</td>
<td>0/1,445</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Postoperative Infection</td>
<td>0/83</td>
<td>0/1,445</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Hematoma/Seroma</td>
<td>0/83</td>
<td>1/1,445</td>
<td>1.000</td>
<td>N/A</td>
</tr>
<tr>
<td>Foreign Body Retention</td>
<td>0/83</td>
<td>0/1,445</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Acute Reaction to Foreign Body</td>
<td>0/83</td>
<td>0/1,445</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Rh-Incompatible Reaction</td>
<td>0/83</td>
<td>0/1,445</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Other Transfusion Reaction</td>
<td>0/83</td>
<td>0/1,445</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Respiratory Complications</td>
<td>0/83</td>
<td>0/1,445</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Acute Posthemorrhagic Anemia</td>
<td>0/83</td>
<td>0/1,445</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Dysphonia</td>
<td>0/83</td>
<td>0/1,445</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Red Blood Cell Transfusion</td>
<td>0/83</td>
<td>0/1,445</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
mission, our results are an estimate of readmission within seven days of discharge, rather than the standard 30-day window used in most readmission analyses; this would most likely artificially lower our readmission rates in comparison. Further complicating our results is the inability of the NJ SASD to distinguish one-level from two-level operations, as the majority of previous studies have had a majority of one-level ACDFs, whereas our results may have involved significantly more two-level ACDFs.\textsuperscript{1-2,4-5,16-19} The previous studies were single-center analyses which may have been subject to reporting bias in order to favor the safety of outpatient ACDF, whereas the present study used a state database with larger numbers from multiple centers and standardized reporting.

Noteworthy is the fact that the readmission rate in our study is by far the highest in the reported literature (Table 3). This may be due to the aforementioned mitigating factors, or it may be due to the fact that our sample size is at least 50\% larger than any previous report examining outpatient ACDF readmissions and greater than the combined sample size of the next seven largest previous single-center reports that reported readmission data (Table 3). One alternative hypothesis is that the majority of the published literature may only define readmission as cases requiring actual hospital admission, as opposed to the SASD which documents Emergency Department visits regardless of whether they require hospital admission. This may actually result in our findings being more in line with the true rate of readmission than the published literature.

Another noteworthy finding is that no patient requiring readmission suffered any respiratory complications or hematoma/seroma (Table 2), given that postoperative airway issues (often secondary to an operative field hematoma) are a potentially life-threatening cause of readmission following ACDF, and have been a source of reluctance to performing ACDF on an outpatient basis.\textsuperscript{6} A pertinent criticism of this study is that our definition of an outpatient (any patient recorded in the SASD) may be less strict than in previous reports, since almost none of those patients had any hospital LOS initially. To address this, we performed a subanalysis of New Jersey SASD ACDF patients with LOS of zero days, which comprised 84\% of our overall population. This analysis revealed a readmission rate of 5.8\%, which is nearly identical to the 5.4\% readmission rate from our overall ACDF outpatient cohort. Furthermore, since the SASD definition of LOS is the date of discharge minus the date of admission, it is likely that outpatients in previously reported studies who underwent 23-hour observation would be included as a LOS = 1 in the SASD. In fact, 1,525 of the 1,528 patients in our study (99.8\%) had LOS of 1 day or less.

Unfortunately, despite the relatively large sample size, the number of readmissions (83) remained too small to adequately power this study to detect significant differences involving the 14 perioperative complications examined (Table 2). It is possible that there exist differences between outpatient ACDF readmission and nonreadmission patients with regard to these complications; however this study was simply not powered to detect any such difference.

The most prominent limitations of this study are its retrospective nature and reliance on a single state.

<table>
<thead>
<tr>
<th>Number of outpatient ACDF patients</th>
<th>Readmission rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silvers et al., 1996</td>
<td>50</td>
</tr>
<tr>
<td>Stieber et al., 2005</td>
<td>30</td>
</tr>
<tr>
<td>Villavicencio et al., 2007</td>
<td>103</td>
</tr>
<tr>
<td>Erickson et al., 2007</td>
<td>58</td>
</tr>
<tr>
<td>Liu et al., 2009</td>
<td>45</td>
</tr>
<tr>
<td>Garringer et al., 2010</td>
<td>645</td>
</tr>
<tr>
<td>Trahan et al., 2011</td>
<td>59</td>
</tr>
<tr>
<td>Lied et al., 2013</td>
<td>96</td>
</tr>
<tr>
<td>Tally et al., 2013</td>
<td>119</td>
</tr>
<tr>
<td>McGirt et al., 2015</td>
<td>1,168</td>
</tr>
<tr>
<td>Adamson et al., 2016</td>
<td>1,000</td>
</tr>
<tr>
<td>Present study</td>
<td>1,528</td>
</tr>
</tbody>
</table>

NR = Not reported. * = Did not specifically report readmission rate; rate of “major morbidity” (surgical site infection, new neurological deficit, stroke, reintubation, deep vein thrombosis/pulmonary embolism, myocardial infarction, postoperative hematoma, return to operating room within 30 days) was 0.94\%.
Utilization of the SASD allows for potential uncertainty regarding the accuracy of case assignment for the database, given the reliance of the database on ICD-9 rather than current procedural terminology (CPT) coding; the SASD is unable to assess the specific reasoning behind a patient seeking readmission beyond ICD-9 coding data. This reliance on ICD-9 coding also prohibits the differentiation between one-level and two-level fusions (respectively two vertebrae and three vertebrae fusions), since they both share the same ICD-9 procedure code of 81.62. Furthermore, the SASD does not allow for determination of the chronological relation between the ICD-9 codes and the surgical procedure, which eliminates the possibility of performing analysis involving temporal association. Another important limitation is the lack of granularity in the SASD to perform an analysis of comorbidities and other factors previously shown to be associated with longer LOS in ACDF. A sixth limitation is the fact that more than 24% of patients who received outpatient ACDF did not have readmission data; it is possible that these patients may have suffered more severe postoperative complications than the 76% of patients who did have readmission data. A seventh limitation is that given the outpatient nature of this database, potential complications which occurred following discharge that did not involve a patient being readmitted may have not been included; for instance, a patient discharged from an ambulatory center who subsequently died at home without having been readmitted may not have been included as a mortality in the SASD. However, the SASD contains hospital identifiers that permit linkage to inpatient hospital databases, such as the Agency for Healthcare Research and Quality-sponsored State Inpatient Databases and the American Hospital Association Annual Survey File; therefore the likelihood of not capturing mortality in the SASD remains extremely low, even beyond 90 days following discharge. The nature of the HCUP database family collection of data prohibits determination of 30-day mortality rates, which is certainly a limitation compared with other population-based databases. Finally, because the SASD readmission data for New Jersey only involves the first seven postoperative days, any subsequent complications would not have been captured by the New Jersey SASD, even if they occurred within the first 30 days postoperatively. Of the 34 states that currently participate in the SASD, New Jersey is one of only three that contains any readmission data, with the other two being Maryland and Vermont.

**Conclusions**

Accepting the limitations of the SASD, these findings from a population-based database of 1,528 outpatient 1-2 level ACDF cases comprising a 10-year period indicate that more than 5% of outpatient ACDFs require readmission within the first seven days following discharge. Future studies involving outpatients from several states will be necessary to determine whether this study’s results are applicable nationwide.

**References**

7. Silvers HR, Lewis PJ, Suddaby LS, Asch HL,

Disclosures & COI
The authors declare no relevant disclosures.

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