

Clinical Study

Predictors of outcomes and hospital charges following atlantoaxial fusion

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Abstract

BACKGROUND CONTEXT: Atlantoaxial fusion is used to correct atlantoaxial instability that is often secondary to traumatic fractures, Down syndrome, or rheumatoid arthritis. The effect of age and comorbidities on outcomes following atlantoaxial fusion is unknown.

PURPOSE: This study aimed to better understand trends and predictors of outcomes and charges following atlantoaxial fusion and to identify confounding variables that should be included in future prospective studies.

STUDY DESIGN: A retrospective analysis of data from the Nationwide Inpatient Sample (NIS), a nationally representative, all-payer database of inpatient diagnoses and procedures in the United States.

PATIENT SAMPLE: We included all patients who underwent atlantoaxial fusion (International Classification of Disease, Ninth Revision, Clinical Modification code 81.01) between 1998 and 2011 who were 18 years or older at the time of admission.

OUTCOME MEASURES: Outcome measures included in-hospital charges, hospital length of stay (LOS), in-hospital mortality, and discharge disposition.

METHODS: Predictors of outcome following atlantoaxial fusion were assessed using a series of univariable analyses. Those predictors with a p-value of less than .2 were included in the final multivariable models. Independent predictors of outcome were those that were significant at an alpha level of 0.05 following inclusion in the final multivariable models. Logistic regression was used to determine predictors of in-hospital mortality and discharge disposition whereas linear regression was used to determine predictors of hospital charges and LOS. Discharge weights were used to produce generalizable results.

FDA device/drug status: Not applicable.

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RESULTS: From 1998 to 2011, there were 8,914 hospitalizations recorded wherein atlantoaxial fusion was performed during the inpatient hospital stay. Of these hospitalizations, 8,189 (91.9%) met inclusion criteria. Of the study sample, 62% was white, and the majority of patients were either insured by Medicare (47.2%) or had private health insurance (35.6%). The most common comorbidity as defined by the NIS and the Elixhauser comorbidity index was hypertension (43.2%). The in-hospital mortality rate for the study population was 2.7%, and the median LOS was 6.0 days. The median total charge (inflation adjusted) per hospitalization was \$73,561. Of the patients, 48.9% were discharged to home. Significant predictors of in-hospital mortality included increased age, emergent or urgent admissions, weekend admissions, congestive heart failure, coagulopathy, depression, electrolyte disorder, metastatic cancer, neurologic disorder, paralysis, and non-bleeding peptic ulcer. Many of these variables were also found to be predictors of LOS, hospital charges, and discharge disposition.

CONCLUSION: This study found that older patients and those with greater comorbidity burden had greater odds of postoperative mortality and were being discharged to another care facility, had longer hospital LOS, and incurred greater hospital charges following atlantoaxial fusion. © 2016 Elsevier Inc. All rights reserved.

Keywords: Atlantoaxial fusion; Cervical fusion; Hospital charges; Inpatient sample; Mortality; Nationwide

Introduction

Atlantoaxial fusion is used to correct atlantoaxial instability (AAI) that is often secondary to traumatic fractures (17%) [1], Down syndrome (10–30%) [2,3], degenerative disease, or rheumatoid arthritis (RA) (20%–86% have atlantoaxial instability) [4]. Among patients who undergo atlantoaxial fusion, 4.1% develop vertebral artery injury [5], 11.2% develop an area of sensory loss in the distribution of the C2 nerve [1], and 16.7% develop a complication [6]. Prior studies on atlantoaxial fusion relied on single-institution data to quantify outcomes in the context of specific pathologies [7–11]. Limitations caused by sample size and sampling bias render prior studies unable to accurately determine predictors of outcome following atlantoaxial fusion because they cannot control for confounders such as socioeconomic status, race, and patient clustering. Insufficient sample size is also likely a problem for studies that would use disease-specific registries. Identifying the preoperative factors that predict postoperative outcomes for relatively rare procedures such as atlantoaxial fusion depends on having significant sample sizes such as those available in administrative databases. Additionally, administrative databases are uniquely positioned to study regional differences in practice patterns and hospital charges because they can draw from multiple institutions across the country.

Prior studies that used larger national patient databases have focused on the predictors of outcomes following surgery at any vertebral level in the subaxial spine rather than atlantoaxial fusion specifically [12–14]. Such studies have found that age and comorbidity burden of patients undergoing spinal fusion has increased over the last decade [12]. However, the effects of age, specific comorbidities, and hospital characteristics on outcomes immediately following atlantoaxial fusion have not yet been quantified. Identifying and quantifying predictors of postoperative outcome can improve patient risk counseling for atlantoaxial fusion. As the US health-care

system continues to transition toward value-based care, understanding the predictors of outcomes and hospital charges following spinal procedures such as atlantoaxial fusion will benefit patients, surgeons, and hospital systems.

There is a dearth of large-scale studies that identify predictors of outcomes following atlantoaxial fusion. The present study uses a large, multi-institutional, retrospectively collected, all-payer database of inpatient diagnoses and procedures to determine significant predictors of outcomes following atlantoaxial fusion. We hypothesized that older patients and those with greater comorbidity burden would have greater odds of postoperative in-hospital mortality, longer hospital length of stay (LOS), and incur greater hospital charges [12,15].

Methods

Data collection

This study used Nationwide Inpatient Sample (NIS) data from 1998 to 2011. Data points were included if any diagnosis listed the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) procedure code for atlantoaxial fusion (81.01).

The NIS is the largest all-payer health-care database in the United States [16]. Established by the Agency for Healthcare Research and Quality (AHRQ), the database is composed of a 20% stratified sample of all hospital discharges from 1988 to 2011. Within the NIS, each entry represents a single hospital admission. Data recorded in the NIS include patient demographics, comorbidities, diagnoses, procedures performed, outcomes (eg, hospital LOS, hospital charges, in-hospital mortality), and hospital features [16]. Lastly, the NIS records admission diagnoses, procedures, and in-hospital complications using ICD-9-CM codes.

We used data starting in 1998 to mitigate bias, as the sampling strategy of the NIS changed that year [17]. Additionally, Elixhauser comorbidity data [18,19] were collected begin-

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