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Clinical Study

# National trends in the management of central cord syndrome: an analysis of 16,134 patients

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**Abstract**

**BACKGROUND CONTEXT:** Central cord syndrome (CCS) is a common cause of incomplete spinal cord injury. However, to date, national trends in the management and mortality after CCS are not fully understood.

**PURPOSE:** To analyze how patient, surgical, and institutional factors influence surgical management and mortality after CCS.

**STUDY DESIGN:** A retrospective cohort analysis.

**PATIENT SAMPLE:** The Nationwide Inpatient Sample (NIS) was queried for records of patients with a diagnosis of CCS from 2003 to 2010.

**OUTCOME MEASURES:** They included in hospital mortality and surgical management, including anterior cervical decompression and fusion (ACDF), posterior cervical decompression and fusion (PCDF), and posterior cervical decompression (PCD).

**METHODS:** Using International Classification of Diseases, Ninth Revision, Clinical Modification codes, patient records with a diagnosis of CCS from 2003 to 2010 were selected from the NIS database and sorted by inpatient mortality and surgical management. Demographic information (age, gender, and race) and hospital characteristics were evaluated with $\chi^2$-tests for categorical variables and *t* tests for continuous variables. Multivariate logistic regression models controlled for confounding.

**RESULTS:** In this sample of 16,134 patients, a total of 39.7% of patients (6,351) underwent surgery. ACDF was most common (19.4%), followed by PCDF (7.4%) and PCD (6.8%). From 2003 to 2010, surgical management increased by an average of 40% each year. The overall inpatient mortality rate was 2.6%. Increasing age and comorbidities were associated with higher rates of patient mortality and a decreasing surgical rate ($p<.01$). Hospitals greater than 249 beds ($p<.01$) and the south ($p<.01$) were associated with a higher surgical rate. Rural hospitals ($p<.01$) and people in the second income quartile ($p<.01$) were associated with higher inpatient mortality.

**CONCLUSIONS:** Elderly patients with medical comorbidities are associated with a lower surgical rate and a higher mortality rate. Surgical management was more prevalent in the south and large hospitals. Mortality was higher in rural hospitals. It is important for surgeons to understand how patient, surgical, and institutional factors influence surgical management and mortality. 

*Keywords:* Central cord syndrome; National database; Surgical management; Inpatient mortality; Demographics; Comorbidities

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EVIDENCE & METHODS

**Context**
The treatment of central cord syndrome (CCS) has evolved considerably over the last two decades, with many surgeons taking a more aggressive approach to treatment. The authors sought to evaluate national trends in the management of CCS using data from the Nationwide Inpatient Sample (NIS).

**Contribution**
Between 2003 and 2010, the rate of surgical intervention for patients with CCS increased by 40% annually. Overall, close to 40% of patients received surgery and the mortality rate approximated 3%. The desire to perform surgery appeared to be influenced by patient age as well as the number of medical co-morbidities. These factors were also indicative of increased mortality as was treatment at rural institutions.

**Implications**
The trends noted in the NIS confirm findings presented in other initiatives limited to single centers or multicenter collaboratives. The NIS is a stratified sample that requires weighting in order to develop estimates for the American demographic. It is unclear whether resultant determinations can be considered nationally representative when the weighting algorithm is employed for conditions that are rare (such as CCS). In addition, patients who were discharged from the hospital without surgery at the time of initial presentation, only to return on an elective delayed basis for surgical intervention, may not have been appropriately captured by the NIS. Recent reports from Jonathan Grauer's group at Yale have called into question the reliability of co-morbidity coding in the NIS, a factor which could have an important impact on a study such as this one, which is trying to use ICD-9 coding for diagnosis, co-morbidity and surgical intervention to determine national trends. Multiple comparisons without statistical correction and the sheer number of co-variates included in the adjusted models might also mean that some of the statistically significant findings reported in this study may be present solely due to chance. As a result, the risk factors identified here likely require independent confirmation using a more clinically granular dataset (such as NSQIP) or a prospective cohort design.

*—The Editors*

## Introduction

Central cord syndrome (CCS), the most common incomplete spinal cord injury, is a debilitating disorder with an incidence of approximately 11,000 cases a year [1]. Central cord syndrome commonly affects older adults with underlying cervical spondylosis who sustain hyperextension injuries [2]. Spinal cord pathology is primarily associated with the medial portion of the lateral corticospinal tract in the cervical spine [3].

Historically, initial treatment was often conservative. Physical/occupational and corticosteroid therapies have been commonly encouraged before the decision for surgery [4]. However, it has been shown that many CCS patients plateau before worsening [5]. Moreover the STASCIS study (Surgical Timing in Acute Spinal Cord Injury Study), published in 2012, has demonstrated the benefits of early decompression (less than 24 hours) in regaining motor strength compared with late decompression (more than 24 hours) after cervical spinal cord injury [6].

The extent of neurologic deficit often correlates with surgical urgency [7]. Central cord syndrome may be managed surgically with anterior cervical decompression and fusion (ACDF), posterior cervical decompression and fusion (PCDF), and/or posterior cervical decompression (PCD) alone. Most agree that surgical management is safe and prudent in the treatment of acute fractures and disc herniations, but there is still some disagreement regarding the role of surgery in classic CCS.

Central cord syndrome has not been examined on a national scale except for a recent analysis by Yoshihara and Yoneoka [8]. The present study examined national inpatient surgical and mortality characteristics in a population of cervical CCS patients using discharge data from the Nationwide Inpatient Sample, Healthcare Cost and Utilization Project, and Agency for Healthcare Research and Quality [9]. Awareness of associations between patient demographics, comorbidities, hospital characteristics, and outcomes on an epidemiologic level may influence the care of CCS patients. The aim of our study was to analyze how patient, surgical, and institutional factors influence surgical management and mortality.

## Materials/Methods

### *Data source*

Nationwide Inpatient Sample hospital discharge data from the Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality, Rockville, MD, USA was used in this study [9]. The Nationwide Inpatient Sample is the largest all-payer inpatient care administrative database in the United States, containing discharge records organized according to the procedure and diagnostic codes from the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD9-CM). Each annual data set is approximately eight million records and represents a 20% random sample of hospitals in the country, stratified by geographic region, teaching status, hospital size, and other characteristics. Discharge weights were applied to