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# Increasing Rates of Surgical Management of Multilevel Spinal Curvature in Elderly Patients

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**Abstract**

**Study Design:** Retrospective analysis of Nationwide Inpatient Sample (NIS) database.
**Objective:** To analyze trends in utilization and hospital charges for multilevel spinal curvature surgery in patients over 60 from 2004 to 2011.
**Summary of Background Data:** Multilevel spinal curvature has been increasingly recognized as a major source of morbidity in patients over sixty years of age. The economic burden of non-operative management for spinal curvature is elusive and likely underestimated. Though patient reported outcomes suggest that surgical treatment of spinal curvature may be superior to non-operative treatment in selected patients, surgical utilization trends remain unclear.
**Methods:** Data were obtained from the NIS between 2004 and 2011. The NIS is the largest all-payer inpatient care database with approximately eight million annual patient discharges throughout the United States. Analysis included patients over age 60 with a spinal curvature diagnosis treated with a multi-level spinal fusion (⩾3 levels fused) determined by ICD-9-CM diagnosis and procedure codes. Population-based utilization rates were calculated from US census data.
**Results:** A total of 84,302 adult patients underwent multilevel spinal curvature surgery from 2004 to 2011. The annual number of ⩾3 level spinal curvature fusions in patients over age 60 increased from 6,571 to 16,526, representing a 107.8% increase from 13.4 cases per 100,000 people in 2004 to 27.9 in 2011 ($p < .001$). Utilization rates in patients 65–69 years old experienced the greatest growth, increasing by 122% from 15.8 cases per 100,000 people to 35.1. Average hospital charges increased 108% from $90,557 in 2007 to $188,727 in 2011 ($p < .001$).
**Conclusions:** Rates of surgical management of multilevel spinal curvature increased from 2004 to 2011, exceeding growth of the 60+ age demographic during the same period. Growth was observed in all age demographics, and hospital charges consistently increased from 2004 to 2011 reflecting a per-user increase in expenditure.
**Level of Evidence:** III.
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*Keywords:* Multilevel fusion; Scoliosis; Elderly; Epidemiology; Trends

## Introduction

Spinal curvature is a common pathology that affects the spine in older patients [1], encompassing a broad spectrum of pathology including scoliosis, sagittal plane malalignment, and segmental rotational alignments [2]. In the adult with spinal curvature, degenerative pathologies including

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spinal stenosis, spondylolisthesis, and disc degeneration coexist with spinal malalignment, leading to complex clinical presentations of pain, neural pathology, functional limitations, social isolation, and dissatisfaction with appearance. The impact of spinal curvature on health-related quality of life is significant and exceeds the impact of many other common medical conditions [3,4].

The operative and medical/interventional management of spinal curvature is characterized by significant variability, indicating the absence of an evidence-based approach to care [5,6]. Although studies have demonstrated positive outcomes with operative correction of spinal curvature with patient-reported improvement in quality of life [7], complications associated with surgery are not uncommon in the elderly or in patients with significant comorbidities, including pseudoarthrosis, infection, neurologic deficits, cerebrospinal fluid (CSF) leaks, adjacent segment disease, systemic complications, and pulmonary embolism [8,9].

Although increasing trends in the use and complexity of surgical treatments for spinal pathologies have been reported [10-13] no similar studies have examined trends in major spinal reconstruction surgeries for spinal curvature in the elderly. Schwab et al. demonstrated spinal deformity in more than 60% of adult volunteers older than 60 years [1]. Older patients present with greater disability compared to younger patients, and the risk-to-benefit ratio may support operative intervention in patients with limited comorbidities [14]. The purpose of this study is to examine the use of multilevel spine surgery in the context of spinal curvature from 2004 to 2011. As the age distribution of the United States continues to shift toward an older population, this information becomes increasingly important in guiding clinicians, researchers, and administrators in decision making.

## Methods

### *Data source*

Patients undergoing spinal fusion for spinal curvature were identified using data from the Nationwide Inpatient Sample (NIS) from the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality (AHRQ) from years 2004 to 2011. The NIS is the largest national database of all-payer inpatient discharge information, sampling approximately 20% of all nonfederal US hospitals and including approximately 9 million hospital admissions each year. Each NIS entry includes ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification) diagnosis and procedure codes of activity during the patient's hospitalization at the time of discharge, as well as patient demographics, hospital characteristics, and duration of stay. More information about the NIS can be found at http://www.hcup-us.ahrq.gov/nisoverview.jsp.

### *Data extraction*

All available NIS data from 2004 through 2011 were queried. To identify the elderly population treated for spinal curvature, patients older than age 60 years were included in the study. Patients with a diagnosis of spinal curvature undergoing primary spinal fusion were identified using ICD-9-CM coding (Table 1). Spinal fusion categories were subcategorized based on region (cervical, thoracic, lumbar) and approach (anterior, posterior). Combined anterior and posterior approaches were determined by identifying patients who underwent both anterior and posterior column fusion. Patients with combined anterior and posterior fusion were excluded from other approaches. Patients undergoing fusion of 3 or more levels (4–8 vertebrae or ⩾9 vertebrae) were identified using ICD-9-CM codes. Patients were

Table 1
ICD-9-CM codes.

| | |
|---|---|
| ICD-9 diagnosis codes | |
| Spinal Curvature | 737.0, 737.1x, 737.2x, 737.3x, 737.4x, 737.8, 737.9, 738.2, 738.3, 738.4, 738.5, 738.6 |
| ICD-9 procedure codes | |
| Cervical fusion, anterior column | 81.02 |
| Cervical fusion, posterior column | 81.03 |
| Thoracic fusion, anterior column | 81.04 |
| Thoracic fusion, posterior column | 81.05 |
| Lumbar fusion, anterior column | 81.06 |
| Lumbar fusion, posterior column | 81.07 |
| Lumbar fusion, anterior column | 81.08 |
| Recombinant bone morphogenetic protein | 84.52 |
| Excision of bone for graft, other | 77.79 |
| Fusion of 4–8 vertebrae (3–7 levels) | 81.63 |
| Fusion of 9 or more vertebrae (⩾8 Levels) | 81.64 |
| Osteotomy | 77.20, 77.29, 77.10, 77.19, 77.30, 77.39 |
| Cervical fusion | 81.02-81.03 |
| Thoracic fusion | 81.04-81.05 |
| Lumbar fusion | 81.06-81.08 |
| Anterior-posterior combined fusion | (anterior cervical OR anterior thoracic OR anterior lumbar OR posterior lumbar interbody fusion) AND (posterior cervical OR posterior thoracic OR posterior lumbar) |
| Anterior column fusion | (anterior cervical OR anterior thoracic OR anterior lumbar OR posterior lumbar interbody fusion) NOT (anterior-posterior combined) |
| Posterior column fusion | (posterior cervical OR posterior thoracic OR posterior lumbar) NOT (anterior-posterior combined) |

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