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[John Rhee](#), *Emory University*  
AT Anastasio, *Duke University Medical Center*  
KX Farley, *Emory University School of Medicine*

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## Clinical Studies

# Depression and anxiety as emerging contributors to increased hospital length of stay after posterior spinal fusion in patients with adolescent idiopathic scoliosis

Albert T. Anastasio<sup>a,\*</sup>, Kevin X. Farley<sup>b</sup>, John M. Rhee<sup>c</sup><sup>a</sup> Duke University Medical Center, Department of Orthopaedic Surgery, Box 3000, PGY-1 Orthopaedic Surgery Resident, Durham, NC 27710, United States<sup>b</sup> Emory University School of Medicine, 201 Dowman Dr, Atlanta, 30322, United States<sup>c</sup> Emory University Department of Spine Surgery, 201 Dowman Dr, Atlanta, 30322, United States

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## ABSTRACT

**Background Context:** The diagnosis of generalized anxiety disorder (GAD) and major depressive disorder (MDD) amongst adolescents is rising worldwide. Rates of these disorders are higher in those with adolescent idiopathic scoliosis.

**Purpose:** To elucidate whether or not depression and anxiety are associated with increased length of stay and total cost after posterior spinal fusion for adolescent idiopathic scoliosis.

**Study Design/Setting, Patient Sample:** This study utilized the Nationwide Inpatient Sample (NIS) to obtain a sample of  $n = 564$  in the depression and anxiety cohort and  $n = 5,185$  in the cohort without concomitant diagnosis of depression and anxiety.

**Outcome Measures:** Length of stay and total cost after posterior spinal fusion for adolescent idiopathic scoliosis.

**Methods:** The Nationwide Inpatient Sample (NIS) was queried for patients undergoing posterior spinal fusion (PSF) for adolescent idiopathic scoliosis with either the concomitant diagnosis of major depressive disorder or generalized anxiety disorder. Comorbidities and other confounders were controlled for using multivariate regression analysis to determine the effect of having either mood disorder on cost and length of stay (LOS) after PSF.

**Results:** We determined that after controlling for confounding variables and comorbidities through multivariate regression analysis, patients with either depression or anxiety had increased odds ratios for increased LOS but not for cost.

**Conclusions:** The emergence of adolescent MDD and GAD may have significant implications on the inpatient stay for patients undergoing major surgery, including PSF for adolescent idiopathic scoliosis.

## Introduction

The diagnosis of generalized anxiety disorder (GAD) and major depressive disorder (MDD) amongst adolescents is not only rising worldwide, but is likely underrecognized. [1] Adolescent idiopathic scoliosis (AIS) is a common pathology of the spine and severe deformities are often corrected by posterior spinal fusion (PSF) to correct the curvature. [2] These procedures are extremely costly and hospital length of stay (LOS) after PSF is significant. [3]

Rates of depression in patients with AIS are higher than the national average of roughly 4%, with roughly 1/5 of adolescents with AIS exceeding the Children's Depression Inventory cut off score of 13. [4,5]

We hypothesized that cost and LOS after PSF for patients with AIS with concomitant major depressive disorder or generalized anxiety disorder would be increased over a matched cohort without these psychiatric disorders.

## Methods

## Database query

The Nationwide Inpatient Sample (NIS) is a part of the Healthcare Cost and Utilization Project (HCUP) and is maintained by the Agency for Healthcare Research and Quality (AHRQ). Approximations are based

\* Corresponding author.

E-mail addresses: [albert.anastasio@duke.edu](mailto:albert.anastasio@duke.edu) (A.T. Anastasio), [kevin.xavier.farley@emory.edu](mailto:kevin.xavier.farley@emory.edu) (K.X. Farley), [jmrhee@emory.edu](mailto:jmrhee@emory.edu) (J.M. Rhee).<https://doi.org/10.1016/j.xnsj.2020.100012>

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**Table 1**  
Demographic information of the study population.

Variable	Number of patients	% of group
Total		
Study grouping		
Depression/anxiety	564	10.9%
Norm	5185	89.1%
Age Category		
0–10 years, and >17 years	907	15.8%
11–16 years	4842	84.2%
Sex		
Female sex	4914	85.5%
Male sex	835	14.5%
Region of hospital		
Northeast	927	16.1%
Midwest	1294	22.5%
South	2510	43.7%
West	1018	17.7%
Bed size of hospital*		
Small	785	13.7%
Medium	1265	22.0%
Large	3699	64.3%
Location/teaching status of hospital*		
Rural	22	0.3%
Urban non-teaching	137	2.4%
Urban teaching	5590	97.3%
Insurance payer status		
Other	353	6.1%
Medicare	14	0.2%
Medicaid	1509	26.2%
Private	3873	67.5%
Total	5749	100%

\*Bed size of hospital is nested by region of hospital. Small bed size ranges from 1 to 249 beds, medium bed size ranges from 30 to 449, and large bed size ranges from 50+ to 450+ depending on population density of region.

\*A metropolitan statistical area is considered urban, and a non-metro statistical area is rural.

on weighting variables which are assigned to the data and can then be extrapolated to the country as a whole.

This study was exempt from institutional review board approval. We queried the NIS database from 2003 to 2015 for patients with the ICD 9 code of 737.30 for adolescent idiopathic scoliosis who had an inpatient admission with any of the following procedural codes for posterior spinal fusion: 8105, 8107, 8108 (excluding 8104, 8106, 8162). Additionally, patient comorbidities (including presence or absence of generalized anxiety disorder and major depressive disorder) were identified using the Elixhauser comorbidity index, and these factors were controlled for in the model along with other potential confounders. [6] The Elixhauser comorbidity index is a method of categorizing comorbidities based on the ICD coding in hospital administrative data and includes over 30 comorbid conditions, including alcohol abuse, drug abuse, diabetes, cardiac arrhythmias, fluid, and electrolyte disorders, weight loss, and many other confounders which are likely to be relevant to our cohort. Patients were grouped into either a depression and anxiety “DA cohort” (patients the concomitant diagnosis of either major depressive disorder or generalized anxiety disorder) or a “NDA cohort” (norm).

**Table 2**

Univariate and multivariate analyses showing contribution of depression and anxiety (DA cohort) to increases in cost and length of stay (LOS) after posterior spinal fusion for adolescent idiopathic scoliosis.

Univariate modeling				p value
Variable	% DA cohort	% Norm	% Difference	
LOS>80th percentile	39.6%	33.5%	6.1%	<i>P</i> < 0.001
cost>80th percentile	30.8%	24.7%	6.1%	<i>P</i> < 0.001
Multivariate Modeling				
Variable	Odds ratio (DA cohort)	Confidence interval		
Cost	OR, 0.986	[CI,0.904, 1.076]		<i>p</i> = 0.674
LOS	OR, 1.164	[CI,1.077, 1.259]		<i>P</i> < 0.001

*Statistical analysis*

X<sup>2</sup> analysis was used to determine percent risk for increased LOS and cost in the DA versus NDA cohorts. After univariate analysis, multivariate regression modeling was performed, using logistical regression algorithms run on SPSS version 25.0 (IBM; Armonk, NY, USA). Included in regression modeling were multiple medical comorbidities as well as the patient demographic factors described in Table 1. An  $\alpha < 0.05$  was considered statistically significant for all tests.

**Results**

*Demographic information*

We worked with a sample size of *n* = 564 in the DA cohort and *n* = 5185 in the NDA cohort. Full demographic information can be seen in Table 1. Notably, 85.5% of the sample was female sex. The vast majority of procedures were performed in an urban, teaching hospital (97.3%) and 84.2% of the sample was between the ages of 11–16 years Table 2.

*Multivariate analysis*

We determined that after controlling for confounding variables and comorbidities through multivariate regression analysis, patients with DA had increased odds ratios for increased LOS but not for cost. Odds ratios and confidence intervals for these variables after controlling for confounders/comorbidities are as follows: odds ratio for having a cost>80th percentile after PSF in the DA cohort compared to the NDA cohort: (OR, 0.986 [CI,0.904, 1.076]) and odds ratio for having a LOS>80th percentile after PSF: DA cohort compared to NDA cohort: (OR, 1.164 [CI,1.077, 1.259]).

**Discussion**

In a sample of 5749 patients undergoing PSF for AIS, 564 patients had a coexisting diagnosis of either depression or anxiety (10.9%). While several studies have shown an increased rate of MDD in patients with AIS [4], our study represents the first to show MDD and GAD adversely impacting the inpatient stay. These results remain true for increased LOS, even after controlling for a wide array of potential confounders, of which a multiplicity exists given linkages between patient comorbidities and mood disorders. [7,8] LOS may be effected by increased pain scores noted in patients with anxiety and depression [9], but future research should aim to further delineate this finding. We posit that the emergence of adolescent MDD and GAD remains under-investigated as a cause of increased LOS burden on the hospital system after surgical procedures.

**Declaration of Competing Interest**

None.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.xnsj.2020.100012](https://doi.org/10.1016/j.xnsj.2020.100012).

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