International Journal of Spine Surgery, Vol. 13, No. 5, 2019, pp. 474–478
https://doi.org/10.14444/6063

Cost and Clinical Outcome of Adolescent Idiopathic Scoliosis Surgeries—Experience From a Nonprofit Community Hospital

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ABSTRACT

Background: Recognition of the variables that drive the cost of adolescent idiopathic scoliosis (AIS) surgeries will help physicians and hospitals to initiate cost-effective measures. The purpose of this study is to analyze the hospital costs and clinical outcome for AIS surgeries.

Methods: A total of 6417 individual hospital costs and charges for 42 consecutive AIS surgeries were reviewed. The patients' demographic, surgical, and radiographic data were recorded. The costs were categorized. The relationships between total costs, categorized costs, and the independent variables were analyzed. Perioperative and postoperative complications were reviewed. Back pain, leg pain, and Oswestry Disability Index scores were obtained.

Results: The patients' mean age was 15 years, and 37 patients were female. Their mean main curve measured 55°. A total of 39 patients had posterior-only procedures, and 3 patients had anterior/posterior procedures. The average number of levels fused was 8. The mean hospital charge was $126,284 (range, $76,171–$215,516). The mean hospital cost was $44,126 (range, $23,205–$74,302). The average hospital stay was 5 days, with an average cost per day of $8825. The largest contributors to the overall hospital cost were spinal implants (31%), and surgery department labor cost (23%). Other categoric cost contributors included medical/surgical bed (19%), central supply/operating room supplies (9%), intensive care unit (6%), bone graft (3%), and others. No complications or revision surgeries occurred in these patients. For patients who had back and/or leg pain preoperatively, their back pain visual analog scale scores improved 1.8 points (4.5 versus 2.7 points, $P < .05$) and their leg pain visual analog scale scores improved 1.5 points (2.1 versus 0.6 points, $P < .05$). Their Oswestry Disability Index scores improved 6.1 points (17.3 versus 11.2 points, $P > 0.05$).

Conclusions: The hospital cost for AIS surgeries is significant, with spinal implants and surgery department labor being the largest contributors. These are also areas for potential cost-effective measures.

Other & Special Categories

Keywords: adolescent idiopathic scoliosis, cost, outcome, surgery

INTRODUCTION

There has been increasing scrutiny regarding the costs of surgical care, especially as it relates to spinal surgery, during the past few years. Several studies have evaluated the costs and charges generated by surgical procedures. One area drawing attention is spinal deformity surgery, where the average costs can reach $120,394.[1,2] Because of the high total costs and charges of both adult deformity surgery and adolescent idiopathic scoliosis (AIS) surgery, there is an interest in defining the true costs of these surgeries. Additionally, attempts are being made to link surgical outcomes to costs, in an effort to further define value-based care. This highlights the importance of appropriate outcome measures for spinal deformity surgery.

The 2009 cost of AIS surgeries in the United States was estimated at $514 million and ranked second only to treatment of appendicitis among children ages 10 to 17 years.[3] The number of adult and adolescent deformity surgeries has increased.[4,5] The rising cost of implants, as well as increasing use of posterior-based pedicle screw constructs, has driven the cost of deformity surgery up. Physicians have not generally not been involved in the business side of medicine, but increasing overall health care costs, decreasing reimbursement, and working towards developing a sustainable health care system have led many to become more active in cost-saving measures. The first step in this direction is defining the costs of care.

The purpose of this study is to analyze the hospital costs and clinical outcome for AIS surgeries

Table 1. Demographics of the patients.

Parameter	Value
Patients, n	42
Mean age, y (range)	15 (12–18)
Sex, female:male	37:5
Main coronal curve (range)	55° (36°–105°)

Table 2. Surgical details of the patients.

	Number (Range)
Procedures	
Posterior only, n	39
Anterior and posterior, n	3
Mean levels fused	8 (4–12)
Mean pedicle screws placed	18 (10–26)
Mean hospital stay, days	5 (3–11)

at a scoliosis center in a nonprofit community hospital. This retrospective review of 42 consecutive patients who underwent corrective spinal fusion for AIS elucidates individual hospital costs and charges, patient demographics, surgical data, and radiographic data. Patient outcomes are also included and discussed for these patients.

MATERIALS AND METHODS

There were 42 consecutive AIS cases included in the review. Institutional Review Board approval was obtained. The hospital accounting system was used to gather data on 6417 individual hospital costs and charges. All the surgeries were performed by the senior author between 2010 and 2016. The demographic data included age and sex. Surgical data included date of surgery, number of levels fused, number of pedicle screws placed, type and timing of surgical approaches, complications, length of hospitalization, and length of follow-up. Radiographic data included Cobb angles. Surgical factors for consideration included the spinal implant system used in all cases, which was the Synthes Universal Spinal System (Synthes, Raynham, Massachusetts), and bone graft, which was allograft chips.

Patient outcome data were recorded in the form of Oswestry Disability Index (ODI) and visual analog scale (VAS). The VAS was divided into neck, back, arm, and leg pain. These were obtained preoperatively and at the last follow-up visit. The total hospital cost was divided into the following categories: implants, surgery department labor, postanesthesia care unit, anesthesiology, pharmacy, medical/surgical floor, intensive care unit, physical therapy, respiratory therapy, laboratory, bone tissue products, radiology, central supply/operating room, central service, and food and nutrition. These costs were further defined as a percentage of the total. Total hospital charges were also evaluated. The relationships between total costs, categorized costs, and the independent variables were analyzed.

RESULTS

The patients' mean age was 15 years (range, 12–18 years). Female patients comprised 37 of the 42 patients (88%). The mean preoperative main curve measured 55° (range, 36°–105°; Table 1). Of the 42 patients, 39 patients had posterior-only procedures, whereas 3 patients had combined anterior and posterior procedures. Of the 3 patients who underwent anterior and posterior surgery, 2 patients' surgeries were performed in a single surgical setting, and 1 patient had a staged procedure with 2 surgery days. The average number of levels fused was 8 (range, 4–12). The average number of pedicle screws placed was 18 (range, 10–26). The average hospital stay was 5 days (range, 3–11 days; Table 2). There were no intraoperative complications.

The mean hospital charge per patient was $126,284 (range, $76,171–$215,516). The mean hospital cost per patient was $44,126 (range, $23,205–$74,302). The average cost per day was $8825. The largest contributors to the overall hospital cost were spinal implants (average, $13,679; 31% of total cost) and surgery department labor cost (average, $10,093; 23% of total cost). Other categoric cost contributors included the following: medical/surgical bed (average, $8440; 19% of total cost); central supply/operating room supplies (average, $3971; 9% of total cost); intensive care unit (average, $2757; 6% of total cost); bone graft (average, $1495; 3.3% of total cost); anesthesia unit/equipment (physician fee not included; average, $1063; 2.4% of total cost); pharmacy (average, $942; 2.1% of total cost); physical therapy and respiratory therapy (average, $859; 2.0% of total cost); radiology (average, $926; 2.1% of total cost); laboratory (average, $435; 1.0% of total cost; Table 3).

No complications or revision surgeries occurred in these patients at an average of 16 months of follow-up. A total of 27 patients (64.3%) had back pain preoperatively, and on average their back pain

Table 3. Cost analysis.

Item	Value (Range)
Cost, $	
Mean hospital charge	126,284 (76,171–215,516)
Mean hospital cost	44,126 (23,205–74,302)
Average cost per day	8825
Cost by category, %	
Spinal implants	31
Surgery department labor	23
Medical/surgical bed	19
Central supply/operating room supplies	9
Intensive care unit	6
Bone graft	3
Anesthesia unit/equipment	2
Pharmacy	2
Physical and respiratory therapy	2
Radiology	2
Laboratory	1

VAS scores improved 1.8 points (4.5 versus 2.7 points, $P < .05$). On average, their ODI scores improved 6.1 points (17.3 versus 11.2 points, $P > .05$). A total of 13 patients (31.0%) had leg pain preoperatively, and on average their leg pain VAS scores improved 1.5 points (2.1 versus 0.6 points, $P < .05$).

DISCUSSION

In a recent retrospective review of more than 60 000 patients in the United States, Theologis et al.[6] confirmed that there has been a trend towards all posterior pedicle screw–based surgery for AIS. There has been a decrease in combined anterior- and posterior-based surgery in both the thoracic spine and, to a smaller extent, the lumbar spine. They found increased use of autologous iliac crest bone graft, and a decrease in thoracoplasty. There were increased hospital charges, decreased lengths of stay, and stable complication rates during their 13-year period of review. This review mirrors what has been seen nationwide, and it confirms an important finding in this study, which is the high cost of spinal instrumentation, in part due to the shift towards pedicle screw–based posterior spinal fusions.[6] In another cost study focused on AIS, Kamerlink et al.[2] outlined the costs of AIS for 125 consecutive patients. They showed that the largest contributor to cost was implants, at 29% of the overall cost. Other major contributors were inpatient costs (22%), operating room costs (9.9%), and bone graft costs (6%).

Martin et al.[7] looked at the costs and charges for AIS using the National Inpatient Service database. They found that national use rates for AIS surgery were relatively stable between 2001 and 2011. However, the overall cost has increased due to increased use of pedicle screws, higher pedicle screw density, more posterior-only surgeries, and higher costs of pedicle screws. They found that implant charges for AIS have increased 27.7% per year relative to inflation. Cost for AIS fusions increased by 11.3% per year for 10 years after adjusting for inflation. Finally, they showed that implants represented 28% of the hospital bill in 2003, and 53% of the hospital bill in 2012. The 2 key drivers of cost were the increased use of pedicle screws and the higher charges associated with them over time.[7]

In another study evaluating the costs of AIS, Vigneswaren et al.[5] found there was an increasing trend toward using posterior surgery. The number of comorbid conditions per patient, and thus the medical complexity of patients treated for AIS, also increased.[5] This raises an important point of patient selection for these surgeries, and preoperative optimization, especially in the setting of increasing costs. Even nonsurgical treatment, however, has costs.

Spinal implant, surgery department labor, and medical/surgical bed costs were the largest contributors to overall cost in this study. These are all areas that could benefit from cost-containment measures. In terms of implant costs and charges, possible solutions may include physicians partnering with hospitals to negotiate more favorable contracts with device companies, and more favorable hospital implant charges to the patient. However, physician autonomy regarding implant selection should not be compromised. Transparency of costs and cooperation between physicians and hospitals are crucial in order to improve the cost-effectiveness of AIS surgeries. Additionally, physicians need to be active participants in the discussion of surgical costs and charges with their hospitals.

Our study also showed that for those patients who presented with preoperative back and/or leg pain, their pain scores improved significantly at the latest follow-up. However, we still think the instruments commonly used to assess the clinical outcome in adult spinal surgery patients (VAS, ODI) may not be the most appropriate outcome measurements for AIS patients. Rather, the progression of curvature and deformity associated with both psychosocial and functional implications may be more clinically relevant. There are numerous patient outcome instruments; the VAS and ODI were used as part of a standardized practice in our clinic, but more specific questionnaires could be considered for AIS if they could be shown to more effectively measure psychosocial and functional outcomes. This is an area of ongoing research that continues to develop. Metrics ranging from psychologic evaluations to gait lab studies are still being advanced for this subset of patients.

Another possible way to analyze AIS surgery from a cost perspective is through the calculation of quality-adjusted life years (QALY). This measure is based on a year of perfect health equal to 1, and a year of less-than-perfect health equal to less than 1. A cost per QALY or incremental cost utility ratio can be calculated in an effort to define financial value for a certain procedure. This can then be compared to the societal willingness to pay threshold, which has been defined at a range from $50,000/QALY to $200,000/QALY, or based on 2 to 3 times the per capita gross domestic product depending on the study, the calculation, or the economist.[8,9] Traditionally, $50,000/QALY has been used. This metric has been used extensively in the adult reconstruction literature for hips and knees as economic proof of increased QALYs and acceptable willingness to pay thresholds.[10,11] There are numerous economic papers on this topic, and many for various other procedures, but specific to AIS surgery, Jain et al.[12] compared operative to nonoperative treatments in a hypothetical 15-year-old girl with a 55° right thoracic curve using available literature to estimate probability, health utility, and QALYs gained. They found that in 98.5% of simulations of operative and nonoperative, each with complications based on accepted rates, that operative treatment was favored compared with nonoperative treatment. They calculated, among other things, that the median incremental cost utility ratio was $20,600/QALY (95% confidence interval, $20,500–$21,900), which falls below the $50,000/QALY willingness to pay threshold.[12]

Key findings in this study of 42 consecutive AIS patients mirrored what has been shown in other studies, while providing additional information on overall costs of surgery. Spinal implants and operating room costs were the 2 largest contributors to hospital costs, and they represent areas of potential improvement. Because pedicle screw fixation in theses surgeries has proven effective, an ongoing area of research is the density of screws, and how this relates to cost.

ACKNOWLEDGMENTS

A.E.B. and X.H. contributed equally to this work.

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Disclosures and COI: The authors declare that there is no direct conflict of interest associated with this manuscript. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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Published 31 October 2019