

Quality, Safety, and Value in Pediatric Spine Surgery



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KEYWORDS

• Infection • Implant density • Cost • Scoliosis

KEY POINTS

- Progress has been made toward the elimination of surgical site infections in pediatric spine surgery with the use of topical antibiotic powder and multidisciplinary pathways.
- Reducing the length of stay following pediatric spine surgery has been shown to provide modest cost savings and may provide positive clinical benefits for patients.
- Given the potential financial impact and clinical benefit for patients, the appropriate pedicle screw density should be used for patients undergoing pediatric spine surgery.
- A variety of intraoperative techniques from tactile sensation to computed-tomography (CT)-guided navigation can help surgeons minimize the risk of pedicle screw malposition and its associated consequences.
- Physicians should implement strategies designed to reduce radiation exposure with posteroanterior versus anteroposterior imaging, low-dose CT, and minimization of radiographs.

Quality, safety, and value initiatives (QSVIs) have increasingly been implemented in orthopedic centers. A review of the reported outcomes following pediatric spine surgery quickly shows the need for improvement ([Table 1](#)). For all pediatric spine surgeries, the Scoliosis Research Society's Morbidity and Mortality database reports overall complications rates at 8.5%, infection rates at 2.7%, and new neurologic deficits at 1.4%.¹ For scoliosis surgery in particular, there was a 10% complication rate, 0.7% new neurologic deficit for patients treated with pedicle screws, 0.3% mortality for congenital and neuromuscular scoliosis, and 0.02% mortality for idiopathic scoliosis.² Outcomes at 30 days postoperatively from patients entered in the National Surgical Quality Improvement Program's (NSQIP)

database show a 10% complication rate, 0.15% mortality, and 3.7% reoperation rate.³ Morbidity was highest in neuromuscular patients at 13.0% and lowest in the idiopathic cohort (5.7%).³ For adolescent idiopathic scoliosis, the 2-year return to the operating room (OR) for all pedicle screw constructs is high at 3.5%⁴ and the 5-year follow-up was reported at 7.5% return to the OR.⁵ With the advent of quality initiatives, major progress has been made to decrease the length of stay, lower blood transfusion rates, and reduce infection rates; but further comprehensive work is needed.

Many of the quality premises now being used in medicine are taken from other industries, including aviation and manufacturing. A multidisciplinary approach is key, engaging teams in the

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Table 1
Complications in pediatric spine surgery

Major Complication Rate	
Fu ¹	
Rate for all pediatric spine surgery	8.5%
Reames ²	
Rate for all diagnoses	10%
Rate for neuromuscular scoliosis	17.9%
Rate for congenital scoliosis	10.6%
Rate for idiopathic scoliosis	6.3%
Pugley ³	
Rate for all diagnoses	10%
Infection Rate	
Fu ¹	
Rate for all pediatric spine surgery	2.7%
Pugley ³	
Rate for neuromuscular scoliosis	1.5%
Rate for congenital scoliosis	0%
Rate for idiopathic scoliosis	1.4%
Marks ⁸	
Rate for idiopathic scoliosis	1.6%
Mackenzie ⁹	
Rate for neuromuscular scoliosis	9.2%
Rate for syndromic scoliosis	8.4%
Rate for congenital scoliosis	3.9%
Rate for idiopathic scoliosis	2.6%
Neurologic Deficit	
Fu ¹	
Rate for all pediatric spine surgery	1.4%
Reames ²	
Rate for congenital scoliosis	2.0%
Rate for neuromuscular scoliosis	1.1%
Rate for idiopathic scoliosis	0.8%
Return to the Operating Room	
Pugley ³	
Rate for all diagnoses	3.7%
Rate for congenital scoliosis	6.2%
Rate for neuromuscular scoliosis	5.5%
Rate for idiopathic scoliosis	2.8%
Samdani ⁴	
2-y rate for idiopathic scoliosis	3.5%
Ramo ⁵	
5-y rate for idiopathic scoliosis	7.5%

Plan-Do-Study-Act cycle. In addition, multiple interventions are undertaken at once, including bundles to address a specific topic, such as surgical site infection, from different angles concomitantly. Although this results in rapid implementation, the downside is that it is difficult to determine which dosing, timing, and screening strategies are most effective. The very nature of QSVI entails simultaneous implementation of multiple quality improvement measures, which allows little room for scientific method to determine which interventions are worthwhile. Thus, quality initiatives must work in tandem with high-quality research to determine which interventions should be implemented on a large scale and which patient populations may most benefit. Clear areas for quality improvement in the realm of pediatric spine surgery include lowering the infection risk, reducing the length of stay, maximizing value by achieving optimal screw numbers for fusion surgeries, eliminating the return to the OR for pedicle screw malposition, and improving patient safety by reducing radiation exposure and neurologic events. This article summarizes the recent developments in each of these areas.

INFECTION

Surgical site infections (SSIs) following surgery for pediatric spinal deformity are significant complications with rates ranging from 0.5% to 2.6% in idiopathic scoliosis and up to 40% in patients undergoing surgery for early onset scoliosis.⁶⁻⁹ There is a paucity of level 1 evidence to help guide physicians in the prevention and management of SSIs following pediatric spinal surgery. Because infections are relatively rare, it is difficult to perform a randomized controlled trial with SSI as the outcome, as many patients would need to be prospectively enrolled. Most series are retrospective, case control studies, or based on registry or administrative data sets.¹⁰ Thus, practices vary among surgeons and institutions. A recent survey illustrated the variability in clinical strategies for infection prevention among physicians managing patients with early onset scoliosis with growth-friendly spinal procedures.¹¹ To some extent, literature from the adult spinal deformity population can be applied to children; but comorbidities and patient considerations may differ.

Several meta-analyses have been performed to help summarize the existing literature and to provide evidence-based recommendations regarding the prevention of SSIs in pediatric spine patients. A recent literature review found that patients with underlying diseases, such as

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