Pediatric Spinal Surgery in the USA: Analyses of Peri-operative Outcomes

Author: **Senthilkumar Sadhasivam MD**
Affiliation: **Dept of Anesthesia, Cincinnati Children's Hospital Medical Center, Cincinnati, USA.**

Background and Aims: Idiopathic scoliosis (IS) is the most common type of scoliosis, which typically occurs in children older than 10 years and the rate of curve progression is typically slow. In contrast, neuromuscular scoliosis (NMS) occurs at an early age, is most often rapidly progressive, and is associated with systemic and chronic illnesses. NMS occurs in nearly all children with Duchenne muscular dystrophy and the majority of children with quadriplegic cerebral palsy, and spina bifida above the sacral level. Surgical stabilization of spinal curves is indicated in both types of scoliosis population to minimize complications of severe spinal deformities, chronic pain, pelvic obliquity, and restrictive lung disease with respiratory insufficiency. Complication rates reported in the literature after spinal fusion and instrumentation for NMS are high (44 to 62%) from coexisting cardiopulmonary, gastrointestinal, and neurological disorders with NMS. National cross-sectional outcomes (peri-operative surgery, patient, anesthesia and analgesia related morbidities and mortality) for children undergoing spine stabilization have not been reported. Knowledge of the differences in the hospital course between the two groups of scoliosis and the factors associated with these differences can provide important baseline data against which to measure the effect of interventions designed to reduce the morbidity of surgery for NMS. In this study, peri-operative co-morbidities and complications (including higher respiratory failures), mortality, length and cost of hospitalization following pediatric spinal surgery performed in 2003 in the USA were analyzed.

Methods: The 2003 Healthcare Cost and Utilization Project's (HCUP) Kids' Inpatient Database (KID)[1], a nationally representative weighted survey of hospital discharges for patients younger than 20 years (at admission) from 36 US State Inpatient Databases, is used to describe and compare peri-operative outcomes and experiences (after spinal fusion and instrumentation for curve stabilization) of children with scoliosis. The HCUP KID[1] represents discharge data from 3,438 hospitals during 2003 and includes 2.98 million discharge records. When weighted for survey parameters, this data set represents 7.4 million discharges of patients younger than 20 years at admission. Pediatric discharges are defined as all discharges where a patient was 20 years or less at admission. Discharges with missing, invalid, or inconsistent ages are excluded. The KID 2003 is a public utility database composed of more than 100 clinical and non-clinical variables for each hospital stay, including vital statistics, socio-demographics, treatment, and clinical outcome data without geographic or personal identifiers[1]. The diagnostic and procedural codes according to the manual of International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)[5] are used to establish subpopulations for this study. First, children with scoliosis of any type were identified using ICD-9 codes 737.0 to 737.9. This group was further characterized according to the presence or absence of neuromuscular disease. The IS group consisted of children with scoliosis and without neuromuscular disease. The final study population overall included all children with either IS or NMS who underwent spinal fusion and instrumentation (ICD-9 codes 81.0-81.9). Complications associated with scoliosis surgery including pneumonia (ICD-9 codes 482-487.0), aspiration pneumonia (ICD-9 code 507.0), respiratory failure (ICD-9 codes 518.0-518.89), paralytic ileus (ICD-9 code 560.1), urinary tract infection (ICD-9 code 599.0), surgical wound dehiscence (ICD-9 code 998.3), and surgical wound infection (ICD-9 code 998.59) were explored. Procedures frequently associated with spinal surgeries, including the mechanical ventilation, central line insertion, tracheostomy tube insertion, autologous blood transfusion, donor blood transfusion, and chest tube insertion were analyzed. Finally, hospitalization variables between children with IS and NMS including

the number of procedures performed, mortality, disposition discharge status, length of stay (LOS), and total charges were analyzed.

Results: The HCUP KID 2003 data represent hospital discharges for 4443 children with NMS and 5952 children with IS after spinal surgery. All results presented in this paper are based on the weighted survey analysis and are therefore considered to be representative of national experience. Children with IS who underwent spinal surgery were much more likely to be girls and were an average of about 1 year older than those hospitalized for NMS surgery. Nearly all of the children in both groups were admitted routinely, and the 2 groups did not differ by race or median household income. When compared with children with IS, those with NMS had more than twice as many diagnoses, significantly higher rates of gastro-esophageal reflux disease and failure to thrive. Children with neuromuscular disorders had longer lengths of hospital stay and greater total charges than children with IS. When compared with children with IS, those with NMS had more procedures. Although the frequency of death was higher in the group of children with NMS, death was a rare event, and the difference was not statistically significant.

Discussion: Children with NMS who had spine surgery have more co-morbidities, undergo more procedures, have longer and more costly hospitalizations, and experience more complications than children with IS. There was no selection bias between children with NMS and idiopathic IS according to race and income that would account for the differences in outcomes. The medical complexity of children with NMS in this study is evidenced by the significantly higher proportion of failure to thrive, and gastroesophageal reflux disease among children with NMS, and significantly more additional diagnoses per child with NMS when compared with those with IS. Children with NMS experienced respiratory failure and pulmonary infections at much higher rates than did those with IS, with corresponding needs for mechanical ventilation. Despite significantly longer hospitalizations, children with NMS were more likely to be transferred to other facilities and more likely to be discharged with home health care services, suggesting ongoing medical needs upon discharge. Nearly all of the children hospitalized for scoliosis surgery in the KID 2003 database were admitted electively. This could provide opportunities in future to optimize the preoperative condition of each child before hospitalization and surgery. Studies to evaluate interventions designed to reduce risk and improve postoperative outcomes would be an important contribution to the care of these children. Despite no difference in median household income between the 2 groups, children with NMS were twice as likely to have Medicaid as the primary payer; those with IS were more often privately insured. This observation likely reflects the chronic and complex medical needs of children with NMS. The selection of large, urban teaching hospitals as the sites to perform spinal fusion and instrumentation procedures in both populations suggests that orthopedic surgeons anticipate postoperative tertiary care needs among children with scoliosis of any etiology. As Medicaid usually reimburses less than commercial insurance, these hospitals may bear a disproportionate share of the financial burden associated with providing surgery for children with neuromuscular disorders. Given the longer lengths of stay for these children, the economical burden is significant. In conclusion, during 2003 in the USA, 4443 children with NMS underwent spinal surgeries, totaling to hospital charges of about $350 million and 31545 hospital days. Children with NMS had significantly longer lengths of hospitalization, more diagnoses and underwent more procedures. These results provide additional information on preoperative care, surgical decision-making, discussions of informed consent, and the provision of anticipatory guidance for children and their caregivers. Strategies to identify and modify surgical risk factors in children with NMS are needed.