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Frequency of Complications Following Spinal Fusion in Children with Cerebral Palsy

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FREQUENCY OF COMPLICATIONS FOLLOWING SPINAL FUSION IN CHILDREN WITH CEREBRAL PALSY

A Master's Thesis Presented

By

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FREQUENCY OF COMPLICATIONS FOLLOWING SPINAL FUSION IN CHILDREN

WITH CEREBRAL PALSY

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Abstract

Background:

Neuromuscular Scoliosis is a frequent complication of Cerebral Palsy that requires surgical management including spinal fusion. The objective of this observational study was to describe differences in the frequency of postoperative complications in children with Cerebral Palsy following spinal fusion surgery compared to children with Idiopathic Scoliosis.

Methods:

The 2016 Kids' Inpatient Database was queried to identify pediatric patients (<21 years old) with concurrent diagnoses of Cerebral Palsy and Neuromuscular Scoliosis undergoing spinal fusion surgery. Cases were compared to children without Cerebral Palsy and with a diagnosis of Idiopathic Scoliosis undergoing the same procedure. Fitted Poisson regression analysis with robust variance was performed to estimate relative risks in the frequency of various clinical complications while adjusting for several potentially confounding variables of importance.

Results:

A total of 660 cases and 5,244 comparators were identified. Compared to children with Idiopathic Scoliosis, children with Cerebral Palsy were younger (13.6 vs. 14.3 years), more likely to be male (54% vs. 23%), and more likely to have had governmental insurance (52% vs. 32%). They also had longer hospital lengths of stay (8 days vs. 4 days). After adjusting for a number of potentially confounding sociodemographic and clinical variables, children with Cerebral Palsy were more

likely to have postoperative pulmonary, gastrointestinal, and surgical complications, receive blood transfusions, and be admitted to the ICU.

Conclusions:

Children with Cerebral Palsy have an increased risk of complications following spinal fusion surgery leading to longer hospital stays. These results further inform surgical decision-making and anticipatory guidance for these children and their caregivers.

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Chapter 1: Introduction

Cerebral Palsy and Neuromuscular Scoliosis

Cerebral Palsy (CP) is a group of disorders that affect movement, muscle tone, and posture secondary to lesions or anomalies of the brain arising in the early stages of development [1]. It is one of the most common physical and developmental disabilities in childhood, with a prevalence of 3 per 1,000 births [1-3]. The condition presents when a child fails to reach their motor milestones and when they show qualitative differences in motor development such as asymmetric motor function or unusual stiffness or floppiness [2].

When the motor impairment affects the trunk, Neuromuscular Scoliosis (NMS) often develops. NMS typically presents before the age of 10 years, is rapidly progressive, and tends to progress even after skeletal maturity [4-7]. This condition is associated with several systemic and chronic illnesses of which CP is the leading cause. The prevalence of NMS in children with CP ranges from 38% to 64% and is directly related to the severity of neurological impairment [4, 5, 8, 9]. The spinal deformity seen in children with CP as a result of NMS often leads to pelvic obliquity, which adversely affects seating and posture [5, 10] and increases the risk for decubitus ulcers, thoracic-pelvic impingement and pain, and restrictive lung disease [4]. Non-surgical interventions, including the use of physical therapy and orthotic braces, are often unsuccessful in controlling the progression of NMS and surgical correction is often necessary [11].

Idiopathic Scoliosis

Idiopathic Scoliosis (IS), the most common type of scoliosis with a prevalence ranging from 0.47% to 5.2%, typically occurs in otherwise healthy adolescents and often develops when children are older than 10 years [11, 12]. This condition typically presents with uneven shoulders, waist

line asymmetry, or a rib prominence and is usually first identified by the patient, family member, general practitioner, or a school nurse [12]. The diagnosis of IS is one of exclusion and is made only when other syndromes have been ruled out. There is no single cause of IS and the current view is that it is a multifactorial disease with predisposing genetic factors [13, 14].

Scoliosis curve progression increases at the time of the adolescent growth spurt and markedly slows or ceases at the time of completion of growth; however, rates of curve progression in children with IS are usually slow overall [12].

The management of IS often begins with physical therapy and orthotic braces. When non-operative interventions fail, however, surgical correction is often indicated [15]. In general, curves greater than 45 degrees should be treated surgically and surgery is performed in approximately 10% of adolescents diagnosed with IS [12, 16].

The goals of surgical stabilization for both NMS and IS are similar and are intended to achieve maximum permanent correction of the deformity, improve appearance by balancing the trunk, and improve the child's level of function, respiratory status, pain, and quality of life while preventing progression of the curvature [13, 17].

Overview of the Kids' Inpatient Database (KID)

The KID is the largest publicly available administrative all-payer national sampling of pediatric (≤ 21 years of age) inpatient discharges and is managed as part of the Healthcare Cost and Utilization Project (HCUP) by the Agency for Healthcare Research and Quality (AHRQ) [18]. The KID is published on a triennial interval and includes data from non-federal hospitals, short-term stay hospitals, academic medical centers, and specialty hospitals. Hospitals not included in the dataset are federal hospitals, rehabilitation hospitals, psychiatric hospitals, or substance treatment centers.

The 2016 iteration is the most recent available data and includes information from more than 4,200 hospitals and 6 million weighted discharges across 47 states designed to be representative of pediatric hospital care in the United States. The KID represents a sample of approximately 80% of all annual pediatric discharges.

The KID contains over 100 sociodemographic and clinical variables and utilizes the International Classification of Diseases, Tenth Revision (ICD-10) classification system of diagnoses and procedures. It also includes variables regarding payer status, geographic region, hospital charges, length of stay, and hospital characteristics including size and teaching status (Figure 1). The observational unit of the KID is at the level of facility discharges and does not enable prospective tracking of patients across repeat encounters.

Specific Aims

The primary aim of this large observational study was to describe differences in the frequency of several postoperative complications in children with and without CP following spinal fusion surgery. We utilized the 2016 KID to examine these endpoints among children and young adults (<21 years) who had a diagnosis of CP. We hypothesized that children with CP who had spinal fusion surgery would have longer and more costly hospitalizations, and experience more postoperative clinical complications, than children with IS.

Chapter 2: Methods

Data Source

A cross-sectional analysis was performed using the 2016 KID.

Selection of Study Population

Using International Classification of Diseases, Tenth Revision (ICD-10) diagnosis codes, all patients with CP (G80.0-G80.9) and a concurrent diagnosis of NMS (M41.40-M41.47) were identified in either the primary or any of the secondary discharge diagnoses (case population). To be included in the present study, patients had to have undergone spinal fusion surgery within 3 days of admission. Cases due to trauma, with an additional diagnosis of IS, and who were missing data on critical variables such as age, gender, race, primary payer, total hospital charges, median income by ZIP code, or mortality were excluded. Spinal fusion surgery was limited to those performed via a posterior approach on the thoracic or lumber spine with fusion of greater than 1 vertebra (see Appendix A for specific codes). We chose to focus on the posterior approach since it is the most common approach for this surgery and because there are substantial anatomic differences in anterior approaches that may confound results.

All patients with a diagnosis of IS (M41.112-M41.27), without CP or NMS, who underwent spinal fusion surgery within 3 days of admission, were not admitted due to trauma, and who were not missing data on critical variables were identified and served as our comparison group.

Overall, 15% of cases and 12% of comparators (p-value: 0.27) were excluded, and the main reasons for exclusion were due to missing data on race (10% of cases, 9% of comparators, p-value:

0.76) and admissions due to trauma (5% of cases, 3% of comparators, p-value: 0.15). One additional case was excluded due to an exceedingly long hospital length of stay (LOS) of 162 days.

Independent and Dependent Variables

Patient and hospital variables assessed included patient age, gender, race (white, black, Hispanic, other; defined as Asian Pacific, Native American, or unknown), payer (private, government; defined as Medicaid or Medicare, and other; defined as self-pay, no charge, or unknown), total hospital charges, median income quartile by ZIP code, and hospital LOS. Age was assessed both continuously and categorically via six age-groups, defined by the National Institute of Child Health and Human Development (NICHD): infant (<1 year), toddler (1-2 years), early childhood (3-5 years), middle childhood (6-11 years), early adolescence (12-18 years), and late adolescence (19+ years) [19]. The patient setting was defined as either urban-teaching hospital (central and fringe counties of ≥1 million population), urban-nonteaching hospital (counties in metro areas of 250k-<1 million and counties 50k - <250k) or rural hospital (micropolitan or non-core counties). We defined four hospital regions consistent with the U.S. Census Bureau geographic definitions (East, South, Midwest, West) [20].

We examined a variety of postoperative complications using a modified definition of morbidity that has been used in other pediatric studies using the KID [21-25]. These complications broadly include infections, surgical complications, mechanical wounds, as well as pulmonary and gastrointestinal related complications. We identified procedures frequently associated with spinal surgery including autologous and donor blood transfusions and compared differences between our respective comparison groups in terms of ICU admission characteristics, using ICD-10 diagnosis and procedure surrogates, including arterial line placement, ventilator use, and central line

placement. The specific postoperative complications that comprise each category and their corresponding ICD-10 codes are found in Appendix B.

Statistical Analysis

We examined differences in the distribution of categorical variables, using chi-square tests, and Student's t-test for continuous variables, between children with CP and those without CP undergoing spinal fusion surgery. All statistical tests were two-sided with statistical significance considered as a p-value <0.05. The data were weighted, using HCUP-provided weights, to be representative of all U.S. inpatient discharges using the STATA svy function. A Fitted Poisson regression analysis with robust variance was performed simultaneously adjusting for age, gender, race, insurance payer, and common comorbidities associated with CP (gastroesophageal reflux disease, failure to thrive, nutritional deficiency, gastrostomy tube, tracheostomy tube), for purposes of estimating relative risks of certain patient morbidities between children with and without CP. For stratum with single sampling units, the average of the variances from the strata with multiple sampling units was used to calculate variance estimates. All statistical analyses for this study were performed in STATA 16.0 statistical software (Stata Corps. 2019. College Station, TX).

Ethical Considerations

The Institutional Review Board at the University of Massachusetts Medical School deemed this study exempt from IRB review due to the de-identified nature of the data. In compliance with the KID data use agreement, this study does not report information where the number of observations is less than or equal to 10.

Chapter 3: Results

Patient and Hospital Characteristics

We identified a total of 660 cases with CP and 5,244 comparators with IS who underwent spinal fusion surgery. Compared with children undergoing spinal fusion surgery for IS, children with CP were more likely to be younger and to be male (Table 1). Children with CP were more likely to be in the Middle Childhood age group while children with IS were more likely to undergo surgery during their Early Adolescent years (Table 1). Children with CP were more likely to have governmental health insurance while those with IS were more likely to have private insurance (Table 1).

Approximately 62% of the surgeries were performed in large hospitals and the vast majority of surgeries were performed at urban teaching hospitals. Spinal surgeries were performed throughout the United States with minimal regional variation (Table 1).

Hospital Course in Children with CP Undergoing Spinal Fusion Surgery

The overall complication rate for children with CP was 44%, which is approximately double the rate when compared to children with IS (Table 2). The majority of complications were due to the need for blood transfusions (30%). Slightly more than 10% of complications were due to pulmonary complications, including postoperative pulmonary insufficiency and postoperative pneumothorax. Approximately 6% of complications were due to gastrointestinal complications such as paralytic ileus and postoperative obstruction. There were also more surgical related complications, such as intraoperative hemorrhages and accidental punctures or lacerations of nearby structures, in children with CP (3% vs. 0.5%) . Children with IS were more likely to have no postoperative complications while children with CP were more likely to have at least one or

two postoperative complications (Table 2). Approximately 15% of children with CP were admitted to the ICU postoperatively compared to 1% of children with IS (Table 2). Children with CP had longer hospital lengths of stay and greater total charges than did children with IS (Table 1).

Fitted Poisson Regression Analysis

After adjusting for age, race, gender, insurance payer, and common comorbidities that influence the health of children with CP, those with CP had a greater than 70% increased risk of having any postoperative complication compared to children with IS (Table 3). Children with CP had approximately 8 times (95% CI: 2.9-20.7) the risk of experiencing pulmonary complications and more than 3 times (95% CI: 1.5-7.0) the risk of having gastrointestinal complications. They also had an almost 5 times (95% CI: 1.9-20.8) the risk of having surgical complications. With regards to the need for blood transfusions, children with CP had more than a 50% increased risk compared to those with IS. They also had more than 6 times (95% CI: 1.1-2.2) the risk of being admitted to the ICU.

Chapter 4: Discussion

To our knowledge, this is the largest and most recent study to date analyzing spinal fusion surgery in pediatric patients with CP. We used a national sample of pediatric hospital discharges to describe differences in the frequency of complications and in-hospital outcomes between children with CP and those with IS following spinal fusion surgery. We found that following spinal fusion surgery, children with CP would have longer and more costly hospitalizations, and experience more pulmonary, gastrointestinal, or surgical complications, need a blood transfusion, or require admission to the ICU compared to children undergoing spinal fusion surgery for IS.

Pulmonary Complications Following Spinal Fusion Surgery in Children with CP

Similar to the results of previous studies that have examined the frequency of complications in children with NMS who underwent corrective surgery, our study supports the findings that pulmonary complications were among the most frequently occurring major complications after spinal surgery in this population [10, 11, 26, 27].

Pulmonary dysfunction is a common complication of neuromuscular disorders such as CP, secondary to factors including poor airway tone, recurrent aspiration, and thoracic cage deformity [28]. Although correction of the spinal curvature attempts to relieve the physical stress on the lungs and delay declining pulmonary function, functional respiratory status might be adversely affected perioperatively by a combination of factors including, but not limited to, poor pain control, atelectasis, and an inability to participate in pulmonary toilet [27]. This study affirms the importance of expert pulmonary management and surveillance in the care of these patients. Other studies have shown that use of preoperative non-invasive ventilation to strengthen respiratory muscles is a safe and effective way to mitigate potential respiratory complications [28, 29].

Additionally, a thorough examination of the child's respiratory system, including pulmonary function tests and preoperative chest x-ray, may be important to guide both preoperative and perioperative planning.

Gastrointestinal Complications Following Spinal Fusion Surgery in Children With CP

Our study demonstrates that children with CP have more than three times the risk of developing postoperative gastrointestinal complications compared to children with IS. These results are similar to other studies that have shown increased rates of ileus, obstruction, and pancreatitis following orthopedic surgeries in children with CP [30-32].

Gastrointestinal disorders, including dysphagia, gastroesophageal reflux disease (GERD), and reduced bowel motility are common in children with CP and up to 70% of patients with CP have a diagnosis of GERD [28, 31]. Additionally, children with CP also frequently have nutritional deficits. In our study, 40% of children with CP had a diagnosis of either GERD, failure to thrive, or nutritional deficiency. Furthermore, 46% of children with CP had a gastrostomy tube in place suggesting nutritional concerns. Poor nutritional status has been linked to worse postoperative outcomes and a higher rate of complications [7, 33]. Other risk factors for gastrointestinal complications include limited mobility, intraoperative positioning, and hypotensive anesthesia [32]. Postoperative patient monitoring for signs of gastric distention and decreased tolerance of feeds is necessary to identify the possible development of gastrointestinal related complications [31, 34].

Blood Transfusions Following Spinal Fusion Surgery in Children with CP

Our data support previous findings suggesting that postoperative blood loss in children with CP is greater compared to children with other diagnoses [35, 36]. In a prior multicenter study that examined risk factors for blood loss during spinal fusion surgery in 272 children with CP, coronal curve magnitude and unit rod constructs were the strongest predictors of high volume blood loss [36]. Since NMS is often more rapidly progressive than IS, children with CP may have greater degrees of curvature in their spine necessitating more extensive and an increased number of bony releases to achieve the same correction compared to children with IS. The increased number of bony releases required may result in greater blood loss. Additionally, valproic acid, an anticonvulsant medication frequently used in the treatment of seizure disorders in patients with CP, increases the risk of bleeding during surgery in children with neuromuscular disease who undergo spine surgery [37-39]. While the KID does not provide information on medication use, 60% of children with CP had a diagnosis of epilepsy compared to 1% of children with IS. Other factors implicated in major blood loss in this population include poor nutritional status and a greater depletion of clotting factors during spinal fusion surgery [40, 41]. The causes of greater blood loss are likely multifactorial and preoperative planning measures should consider the use of strategies for decreasing blood loss such as nutritional optimization, thorough medication review, consult with the patient's neurologist for potential adjustment of antiepileptics such as valproic acid prior to surgery, and preparation for safe replacement of red cells as well as fresh frozen plasma to replace clotting factor deficiencies perioperatively.

ICU Admissions Following Spinal Fusion Surgery in Children with CP

Our findings suggest that children with CP have more than 6 times the risk of being admitted to the ICU following spinal fusion surgery compared to children with IS. Most of the admissions to

the ICU in children with CP were due to the need for a ventilator. Notably, 10% of children with CP while only 0.1% of children with IS needed ventilator support. Differences in ICU admissions may also be the result of hospital practice or preoperative planning. Given the high risk of perioperative complications in this population, many care teams send all patients with CP directly to the ICU postoperatively [5]. Further research and data are needed to guide surgeons regarding which patients with CP would most benefit from postoperative ICU admission.

Study Strengths and Limitations

The major strength of this study was the size and national representativeness of the KID which consists of more than 4,200 participating hospitals and is larger than alternative data sources such as the Pediatric Health Information System or the American College of Surgeons National Surgical Quality Improvement Program – Pediatric. The use of this database enabled us to identify over 600 children and adolescents who underwent this relatively uncommon surgery.

There are several limitations associated with this study that need to be considered in its interpretation. The KID depends on ICD-10 codes to determine the presence of various diagnoses and procedures, and these ICD-10 codes are susceptible to misclassification or miscoding. However, this database has been used in multiple neurologic [11, 27, 33, 42, 43] and orthopedic [42, 44-47] studies and has been accepted as a nationally representative data set.

The KID is not a longitudinal data set and, therefore, it is not possible to determine if one patient had multiple admissions for the same reason or to be able to track re-admissions. Although this possibility cannot be excluded, we assume that multiple admissions in a given year for the same operation is uncommon, particularly for an extensive and invasive procedure such as spinal fusion.

The KID does not contain indicators of function or severity of illness, thus we lacked data on the patient's clinical presentation, physical examination findings, radiological evaluation, specific indications for surgery, as well as length of operation.

Notably, we were unable to report the frequency of mechanical wounds, infections, urinary complications, cardiovascular complications, foreign body complications, decubitus ulcer, complications related to central venous catheters, or venous thromboembolism because the sample size was fewer than 10, which requires suppression by the HCUP due to concerns with patient confidentiality.

Future Areas of Research

Further research designed to examine the risk of surgical complications associated with an anterior or combined anterior-posterior surgical approach is necessary in order to increase current knowledge and inform surgical techniques in this population. Additionally, further research designed to reduce the risk of surgical complications among children with CP is necessary to develop guidelines for caregivers, surgeons, and other providers on both the appropriateness of surgery given the potential risks and also expectations for outcomes. Once additional prospective and contemporary data are available regarding outcomes in this population, interventions could be developed to reduce the rates of postoperative complications. These interventions could include preoperative pulmonary function tests and nutritional optimization, and plan for perioperative repletion of fresh frozen plasma and red blood cells.

Chapter 5: Conclusions

NMS in children with CP presents at a young age, is rapidly progressive, and often requires surgical correction. In the present study, we analyzed the 2016 KID to examine the frequency of several in-hospital complications for pediatric patients with CP undergoing spinal fusion surgery compared to pediatric patients with IS. Our analysis revealed that children with CP are more likely to be male, to be younger, and to be on government health insurance. They also require longer hospital stays that incur greater costs. Children with CP were at increased risk of pulmonary complications, gastrointestinal complications, surgical complications, needing a blood transfusion, and being admitted to the ICU. These results will help to inform preoperative care and surgical decision-making. They may guide discussions of informed consent, and conversations regarding anticipatory guidance for children and their caregivers. Given the increased morbidity associated with scoliosis surgery in children with CP, further research into the short and long-term outcomes of these patients remains needed and identification of potentially modifiable prognostic factors is important.

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Tables

Table 1: Characteristics of Children with CP vs. IS undergoing Spinal Fusion Surgery and Hospital Characteristics

Table 1. Characteristics of Children with CP vs. IS undergoing Spinal Fusion and Hospital Characteristics			
	CP (n=660) n(%)	IS (n=5,244) n(%)	P-value
Male	359 (54.4)	1,195 (22.8)	<0.001
Age (median, yrs) (Q1, Q3)	13 (12,16)	14 (13,16)	<0.001
Age Categories			
Infant, <1 yr	NR	NR	<0.001
Toddler, 1-2 yr	NR	NR	
Early Childhood, 3-5 yr	NR	NR	
Middle Childhood, 6-11 yr	156 (23.6)	396 (7.8)	
Early Adolescence, 12-18 yr	473 (71.7)	4,641 (88.5)	
Late Adolescence, >19 yr	28 (4.3)	203 (3.9)	
Race			
Non-Hispanic White	359 (54.5)	3,320 (63.3)	0.009
Black	129 (19.6)	784 (15.0)	
Hispanic	127 (19.2)	661 (12.6)	
Other	44 (6.7)	479 (9.1)	
Income Quartile by ZIP Code			
1st	182 (27.5)	1,227 (23.4)	0.16
2nd	157 (23.9)	1,130 (21.6)	
3rd	148 (22.4)	1,312 (25.0)	
4th	153 (23.2)	1,495 (28.5)	
Insurance Payer			
Private	269 (40.8)	3,231 (61.6)	<0.001
Government	343 (52.0)	1,680 (32.0)	
Other	48 (7.2)	324 (6.2)	
Length of Stay: median (Q1, Q3), days	6 (5,8)	4 (3,5)	<0.001
Adjusted Hospital Charges in US $, mean (± SD)	280,576 (182,837)	186,084 (98,808)	<0.001
Hospital Bed Size			
Small	105 (15.9)	999 (19.1)	0.64
Medium	151 (22.9)	1,015 (19.4)	

Large	404 (61.2)	3,229 (61.6)	
Hospital Location/Teaching Status			
Rural	NR	NR	0.76
Urban Non-Teaching	30 (4.5)	207 (4.0)	
Urban Teaching	628 (95.1)	5,015 (95.6)	
Hospital Region			
Northeast	109 (16.5)	1,094 (20.9)	0.40
Midwest or North Central	161 (24.4)	1,193 (22.7)	
South	220 (33.3)	1,892 (36.1)	
West	170 (25.8)	1,065 (20.3)	

Note: weighted data
NR = Not Reported in compliance with the HCUP data use agreement

Table 2: Frequency of Complications of Children with CP vs. IS undergoing Spinal Fusion

Table 2. Morbidity of Children with CP vs. IS undergoing Spinal Fusion			
	CP n(%)	IS n(%)	P-value
Morbidity			
Any Complication	288 (43.6)	1,111 (21.2)	<0.001
Pulmonary	68 (10.4)	50 (1.0)	<0.001
Gastrointestinal	38 (5.8)	75 (1.4)	<0.001
Surgical	18 (2.8)	26 (0.5)	<0.001
Blood Transfusion	200 (30.4)	979 (18.7)	0.002
Number of Complications			
None	372 (56.4)	4,133 (78.8)	<0.001
One	217 (32.9)	1,058 (20.2)	0.002
Two or More	71 (10.7)	52 (1.0)	<0.001
ICU Admission	96 (14.6)	68 (1.3)	<0.001

Note: weighted data

Table 3: Estimated Relative Risk of Morbidity in Children with CP vs. IS Undergoing Spinal Fusion

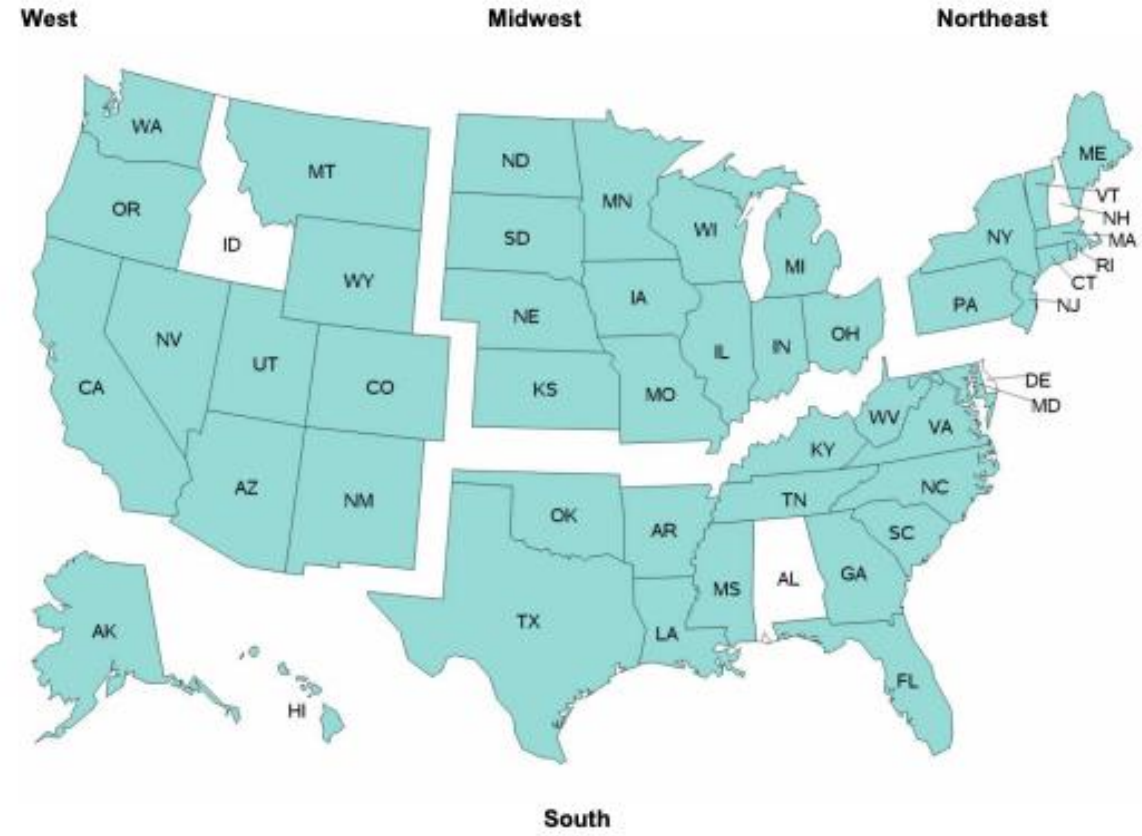
Table 3. Estimated Relative Risk of Morbidity in Children with CP vs IS undergoing Spinal Fusion				
	Unadjusted		Adjusted**	
	Relative Risk	95% CI	Relative Risk	95% CI
Complications				
Any Complication	2.06	1.61-2.62	1.73	1.26-2.36
Pulmonary	10.85	5.18-22.74	7.78	2.93-20.66
Gastrointestinal	4.06	2.19-7.51	3.26	1.53-6.96
Surgical	5.63	2.10-15.10	4.97	1.19-20.81
Blood Transfusion	1.63	1.21-2.19	1.54	1.06-2.23
ICU Admission	11.16	4.94-25.20	6.11	2.44-15.30

Note: weighted data

**Adjusted for age (continuous), race, gender, insurance payer, gastroesophageal reflux disease, failure to thrive, presence of a gastrostomy tube, presence of a tracheostomy, and nutritional deficiency

Figures

Figure 1: Map of U.S. States by U.S. Census Bureau Regions



All States, by Region[12]

Region	States
1: Northeast	Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont.
2: Midwest	Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin.
3: South	*Alabama*, Arkansas, *Delaware*, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia.
4: West	Alaska, Arizona, California, Colorado, Hawaii, *Idaho*, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming.

2016 Introduction to the KID. Healthcare Cost and Utilization Project (HCUP). September 2018. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/db/nation/kid/kid_2016_introduction.jsp

Appendix

Appendix A: List of ICD-10 Codes Spinal Fusion Surgery

ICD-10 Procedure Codes	Description
0RG7071	Fusion of 2 to 7 Thoracic Vertebral Joints with Autologous Tissue Substitute, Posterior Approach, Posterior Column, Open Approach
0RG707J	Fusion of 2 to 7 Thoracic Vertebral Joints with Autologous Tissue Substitute, Posterior Approach, Anterior Column, Open Approach
0RG70AJ	Fusion of 2 to 7 Thoracic Vertebral Joints with Interbody Fusion Device, Posterior Approach, Anterior Column, Open Approach
0RG70J1	Fusion of 2 to 7 Thoracic Vertebral Joints with Synthetic Substitute, Posterior Approach, Posterior Column, Open Approach
0RG70JJ	Fusion of 2 to 7 Thoracic Vertebral Joints with Synthetic Substitute, Posterior Approach, Anterior Column, Open Approach
0RG70K1	Fusion of 2 to 7 Thoracic Vertebral Joints with Nonautologous Tissue Substitute, Posterior Approach, Posterior Column, Open Approach
0RG70KJ	Fusion of 2 to 7 Thoracic Vertebral Joints with Nonautologous Tissue Substitute, Posterior Approach, Anterior Column, Open Approach
0RG7371	Fusion of 2 to 7 Thoracic Vertebral Joints with Autologous Tissue Substitute, Posterior Approach, Posterior Column, Percutaneous Approach
0RG737J	Fusion of 2 to 7 Thoracic Vertebral Joints with Autologous Tissue Substitute, Posterior Approach, Anterior Column, Percutaneous Approach
0RG73AJ	Fusion of 2 to 7 Thoracic Vertebral Joints with Interbody Fusion Device, Posterior Approach, Anterior Column, Percutaneous Approach
0RG73J1	Fusion of 2 to 7 Thoracic Vertebral Joints with Synthetic Substitute, Posterior Approach, Posterior Column, Percutaneous Approach
0RG73JJ	Fusion of 2 to 7 Thoracic Vertebral Joints with Synthetic Substitute, Posterior Approach, Anterior Column, Percutaneous Approach
0RG73K1	Fusion of 2 to 7 Thoracic Vertebral Joints with Nonautologous Tissue Substitute, Posterior Approach, Posterior Column, Percutaneous Approach
0RG73KJ	Fusion of 2 to 7 Thoracic Vertebral Joints with Nonautologous Tissue Substitute, Posterior Approach, Anterior Column, Percutaneous Approach
0RG7471	Fusion of 2 to 7 Thoracic Vertebral Joints with Autologous Tissue Substitute, Posterior Approach, Posterior Column, Percutaneous Endoscopic Approach
0RG747J	Fusion of 2 to 7 Thoracic Vertebral Joints with Autologous Tissue Substitute, Posterior Approach, Anterior Column, Percutaneous Endoscopic Approach
0RG74AJ	Fusion of 2 to 7 Thoracic Vertebral Joints with Interbody Fusion Device, Posterior Approach, Anterior Column, Percutaneous Endoscopic Approach
0RG74J1	Fusion of 2 to 7 Thoracic Vertebral Joints with Synthetic Substitute, Posterior Approach, Posterior Column, Percutaneous Endoscopic Approach
0RG74JJ	Fusion of 2 to 7 Thoracic Vertebral Joints with Synthetic Substitute, Posterior Approach, Anterior Column, Percutaneous Endoscopic Approach
0RG74K1	Fusion of 2 to 7 Thoracic Vertebral Joints with Nonautologous Tissue Substitute, Posterior Approach, Posterior Column, Percutaneous Endoscopic Approach

0RG74KJ	Fusion of 2 to 7 Thoracic Vertebral Joints with Nonautologous Tissue Substitute, Posterior Approach, Anterior Column, Percutaneous Endoscopic Approach
0RG8071	Fusion of 8 or more Thoracic Vertebral Joints with Autologous Tissue Substitute, Posterior Approach, Posterior Column, Open Approach
0RG807J	Fusion of 8 or more Thoracic Vertebral Joints with Autologous Tissue Substitute, Posterior Approach, Anterior Column, Open Approach
0RG80AJ	Fusion of 8 or more Thoracic Vertebral Joints with Interbody Fusion Device, Posterior Approach, Anterior Column, Open Approach
0RG80J1	Fusion of 8 or more Thoracic Vertebral Joints with Synthetic Substitute, Posterior Approach, Posterior Column, Open Approach
0RG80JJ	Fusion of 8 or more Thoracic Vertebral Joints with Synthetic Substitute, Posterior Approach, Anterior Column, Open Approach
0RG80K1	Fusion of 8 or more Thoracic Vertebral Joints with Nonautologous Tissue Substitute, Posterior Approach, Posterior Column, Open Approach
0RG80KJ	Fusion of 8 or more Thoracic Vertebral Joints with Nonautologous Tissue Substitute, Posterior Approach, Anterior Column, Open Approach
0RG8371	Fusion of 8 or more Thoracic Vertebral Joints with Autologous Tissue Substitute, Posterior Approach, Posterior Column, Percutaneous Approach
0RG837J	Fusion of 8 or more Thoracic Vertebral Joints with Autologous Tissue Substitute, Posterior Approach, Anterior Column, Percutaneous Approach
0RG83AJ	Fusion of 8 or more Thoracic Vertebral Joints with Interbody Fusion Device, Posterior Approach, Anterior Column, Percutaneous Approach
0RG83J1	Fusion of 8 or more Thoracic Vertebral Joints with Synthetic Substitute, Posterior Approach, Posterior Column, Percutaneous Approach
0RG83JJ	Fusion of 8 or more Thoracic Vertebral Joints with Synthetic Substitute, Posterior Approach, Anterior Column, Percutaneous Approach
0RG83K1	Fusion of 8 or more Thoracic Vertebral Joints with Nonautologous Tissue Substitute, Posterior Approach, Posterior Column, Percutaneous Approach
0RG83KJ	Fusion of 8 or more Thoracic Vertebral Joints with Nonautologous Tissue Substitute, Posterior Approach, Anterior Column, Percutaneous Approach
0RG8471	Fusion of 8 or more Thoracic Vertebral Joints with Autologous Tissue Substitute, Posterior Approach, Posterior Column, Percutaneous Endoscopic Approach
0RG847J	Fusion of 8 or more Thoracic Vertebral Joints with Autologous Tissue Substitute, Posterior Approach, Anterior Column, Percutaneous Endoscopic Approach
0RG84AJ	Fusion of 8 or more Thoracic Vertebral Joints with Interbody Fusion Device, Posterior Approach, Anterior Column, Percutaneous Endoscopic Approach
0RG84J1	Fusion of 8 or more Thoracic Vertebral Joints with Synthetic Substitute, Posterior Approach, Posterior Column, Percutaneous Endoscopic Approach
0RG84JJ	Fusion of 8 or more Thoracic Vertebral Joints with Synthetic Substitute, Posterior Approach, Anterior Column, Percutaneous Endoscopic Approach
0RG84K1	Fusion of 8 or more Thoracic Vertebral Joints with Nonautologous Tissue Substitute, Posterior Approach, Posterior Column, Percutaneous Endoscopic Approach
0RG84KJ	Fusion of 8 or more Thoracic Vertebral Joints with Nonautologous Tissue Substitute, Posterior Approach, Anterior Column, Percutaneous Endoscopic Approach

0RGA071	Fusion of Thoracolumbar Vertebral Joint with Autologous Tissue Substitute, Posterior Approach, Posterior Column, Open Approach
0RGA07J	Fusion of Thoracolumbar Vertebral Joint with Autologous Tissue Substitute, Posterior Approach, Anterior Column, Open Approach
0RGA0AJ	Fusion of Thoracolumbar Vertebral Joint with Interbody Fusion Device, Posterior Approach, Anterior Column, Open Approach
0RGA0J1	Fusion of Thoracolumbar Vertebral Joint with Synthetic Substitute, Posterior Approach, Posterior Column, Open Approach
0RGA0JJ	Fusion of Thoracolumbar Vertebral Joint with Synthetic Substitute, Posterior Approach, Anterior Column, Open Approach
0RGA0K1	Fusion of Thoracolumbar Vertebral Joint with Nonautologous Tissue Substitute, Posterior Approach, Posterior Column, Open Approach
0RGA0KJ	Fusion of Thoracolumbar Vertebral Joint with Nonautologous Tissue Substitute, Posterior Approach, Anterior Column, Open Approach
0RGA371	Fusion of Thoracolumbar Vertebral Joint with Autologous Tissue Substitute, Posterior Approach, Posterior Column, Percutaneous Approach
0RGA37J	Fusion of Thoracolumbar Vertebral Joint with Autologous Tissue Substitute, Posterior Approach, Anterior Column, Percutaneous Approach
0RGA3AJ	Fusion of Thoracolumbar Vertebral Joint with Interbody Fusion Device, Posterior Approach, Anterior Column, Percutaneous Approach
0RGA3J1	Fusion of Thoracolumbar Vertebral Joint with Synthetic Substitute, Posterior Approach, Posterior Column, Percutaneous Approach
0RGA3JJ	Fusion of Thoracolumbar Vertebral Joint with Synthetic Substitute, Posterior Approach, Anterior Column, Percutaneous Approach
0RGA3K1	Fusion of Thoracolumbar Vertebral Joint with Nonautologous Tissue Substitute, Posterior Approach, Posterior Column, Percutaneous Approach
0RGA3KJ	Fusion of Thoracolumbar Vertebral Joint with Nonautologous Tissue Substitute, Posterior Approach, Anterior Column, Percutaneous Approach
0RGA471	Fusion of Thoracolumbar Vertebral Joint with Autologous Tissue Substitute, Posterior Approach, Posterior Column, Percutaneous Endoscopic Approach
0RGA47J	Fusion of Thoracolumbar Vertebral Joint with Autologous Tissue Substitute, Posterior Approach, Anterior Column, Percutaneous Endoscopic Approach
0RG64AJ	Fusion of Thoracolumbar Vertebral Joint with Interbody Fusion Device, Posterior Approach, Anterior Column, Percutaneous Endoscopic Approach
0RG64J1	Fusion of Thoracolumbar Vertebral Joint with Synthetic Substitute, Posterior Approach, Posterior Column, Percutaneous Endoscopic Approach
0RG64JJ	Fusion of Thoracolumbar Vertebral Joint with Synthetic Substitute, Posterior Approach, Anterior Column, Percutaneous Endoscopic Approach
0RGA4K1	Fusion of Thoracolumbar Vertebral Joint with Nonautologous Tissue Substitute, Posterior Approach, Posterior Column, Percutaneous Endoscopic Approach
0RGA4KJ	Fusion of Thoracolumbar Vertebral Joint with Nonautologous Tissue Substitute, Posterior Approach, Anterior Column, Percutaneous Endoscopic Approach

Appendix B: List of ICD-10 Codes Used for Complications

ICD-10 Diagnosis/Procedure Codes	**Description**
Mechanical Wound	
T8130XA	Disruption of wound, unspecified, initial encounter
T8131XA	Disruption of external operation (surgical) wound, not elsewhere classified, initial encounter
T8132XA	Disruption of internal operation (surgical) wound, not elsewhere classified, initial encounter
T8133XA	Disruption of traumatic injury wound repair, initial encounter
Infectious	
A40.0- A40.9	Streptococcal sepsis
A41.0-A41.9	Other sepsis
T81.12XA	Postprocedural septic shock, initial encounter
T81.40XA	Infection following a procedure, unspecified, initial encounter
T81.41XA	Infection following a procedure, superficial incisional surgical site, initial encounter
T81.42XA	Infection following a procedure, deep incisional surgical site, initial encounter
T81.43XA	Infection following a procedure, organ and space surgical site, initial encounter
T81.44XA	Sepsis following a procedure, initial encounter
T81.49XA	Infection following a procedure, other surgical site, initial encounter
Urinary	
N99.89	Other postprocedural complications and disorders of genitourinary system
Pulmonary	
J95.1	Acute pulmonary insufficiency following thoracic surgery
J95.2	Acute pulmonary insufficiency following nonthoracic surgery
J95.811	Postprocedural pneumothorax
J95.812	Postprocedural air leak
J95.821	Acute postprocedural respiratory failure
J95.822	Acute and chronic postprocedural respiratory failure
J95.860	Postprocedural hematoma of a respiratory system organ or structure following a respiratory system procedure
J95.861	Postprocedural hematoma of a respiratory system organ or structure following other procedure
J95.862	Postprocedural seroma of a respiratory system organ or structure following a respiratory system procedure
J95.863	Postprocedural seroma of a respiratory system organ or structure following other procedure
Gastrointestinal	
K56.0	Paralytic ileus
K56.7	Ileus, unspecified

K91.30- K91.32	Postprocedural intestinal obstruction
Cardiovascular	
I82.601-I82.609	Acute embolism and thrombosis of veins of upper extremity
I82.611-I82.619	Acute embolism and thrombosis of superficial veins of upper extremity
I82.621- I82.629	Acute embolism and thrombosis of deep veins of upper extremity
I82.811- I82.819	Embolism and thrombosis of other specified veins
I82.890	Acute embolism and thrombosis of other specified veins
I82.A11- I82.A19	Acute embolism and thrombosis of axillary vein
I82.B11-I82.B19	Acute embolism and thrombosis of subclavian vein
I82.C11- I82.C19	Acute embolism and thrombosis of internal jugular vein
T81.10XA	Postprocedural shock unspecified, initial encounter
T81.11XA	Postprocedural cardiogenic shock, initial encounter
T81.19XA	Other postprocedural shock, initial encounter
Decubitus Ulcer	
L89.000- L89.029	Pressure ulcer of elbow
L89.100- L89.149	Pressure ulcer of back
L89.150- L89.159	Pressure ulcer of sacral region
L89.200- L89.229	Pressure ulcer of hip
L89.300-L89.329	Pressure ulcer of buttock
L89.40-L89.46	Pressure ulcer of contiguous site of back, buttock and hip
L89.500-L89.529	Pressure ulcer of ankle
L89.600- L89.629	Pressure ulcer of heel
L89.810- L89.899	Pressure ulcer of other site
L89.90- L89.96	Pressure ulcer of unspecified site
Foreign Body	
T81.500A	Unspecified complication of foreign body accidentally left in body following surgical operation, initial encounter
T81.504A	Unspecified complication of foreign body accidentally left in body following endoscopic examination, initial encounter
T81.506A	Unspecified complication of foreign body accidentally left in body following aspiration, puncture or other catheterization, initial encounter
T81.507A	Unspecified complication of foreign body accidentally left in body following removal of catheter or packing, initial encounter
T81.508A	Unspecified complication of foreign body accidentally left in body following other procedure, initial encounter
T81.509A	Unspecified complication of foreign body accidentally left in body following unspecified procedure, initial encounter
T81.510A	Adhesions due to foreign body accidentally left in body following surgical operation, initial encounter
T81.511A	Adhesions due to foreign body accidentally left in body following infusion or transfusion, initial encounter

T81.514A	Adhesions due to foreign body accidentally left in body following endoscopic examination, initial encounter
T81.516A	Adhesions due to foreign body accidentally left in body following aspiration, puncture or other catheterization, initial encounter
T81.517A	Adhesions due to foreign body accidentally left in body following removal of catheter or packing, initial encounter
T81.518A	Adhesions due to foreign body accidentally left in body following other procedure, initial encounter
T81.519A	Adhesions due to foreign body accidentally left in body following unspecified procedure, initial encounter
T81.520A	Obstruction due to foreign body accidentally left in body following surgical operation, initial encounter
T81.521A	Obstruction due to foreign body accidentally left in body following infusion or transfusion, initial encounter
T81.524A	Obstruction due to foreign body accidentally left in body following endoscopic examination, initial encounter
T81.526A	Obstruction due to foreign body accidentally left in body following aspiration, puncture or other catheterization, initial encounter
T81.527A	Obstruction due to foreign body accidentally left in body following removal of catheter or packing, initial encounter
T81.528A	Obstruction due to foreign body accidentally left in body following other procedure, initial encounter
T81.529A	Obstruction due to foreign body accidentally left in body following unspecified procedure, initial encounter
T81.590A	Other complications of foreign body accidentally left in body following surgical operation, initial encounter
T81.591A	Other complications of foreign body accidentally left in body following infusion or transfusion, initial encounter
T81.594A	Other complications of foreign body accidentally left in body following endoscopic examination, initial encounter
T81.596A	Other complications of foreign body accidentally left in body following aspiration, puncture or other catheterization, initial encounter
T81.597A	Other complications of foreign body accidentally left in body following removal of catheter or packing, initial encounter
T81.598A	Other complications of foreign body accidentally left in body following other procedure, initial encounter
T81.599A	Other complications of foreign body accidentally left in body following unspecified procedure, initial encounter
T81.60XA	Unspecified acute reaction to foreign substance accidentally left during a procedure, initial encounter
T81.61XA	Aseptic peritonitis due to foreign substance accidentally left during a procedure, initial encounter

T81.69XA	Other acute reaction to foreign substance accidentally left during a procedure, initial encounter
Central Venous Catheter	
T800XXA	Air embolism following infusion, transfusion and therapeutic injection, initial encounter
T801XXA	Vascular complications following infusion, transfusion and therapeutic injection, initial encounter
T80211A	Bloodstream infection due to central venous catheter, initial encounter
T8029XA	Infection following other infusion, transfusion and therapeutic injection, initial encounter
Surgical	
G97.32	Intraoperative hemorrhage and hematoma of a nervous system organ or structure complicating other procedure
G97.41	Accidental puncture or laceration of dura during a procedure
G97.49	Accidental puncture and laceration of other nervous system organ or structure during other procedure
G97.81	Other intraoperative complications of nervous system
I97.42	Intraoperative hemorrhage and hematoma of a circulatory system organ or structure complicating other procedure
I97.52	Accidental puncture and laceration of a circulatory system organ or structure during other procedure
I97.711	Intraoperative cardiac arrest during other surgery
I97.791	Other intraoperative cardiac functional disturbances during other surgery
I97.811	Intraoperative cerebrovascular infarction during other surgery
I97.88	Other intraoperative complications of the circulatory system, not elsewhere classified
J95.62	Intraoperative hemorrhage and hematoma of a respiratory system organ or structure complicating other procedure
J95.72	Accidental puncture and laceration of a respiratory system organ or structure during other procedure
J95.88	Other intraoperative complications of respiratory system, not elsewhere classified
K91.62	Intraoperative hemorrhage and hematoma of a digestive system organ or structure complicating other procedure
K91.72	Accidental puncture and laceration of a digestive system organ or structure during other procedure
K91.81	Other intraoperative complications of digestive system
L76.02	Intraoperative hemorrhage and hematoma of skin and subcutaneous tissue complicating other procedure
L76.12	Accidental puncture and laceration of skin and subcutaneous tissue during other procedure
L76.22	Postprocedural hemorrhage of skin and subcutaneous tissue following other procedure

L76.32	Postprocedural hematoma of skin and subcutaneous tissue following other procedure
L76.81	Other intraoperative complications of skin and subcutaneous tissue
M96.810	Intraoperative hemorrhage and hematoma of a musculoskeletal structure complicating a musculoskeletal system procedure
M96.811	Intraoperative hemorrhage and hematoma of a musculoskeletal structure complicating other procedure
M96.820	Accidental puncture and laceration of a musculoskeletal structure during a musculoskeletal system procedure
M96.821	Accidental puncture and laceration of a musculoskeletal structure during other procedure
M96.89	Other intraoperative and postprocedural complications and disorders of the musculoskeletal system
N99.62	Intraoperative hemorrhage and hematoma of a genitourinary system organ or structure complicating other procedure
N99.72	Accidental puncture and laceration of a genitourinary system organ or structure during other procedure
N99.81	Other intraoperative complications of genitourinary system
Blood Transfusion	
3023AZ- 30233Y4	Transfusion of blood products into peripheral vein
30240AZ-30243Y4	Transfusion of blood products into central vein
30280B1- 30283B1	Transfusion of Non-autologous 4-Factor Prothrombin Complex Concentrate into Vein
Venous Thromboembolism (Lower Extremity)	
I82.401-I82.409	Acute embolism and thrombosis of unspecified deep veins of lower extremity
I82.411-I82.419	Acute embolism and thrombosis of femoral vein
I82.421-I82.429	Acute embolism and thrombosis of iliac vein
I82.431-I82.439	Acute embolism and thrombosis of popliteal vein
I82.441-I82.449	Acute embolism and thrombosis of tibial vein
I82.491-I82.499	Acute embolism and thrombosis of other specified deep vein of lower extremity
I82.4Y1-I82.4Y9	Acute embolism and thrombosis of unspecified deep veins of proximal lower extremity
I82.4Z1-I82.4Z9	Acute embolism and thrombosis of unspecified deep veins of distal lower extremity
Arterial Line	
4A130B1	Monitoring of Arterial Pressure, Peripheral, Open Approach
4A133B1	Monitoring of Arterial Pressure, Peripheral, Percutaneous Approach
Ventilator Use	
5A1935Z	Respiratory Ventilation, Less than 24 Consecutive Hours
5A1945Z	Respiratory Ventilation, 24-96 Consecutive Hours

5A1955Z	Respiratory Ventilation, Greater than 96 Consecutive Hours
Internal Jugular Central Line	
05HN03Z	Insertion of Infusion Device into Left Internal Jugular Vein, Open Approach
05HN0DZ	Insertion of Intraluminal Device into Left Internal Jugular Vein, Open Approach
05HN33Z	Insertion of Infusion Device into Left Internal Jugular Vein, Percutaneous Approach
05HN3DZ	Insertion of Intraluminal Device into Left Internal Jugular Vein, Percutaneous Approach
05HN43Z	Insertion of Infusion Device into Left Internal Jugular Vein, Percutaneous Endoscopic Approach
05HN4DZ	Insertion of Intraluminal Device into Left Internal Jugular Vein, Percutaneous Endoscopic Approach
05HM03Z	Insertion of Infusion Device into Right Internal Jugular Vein, Open Approach
05HM0DZ	Insertion of Intraluminal Device into Right Internal Jugular Vein, Open Approach
05HM33Z	Insertion of Infusion Device into Right Internal Jugular Vein, Percutaneous Approach
05HM3DZ	Insertion of Intraluminal Device into Right Internal Jugular Vein, Percutaneous Approach
05HM43Z	Insertion of Infusion Device into Right Internal Jugular Vein, Percutaneous Endoscopic Approach
05HM4DZ	Insertion of Intraluminal Device into Right Internal Jugular Vein, Percutaneous Endoscopic Approach
Subclavian Central Line	
05H603Z	Insertion of Infusion Device into Left Subclavian Vein, Open Approach
05H60DZ	Insertion of Intraluminal Device into Left Subclavian Vein, Open Approach
05H633Z	Insertion of Infusion Device into Left Subclavian Vein, Percutaneous Approach
05H63DZ	Insertion of Intraluminal Device into Left Subclavian Vein, Percutaneous Approach
05H643Z	Insertion of Infusion Device into Left Subclavian Vein, Percutaneous Endoscopic Approach
05H64DZ	Insertion of Intraluminal Device into Left Subclavian Vein, Percutaneous Endoscopic Approach
05H503Z	Insertion of Infusion Device into Right Subclavian Vein, Open Approach
05H50DZ	Insertion of Intraluminal Device into Right Subclavian Vein, Open Approach
05H533Z	Insertion of Infusion Device into Right Subclavian Vein, Percutaneous Approach

05H53DZ	Insertion of Intraluminal Device into Right Subclavian Vein, Percutaneous Approach
05H543Z	Insertion of Infusion Device into Right Subclavian Vein, Percutaneous Endoscopic Approach
05H54DZ	Insertion of Intraluminal Device into Right Subclavian Vein, Percutaneous Endoscopic Approach
Femoral Central Line	
06HN03Z	Insertion of Infusion Device into Left Femoral Vein, Open Approach
06HN0DZ	Insertion of Intraluminal Device into Left Femoral Vein, Open Approach
06HN33Z	Insertion of Infusion Device into Left Femoral Vein, Percutaneous Approach
06HN3DZ	Insertion of Intraluminal Device into Left Femoral Vein, Percutaneous Approach
06HN43Z	Insertion of Infusion Device into Left Femoral Vein, Percutaneous Endoscopic Approach
06HN4DZ	Insertion of Intraluminal Device into Left Femoral Vein, Percutaneous Endoscopic Approach
06HM03Z	Insertion of Infusion Device into Right Femoral Vein, Open Approach
06HM0DZ	Insertion of Intraluminal Device into Right Femoral Vein, Open Approach
06HM33Z	Insertion of Infusion Device into Right Femoral Vein, Percutaneous Approach
06HM3DZ	Insertion of Intraluminal Device into Right Femoral Vein, Percutaneous Approach
06HM43Z	Insertion of Infusion Device into Right Femoral Vein, Percutaneous Endoscopic Approach
06HM4DZ	Insertion of Intraluminal Device into Right Femoral Vein, Percutaneous Endoscopic Approach
ECMO	
5A1522F	Extracorporeal Oxygenation, Membrane, Central
5A1522G	Extracorporeal Oxygenation, Membrane, Peripheral Veno-arterial
5A1522H	Extracorporeal Oxygenation, Membrane, Peripheral Veno-venous
5A05121	Extracorporeal Hyperbaric Oxygenation, Intermittent
5A0512C	Extracorporeal Supersaturated Oxygenation, Intermittent
5A05221	Extracorporeal Hyperbaric Oxygenation, Continuous
5A0522C	Extracorporeal Supersaturated Oxygenation, Continuous