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Risk Factors for Surgical Site Infections after Posterior Spinal Fusion in Neuromuscular and Cerebral Palsy Scoliosis Patients: A Retrospective ACS NSQIP Pediatric Database Analysis

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Introduction

Surgical site infections (SSI) after pediatric spinal deformity surgery greatly increase postoperative morbidity and rates of readmission. In addition, these complications drastically increase healthcare costs with mean hospitalization of 29 days and hospital charges of $154,000, respectively. In some cases, a deep SSI may result in hardware removal, deformity progression, and failure to cure.[1-4] Incidence greatly varies depending on scoliosis etiology, ranging from 0.5% with adolescent idiopathic scoliosis to ≥ 25% for neuromuscular scoliosis. Despite unique patient population-specific infection rates and risk factors, multiple etiologies are often combined as single cohorts in the literature.[1]

Studies have shown higher SSI incidence in neuromuscular scoliosis patients, with associated risk factors including incontinence, inappropriate antibiotics, obesity, malnutrition, pelvic fixation, operative time, blood transfusion, prolonged hospitalization, and others.[3] Existing studies analyzing SSI risk factors are generally small, single-center studies, and research of risk factors on subtypes of neuromuscular scoliosis such as cerebral palsy (CP) is very limited.[2,5-7] Thus, the purpose of our study was to identify perioperative risk factors for wound complications in neuromuscular and CP scoliosis patients using the American College of Surgeons (ACS) National Surgical Quality Improvement Program Pediatric (NSQIP-P) database.

Methods

Data Collection

The NSQIP-P databases for available years 2012 and 2013, containing 51,008 and 63,387 cases at 50 and 56 participating sites respectively, were retrospectively queried. CPT codes for posterior spinal fusion (PSF) as a main, other, or concurrent procedure of >7 segments were used. Other etiologies of scoliosis or spinal pathology were excluded by ICD-9 codes (Figure 1), confining our cohort to neuromuscular scoliosis patients with or without CP (NMS) (n = 702), and neuromuscular scoliosis patients with CP (CPS) (n = 411). SSI was classified according to CDC National Healthcare Safety Network criteria.[8] We collectively grouped all SSI types as one outcome, wound complications, which included superficial and deep incisional SSI, organ/space SSI, and deep and superficial wound disruption. We evaluated individual and perioperative factors as risk factors for that outcome.

Statistical Analysis

Statistical analysis was completed with. Univariate analysis was conducted to identify appropriate regressors for multivariate analysis. We performed binary logistic regression using regressors which were significant on univariate at the 0.10 level or less. Finally, we used Receiver Operating Characteristic (ROC) curves on significant continuous variables to select thresholds that optimize sensitivity and specificity, and then recoded the variables so that the continuous variables were the new binary variables discovered in the ROC analysis. A new regression model including odds ratios (OR) was created based upon binary variables created in the previous step. All analysis was completed with SPSS v.20.

Results

Demographics, perioperative factors, and comorbidities are detailed in Table 1. Postoperative adverse events including wound complications and unplanned reoperation details are listed in Table 2.

Neuromuscular Scoliosis

Wound complication and unplanned reoperation related to index procedure rates were 57/702 (8.1%) and 42/702 (6.0%), respectively. Logistic regression showed ASA classes 3&4 ($p = 0.043$, OR = 3.0), pelvic fixation ($p = 0.047$, OR = 1.9), and operative time ($p = 0.011$), where exceeding 6.5 hours resulted in even higher risk ($p = 0.007$, OR = 2.1), to be risk factors for wound complications. Congenital heart disease (CHD) approached statistical significance as a risk factor ($p = 0.052$, OR = 2.3).

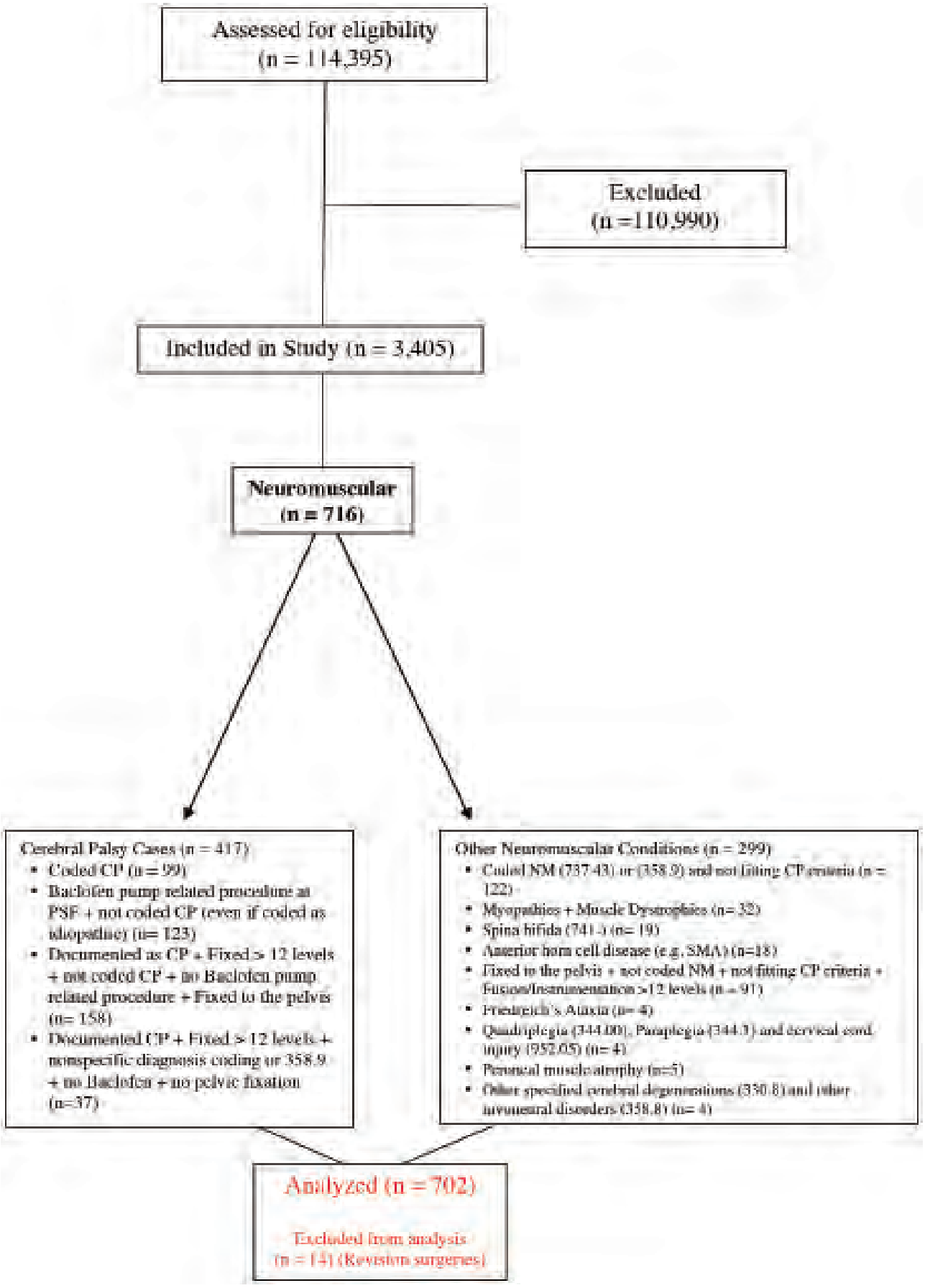

Figure 1. Consort diagram showing patients included and excluded for analysis.

Table 1. Demographics and perioperative comorbidities documented for Idiopathic, Neuromuscular and CP patients in NSQIP Ped database for 2012 & 2013

		All Neuromuscular Cases (n = 702)	CP Cases (n = 411)	All patients (N = 3362)
Preoperative				
Age at surgery in years		13.2±3	13.5±2.8	14±2.4
Gender	M (%)	316 (45%)	177 (43.1%)	927 (27.6%)
F (%)	386 (55%)	234 (56.9%)	2435 (72.4%)	
Weight at surgery in kg		39.5±17.1	38.9±16.2	50.8±17.5
Body Mass Index (BMI) in kg/m2		18.2±10.3	17.7±9.8	20.5±8.1
Diabetes		0	0	11 (0.3%)
Seizure Disorder		267 (38%)	205 (49.9%)	367 (10.9%)
Asthma		116 (16.5%)	71 (17.3%)	303 (9%)
O2 Support preoperatively		59 (8.4%)	27 (6.6%)	77 (2.3%)
Tracheostomy		41 (5.8%)	20 (4.9%)	50 (1.5%)
Congenital Heart Disease		54 (7.7%)	22 (5.4%)	163 (4.8%)
Previous Cardiac Surgery		31 (4.4%)	17 (4.1%)	114 (3.4%)
Cardiac Risk	None	617 (87.9%)	379 (92.2%)	3121 (92.8%)
Minor	52 (7.4%)	22 (5.4%)	150 (4.5%)	
Major	28 (4%)	8 (1.9%)	74 (2.2%)	
Severe	5 (0.7%)	2 (0.5%)	17 (0.5%)	
Steroid Use within 30 days		21 (3%)	6 (1.5%)	44 (1.3%)
Prior Operation within 30 days		19 (2.7%)	5 (1.2%)	31 (0.9%)
Open Wounds (with or without infection)		12 (1.7%)	5 (1.2%)	18 (0.5%)
Weight Loss/ Failure to Thrive		29 (4.1%)	18 (4.4%)	47 (1.4%)
Nutritional support		247 (35.2%)	181 (44%)	314 (9.3%)
Bleeding Disorders		14 (2%)	9 (2.2%)	32 (1%)
Preoperative Serum Albumin (gm/dL)		4.3±0.5	4.3±0.6	4.4±0.4
Preoperative WBCs		7.2±2.6	6.9±2.6	6.9±2.6/dL
Preoperative HCT		40.7±4.7	41±4.9	39.7±4.1%
ASA Class.	ASA 1	29 (4.1%)	25 (6.1%)	679 (20.2%)
	ASA 2	128 (18.2%)	79 (19.2%)	1680 (50%)
	ASA 3	490 (69.8%)	286 (69.6%)	924 (27.5%)
	ASA 4	54 (7.7%)	20 (4.9%)	71 (2.1%)
	None assigned	1	1	8
Intraoperative				
Anaesthesia Time in Hours		8.2±2.4	8.2±2.1	6.8±2.1
Operative Time		6±2.2	6.1±1.9	5±1.9
Spinal Osteotomy		227 (32.3%)	149 (36.3%)	1034 (30.8%)
13-level instrumentation or more		586 (83.5%)	338 (82.2%)	1418 (42.2%)
Pelvic Fixation		399 (56.8%)	243 (59.1%)	402 (12%)
Concomitant Anterior Spinal Fusion		19 (2.7%)	9 (2.2%)	53 (1.6%)
Baclofen Pump-Related Procedure		134 (19.1%)	134 (32.6%)	134 (4%)
Inotropic Support intraoperatively		16 (2.3%)	8 (1.9%)	119 (3.5%)
Cases with Blood Transfusion		568 (80.9%)	337 (82%)	2376 (70.7%)
Days until Transfusion		0.1±0.5	0.1±0.5	0.1±0.5 days
Total Amount Transfused in ml		913.8±756.4	955.2±761.7	444.2±603

Table 2. Postoperative adverse events documented for Idiopathic, Neuromuscular and CP patients in NSQIP Ped database for 2012 & 2013

Postoperative Adverse Event	All Neuromuscular Cases (n = 702)	CP Cases (n = 411)	All patients (N = 3362)
Postoperative Wound Problems	57 (8.1%)	36 (8.8%)	120 (3.6%)
Superficial Incisional SSI	11 (1.6%)	5 (1.2%)	34 (1%)
Deep Incisional SSI	15 (2.1%)	11 (2.7%)	44 (1.3%)
Organ/Space SSI	5 (0.7%)	4 (1%)	12 (0.4%)
Superficial Wound Disruption	21 (3%)	14 (3.4%)	58 (1.7%)
Deep Wound Disruption	16 (2.3%)	10 (2.4%)	36 (1.1%)
Unplanned Reoperation	50 (7.1%)	37 (9%)	151 (4.5%)
Related to the index surgery	42	32	136
Second Unplanned Reoperation	16 (2.3%)	12 (2.9%)	42 (1.2%)
Third Unplanned Reoperation	9 (1.3%)	7 (1.7%)	21 (0.6%)
Unplanned Readmission	59 (8.4%)	43 (10.5%)	171 (5.1%)
Related to the index surgery	42	29	121
Death within 30 days of index surgery	3 (0.4%)	2 (0.5%)	7 (0.2%)

Cerebral Palsy Scoliosis

Wound complication and unplanned reoperation related to index procedure rates were 36/411 (8.8%) and 32/411 (7.8%), respectively. Logistic regression showed CHD ($p = 0.024$, OR = 3.0), inotropic support at time of surgery ($p = 0.003$, OR = 11.0), and pelvic fixation ($p = 0.006$, OR = 3.5) to be predictors of wound complications.

Discussion

Wound problems are clinically and financially devastating to patients and their families after spine deformity surgery, particularly in patients with neuromuscular etiologies. Our rates of wound complications are consistent with multiple independent studies,[9-11] and NSQIP database studies specifically have reported SSI rates for neuromuscular patients of 4.67%, 1.52%, and 4.5%.[12-14] Variation between studies is largely due to different patient inclusion/exclusion and dependent outcome criteria, for example our study combines wound disruptions with SSI.

ASA classes 3&4 and pelvic fixation were shared risk factors in NMS and CPS patients, which has been observed in other literature.[12-16] Previous NSQIP studies have identified complication risk factors for spine deformity surgery using multivariate analysis, including cardiac and hepatobiliary disease, obesity, cognitive impairment, ASA classes 3&4, and prolonged operative time; however, they did not separate patients with CP as done here.[12,13]

Basques et al analyzed neuromuscular scoliosis patients in NSQIP using multivariate analysis, and they found that BMI-for-age $\geq 95^{th}$ percentile, ASA classes 3&4, and pelvic fixation were risk factors for infection. Our study uniquely found operative time as a wound complication risk factors for neuromuscular patients, and CHD and inotropic support as specific risk factors for CPS patients. In a systematic review on outcomes of scoliosis surgery in CP patients, Toovey et al found insufficient evidence to make clinical recommendations on complication risk factors.[17] Minhas et al found that underweight status was a risk factor for 30-day complications in CP patients undergoing various orthopedic surgeries; however, their sample was not limited to spine procedures.[15]

Limitations of this study include the relatively small sizes of our study samples in comparison to other studies utilizing NSQIP, as well as only 2 years of available data, which limits the statistical power of identifying other wound complication risk factors even though they are likely clinically irrelevant. Furthermore, NSQIP does not record important operative details including implant types, exact number of instrumented segments, and technique variability, nor does it include follow-up past 30 days postoperatively.

Conclusions

Newly identified risk factors unique to the two patient populations in this study may assist surgical candidacy assessment and offer areas for preoperative and intraoperative improvement in wound complication prevention.[1,18] For example, McLeod et al found that broad-spectrum antimicrobial prophylaxis for PSF varied amongst national hospitals, and new studies are needed to compare prophylaxis effectiveness amongst specific high-risk subgroups such as CP patients identified here.[19] Furthermore, this study will allow more effective preoperative counseling of patients and families on the risks of surgery, and illustrates unique risk factors for cerebral palsy scoliosis patients using a large multi-center national database.

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