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ORIGINAL RESEARCH

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Surgical site infections after pediatric open airway reconstruction—A National Surgical Quality Improvement Program-Pediatric analysis

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Abstract

Objectives: To determine the rate of surgical site infections (SSI) after pediatric open airway reconstruction using a nationwide database.

Study Design: Cross-sectional study of the American College of Surgeons National Surgical Quality Improvement Program-Pediatric (ACS NSQIP-P) Database.

Methods: The ACS NSQIP-P was queried for open airway surgeries between 2013 and 2019 determining postoperative SSI and wound dehiscence with a random sample of non-airway cases serving as a control group.

Results: A total of 637 laryngotracheoplasties (LTP), 411 tracheal resections (TR) and 2100 control procedures were included. LTP and TR were both performed on younger children with more comorbidities than control surgeries ($p < .05$). Postoperative wound complications occurred more often after airway reconstructions than non-airway cases (6.4% vs. 2.9%, $p < .001$). Compared to non-airway procedures, LTP (OR: 2.42, 95% CI: 1.62–3.61) and TR (OR: 2.07, 95% CI: 1.28–3.66) developed increased SSI. Multiple logistic regression identified dirty or infected wounds (OR: 4.61, $p < .001$, 95% CI: 2.35–9.03) and American Society of Anesthesiologists (ASA) Class IV (OR: 3.19, $p = .02$, 95% CI: 1.12–8.39) as the strongest predictors of SSI after airway reconstruction.

Conclusions: SSI after pediatric airway reconstruction occur in 6% of cases and are increased in infected wounds and ASA Class IV surgeries. Recognizing common factors for these complications provide reliable benchmarking to design surgical quality improvement initiatives.

Level of Evidence: 4.

KEYWORDS
pediatric airway surgery, surgical site infections, wound dehiscence

1 | INTRODUCTION

Open airway reconstruction procedures in children are typically performed to manage respiratory insufficiency from laryngotracheal stenosis.[1,2] Typically, children requiring these surgeries are medically complex with multiple comorbidities including a history of prematurity, chronic lung disease, and tracheostomy dependence. This vulnerable group can develop high rates of perioperative complications after pediatric airway reconstruction.[3]

Surgical site infections (SSI) are important complications to measure for quality improvement initiatives. The Centers for Disease Control and Prevention (CDC) defines SSI as an infection occurring within 30 days of surgery or within 1 year after a procedure involving an implant.[4] SSI are further categorized as superficial incisional, deep incisional, or organ/space infections.[4,5] The incidence of SSI ranges from 2% to 5% of all surgical procedures,[5] while head and neck surgeries have a superficial SSI risk of 5.5%, deep SSI risk of 3.4%, and organ/space infection risk of 2.0%.[6] Pediatric otolaryngology procedures have a SSI risk of approximately 3.7%.[7]

Airway reconstruction surgeries have a SSI rate of 3%–10%.[8] The etiology of such infections is often secondary to auto-contamination from a patient's native microbial flora.[7] These infections are associated with increased patient morbidity including protracted hospital courses, prolonged antibiotics, and a delay in return to baseline activity.[7,9] In addition, SSI are known to have a profound impact on health care costs,[10,11] both in low-middle and high income countries.[12] Composite morbidity after pediatric airway reconstruction approaches 20% and hospital-acquired SSI develop in 6%.[3] To date, the data regarding SSI after pediatric airway reconstruction has been limited to single institution analyses. No study has been dedicated to evaluation of wound complications in this complex population.

The American College of Surgeon's National Surgical Quality Improvement Program-Pediatric Participant Use File (ACS NSQIP-P PUF) provides a reliable, nationally validated clinical database including unplanned 30-day postoperative events.[13] Access to this database allows for pooling data from enrolled institutions to increase sample size with improved generalizability and validity of results. The primary objective of this study was to determine incidence of SSI after pediatric airway surgery and to describe risk factors for SSIs or dehiscence using the NSQIP-P PUF.

2 | MATERIALS AND METHODS

This study was deemed a non-human study (publicly available data, de-identified at the source) by the University of Texas Southwestern Medical Center Institutional Review Board (IRB). A case–control study was performed using ACS NSQIP-P PUF, a nationally validated, risk-adjusted registry of surgical cases from hospitals participating in the quality program. The PUF contains de-identified patient-level data that makes the patient, hospital, and surgeon's information anonymous. We used the 2013 through 2019 files. See the following resources for details of the registry's methodology and participant use files (https://www.facs.org/quality-programs/acs-nsqip/participant-use).

Patients undergoing laryngotracheoplasty (LTP) and laryngotracheal resection (TR) were identified using the following Current Procedural Terminology (CPT®) codes – 31551, 31553, 31554, 31582, 31587, 31592, 31750, 31780, and 31781. A random 2:1 sample of non-airway reconstruction patients were selected as the control group. The NSQIP-P contains over 300 variables. The following items were used in the study: age in years, sex (male or female), race (non-Hispanic White, non-Hispanic Black, Hispanic, Other), weight in kilograms (kg), weight less than 10 kg (yes/no), gestational age (weeks), cardiac risk factors (yes/no), American Society of Anesthesiologists (ASA) classification (I–V), wound classification (clean, clean-contaminated, contaminated, dirty), operative time (minutes), SSI (superficial surgical site infection, deep incisional infection, organ space infection), wound disruption (i.e., dehiscence), days from operation to dehiscence, and days from operation to infection. Several additional factors recorded included: postoperative pneumonia, unplanned reintubation, unplanned reoperation, sepsis, days from operation to discharge, the total length of stay, hospitalization >30 days, unplanned readmission within 30 days, and 30-day mortality.

The NSQIP uses the following definitions for each SSI type. *Superficial Incisional SSI* - an infection that involves only skin or subcutaneous tissue of the surgical incision. *Deep Incisional SSI* - an infection involving deep soft tissues, such as fascial and muscle layers. *Organ/Space SSI* - an infection involving any part of the anatomy (e.g., organs or spaces), other than the incision, opened or manipulated during the primary procedure.

The airway reconstruction CPT® codes were separated into two groups: laryngotracheoplasty (LTP) (31551, 31553, 31554, 31582, 31587) and laryngotracheal resection (LTS) (31750, 31780, 31781). Gestational age was used to define preterm (< 37 weeks) and extremely preterm (< 28 weeks). The CPT® code 20910 was used to identify patients with a costochondral rib graft harvest. If the patient had an unplanned reoperation, it was determined if an airway procedure was performed (CPT® codes 31500–31899).

Continuous variables and means are presented with standard deviation or medians with interquartile ranges. Categorical data are presented as counts with percentages. To determine significant differences between groups, a one-way ANOVA was used for continuous variables presented as mean values, the Kruskal-Wallis test for median values, and the Pearson chi-square test for categorical data. To determine the risk factors associated with wound occurrences (infections and dehiscence), a backward selection logistic regression model was performed with the wound occurrence as the dependent variable and age, race, weight, gestational age, cardiac risk factors, ASA classification, wound classification, operative time, and the procedure performed (laryngotracheoplasty, laryngotracheal resection, control group). A sub-analysis of just airway reconstruction patients was performed comparing laryngotracheoplasty to laryngotracheal resection subjects. Unplanned operations were identified using CPT® codes.

To further test the robustness of the investigation, we performed a propensity score analysis matching for wound classification, ASA

TABLE 1 Characteristics of Airway and Non-Airway Surgeries, ACS NSQIP-P 2013–2019

Characteristic	No airway surgery	Laryngotracheoplasty	Laryngotracheal resection	Total	*P* value
Total, No (%)	2100 (67)	637 (20)	411 (13)	3148 (100)	—
Age year, med (IQR)	6.9 (11.2)	2.7 (3.3)	3.7 (5.5)	4.8 (9.7)	<.001
Males, No. (%)	1236 (59)	363 (57)	241 (59)	1840 (58)	.70
Race, No. (%)					
Non-Hispanic White	1132 (54)	249 (39)	188 (46)	1569 (50)	<.001
Non-Hispanic Black	259 (12)	185 (29)	101 (25)	545 (17)	
Hispanic	345 (16)	75 (12)	55 (13)	475 (15)	
Other	364 (17)	128 (20)	67 (16)	559 (18)	
Weight, kg mean (SD)	68.8 (55.7)	36.5 (32.5)	46.7 (40.0)	59.3 (51.7)	<.001
Weight < 10 kg, No. (%)	489 (23)	184 (29)	83 (20)	756 (24)	.002
Gest. age week mean (SD)	35.9 (5.4)	31.7 (6.1)	29.9 (5.8)	33.7 (6.2)	<.001
Preterm birth, No.(%)	149 (7.1)	105 (17)	87 (21)	341 (11)	<.001
Extreme preterm, No. (%)	32 (2)	64 (10)	55 (13)	151 (5)	<.001
Cardiac risk, No. (%)					
None	1857 (88)	364 (57)	250 (61)	2471 (79)	<.001
Minor	121 (6)	170 (27)	97 (24)	388 (12)	
Major	105 (5)	95 (15)	59 (14)	259 (8)	
Severe	17 (0.8)	8 (1.2)	5 (1.3)	30 (1.0)	

classification, and demographic variables (age, race, gender) since these characteristics may be confounding the results. The results of matching analysis are presented as the mean difference in percent with 95% confidence intervals.

Stata Statistical Software handled data management and statistics, Version 16, College Station, Texas. This study adhered to Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for observational studies.[14] Statistical significance is set at $P < .05$. To account for multiple comparisons, credence was given to the main study aims (incidence and risk factors for wound occurrences) and less to secondary findings of significance.

3 | RESULTS

The study included 3148 subjects; 637 LTP, 411 LR, and 2100 control patients. The entire cohort's median (IQR) age was 4.8 (9.7) years and most children were male ($n = 1840$, 58%). There were 50% non-Hispanic White ($n = 1569$), 17% non-Hispanic Black ($n = 545$), 15% Hispanic (n = 475), and 18% Other race ($n = 559$). The median (IQR) weight was 17.3 (28.6) kg. 756 (24%) children were ≤ 10 kg at the time of the procedure. Eleven percent ($n = 341$) were preterm and 4.8% ($n = 151$) were extremely preterm. Cardiac risk factors were present in approximately 21% of patients (677/3148). Airway reconstruction patients were significantly different in all demographic variables except for sex. Airway patients were younger, more likely to be non-Hispanic Black, lower weight, born preterm or extremely preterm, and have cardiac risk factors than control subjects. See Table 1 for more details.

Similar discrepancies were noted in ASA classification, wound classification, and operative times when comparing airway cases to the control group. LTP and TR patients were more likely to be considered to have severe systemic disease. The median operative time was over 200 min for airway cases compared to 68 min for the control group ($p < .001$). About a third of airway cases had a costochondral graft listed as an additional procedure.

The postoperative SSI rate was 3.9% (122/3148). LTP/TR patient infection rates were 6.4% and 5.6% respectively ($P < .001$). The median time to documentation of the SSI for airway patients was 9.0 days (IQR = 13 days). Wound disruption occurred in 48 patients (1.5%). The rate of wound disruption was similar when comparing airway patients to the control group ($P = .96$). The postoperative pneumonia rate was higher in airway patients (LTP = 6.4%, TR = 3.2%, control = 0.6%, $P < .001$). Unplanned reintubation was also common in LTP/TR patients compared to controls (>6% vs. <1%, $P < .001$). Unplanned reoperations occurred in 3.2% ($n = 68$) of controls, 17% ($n = 111$) LTPs, and 17% ($n = 68$) TR patients ($P < .001$). Most unplanned reoperations were airway procedures for LTP/TR patients (78% and 68% respectively $P < .001$).

The median (IQR) total length of stay for the control group was 1.0 (3.0) days compared to 9.0 (13.0) days for LTP and 8.0 (11.0) days for TR subjects ($P < .001$). Around 10% of LTP/TR patients were in the hospital for greater than 30 days compared to 3.1% of the control group ($P < .001$). Unplanned readmissions were more common in the LTP/TR children as compared to controls (>9.0% vs. 4.3%, $P < .001$). However, wound problems were not more likely to be the reason. Death within 30 days was rare for all patients with no significant difference (0.3%, $P = .51$). See Table 2 for additional details.

TABLE 2 Perioperative Outcomes of Airway and Non-Airway Surgeries, ACS NSQIP-P 2013–2019

Characteristic	No airway surgery	Laryngotracheoplasty	Laryngotracheal resection	Total	*P* value
Total, No (%)	2100 (67)	637 (20)	411 (13)	3148 (100)	—
ASA class, No. (%)					
I, Normal/healthy	649 (31)	5 (0.8)	3 (0.7)	657 (21)	<.001
II, Mild disease	907 (43)	103 (16)	53 (13)	1063 (34)	
III, Severe disease	452 (22)	463 (73)	318 (78)	1233 (39)	
IV, Life threatening	79 (3.7)	64 (10)	35 (8.5)	178 (5.6)	
V, Moribund	8 (0.4)	0	0	8 (0.3)	
Wound class, No. (%)					
Clean	943 (45)	60 (9)	49 (12)	1052 (33)	<.001
Clean/contaminated	809 (39)	565 (89)	356 (87)	1730 (55)	
Contaminated	193 (12)	4 (0.6)	4 (1.0)	201 (6.4)	
Dirty/infected	155 (7)	8 (1.3)	2 (1.0)	165 (5.2)	
Operative time hour, med (IQR)	68.0 (89.8)	228.0 (185.0)	246.0 (136.0)	98.0 (177.0)	<.001
Rib graft, No. (%)	0	238 (37)	151 (37)	389 (12)	<.001
SSI all, No. (%)	58 (2.8)	41 (6.4)	23 (5.6)	122 (3.9)	<.001
Superficial SSI, No. (%)	28 (1.3)	14 (2.2)	10 (2.4)	52 (1.7)	.13
Deep incision, No. (%)	4 (0.2)	20 (3.1)	10 (2.4)	14 (0.4)	.01
Organ space, No. (%)	26 (1.2)	20 (3.1)	10 (2.4)	56 (1.8)	.004
Time to infection, day med (IQR)	13.5 (11.5)	9.0 (14.5)	9.0 (16.0)	12.5 (13.2)	.18
Wound dehiscence, No. (%)	25 (1.2)	15 (2.4)	8 (1.9)	48 (2.1)	.08
Time to dehiscence, day med (IQR)	9.0 (20.5)	13.5 (15.5)	11.0 (2.5)	10.5 (13.0)	.96
Postop pneumonia, No. (%)[a]	13 (0.6)	41 (6)	13 (3)	67 (2.1)	<.001
Unplanned reintubation, No. (%)	18 (0.8)	48 (8)	25 (6)	91 (2.9)	<.001
Unplanned reoperation, No. (%)	68 (3.2)	111 (17)	68 (17)	247 (7.8)	<.001
Unplanned airway, No. (%)	3 (0.1)	86 (14)	46 (11)	135 (4.4)	<.001
Hospitalization, day mean (SD)	4.2 (11.2)	11.7 (12.4)	10.8 (10.8)	6.5 (11.9)	<.001
Hospitalized >30 days, No. (%)	65 (3)	66 (10)	37 (9)	168 (5.3)	<.001
Unplanned readmission, No. (%)	91 (4.3)	59 (9.3)	39 (10)	189 (6.0)	<.001
Readmission reason, No. (%)					
SSI, all[a]	12 (13)	4 (6.8)	3 (10)	19 (10)	.31
Dehiscence	4 (4.4)	1 (2)	0	5 (2.6)	
Pneumonia	2 (3.3)	3 (5.1)	3 (10)	8 (4.2)	
Sepsis	2 (3.2)	0	0	2 (1.0)	
Other	54 (73)	44 (85)	24 (80)	122 (78)	
30-day mortality, No., (%)	7 (0.3)	2 (0.3)	0	9 (0.3)	.51

[a]Includes all SSI grouped together (superficial, deep, and organ spaced).

The backward selection logistic regression models for SSIs and disruptions are presented in Tables 3 and 4. Laryngotracheoplasty was more likely to result in SSI in the setting of a dirty wound (OR: 4.6, $P < .001$, 95% CI: 2.35–9.02) or wound disruption (OR: 2.0, $P = .04$, 95% CI: 1.05–3.82) when compared to control patients. TR patients are equally likely after controlling for potential confounders. ASA and wound classification were important contributors to SSI risk, while no other predictors were associated with wound disruptions. We did not find any effect modifiers.

Our sensitivity analysis comparing LTP to TR patients showed mostly similar characteristics between the two groups. The following variables showed statistically significant differences ($P < .05$): age, weight, gestational age, operative time, and postoperative pneumonia. SSI, disruption, reoperations, and readmissions were similar. See Table 5.

The sensitivity analysis using propensity matching continued to show that LTP/TR patients had a higher proportion of SSI after matching for ASA classification, wound classification, age, sex, and race (mean difference = 3.4, 95% CI = 0.5–6.3, $P = .02$).

TABLE 3 Multivariable logistic regression for variables associated with SSI (superficial, deep, and organ space)

Characteristic, No. (%)	Odds ratio	SE	z	*P* value	95% CI
Laryngotracheoplasty	2.01	0.54	2.60	.009	1.19–3.40
Laryngotracheal resection	1.76	0.54	1.85	.064	0.97–3.21
ASA Class II	2.42	0.92	2.33	.02	1.15–5.08
ASA Class III	2.83	1.13	2.62	.009	1.30–6.18
ASA Class IV	3.19	1.57	2.35	.02	1.21–8.39
Clean/contaminated wound	1.19	0.31	0.67	.50	0.71–1.98
Contaminated wound	0.99	0.54	−0.02	.99	0.34–2.90
Dirty/infected wound	4.61	1.58	4.45	<.001	2.35–9.03

TABLE 4 Multivariable logistic regression for variables associated with wound dehiscence

Characteristic, No. (%)	Odds Ratio	SE	z	*P* value	95% CI
Laryngotracheoplasty	2.00	0.66	2.10	.04	1.05–3.82
Laryngotracheal resection	1.65	0.68	1.22	.22	0.74–3.68

TABLE 5 Characteristics and perioperative outcomes of airway surgeries, ACS NSQIP-P 2013–2019

Characteristic	Laryngotracheoplasty	Laryngotracheal resection	Total	*P* value
Total, No (%)	637 (61)	411 (39)	1048 (100)	—
Age year, med (IQR)	2.7 (3.3)	3.7 (5.5)	3.0 (4.3)	<.001
Males, No. (%)	363 (57)	241 (59)	604 (58)	.60
Race, No. (%)				
Non-Hispanic White	249 (39)	188 (46)	437 (42)	.07
Non-Hispanic Black	185 (29)	101 (25)	286 (27)	
Hispanic	75 (12)	55 (13)	130 (12)	
Other	128 (20)	67 (16)	195 (19)	
Weight, kg mean (SD)	12.4 (7.1)	14.4 (12.2)	13.0 (8.6)	<.001
Weight < 10 kg, No. (%)	184 (29)	83 (20)	267 (26)	.002
Gest. age week mean (SD)	31.7 (6.1)	29.9 (5.8)	30.9 (6.0)	.02
Preterm birth, No. (%)	105 (17)	87 (21)	192 (18)	.06
Extreme preterm, No. (%)	64 (10)	55 (13)	119 (11)	.10
Cardiac risk, No. (%)				
None	364 (57)	250 (61)	614 (59)	.67
Minor	170 (27)	97 (24)	267 (26)	
Major	95 (15)	59 (14)	154 (15)	
Severe	8 (1.3)	5 (1.2)	13 (1.3)	
ASA class, No. (%)				
I, Normal/healthy	5 (0.8)	3 (0.7)	8 (0.8)	.37
II, Mild disease	103 (16)	53 (13)	156 (15)	
III, Severe disease	463 (73)	318 (78)	781 (75)	
IV, Life threatening	64 (10)	35 (8.6)	99 (10)	
Wound class, No. (%)				
Clean	60 (9.4)	49 (12)	109 (10)	.31
Clean/contaminated	565 (89)	356 (87)	921 (88)	
Contaminated	4 (0.6)	4 (1.0)	8 (0.8)	
Dirty/infected	8 (1.3)	2 (0.5)	10 (1.0)	
Operative Time hour, med (IQR)	228.0 (185.0)	246.0 (136.0)	238.5 (164.0)	.01
Rib Graft, No. (%)	238 (37)	151 (37)	389 (37)	.84

TABLE 5 (Continued)

Characteristic	Laryngotracheoplasty	Laryngotracheal resection	Total	P value
Postop SSI, No. (%)	41 (6.4)	23 (5.6)	64 (6.1)	.58
Superficial SSI, No. (%)	14 (2.2)	10 (2.4)	24 (2.3)	.80
Deep incision, No (%)	7 (1.1)	3 (0.7)	10 (1.0)	.55
Organ space, No (%)	20 (3.1)	10 (2.4)	30 (2.9)	.50
Time to infection, day med (IQR)	9.0 (14.5)	9.0 (16.0)	9.0 (14.2)	.29
Wound dehiscence, No. (%)	15 (2.4)	8 (1.9)	23 (2.2)	.66
Time to dehiscence, day med (IQR)	13.5 (15.5)	11.0 (2.5)	11.0 (12.5)	.99
Postop pneumonia, No. (%)	41 (6)	13 (3)	54 (5.1)	.02
Unplanned reintubation, No. (%)	48 (7)	25 (6)	73 (6.9)	.37
Unplanned reoperation, No. (%)	111 (17)	68 (17)	179 (17)	.71
Unplanned airway, No. (%)	86 (14)	46 (11)	132 (13)	.27
Hospitalization, day mean (SD)	11.7 (12.4)	10.8 (10.8)	11.4 (11.8)	.25
Hospitalized >30 days, No. (%)	66 (10)	37 (9.0)	103 (10)	.47
Unplanned readmission, No. (%)	59 (9)	39 (10)	98 (9)	.90
Readmission reason, No. (%)				
SSI	4 (8)	3 (10)	7 (9)	.75
Dehiscence	1 (2)	0	1 (1)	
Pneumonia	3 (5)	3 (10)	6 (6)	
Other	44 (85)	24 (80)	68 (83)	
30-day mortality, No, (%)	2 (0.3)	0	2 (0.2)	.26

4 | DISCUSSION

ACS-NSQIP-P is a recognized surgical quality improvement platform to evaluate safety and quality in children undergoing operative procedures. Use of this database enables analysis on a large scale with multi-institutional contributions. To our knowledge, this is the first study focused on postoperative surgical site infections in children undergoing open airway procedures. In this study, a nationally representative sample of airway reconstruction patients showed that the risk of postoperative wound complications are significantly more likely in children undergoing open airway reconstructions when compared to a randomly selected control group.

Children undergoing airway reconstruction, either by LTP or TR, were more likely to be born preterm, weigh <10 kg, and have severe cardiac risk factors as compared to controls. It is well-recognized that children requiring open airway reconstructive surgery have multiple medical comorbidities.[15] Additionally, airway surgery patients were younger at time of surgery compared to controls. As elective surgical procedures are often postponed until the anesthetic risk is decreased,[16] the fact that these children needed such procedures earlier speaks to their disease severity. It has also previously been noted that children with multiple comorbidities tend to fare worse globally after surgery compared to their counterparts.[17] Therefore, it is fitting that children requiring airway reconstructive procedures would have higher rates of postoperative complications, including infection.

Regression modeling suggested that LTP/TR patients are particularly more likely to have a SSI compared to control patients, especially when taking ASA and wound classification into account. A previous study found that most children undergoing pediatric otolaryngology procedures are ASA I (40.7%) or ASA class II (46.1%).[3] In this cohort, the majority of children undergoing an airway reconstructive procedure were ASA class III (LTP 72.9%, TR 77.8%). Literature regarding an association between ASA and SSI is conflicted. A study in adults noted ASA may be an indirect measure of an inability to fight infection and is a significant predictor of SSI.[18] In a study of general surgical procedures, Isik et al demonstrated a higher ASA score was an independent risk factor for SSI.[19] Other studies in adults, however, did not support this association.[20,21] SSI in children undergoing non-shunt neurosurgical procedures did identify ASA Class III as a significant risk factor to development of an infection, though the other classes did not reach significance.[22] To the best of our knowledge, this has not previously been analyzed in children undergoing an otolaryngology or airway procedure and further study will be necessary to determine etiology.

The operative time for children in this study was significantly longer compared to control procedures. Operative time is an established risk factor for postoperative complications including SSI.[22–24] Wound classification was also associated with development of SSI. Almost half of all pediatric otolaryngology cases are considered clean-contaminated (49.6%), with dirty/infected cases less common (10.9%).[3] In this study, most LTP/TR cases were classified as clean-contaminated. Classification of the wound as dirty/infected at time of surgery was significantly associated with development of SSI. This finding is logical as a wound exposed to infection at the time of surgery is inherently more likely to become infected. The reason for why such wounds were considered dirty/infected is not described in the database, which is a notable limitation.

Encouragingly, there was no significant difference in infection rates between LTP and TR patients. An LTP is typically performed using one or two devascularized cartilage grafts creating airway expansion. These grafts may be predisposed to infection from poor blood supply in the perioperative period. Infection rates in patients undergoing this procedure ranges with rates as high as 24.2%.[25,26] Rates of infection in tracheal resections is lower, ranging from 3–10%.[8,27]

A previous analysis of the ACS-NSQIP database for outcomes in children undergoing airway reconstruction identified an overall infection rate of 1.5%.[15] An important distinction between this article and the current study are the years included, with the current paper spanning 2013–2019 versus 2012–2014. Additionally, that study did not distinguish between LTP/TR, included 198 cases versus 1048 airway cases shown here, and did not have a control group. Our propensity matching analysis also showed that LTP/TR patients proportionally have higher than expected SSI even when patients are matched by potentially confounding variables. Therefore, we feel the data presented from this analysis are unique with important, novel findings.

Limitations of this study are inherent to the design. Utilization of the ACS-NSQIP-P database is reliant on accurate CPT coding to reflect the surgical procedure performed. Variations in coding between physicians and different participating medical centers can influence the analysis. Additionally, if codes are not entered correctly, patients may be inappropriately excluded from the study. The ACS-NSQIP-P also only tracks morbidity for the first 30 days post procedure. It is possible that the studied outcomes occurred after this time frame and therefore were missed by this data set. Lastly, the case definitions of SSI are defined by NSQIP protocols and may include some controversial cases, such as tracheitis being classified as a deep organ space infection.

5 | CONCLUSION

This analysis of the ACS-NSQIP-P database of children undergoing open airway reconstructive surgery identified important patient features associated with the development of a surgical site infection. Preterm birth, weight < 10 kg, higher ASA, presence of a cardiac comorbidity, longer operative times, and a dirty/infected wound were all significantly associated with SSI. Importantly, this study determined a baseline rate of SSI for LTP of 6.4%, and 5.6% for TR. These data taken together can help surgeons risk stratify and develop quality improvement strategies to reduce these occurrences.

CONFLICT OF INTEREST

Dr. Johnson is the editor of *Laryngoscope Investigative Otolaryngology*. He was not involved in the editorial evaluation of or decision to accept this article for publication.

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