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30-Day morbidity after augmentation enterocystoplasty and appendicovesicostomy: a NSQIP pediatric analysis

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Summary

Introduction—Augmentation enterocystoplasty and appendicovesicostomy are complex pediatric urologic procedures. Although there is literature identifying long-term outcomes in these patients, the reporting of short-term postoperative outcomes has been limited by small numbers of cases and lack of prospective data collection. Here we report 30-day outcomes from the first nationally based, prospectively assembled cohort of pediatric patients undergoing these procedures.

Objective—To determine 30-day complication, readmission and reoperation after augmentation enterocystoplasty and appendicovesicostomy in a large national sample of pediatric patients, and to explore the association between preoperative and intraoperative characteristics and occurrence of any 30-day event.

Study design—We queried the 2012 and 2013 American College of Surgeons National Surgical Quality Improvement Program Pediatric database (ACS-NSQIPP) for all patients undergoing augmentation enterocystoplasty and/or appendicovesicostomy. Surgical risk score was classified on a linear scale using a validated pediatric-specific comorbidity score. Intraoperative characteristics and postoperative 30-day events were reported from prospectively collected data. A composite measure of complication, readmission and/or reoperation was used as primary outcome for the multivariate logistic regression.

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Conflict of interest

None. American College of Surgeons National Surgical Quality Improvement Program and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

Results—There were 461 patients included in the analysis: 245 had appendicovesicostomy, 97 had augmentation enterocystoplasty and 119 had both procedures. There were a total of 110 NSQIP complications seen in 87 patients. The most common complication was urinary tract infection(see Table for 30-day outcomes by patient). The composite measure of any 30-day event was seen in 27.8% of the cohort and this was associated with longer operative time, increased number of procedures done at time of primary surgical procedure and higher surgical risk score.

Discussion—The ACS-NSQIPP provides a tool to examine short-term outcomes for these complex urologic procedures that has not been possible before. Although ACS-NSQIP has been used extensively in the adult surgical literature to identify rates of complications, and to determine predictors of readmission and adverse events, its use in pediatric surgery is new. As in the adult literature, the goal is for standardization of practice and transparency in reporting outcomes that may lead to reduction in morbidity and mortality.

Conclusion—In this cohort, any 30-day event is seen in almost 30% of the patients undergoing these urologic procedures. Operative time, number of concurrent procedures and higher surgical risk score all are associated with higher odds of the composite 30-day event of complication, readmission and/or reoperation. These data can be useful in counseling patients and families about expectations around surgery and in improving outcomes.

Keywords

Augmentation enterocystoplasty; Appendicovesicostomy; Pediatrics; Complications

Introduction

Augmentation enterocystoplasty and appendicovesicostomy are some of the most complex and rare procedures within pediatric urology. This makes reporting outcomes and improving care of these patients difficult, as even busy centers perform relatively few procedures. Studies to date looking at outcomes from these procedures have often focused on long-term outcomes, including stones, metabolic abnormalities, stomal stenosis, bladder perforation, infection, need for further surgery and death [1-5]. There is scant literature on other aspects of quality of surgical care, particularly regarding short-term postoperative outcomes and morbidity.

The purpose of this study was to use a prospective national database to report 30-day events after appendicovesicostomy (AV), augmentation enterocystoplasty (AE) and augmentation enterocystoplasty with appendicovesicostomy (AE+AV). Our aims were to 1) describe 30-day complication rates, readmission rates and reoperation rates, and 2) identify patient and operative characteristics associated with any 30-day adverse event in these procedures.

Methods

Study design and data source

We conducted a cohort study of pediatric patients using the 2012 and 2013 American College of Surgeons National Surgical Quality Improvement Program-Pediatric Database (ACS-NSQIPP). The ACS-NSQIPP is a prospective national sample of pediatric cases in

patients 0–17 years of age. In 2012 and 2013, there were 50 participating sites and up to 147 variables collected, including preoperative risk factors, intraoperative variable, and 30-day postoperative mortality and morbidity outcomes for patients undergoing major surgical procedures in both the inpatient and outpatient settings. There is a trained surgical clinical reviewer (SCR) at each site who collects data and tracks 30-day outcomes for every patient [6].

Patient selection

We identified all patients with a CPT code and description for enterocystoplasty with intestinal anastomosis (CPT 51960) and/or cutaneous appendicovesicostomy (CPT 50845). The CPT codes were assigned as the principal operative procedure or as a concurrent procedure.

Variables

We extracted multiple patient characteristics from the dataset, including age, gender, race and ethnicity, height, weight, diagnosis and comorbidities. BMI category was calculated using z-scores to account for age, weight and height according to CDC categories [7]. The categories were normal (<85th percentile), overweight (85th-<95th percentile) and obese (≥95th percentile). The operative characteristics included operative time in hours, type of procedure, number of concurrent procedures done at time of primary surgical procedure and length of stay. Procedure count was categorized as one procedure, two to five procedures and greater than five procedures.

Surgical risk score

Using the validated multispecialty surgical risk score developed by Rhee *et al.*, we assigned a risk score to each patient based on preoperative patient characteristics and comorbidities [8]. This validated 7-category point scale can be used for risk stratification and predicts inpatient mortality in the pediatric population better than the Charlson Comorbidity Index, which is primarily used in adults for risk stratification. In this cohort, we dichotomized the surgical risk score into low-risk score (score 0–1) and high-risk score (score 2–6).

Complications and outcomes

ACS-NSQIP Pediatric collects data on 21 defined postoperative complications that are tracked for 30 days following surgery. These can be viewed in Appendix A. We combined superficial, deep, organ/space surgical site infection and wound disruption into a single “wound complications” outcome. We analyzed NSQIP complications for the patients undergoing AV, AE or AE+AV. Readmission and unplanned reoperation within 30 days after primary surgery were also collected. Reasons for readmission are not required to be collected in NSQIP; however, we reported reason for readmission for those patients for whom a NSQIP complication or ICD-9 diagnostic code was provided. Unplanned reoperations were recorded using CPT codes. A composite adverse event measure was used to indicate occurrence of any 30-day event, which included complication, readmission and/or reoperation.

Statistical analysis

Descriptive statistics were used to characterize the population of patients undergoing AV, AE and AE+AV. Univariate and multivariate associations between patient and procedure characteristics and the composite any 30-day event were investigated using logistic regression. Statistically significant covariates in univariate analyses and clinically important covariates were included in the multivariate model. Functional forms of continuous covariates were evaluated. Diagnostic and multicollinearity checks of the final model were performed. Analyses were performed using SAS, version 9.3. A two-tailed *p* value of less than 0.05 was considered significant.

Results

Characteristics of patients

We identified 461 patients in 2012 and 2013 ACS-NSQIPP with the defined CPT codes; 245 patients had AV, 97 patients had AE and 119 patients had AE+AV. The majority of these patients were white, non-Hispanic (71.4%) and female (57.3%), and the median age was 9.4 years (IQR 6.1–12.3). The majority of patients had a low-risk surgical risk score (84.4%). The primary diagnoses assigned to patients were: 251 neurogenic bladder/bowel, 41 spina bifida or spinal cord injury, 32 bladder exstrophy, 20 urinary incontinence, 66 other urinary diagnosis, 39 other gastrointestinal diagnosis, 5 malignancy, 2 renal failure and 5 other. Of the 461 patients, 274 (59%) were admitted to the hospital prior to surgery, with 264/461 (57%) admitted 1–3 days prior to surgery, most likely as a planned pre-admission. Patient and operative characteristics by procedure are shown in Table 1.

Outcomes

There were 110 NSQIP-defined complications seen in 87/461 (18.9%) patients. More than one complication was seen in 17/87 (19.5%) patients. In those patients with complications the most common complication was urinary tract infection (UTI) seen in 43/87 (49.4%), followed by wound complications in 35/87 (40.2%), bleeding/transfusion in 19/87 (21.8%) and sepsis in 8/87 (9.2%). There were no deaths in this cohort.

Of the 461 patients, 4 (0.9%) were still hospitalized at 30 days and were not included in the readmission analysis. There were 62/457 (13.6%) patients with readmissions within 30 days after primary surgery. On bivariate analysis, there was no association with readmission and length of stay in the hospital (p=0.11). The reasons for readmission were collected on 51 of these patients and included NSQIP complications such as UTI (8 patients) and wound complications (10), as well as other reasons given by ICD9 codes, including ileus/obstruction (6), abdominal pain/gastritis (4), malfunctioning/infected GU device (6), acute pyelonephritis (3), other urinary issues (4), fistula (2), dehydration/metabolic abnormalities (3), bowel anastomotic leak (2), urinary anastomotic leak (1), DVT (1), and clostridium difficile (1). The median time from discharge to readmission was 9 days (range 0–24 days).

There were 32/461 (6.9%) patients taken back to the operating room for an unplanned reoperation within 30 days of primary surgery. Fourteen of these patients were still in the hospital at time of reoperation while the other 18 were readmitted. The surgical procedures

included the following: procedures involving the bladder (i.e. cystourethroscopy, suprapubic tube placement, difficult foley catheter) in 15 patients, revision and exploration of intestinal anastomosis in 10 patients, exploratory laparotomy in 4 patients, complex wound closure in 2 patients and central line placement in 1 patient. The composite outcome of any 30-day event occurred in 128/461 (27.8%) patients. The complications, readmissions and reoperations by procedure are shown in Table 2.

On univariate analysis we looked at the association between our composite outcome of any 30-day event and age, gender, race and ethnicity, BMI categories, primary diagnosis, surgical risk score, operative time, procedure count and type of surgery (AV, AE, AE+AV). The covariates of operative time, procedure count and high surgical risk score were each significant on univariate analysis. After controlling for age, gender and type of surgery, these covariates remained significantly associated with the composite outcome of any 30-day event. Longer operative time (in hours) was associated with higher risk of 30-day complications, readmission and/or reoperation, with a 12% increase in odds of the composite outcome corresponding to every hour increase in the operative time (95% CI 3–21%, p=0.005). High surgical risk score was associated with higher odds of 30-day complications with odds ratio of 2.33 (95% CI 1.36–3.99, p=0.002). We also saw that as number of procedures increased, so did the odds of composite outcome, with two to five procedures having an odds ratio of 2.16 (95% CI 1.10–4.21, p=0.02) and greater than five procedures having an odds ratio of 3.78 (95% CI 1.51–9.45, p=0.005). Unadjusted and adjusted odds ratios for all covariates are shown in Table 3.

Discussion

In this study we leveraged the unique capabilities of a national surgical sample to examine 30-day outcomes for bladder augmentation and appendicovesicostomy, complex reconstructive procedures that most individual centers perform in low numbers. This national perspective gives us the power to understand short-term outcomes for these procedures at a scale that is simply not possible in most single-center case series. Furthermore, the unique design of NSQIPP permits tracking of outcomes with a level of detail and completeness of follow-up that is impossible with most large administrative datasets.

Our findings that operative time, increasing procedure count and high surgical risk scores correlated with complications should not be surprising. These findings have both similarities and differences with previous reports on bladder augmentation and postoperative complications. Schlomer *et al.* used the Kids Inpatient Database (KID) to look at trends in bladder augmentation and reported a 30% complication rate [9], most commonly from digestive issues (12.5%). Their study may have underestimated complications, as KID does not provide longitudinal follow-up on individual patients; patients returning for readmission after the initial surgery would not be identified. Predictors of complications in their study were age and the diagnosis of bladder exstrophy, which were not significant predictors in our cohort.

Scales *et al*. published a systematic review of outcomes in enterocystoplasty [10]. While they reported complication rates and other measures of outcomes including urodynamic testing, satisfaction measures and continence, there is no mention of any studies that report immediate postoperative complications, readmission and reoperation. Our study provides these data from a nationally collected dataset. Outcomes, including 30-day complication rates, readmission and reoperation are important measures of quality of care and can be used to identify areas of needed improvement.

ACS-NSQIP has been used extensively in the adult surgical literature to identify rates of complications, and to determine predictors of readmission and adverse events. Standardization of practice and transparency in reporting outcomes has led to reductions in morbidity and mortality [11]. ACS-NSQIP-Pediatrics was initiated in 2008 with a similar goal of driving quality improvement in pediatric surgery [12]. Our study is the first to identify 30-day complications as well as readmission rate within this cohort of patients undergoing complex urologic surgery. The outcomes that we are able to collect from ACS-NSQIPP provide a target for future quality improvement interventions within our own institution and nationally.

There are limitations to this study and these results must be interpreted in the context of the study design. This is an observational study that hinges on the reliability of the ACS-NSQIPP data collection process; regular audits and specialized training for the SCR's should limit data collection errors. We are limited by the available CPT codes in our ability to differentiate appendicovesicostomy procedures from other continent diversion procedures, such as the Monti, which may have different morbidity profiles. In addition, ACS-NSQIPP does not collect data on every possible 30-day complication; those collected have been predefined for tracking and documentation by the SCRs. The NSQIP complications are not procedure-specific and are uniformly collected on all surgical procedures. This may underestimate the 30-day complication rate for our procedures of interest as some relevant complications may not have been documented as part of the standard NSQIPP procedures. Also, ACS-NSQIPP does not provide other covariates that may be important when analyzing outcomes, including hospital identifiers, hospital characteristics and sociodemographic characteristics of patient. Without these, we are unable to examine variation in outcomes among different centers, which would obviously be of great interest.

Conclusion

Augmentation enterocystoplasty and appendicovesicostomy in the pediatric population are complex procedures that have high incidence of 30-day morbidity. Substantial numbers of patients will require readmission and/or reoperation. ACS-NSQIPP provides a system to identify, measure and quantify these outcomes. These data can be useful in counseling patients and families about expectations around surgery and in improving outcomes.

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Appendix A. NSQIP complications

NSQIP complications

Superficial incisional surgical site infection

Deep incisional surgical site infection

Organ/space surgical site infection

Wound disruption

Pneumonia

Unplanned intubation

Pulmonary embolism

Progressive renal insufficiency

Acute renal failure

Urinary tract infection

Coma>24 hours

CVA/stroke

Seizure

Nerve injury

IVH Grade1-Grade4 and unknown

Cardiac arrest

Bleeding/transfusion

Graft/prosthesis/flap failure

VT

Sepsis

Central line associated blood stream infection

Death

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Table 1

Patient and operative characteristics

	Appendicovesicostomy (AV) *n*=245	Augmentation enterocystoplasty (AE) *n*=97	Augmentation enterocystoplasty with appendicovesicostomy (AE +AV) *n*=119
2012, *n*=232	**116**	**46**	**70**
2013, *n*=229	**129**	**51**	**49**
Gender			
Male	101 (41.2)	46 (47.4)	50 (42)
Age, years	9.4 (5.9-12.8)	9.8 (7-12.7)	9.1 (6.2-11.8)
Race/ethnicity			
White, non-Hispanic	177 (72.2)	73 (75.3)	79 (66.4)
Other	54 (23)	17 (17.5)	26 (21.8)
Missing	14 (5.7)	7 (7.2)	14 (11.8)
BMI category			
Normal	137 (55.9)	48 (49.5)	71 (59.7)
Overweight	46 (18.8)	13 (13.4)	18 (15.1)
Obese	37 (15.1)	21 (21.6)	21 (17.6)
Missing	25 (10.2)	15 (15.5)	9 (7.6)
Surgical risk score			
Low-risk	**204(83.3)**	**81(83.5)**	**104(87.4)**
0	155	62	85
1	49	19	19
High-risk	**41(16.7)**	**16(16.5)**	**15(12.6)**
2	28	11	9
3	11	2	5
4	1	2	0
5	1	1	1
6	0	0	0
No. surgical procedures [a]			
Single procedure	72(29.4)	20(20.6)	0
2-5 procedures	161(65.7)	67(69.1)	94(79)
>5 procedures	12(4.9)	10(10.3)	25(21)
Operative time, hours [b]	3.9 (2.6-6)	5.3 (3.7-6.8)	7.1 (4.9-9.3)
Length of stay, days [b]	6 (4-8)	7 (5-10)	8 (7-11)

Data given as *n* (%) or median (IQR).

[a] $p<0.01$ Fisher's exact test.

[b] $p<0.01$ Kruskal-Wallis test.

Table 2

Patient 30-day complications by procedure

	Appendicovesicostomy (AV) *n*=245	Augmentation enterocystoplasty (AE) *n*=97	Augmentation enterocystoplasty with appendicovesicostomy (AE +AV) *n*=119
Any NSQIP complication	38 (15.5)	18 (18.6)	31 (26.1)
UTI	20 (8.2)	9 (9.3)	14 (11.8)
Wound complications			
Superficial SSI	12 (4.9)	3 (3.1)	4 (3.4)
Deep SSI	2 (0.8)	0	2 (1.7)
Organ SSI	3 (1.2)	0	2 (1.7)
Dehiscence	3 (1.2)	1 (1)	4 (3.4)
Pneumonia	0	1 (1)	0
Reintubation	0	1 (1)	0
Bleeding/transfusion	6 (2.5)	6 (6.2)	7 (5.9)
Sepsis [a]	2 (0.8)	1 (1)	5 (4.2)
Central line infection	1 (0.4)	0	0
Renal failure	0	0	1 (0.8)
Other 30-day outcomes			
Readmission	35 (14.3)	12 (12.4)	15 (12.6)
Reoperation	15 (6.1)	8 (8.3)	9 (7.6)
Composite 30-day event	61 (24.9)	28 (28.9)	39 (32.8)

Data given as *n* (%).

[a] UTI present in three patients with sepsis, organ surgical site infection present in two patients with sepsis.

Table 3

Unadjusted univariate and adjusted multivariate logistic regression analysis for association of patient and procedure characteristics with 30-day postoperative event (complication, readmission or reoperation)

	Unadjusted analysis		Adjusted analysis	
Predictors	**Odds ratio (95% CI)**	***p***	**Odds ratio (95% CI)**	***p***
Age (years)	0.99 (0.95–1.04)	0.81	0.99 (0.94–1.05)	0.79
Gender		0.57		0.68
Male (Reference)	NA		NA	
Female	1.13 (0.75–1.71)		1.10 (0.71–1.70)	
BMI category		0.70		
Normal (Reference)	NA			
Overweight	1.20 (0.69–2.10)	0.51		
Obese	0.90 (0.51–1.60)	0.72		
Operation time (hours)	1.16 (1.08–1.24)	<0.001	1.12 (1.03–1.21)	0.005
Procedure Count		<0.001		0.02
Single procedure (Reference)	NA		NA	
2–5 procedures	2.43 (1.29–4.58)	0.006	2.16 (1.10–4.21)	0.02
>5 procedures	5.82 (2.57–13.21)	<0.001	3.78 (1.51–9.45)	0.005
Surgical risk index		<0.001		0.002
Low (Reference)	NA		NA	
High	2.44 (1.45–4.10)		2.33 (1.36–3.99)	
Race/ethnicity		0.32		
White, non-Hispanic (Reference)	NA			
Other	0.77 (0.45–1.29)			
Type of surgery		0.28		0.82
Appendicovesicostomy (AV) only (Reference)	NA		NA	
Augmentation enterocystoplasty (AE) only	1.22 (0.72–2.07)	0.45	1.00 (0.57–1.74)	0.99
AE+AV	1.47 (0.91–2.38)	0.12	0.85 (0.49–1.48)	0.56
Primary diagnosis				
Other (Reference)	NA			
Bladder exstrophy	0.86 (0.38–1.96)	0.72		

Table

30-day events by patient

	Patients, *n*=461
Any NSQIP complications	87 (18.9)
UTI	43 (9.3)
Wound complications	
Superficial SSI	19 (4.1)
Deep SSI	4(0.9)
Organ SSI	5(1.1)
Dehiscence	8 (1.7)
Pneumonia	1 (0.2)
Reintubation	1 (0.2)
Bleeding/transfusion	19 (4.1)
Sepsis	8 (1.7)
Central line infection	1 (0.2)
Renal failure	1 (0.2)
Other 30-day outcomes	
Readmission	62 (13.5)
Reoperation	32 (6.9)
Composite 30-day event	128 (27.8)

Data given as *n* (%).