Exploration of Practice Patterns in Exstrophy Closures: A Comparison Between Surgical Specialties Using a National and Institutional Database

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OBJECTIVE To compare the surgical subspecialties performing bladder exstrophy closures and characterize their practice patterns using both a national and institutional database.

METHODS The National Surgical Quality Improvement Program Pediatric (NSQIPP) database was reviewed for all bladder exstrophy closures performed from 2012 to 2017. A single institutional exstrophy-epispadias complex database of 1337 patients was reviewed for patients with a bladder closure at a referring institution from 1975 to 2018. Patients with cloacal exstrophy were excluded. The subspecialties of the surgeons performing the closures were identified. Practice patterns such as the use of a pelvic osteotomy and postoperative immobilization, and perioperative outcomes were compared for each subspecialty group.

RESULTS A total of 84 bladder exstrophy patients from NSQIPP and 263 from the author's institutional database met the inclusion criteria. From NSQIPP, 88% of closures were performed by pediatric urologists while 12% were done by other subspecialists. From the institutional database, 75% of referred bladder exstrophy closures were done by a pediatric urologist, and 25% by other services. Gender, race, operation time, length of stay, and postoperative complications were not significantly different between the groups. In one database, pediatric surgeons performed closures earlier, and in another database, pediatric urologists had greater utilization of osteotomy with different immobilization techniques. Pediatric urologists had a higher success rate.

CONCLUSION Pediatric urologists performed the most bladder exstrophy closures in both databases; they operated on more delayed closures with a greater use of adjunctive procedures and a higher success rate. Differences in surgical training may contribute to the differences in practice patterns. UROLOGY 131: 211–216, 2019. © 2019 Elsevier Inc.

Bladder exstrophy (BE) closure is an intricate procedure, requiring the collaborative effort of a multidisciplinary team consisting of surgical subspecialists, anesthesiologists, and nurses for the best postoperative outcomes. With the recent board certification in pediatric urology, BE closure often falls under the purview of pediatric urologists. However, even now, multiple surgeon specialties have had a role to play in BE closure such as pediatric surgery or general urology, in addition to pediatric urology.

Evidence suggests that the type of surgical subspecialty fellowship training is independently associated with bladder closure outcomes.[1] For example, Inouye et al demonstrated that closures performed by pediatric surgeons had an increased odds of failed BE closures compared to pediatric urologists. Given the potential difference in closure success between surgical subspecialties, it is reasonable to believe that various practice patterns may differ between these subspecialties. Indeed, very little is known about the differences in the practice patterns of BE closures between pediatric urologists and other surgical specialties within the past decade. Such practice patterns may include the age at which the closure is performed, the use of pelvic osteotomy, and the type of postoperative immobilization applied, all of which have demonstrated an association with bladder closure outcomes.[1-3]

The goal of this study was to determine whether practice patterns related to BE closure or outcomes differ depending on surgical specialty. This question was approached by evaluating a national database and a robust daily-updated single institutional database of large volume in an attempt to capture as many closures as possible in this rare entity.

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The authors' hypothesize that pediatric urologists will have a greater utilization of adjunctive procedures, such as osteotomy and immobilization, coinciding with a greater successful closure rate than other surgical specialties.

METHODS

Data Source

Two databases were used to explore the practice patterns of surgeons performing BE closures: the National Surgical Quality Improvement Program Pediatric (NSQIPP) and a robust single institutional review board-approved database. The NSQIPP database is a public use file which provides data on pediatric surgical cases (patients <18 years of age) from over 120 participating institutions in North America. NSQIPP collects data using 124 variables, including demographics and 30-day postoperative outcomes. The data are prospectively collected and verified at each participating institution through a dedicated surgical clinical reviewer.

The institutional database is a specialized dataset of patients within the exstrophy-epispadias complex (EEC) referred to a single exstrophy center. This prospectively maintained daily-updated database contains 1337 EEC patients, with information collected on 227 variables specifically related to patients within the EEC. This database contains information on bladder closures performed at both the authors' institution as well as nationally and internationally referring institutions. However, only BE closures performed at outside institutions were included in this study.

Each database was used to identify patients in which the bladder closure was performed and the surgeon type was known. Demographic and perioperative outcomes were obtained. There could be minimal potential repetition of patients between databases as some of the referring institutions from the authors' institutional database also participate in the NSQIPP. Inclusion and exclusion criteria for both databases were selected carefully in order to attempt to include only classic BE patients who had undergone a primary bladder closure.

National Database

The NSQIPP database was screened for all BE closures performed between 2012 and 2017 by filtering for 1 CPT code: closure of exstrophy bladder (51940). The CPT code was cross-referenced with the postoperative diagnosis ICD-9 code 753.5 which is exstrophy of urinary bladder (variable PODIAG). Patients were excluded if they had a concomitant diagnosis of omphalocele or imperforate anus or if they had concurrent bowel surgery at the time of their bladder closure in an attempt to exclude cloacal exstrophy patients. Patients were also excluded if they were older than 120 days at the time of bladder closure in an attempt to exclude patients undergoing a repeat closure. This resulted in 84 patients. The subspecialties of the surgeons performing the closures (variable SURGPSEC) were identified and used to classify BE closures into 2 groups: those performed by (1) pediatric urologists and those conducted by (2) other surgical subspecialties (general urologists and pediatric surgeons). Closures without recorded subspecialties were excluded.

Patient demographics such as age at closure (variable AGE_DAYS), gender (variable SEX), and ethnicity (variable RACE) were analyzed for each group. Early age at closure was defined as closures before 30 days of age and delayed closures were closures after 30 days of life. Additional practice patterns investigated were the use of pelvic osteotomy and postoperative pelvic immobilization method. These were obtained from columns designated for other procedures and concurrent procedures (variables OTHERPROC and CONCURR, respectively). Perioperative complications such as blood transfusion rate (variable NOTHBLEED), length of hospital stay (variable TOTHLOS), and occurrences of deep wound dehiscence (variable NDEHIS) were investigated. Postoperative outcomes such as reoperations (variable REOPERATION) and readmissions (variable READMISSION1) were abstracted from the NSQIPP database and analyzed. Due to the intricacies of the NSQIPP database, a local consultant well-versed in the nuances of this database evaluated all data obtained in conjunction with the authors.

Institutional Database

A prospectively maintained daily-updated institutionally review board approved database of 1337 EEC patients was reviewed for all BE closures conducted between 1975 and 2018 at an outside institution and referred to a single exstrophy center. Closures performed at the author's institution were excluded to reduce sampling bias. Patients with cloacal exstrophy were excluded as well. Patients with more than 1 previous closure were also excluded, leading to a final cohort of 263 patients (Fig. 1). As with the national database cohort, the subspecialty of the surgeon performing the BE closure was identified and used to classify patients into 2 groups: (1) closures done by pediatric urologists and (2) other surgical specialties (ie, pediatric surgeons and general urologists). Demographics such as gender, race, and age at closure were investigated. Perioperative variables such as the use of a pelvic osteotomy or pelvic immobilization technique were noted. Data pertaining to postoperative outcomes and complications such as reasons for failure (ie, dehiscence, bladder outlet obstruction, vesicocutaneous fistula, or bladder prolapse) were also investigated.

Statistical Analysis

Fisher's exact tests were performed when testing the association of surgical subspecialties and categorical variables such as age, sex, race, osteotomy status, and complications. Wilcoxon rank sum tests were used to test associations between subspecialties

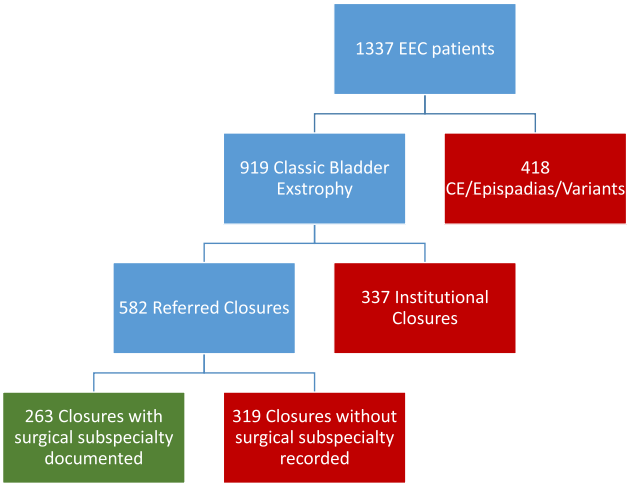

Figure 1. Flow diagram describing the patient population of this study. Red indicates the patients were excluded and green indicates patients that were included. EEC, exstrophy-epispadias complex; CE, cloacal exstrophy. (Color version available online.)

and continuous variables such as age at closure, duration of operation, and length of stay. A 2-sided P value <.05 was considered to be statistically significant. All statistical analyses were performed using R version 3.5.1 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Surgical Subspecialties Performing BE Closures

From 2012 to 2017, a total of 84 exstrophy patients underwent a bladder closure in the NSQIPP database. Of these, 74 (88.0%) were performed by pediatric urologists, while 10 (12.0%) were performed by other surgical specialists, which includes 9 (10.7%) general urologists, and 1 pediatric surgeon (1.3%). The latter 2 were included in the following results as "other" surgical specialists.

From the institutional database, a total of 263 exstrophy closures were performed in an outside referral institution between 1975 and 2018. Of these, 197 (74.9%) were completed by a pediatric urologist, and 66 (25.1%) by other services: 44 (16.7%) by a pediatric surgeon and 22 (8.3%) by a general urologist (Fig. 2).

Practice Patterns of BE Closures

From the NSQIPP database, the overall median age at bladder closure was 8 days (interquartile range 4-31). Pediatric urologists had a greater percentage of patients undergoing delayed BE closures as opposed to early closures compared to other surgical subspecialties, P = .045. Pelvic osteotomies were reported in 57.1% of NSQIPP exstrophy closures. The difference in rates of osteotomy between pediatric urologists and other surgeons was not statistically significant (59.5% vs 40.0%; P = .314). Differences in gender, race, duration of surgery, and length of hospital stay were not statistically significant between pediatric urology and other surgical specialties (Table 1).

From referred patients in the institutional database, the total median age at closures was 2 days (interquartile range 1-3). The difference in median age at closure was not statistically significant between pediatric urologists and other surgical specialists, P = .292. In total, 92 (35.0%) pelvic osteotomies were performed, in 73 patients with pediatric urologists and 19 with other surgeon specialties. Pediatric urologists performed closures with osteotomies at a higher rate than other surgeon types, P = .026. Postoperative immobilization was identified in 218 (82.9%) of closures. The most common techniques among all specialties were spica casting (42%). Differences in gender were not statistically significant between pediatric urology and other surgical specialties. There was a statistically significant difference in the racial category for patients, however, this appears to be strongly influenced by a large unknown category, see Table 1. Length of stay and duration of surgery were excluded from the results due to insufficient data.

Postoperative Complications and Outcomes

In the NSQIPP database, differences of postoperative complications between pediatric urology and other surgical subspecialty closures were not statistically significant. Two relevant complications, transfusion rate and deep wound dehiscence, were examined specifically for these patients. There was no statistically significant difference in either complication rate for the different surgeon groups; P = .238 and P = 1.0, respectively. There is no data from NSQIPP regarding closure outcomes.

From the authors' institutional database, 149 patients of the total 263 (56.7%) patients had a successful bladder closure prior to referral. There was a statistically significant difference in the percent of successful bladder closures when comparing across specialties; pediatric urologists had 125 successful closures of 197 (63.5%) referred patients while other subspecialists had 24 successful closures of 66 (36.4%) referred patients, P <.001 (Table 2).

COMMENT

A BE closure is a highly specialized procedure where the outcome of the procedure strongly influences a patient's

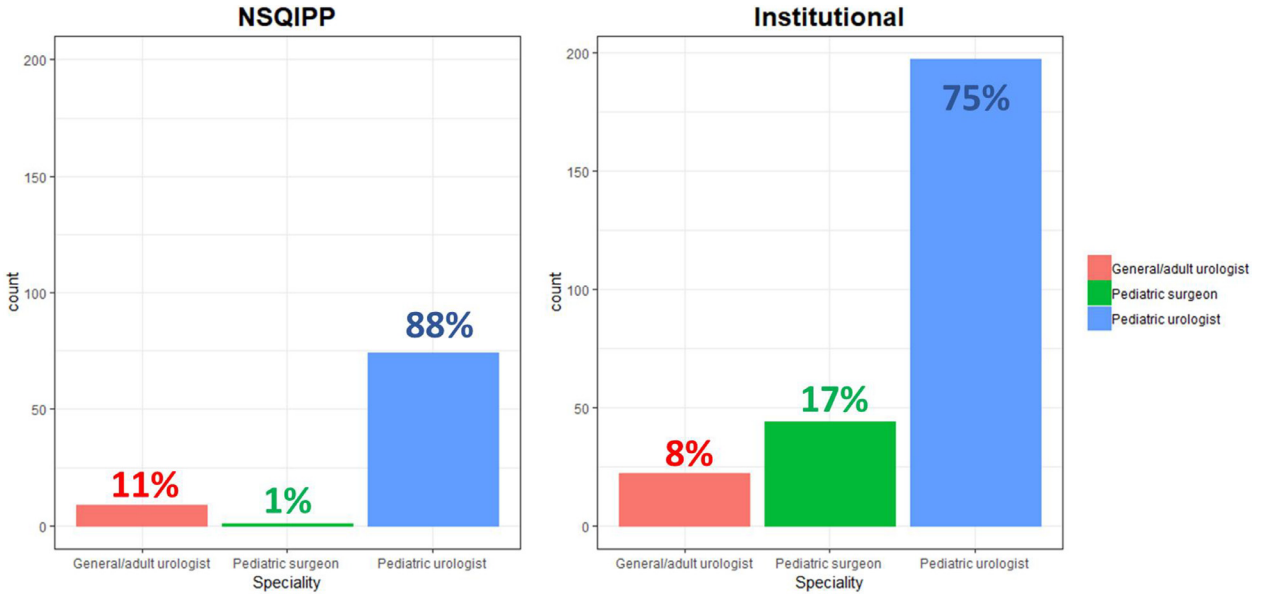

Figure 2. A comparison of surgical subspecialties that perform bladder exstrophy closures as per the NSQIPP (**A**) and single institutional database (**B**). Percentages for each specialty are presented at the top of each column. (Color version available online.)

Table 1. Displays demographic, operative, and postoperative characteristics of bladder exstrophy closures according to the NSQIPP database.

Covariates	Total (N,%)	Peds Uro* (N,%)	Other† (N,%)	*P* Value
Gender				
Male	44 (52.4)	39 (52.7)	5 (50.0)	.872
Female	40 (47.6)	35 (47.3)	5 (50.0)	
Race				
White	53 (63.1))	46 (62.2)	7 (70.0)	1
Black or African American	4 (4.8)	4 (5.4)	0 (0)	
Asian	2 (2.4)	2 (2.7)	0 (0)	
Unknown	25 (29.8)	22 (29.7)	3 (30.0)	
Age at closure (days)				
Median (IQR)	8 (4-31)	9 (3-35)	5 (3-10)	.164
Early	62 (73.8)	52 (70.3)	10 (100)	.045
Delayed	22 (26.2)	22 (29.7)	0 (0)	
Osteotomy	48 (57.1)	44 (59.5)	4 (40.0)	.314
Postoperative Immobilization				
External fixation	13 (15.5)	13 (17.6)	0 (0)	.374
Spica cast	6 (7.1)	5 (6.8)	1 (10.0)	
Unknown	65 (77.4)	56 (75.7)	9 (90.0)	
Operation time (minutes)				
Median (IQR)	328 (236-427)	337 (238-430)	256 (189-330)	.147
Length of stay				
Median (IQR)	22 (11-37)	24 (12-37)	18 (10-27)	.417
Deep Wound dehiscence	3 (3.6)	3 (4.1)	0 (0)	1
Transfusions	31 (36.9)	29 (39.2)	2 (20.0)	.238
Reoperation	9 (10.7)	7 (9.5)	2 (20.0)	.424
Readmission	1 (1.2)	1 (1.4)	0 (0)	1

* Peds Uro = pediatric urologist.
† Other = pediatric surgeon or general urologist.

medical future. A successful BE closure can lead a patient to eventual voided continence while a failed BE closure can lead to multiple, subsequent operations, making voided continence more difficult to achieve.[4] The success of a BE closure has been shown to be impacted by several factors including the use of a pelvic osteotomy for

Table 2. Displays demographic, operative, and postoperative characteristics of bladder exstrophy closures according to the single institutional database.

Covariates	Total (N,%)	Peds Uro* (N,%)	Other† (N,%)	*P* Value
Gender				
Male	172 (65.4)	126 (64.0)	46 (69.7)	.396
Female	91 (34.6)	71 (36.0)	20 (30.3)	
Race				
White	62 (23.5)	54 (27.3)	8 (12.1)	.003
Black or African American	4 (1.5)	2 (1.0)	2 (3.0)	
Asian	6 (2.3)	1 (0.5)	5 (7.6)	
Other	7 (2.7)	5 (2.5)	2 (3.0)	
Unknown	184 (70.0)	135 (68.5)	49 (74.2)	
Age at closure (days)				
Median (IQR)	2 (1-3)	2 (1-3)	2 (1-5)	.292
Early	201 (94.4)	159 (94.6)	42 (93.3)	.735
Delayed	12 (5.6)	9 (5.4)	3 (6.7)	
Osteotomy	92 (35.0)	73 (37.1)	19 (28.8)	.026
Postoperative immobilization				
Bryant's traction	39 (14.8)	35 (17.7)	4 (6.1)	.032
Bucks's traction with ex fix‡	28 (10.6)	25 (12.7)	3 (4.5)	
Spica cast	111 (42.2)	78 (39.4)	33 (50.0)	
Mummy wrap	31 (11.8)	19 (9.6)	12 (18.2)	
Other	9 (3.4)	7 (3.5)	2 (3.0)	
Unknown	43 (16.3)	34 (17.2)	34 (17.2)	
None	1 (0.4)	0 (0)	1 (1.5)	
Successful outcome	149 (56.7)	125 (63.5)	24 (36.4)	<.001

* Peds Uro = pediatric Urologist.
† Other = pediatric surgeon or general urologist.
‡ Ex fix = external fixation.

appropriate cases, postoperative lower extremity immobilization, and subspecialty training of the surgeons performing the closure.[1] Several papers have characterized practice patterns leading to successful closures in BE using large, national databases. However, each of these papers have focused on practice patterns, cost, and readmission factors through the lens of hospital volume for BE closures. To the best of the author's knowledge, no studies have looked at the practice patterns and the outcomes of BE closures through the lens of surgeon subspecialty training. Therefore, this is the first unique study to evaluate the practice patterns and outcomes of BE closures in the context of surgeon subspecialty using both a national and an institutional database.

In this retrospective study, the authors' compared the practice patterns of BE closures of pediatric urologists to other surgical subspecialties using 2 different databases: the NSQIPP and a robust, single institutional database. Not surprisingly, both the NSQIPP and institutional database show that most closures were performed by pediatric urologists. The disparity between the number of closures performed by pediatric urologists and other specialties can be explained by 2 reasons. In the United States, pediatric urologists are more familiar with, not only the procedural aspect of BE closures, but also the postoperative course due to the fellowship training. Although there is no minimum case requirement, a BE closure is considered to be a required procedure in a pediatric urology fellowship in the United States, as recommended by the Accreditation Council for Graduate Medical Education.[5] There are no such requirements for pediatric surgery fellowships or general urology residency training programs. Second, BE closures may be referred to tertiary care centers, which typically have pediatric urologists on service. Some of the children's hospitals that participate in the NSQIPP database are also centers of excellence for exstrophy management.

Moreover, there were some nuanced differences in the practice patterns of pediatric urologists compared to other surgical subspecialties. In the NSQIPP cohort, pediatric urologists performed more delayed closures compared to other practice types, however, this was not statistically significant in the single institution database. Such differences in surgical training may also account for variations in practice patterns. There was a statistically significant difference in age distribution, with pediatric urologists performing more delayed closures than other surgeon subspecialties; these results echo those of Ahn et al.[6] The higher rate of delayed closures may be due to a delay of surgery in order to transfer a patient to a tertiary care facility or to the care of a more experienced, fellowship-trained pediatric urologist. Also, as indicated by the results of Multi-Institutional BE Consortium, surgeons performing CPRE at major centers of BE care, typically do so at a median age of 2.3 months.[7] Therefore, these patients would fall under the delayed closure category. Delayed repairs of exstrophy have been shown to not compromise bladder growth in several studies.[2] However, they may be linked with higher 30 day postoperative complications, particularly blood transfusions,[6] most likely due to the increased use of pelvic osteotomies.[8]

Similarly, there was a statistically significant higher use of osteotomy in pediatric urologists in the single institution database, though this was not statistically significant in the NSQIPP database. A pelvic osteotomy allows for approximation of the pelvic ring and increases the likelihood of success in closures when indicated[9] and is particularly important in repeat closures.[10,11] Since pediatric urologists appeared to perform more delayed closures, and even more closures in general, this is one likely explanation for the higher use of pelvic osteotomy in closures performed by pediatric urologists. In correlation with these results, we also found a difference in the use of postoperative immobilization techniques. The NSQIPP data show a higher rate of external fixation use among pediatric urologists. The authors hypothesize that this higher rate is likely due to the higher rate of pelvic osteotomies. The results from the authors' institutional database provided a more detailed exploration. Pediatric urologists had a significantly higher use of Buck's traction with external fixation compared to other surgical specialties, whereas other surgical specialties had a significantly higher use of spica casts compared to pediatric urologists. Many such differences in practice patterns may be associated with geographic location or resources. Still, as many of these variables have been associated with surgical outcomes, it is not surprising to find differences in postoperative outcomes.

Fortunately, most complications were rare, with a blood transfusion as the most common complication for both pediatric urologists and other surgeons. Such a complication is not unexpected as the reconstruction of BE is arduous and frequently requires pelvic osteotomy, which has been shown to be associated with blood transfusions. Other relevant complications, such as deep wound dehiscence, readmissions, or reoperations, were rare and not statistically significant. The authors' institutional database documents the success of the bladder closure based on certain specific criteria that includes closures that do not result in bladder dehiscence, bladder prolapse, vesicocutaneous fistula, or bladder outlet obstruction.[4,12] The significantly higher rate of success among the pediatric urologists may, at least in part, be owed to the differences in practice patterns. But the outcome of the bladder closure is dependent on a multitude of factors outside of the surgical training. And though many factors have been previously explored, including the surgeon type,[1,13] there is a complex interplay of multiple factors. Closures performed at centers of excellence, where an experienced pediatric urologist is likely staffed, typically provide the necessary practices for successful closures. In addition, these centers to be are also associated with lower rate of deaths and decreased overall costs.[14]

To the best of the authors' knowledge, this is the first study which compares practice patterns of BE closures between surgical subspecialties using a national database. While these national databases are excellent in documenting a multitude

of perioperative variables from a plethora of institutions, it falls short of providing specific BE information. The national databases lack the patient's exact diagnosis, such classic BE vs cloacal exstrophy, or whether the surgery was a primary or repeat closure; they also do not provide outcome data on the bladder closure. Therefore, this study offers a unique perspective of a robust, single institutional database, which has its own strengths. The institutional database provides excellent BE-specific outcomes, such as the closure outcome, arguably the variable that provides the most predictive long-term prognostic value of eventual continence. But certain details, such as the transfusion rate, are not always available as records from referring institutions may omit that information. Thus, this study draws from the strengths of both databases to provide insights into the practice patterns of various subspecialties performing BE closures.

This study is not without limitations. First, this is a retrospective study, and as such, sampling bias likely influences the results. Also, as mentioned previously, the NSQIPP database does not provide information on many important variables (eg, reason for failure, primary vs repeat closures, and specific type of immobilization technique) that may impact the success rates of bladder closures nor does it give the actual success rate of the closures. However, it does provide a snapshot of the national practical patterns for a variety of surgical procedures in the pediatric population. Third, the sample size of the "other" specialties group from the NSQIPP database was limited, as a result of the low incidence of BE. Next, the NSQIPP database is limited by providing data only up to 30 days postoperatively, while BE requires long-term management with multiple procedures to ensure proper voiding continence. The institutional database is limited to its perioperative data as all of these BE closures were performed at outside institutions. As such, there is some minimal possibility of an overlap of patients from both databases, considering that some referring institutions also participate in NSQIPP. Even with these limitations, the results provided herein were able to reliably demonstrate slight practice variability of BE care based on specialty. Furthermore, NSQIPP is an unbiased, risk-adjusted tool that can provide accurate data on 30-day postoperative complications. Additional studies investigating the disparities in practice patterns of BE may lead to discovering areas of improvement in the management of BE as well as showing the need of standardized care through centers of excellence.

CONCLUSION

Whether evaluated from a national multi-institutional database or a robust single institutional database, pediatric urologists performed the most BE closures compared to other surgical subspecialties. They operated on more delayed closures than other specialties, had a higher utilization of adjunctive procedures, and had a greater success rate. In all surgical practices, complication rates were low. Regardless of surgical specialties, all services that conduct closures should collaborate with a dedicated team of pediatric orthopedic surgeons, pain control specialists, and experienced nursing staff, in order to provide the best care of these patients.

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