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Inpatients hypospadias care: Trends and outcomes from the American nationwide inpatient sample

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Purpose: Hypospadias is the most common congenital penile anomaly. Information about current utilization patterns of inpatient hypospadias repair as well as complication rates remain poorly evaluated.

Materials and Methods: The Nationwide Inpatient Sample was used to identify all patients undergoing inpatient hypospadias repair between 1998 and 2010. Patient and hospital characteristics were attained and outcomes of interest included intra- and immediate postoperative complications. Utilization was evaluated temporally and also according to patient and hospital characteristics. Predictors of complications and excess length of stay were evaluated by logistic regression models.

Results: A weighted 10,201 patients underwent inpatient hypospadias repair between 1998 and 2010. Half were infants (52.2%), and were operated in urban and teaching hospitals. Trend analyses demonstrated a decline in incidence of inpatient hypospadias repair (estimated annual percentage change, -6.80%; range, -0.51% to -12.69%; p=0.037). Postoperative complication rate was 4.9% and most commonly wound-related. Hospital volume was inversely related to complication rates. Specifically, higher hospital volume (>31 cases annually) was the only variable associated with decreased postoperative complications.

Conclusions: Inpatient hypospadias repair have substantially decreased since the late 1990's. Older age groups and presumably more complex procedures constitute most of the inpatient procedures nowadays.

Keywords: Hypospadias; Inpatients; Outcome assessment; Postoperative complications

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INTRODUCTION

Advances in perioperative care and decreased operative morbidity have resulted in the migration of inpatient procedures to the outpatient setting. The management of hypospadias exemplifies this trend; from 1997 to 2000, inpatient encounters for hypospadias decreased by seventy-five percent [1]. Information regarding contemporary

patterns of inpatient hypospadias repair, however, is not present in the current pediatric literature, despite hypospadias being one of the most common diagnoses in pediatric urology. Roughly 8.3/1,000 males are born with a congenital penile anomaly with hypospadias accounting for 73.3% of these defects [2]. Further, the incidence of severe and more proximal variants of hypospadias is increasing which often requires treatment in an inpatient setting [3].

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While long-term functional results of hypospadias repair have been previously reported [4], little is known about short-term outcomes in this demanding surgical field. The evaluation of such may hold potential for the optimization of processes of care. Inpatient administrative claims provide an opportunity to comprehensively evaluate immediate postoperative outcomes in the community. On the basis of these considerations, we queried the Nationwide Inpatient Sample (NIS) to examine the contemporary temporal trends and complications in hypospadias repair. Specifically, we sought to assess patient outcomes and their predictors following hypospadias repair in the inpatient setting.

MATERIALS AND METHODS

1. Data source

Data from the most contemporary years (1998–2010) of the NIS were abstracted. The NIS includes inpatient discharge data collected via federal-state partnerships, as part of the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project. As of the year 2009, the NIS contains data from approximately 8 million hospital stays drawn from more than 1,000 community hospitals in 44 States, approximating 20% of community hospitals within the United States (US), including public hospitals and academic medical centers.

2. Sample population and surgical procedures

Patients undergoing hypospadias repair were identified using the *International Classification of Disease, 9th Revision, Clinical Modification* (ICD-9-CM) procedure code 58.45 ("repair of hypospadias or epispadias"), with the concomitant diagnostic code 752.61 ("hypospadias"), so as to exclude all patients with epispadias and patients who were hospitalized for nonoperative indications of hypospadias. The ICD-9 is the standard classification system in the US. Hospital sampling weights were used to estimate the total number of these procedures performed in the US each year, yielding a weighted national estimate of 10,201 inpatient hypospadias repairs over the study period.

3. Patient characteristics and outcomes

Patient characteristics, including age at surgery as well as year of surgery, were examined. Baseline Charlson comorbidity index (CCI) was calculated according to Charlson et al. [5], and adapted according to Deyo et al. [6] (0, 1, 2, ≥ 3). Patients' insurance status was considered and grouped as private or nonprivate (Medicaid, Medicare, and other), as determined at the time of surgery. Outcomes assessed

were intraoperative and postoperative complications and prolonged length of stay, latter defined as stays in the 75th percentile (3 days). Postoperative complications were described as those that occurred in the immediate postoperative period i.e., prior to discharge, as NIS captures only cross-sectional data (single event data).

4. Hospital characteristics

Hospital characteristics included hospital region and hospital teaching status, both of which were obtained from the American Hospital Association Annual Survey of Hospitals and defined by the United States Census Bureau [7]. A hospital was considered a teaching hospital if it had an American Medical Association-approved residency program, was a member of the Council of Teaching Hospitals, or had a ratio of 0.25 or higher of full-time equivalent interns and residents to non-nursing home beds. Annual hospital caseload was defined according to the number of inpatient hypospadias repairs performed annually, as previously described [8].

5. Statistical analysis

First, frequencies and proportions, means, standard deviation, medians and interquartile ranges were generated for categorical and continuously coded variables, respectively. For continuous variables, normality was assessed using the Kolmogorov-Smirnov test [9], the Shapiro-Wilk test [10] and graphical plots. As continuous variables were found to be nonnormally distributed, univariate comparisons were made using the Mann-Whitney test. The chi-square test was used to assess the statistical significance of proportions.

Second, temporal trends in rates were analyzed by the estimated annual percentage change (EAPC), which uses the least squares linear regression methodology as suggested by Anderson et al. [11].

Third, weighted logistic regression analyses were fitted for prediction of complications. Covariates included age, race, CCI, year of surgery, insurance status, median household income, hospital volume (classified into quartiles), location, region and teaching status. Generalized estimating equations further adjusted for clustering among hospitals [12].

An Institutional Review Board waiver was obtained prior to conducting this study, in accordance with institutional regulation when dealing with de-identified administrative data. All tests were two-sided, with a statistical significance set a $p < 0.05$. The R ver. 3.0.1 (R Foundation for Statistical Computing, Vienna, Austria) was used in all analyses.

RESULTS

Overall, a weighted national estimate of 10,201 patients underwent inpatient hypospadias repair between 1998 and 2010.

Table 1 shows the baseline characteristics of the entire cohort. Over half of patients (52.2%) were infants (≤ 1 year old), and three quarters (76.2%) were 5 year olds or under. Most patients were healthy, with 95.1% having no comorbidities and 99.4% having one or fewer comorbidities. Most patients were privately insured (59.3%) and were operated in urban (98.1%) and teaching (89.9%) hospitals. Table 1 and Fig. 1 furthermore show the temporal trends of inpatient hypospadias repair and their incidence respectively. Over the study period, infants comprised a progressively smaller proportion of the group undergoing inpatient repairs (EAPC, -9.39% ; range, -16.88% to -1.22% ; $p=0.029$). Over time, patients with private insurance were also less likely to undergo inpatient repair (EAPC, -10.28% ; range, -17.08% to -3.14% ; $p=0.010$). All other trend analyses were non-significant.

Table 2 displays immediate surgical outcomes and complications. Intraoperative complications (0.1%) and transfusions (0.2%) were exceedingly rare. Postoperative

complications were also rare (4.9%), with wound-related complications representing nearly half of this group (2.1% overall rate).

Table 3 stratifies outcomes by patient age. Adolescents and adults were the most likely to experience postoperative complications (10.3% and 8.2%, respectively), with wound infections representing the largest portion of those

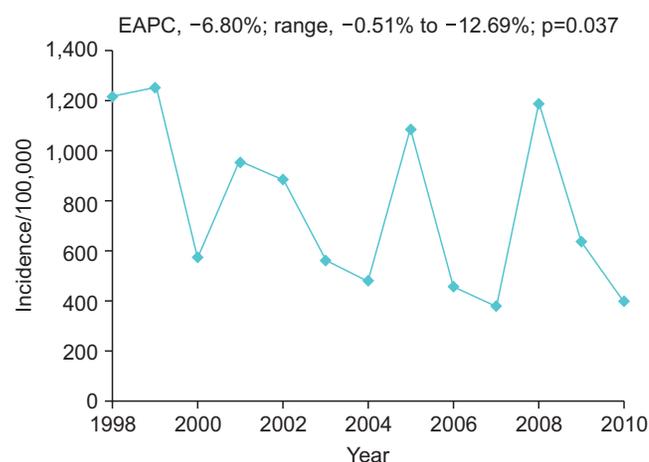


Fig. 1. Temporal trend analyses of incidence of inpatient hypospadias repair during the years 1998–2010. EAPC, estimated annual percentage change.

Table 1. Weighted descriptive characteristics of 10,201 patients undergoing inpatient hypospadias repair, Nationwide Inpatient Sample, 1998–2010

Variable	Overall	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	p-value
No. of cases (%)	10,201 (100)	1,216 (11.9)	1,277 (12.4)	569 (5.6)	954 (9.4)	889 (8.7)	572 (5.6)	482 (4.7)	1,098 (10.8)	463 (4.5)	379 (3.7)	1,227 (12.0)	683 (6.7)	393 (3.9)	-
Age (y)															<0.001
Infants (<1)	52.2	63.9	66.6	46.4	48.6	50.7	45.4	44.9	50.4	42.1	46.1	53.2	46.2	38.4	
Preschool (2–5)	24.0	15.6	19.3	22.9	30.7	29.9	30.5	24.6	22.6	20.5	25.0	27.0	26.5	19.8	
Grade school (6–9)	6.9	5.0	2.9	4.0	4.5	4.8	9.5	6.8	7.7	11.1	4.2	9.3	16.9	7.9	
Preadolescent (10–13)	4.9	5.1	3.7	3.5	5.2	6.3	2.5	5.2	8.1	6.3	4.2	4.2	1.7	6.6	
Adolescent (14–18)	3.5	3.0	3.3	3.5	2.7	2.0	0.9	7.7	2.3	8.1	5.8	1.7	2.2	10.4	
Adult (>18)	8.6	7.4	4.3	19.6	8.2	6.2	11.2	10.8	8.9	11.8	14.7	4.5	6.4	16.8	
CCI															<0.001
0	95.1	98.3	97.7	92.5	97.9	95.4	94.2	93.4	93.6	93.1	94.7	93.8	96.2	86.8	
1	4.3	1.2	1.9	6.0	1.6	4.1	5.8	3.9	5.5	5.8	5.3	6.2	3.8	13.2	
2	0.4	0	0	0.7	0.5	0.6	0	1.9	0.9	1.1	0	0	0	0	
≥ 3	0.2	0.5	0.4	0.9	0	0	0	0.8	0	0	0	0	0	0	
Insurance status															<0.001
Private	59.3	74.9	74.5	69.1	57.3	48.5	59.3	57.9	64.2	46.7	44.9	49.1	42.6	52.4	
Nonprivate	40.8	25.1	25.5	30.9	42.7	51.5	40.7	42.1	45.8	53.3	55.1	50.9	57.4	47.6	
Hospital location															<0.001
Rural	1.9	1.3	1.4	2.8	2.1	2.9	0	2.1	1.0	4.3	7.1	1.1	2.2	1.0	
Urban	98.1	98.7	98.6	97.2	97.9	97.1	100	97.9	99.0	95.7	92.9	98.9	97.8	99.0	
Academic status															<0.001
Nonteaching	10.1	7.3	6.3	30.0	6.6	11.1	21.0	18.0	9.7	9.3	4.7	4.6	11.0	4.6	
Teaching	89.9	92.7	93.7	70.0	93.4	88.9	79.0	82.0	90.3	90.7	95.3	95.4	89.0	95.4	

Values are presented percentage unless otherwise indicated.

CCI, Charlson comorbidity index.

complications. Regarding prolonged length of stay, infant age group did significantly better than the rest and had the best outcomes. Also, infants were more likely to undergo the procedure in a high-volume center whereas adolescents and adults were more likely to undergo repair in a low-volume center ($p<0.001$).

Multivariable logistic regression analysis was performed to assess factors independently associated with postoperative complications and excess length of stay (Table 4). Higher-hospital volume (>31 cases annually) was the only variable independently associated with decreased postoperative complication rates (odds ratio [OR], 0.34; 95% confidence interval [CI], 0.16–0.74; $p=0.007$). Factors associated with increased length of stay included older age, presence of a comorbidity, and higher hospital volume. Increased length of stay had no association with hospital location, or teaching status.

Multivariable analysis could not be performed for intraoperative complications and transfusion rates due to

low number of occurrences.

DISCUSSION

As the incidence of congenital penile anomalies is increasing, hypospadias remain the most common diagnosis with an estimated 0.3% of live male births [2,7,13]. Registry data indicates that rates of hypospadias have increased 2.9% annually, with rates of proximal hypospadias having expanded three to five folds from 1968 to 1993 [3].

While rates of outpatient procedures are on the rise for hypospadias [1], trends in the contemporary inpatient management of hypospadias and factors influencing such care are poorly described. To the best of our knowledge, this is the first report to examine immediate complications of hypospadias repair, as well as factors associated with length of stay, in a representative cohort.

Our study has several key findings. First, while the rates of inpatient hypospadias are decreasing, we observed a shift toward a higher age at surgery over the course of our study (Table 1). According to the current guidelines, primary hypospadias repair should be carried out between 6 to 18 months after birth [14]. However, significant geographic differences exist as to the preferred average age at the time of the first procedure [15]. While in the US patient are mostly operated during the first 2 years of life, European and Chinese patients are operated during the first 3 and 5 years of life, respectively [16]. Specifically, data from the US suggest surgery as early as 3 months after birth without increasing complication rates [17]. This is raising concerns regarding the potential side effects associated with surgery at such an age. Specifically, general anesthesia has been suggested to account for neurodevelopmental impairment

Table 2. Weighted operative outcomes of 10,201 patients undergoing inpatient hypospadias repair, Nationwide Inpatient Sample, 1998–2010

Variable	Overall, n (%)
In hospital mortality	-
Intraoperative complications	12 (0.1)
Postoperative complications	
Overall	495 (4.9)
Genitourinary	98 (1.0)
Wound	216 (2.1)
Other	181 (1.7)
Homologous transfusion	25 (0.2)
Prolonged length of stay ^a (≥ 3 days)	2,355 (23.1)

^a: ≥ 75 th percentile.

Table 3. Univariable characteristics in 10,201 patients undergoing inpatient hypospadias repair, 1998–2010, according to age

Variable	Age (y)						Total	p-value
	Infants (<1)	Preschool (2–5)	Grade school (6–9)	Preadolescent (10–13)	Adolescent (14–18)	Adult (>18)		
Postoperative complications	4.2	6.1	0.9	3.0	10.3	8.2	4.9	<0.001
Wound	1.7	2.7	0	0.8	5.6	4.1	2.1	<0.001
Genitourinary	0.6	1.4	0	1.2	2.9	2.0	1.0	<0.001
Intraoperative complications	0.1	0.2	0	0	0	0	0.1	0.478
Hospital Volume (by quartile)								<0.001
0–3	16.8	23.5	26.4	27.7	47.5	61.7	24.5	
4–9	20.6	24.5	18.8	22.5	25.8	24.0	22.0	
10–31	30.3	22.5	22.8	28.3	20.8	10.7	25.8	
>31	32.3	29.5	32.0	21.5	5.9	3.6	27.7	
Prolonged LOS	17.3	30.6	31.2	24.5	25.4	30.1	23.2	<0.001

Values are presented percentage.

CCI, Charlson comorbidity index; LOS, length of stay.

Table 4. Multivariable risks for postoperative outcomes in 10,201 patients undergoing inpatient hypospadias repair, 1998–2010

Variable	Postoperative complications		
	OR	95% CI	p-value
Year			
1998	Reference	Reference	Reference
1999–2010	1.02	0.96–1.08	0.603
Age (y)			
Infants (<1)	Reference	Reference	Reference
Preschool (2–5)	1.40	0.8–2.4	0.199
Grade school (6–9)	0.16	0.02–1.2	0.077
Preadolescent (10–13)	0.60	0.2–1.8	0.367
Adolescent (14–18)	2.10	0.88–4.8	0.096
Adult (>18)	1.30	0.6–2.8	0.438
CCI			
0	Reference	Reference	Reference
1	1.26	0.55–2.8	0.583
2	4.15	0.5–34.4	0.188
≥3	5.90	0.2–200	0.322
Hospital volume			
0–3	Reference	Reference	Reference
4–9	0.73	0.4–1.35	0.313
10–31	0.92	0.5–1.72	0.790
>31	0.34	0.16–0.74	0.007*
Hospital location			
Rural	Reference	Reference	Reference
Urban	0.75	0.2–2.9	0.670
Academic status			
Nonteaching	Reference	Reference	Reference
Teaching	1.04	0.501–2.2	0.925

Variables in each model: age, gender, race, CCI, median household income quartiles, hospital region, location, academic status and hospital volume quartiles; year of surgery was run in a separate analysis as a continuous variable.

OR, odds ratio; CI, confidence interval; CCI, Charlson comorbidity index.

*p<0.05.

and up to 69 folds higher mortality rates for newborns than for 10 year olds [18,19]. While the rate of inpatient repairs has not changed much in the ages 2–13 (preschoolers, grade-schoolers, and preadolescents, Table 1), the biggest shift was observed in infants (63.9% down 38.4%), adolescents (3% up 10%) and adults (up 7.4% to 16.8%). This trend in our cohort may suggest that these inpatients underwent a secondary or failed hypospadias repair rather than a primary procedure. Although it cannot be directly derived from the data, secondary hypospadias repair is reported to take place at an adult or adolescent age [20], thus resembling our data. While not verifiable with our data, our findings may suggest that inpatient cases represent more complex, secondary surgeries following a failed repair. Further, since the intraoperative complication and transfusion rates were exceedingly low at 0.1% and 0.2%, respectively, it is unlikely that the inpatient status of surgery was the result of a surgical complication. Likewise, the low rate of patient comorbidities suggests that sicker patients did not strongly influence the inpatient status of the surgery. Unfortunately, we were unable to

assess degree and stage of hypospadias, as this was not reported in the NIS database.

Second, while intraoperative and postoperative complications were low overall, we found an immediate complication rate of 4.9%. While long-term complications of hypospadias surgery range from 6%–30% [4,21–23], few investigators have examined immediate complications. One review of immediate complications of hypospadias surgery revealed that edema occurred in 11%, flap necrosis in 7%, and that wound dehiscence, hematoma, urethral stent complications, and penile torsion are a rare cause of postoperative complications [24]. Indeed, in our cohort, wound complications were most common and showed an association with older age (Table 3). This finding parallels other studies that have found higher long-term complication rates in older patients undergoing hypospadias repair [4,23]. In addition to pathophysiological predictors of wound complications, older patients in our cohort were more likely to undergo their surgeries in the low-volume centers than were those in younger age groups. This relationship has been well

established in other studies looking at hospital volume and surgeon experience with patient outcomes [25-28]. Indeed, high hospital volume decreased the odds of postoperative complications in our cohort by 67% (Table 4). Despite support to refer hypospadias patients to specialized centers with adequate volume, our data display a low adherence to these recommendations.

Despite its strengths, our study has several limitations. We were unable to assess rates of outpatient hypospadias repair with this study secondary to lack of a nationally representative outpatient database, and there is a need to evaluate outpatient hypospadias on a population level. Additionally, our study was not able to distinguish between primary vs. secondary procedure, nor the stage of hypospadias, which represent important confounders when assessing complications. Thus it is unclear what proportion in this study represented delayed referral for primary repair vs. repair of complications. We were also unable to assess delayed complications of hypospadias, such as fistula formation or stricture, which remain a notable source of potential complication and need for subsequent reoperation. Further, our study was unable to assess the degree of hypospadias. While more proximal repairs have been associated with higher long-term complication rates, it is unknown whether immediate complication rates are similarly higher. Regardless, overall immediate complication rates as low as 4.9%, which may be helpful in counseling families. Finally, the NIS is an administrative database built upon data extracted from medical records and is subject to any inaccuracies that may occur with this process, however by selecting patients by both procedure and diagnosis codes, we likely decreased this effect.

CONCLUSIONS

Taken together, our data demonstrate that inpatient hypospadias repair has substantially decreased since the late 1990'. In the most contemporary years, older age groups constitute the majority of inpatient repairs. Although the overall complication rate was relatively low at 4.9%, the high rate of procedures at low-volume hospitals indicates that outcomes may improve from selective referrals to high volume centers with more extensive experience in the management of complicated hypospadias repairs.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

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