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Urology Consultation and Emergency Department Revisits for Children with Urinary Stone Disease

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Abstract

Purpose—To determine the association between urology consultation and emergency department (ED) revisits for children with urinary stones.

Materials and Methods—This retrospective cohort study included patients 18 years-old who presented to an ED in South Carolina with a urinary stone from 1997–2015. The primary exposure was urology consultation during the index ED visit. The primary outcome was a stone-related ED revisit occurring within 180 days of discharge from an index ED visit. Secondary outcomes included CT utilization, inpatient admission, and emergent surgery.

Results—Among 5,642 index ED visits for acute urinary stones, 11% resulted in at least one stone-related ED revisit within 180 days. Fifty-nine percent of revisits occurred within 30-days of discharge and 39% were due to pain. The odds of ED revisit were highest within the first 48-hours of discharge (odds ratio [OR] 22.6, 95% confidence interval [CI] 18.0–28.5) and rapidly decreased thereafter. Urology consultation was associated with a 37% lower adjusted odds of ED revisit (OR 0.63, 95% CI 0.44–0.90) and 68% lower odds of CT utilization across all ED visits (OR 0.32, 95%

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CI 0.15–0.69). Among those who revisited, the frequency of pain complaints was 27% among those with urology consultation at the index visit and 39% among those without.

Conclusions—Urology consultation was associated with decreased ED revisits and CT imaging among pediatric patients with urinary stones. Future studies should identify the patients that benefit most from urology consultation and ascertain processes of care that decrease ED revisits among high-risk patients.

Introduction

Urinary stone disease has historically been considered an adult disease. However, the incidence of nephrolithiasis during childhood has doubled since 1996.^{1,2} During this time, the increase in healthcare costs for pediatric stone disease has outpaced medical inflation; and the amount of healthcare dollars spent on it has quadrupled.^{3,4} The shift in disease onset to childhood means that pediatric providers must evaluate and treat a previously uncommon condition with limited evidence to inform care. This increases the possibility of over or under testing, unnecessary irradiation, and inappropriate health services utilization, such as emergency department (ED) revisits.

ED revisits account for substantial healthcare utilization. For example, 6% of pediatric asthmatics revisit the ED within 30 days of an index visit and 14% within 60 days.⁵ Despite the rapid increase in the incidence of pediatric nephrolithiasis, the ED revisit rate for children with urinary stones is unknown. ED revisits often reflect failure to adequately evaluate and treat a condition at an initial encounter and, therefore, increase morbidity and unnecessary healthcare expenditures.^{6,7,8,9} Because many patients with nephrolithiasis initially present to the ED, identifying clinical care practices that decrease ED revisits may facilitate timely, appropriate care and decrease costs.

To date, no studies of adults or children have examined whether urology consultation at the initial ED visit, a modifiable process of care, is associated with ED revisits. In this population-based cohort study, we determined the ED revisit rate among children with urinary stones and examined the association between urology consultation and ED revisit.

Patients and Methods

Study Design and Population

We performed a retrospective cohort study using South Carolina Medical Encounter Data, which contains encounter-level data for patients treated at in-state hospitals from December 30, 1995 to September 30, 2015. This all-payer claims database, by law, captures all ED visits, surgeries, and hospital admissions. It is frequently audited and must be 99.9% accurate and 99.5% complete.² It contains patient-level data including International Classification of Diseases, 9th revision (ICD-9) codes, physician specialty codes as defined by the American Medical Association, payer classification, and unique patient identifiers. Identifiers allow patients to be tracked across all 710 free-standing acute care hospitals in South Carolina.

We included all patients 18 years old residing in South Carolina who presented to an in-state ED for a urinary stone, defined by a first-time primary ICD-9 code(s) for kidney or ureteral stones (Suppl. Table-1). We defined an index ED visit as a first-time ED visit for urinary stones or a subsequent ED visit that occurred > 180 days from the discharge date of a prior stone visit. Index visits occurring after April 3, 2015 were excluded to allow for a 180-day follow-up period. Children who underwent scheduled stone surgery and those diagnosed during an inpatient hospitalization prior to an index visit were excluded to ensure that index visits were not sequelae from prior surgery. Patients with missing demographics or discharge status, and those who died before discharge were also excluded (Figure 1). Age was defined at the date of the index visit.

This study was designed using the Healthcare Cost and Utilization Project Methods Series for Methodological Issues when Studying Readmissions and Revisits.¹⁰ It was deemed exempt from review by the Children's Hospital of Philadelphia Institutional Review Board.

Outcome

The primary outcome was a stone-related ED revisit, defined as an ED visit with a primary or secondary ICD-9 code for urinary stones that occurred within 180 days of discharge from an index ED visit. We chose 180 days because most spontaneous passage or elective intervention occurs within 6 months of diagnosing a symptomatic stone.^{11,12} Reasons for revisits were identified using primary and secondary ICD-9 codes (Suppl. Table-1). Secondary outcomes included CT utilization, inpatient admission, and emergent surgery, identified using ICD-9 procedure codes and hospital charge codes (Suppl. Table-1).

Exposure and Covariates

The primary exposure was urology consultation during the index ED visit, defined by physician specialty codes.

Patient-level covariates included age, sex, race, insurance status, urban/rural residence, and history of nephrolithiasis. Hospital-level covariates included bed number, teaching status, and children's hospital designation. Geographic-level covariates included pediatrician and urologist density defined at the county level using the U.S. Department of Health and Human Services Area Health Resources Files Database.

Statistical Analysis

To examine how the revisit risk changed over time, we used a discrete time failure model to estimate the odds of revisit in the 180 days after discharge. Time elapsed since discharge was categorized as 1–2, 3–5, 6–7, 8–14, 15–60, and 61–180 days. This provided granularity in revisit odds shortly after discharge when revisits were hypothesized to be highest. We adjusted for hospital and county-level urologist density as linear terms in the model.

Multivariable logistic regression was used to estimate the association between urology consultation at index ED visit and ED revisit, categorized as ever/never, and adjusted for the aforementioned patient- and hospital-level covariates, county-level urologist and pediatrician density, and hospital as linear terms. We did not use a discrete time failure model for this

analysis since variation in the magnitude of the association between consultation and ED revisit over time has limited clinical implications. Logistic regression was also used to estimate the association between urology consultation and CT utilization across ED visits. Analyses were performed in R v3.2.2 and SAS 9.4. Tests were two-sided, and statistical significance was set at $p < 0.05$.

Sensitivity Analyses

Sensitivity analyses excluded: 1) patients with complex chronic conditions,¹³ given their increased likelihood of ED visits (Suppl. Table-1); 2) visits that involved a hospital transfer, since there is no consensus on treating transfers in revisit studies; 3) patients who neither had a CT scan nor an ultrasound at the index visit, since imaging is necessary in diagnosis; 4) patients who had surgery at the index visit; and 5) subsequent index visits, such that each patient in the dataset only contributed one index visit.

Results

Patient Characteristics

Between 1996 and 2015, 6,866 children visited a South Carolina ED for urinary stones (Figure 1, Table 1). Fifty-eight percent were female, 94% were 10–18 years old and 84% presented to non-children's hospitals. Of the 5,037 children who met eligibility criteria, 4,554 had one index ED visit, 394 had two, and 89 had 3, resulting in 5,642 index ED visits. Of these index ED visits, 601 (11%) resulted in admission and 375 (7%) resulted in emergent surgery. Seventy-three percent and 5% of visits involved CT and ultrasound, respectively. For patients with 1 index ED visit, the median length of time between index visits was 567 days (IQR: 338–971 days, Suppl. Figure-1).

ED Revisits

Of the 5,642 index ED visits, 584 visits (10%), attributable to 552 patients (11%), resulted in at least one stone-related ED revisit. Eighty-four percent of revisits involved one ED revisit and 16% involved two or more. Thirty-four percent of ED revisits occurred within 5 days of discharge and 59% within 30 days. The odds of ED revisit were highest within the first 48 hours of discharge (OR 22.6, 95% confidence interval [CI] 18.0–28.5) and rapidly decreased thereafter (Figure 2). Revisiting the ED resulted in an increased likelihood of inpatient admission and emergent surgery, with 16% of revisits involving admission and 15% involving surgery, compared to 11% and 7%, respectively. Pain was the most common reason for ED revisit, with 39% of ED revisit encounters involving ICD-9 codes for pain (Suppl. Table-2).

Urology Consultation

A urologist was consulted for 522 index visits (9%) and 122 (17%) of revisits. Urology consultation was associated with a 37% decreased odds of ED revisit (OR 0.63, 95% CI 0.44–0.90, Table 2). Patients who had a urology consultation at the index visit had higher rates of emergent surgery and admission (Suppl. Table-3). Sixty-five percent of children seen by a urologist at an index visit had emergent surgery, compared to 79% seen at revisit. Overall, 6% of children had an ED visit within 180 days after surgery.

Among patients with ED revisits, 39% had 2 CT scans in the ED within 6-months of the index visit (Table 3). Across all stone-related ED visits, the odds of receiving any CT imaging was 68% lower for those with urologic consultation at the index visit compared to those without (Table 3, OR 0.32, 95% CI 0.15–0.69). Among those who revisited, the frequency of pain complaints for those with and without urologic consultation at the index visit was 27% and 39%, respectively.

Older age, public insurance, and stone history were independently associated with increased adjusted odds of ED revisit (Table 2). There were no statistically significant associations between race, sex, hospital size, teaching status, urban/rural designation, or children's hospital and ED revisit.

Sensitivity analyses

Excluding patients with complex chronic conditions (n=67), those who did not have diagnostic imaging (n=1368), hospital transfers (n=48), and subsequent index ED visits (n=605) did not change results (Suppl. Table-4). The direction of the association was the same excluding children who had surgery at the index visit, but was no longer statistically significant (OR 0.87, 95% CI 0.50–1.50, Suppl. Table-4).

Discussion

In this population-based cohort study, 11% of 5,037 children who presented to the ED with urinary stones in South Carolina revisited the ED within 180 days. Nearly 60% of revisits occurred within 30 days of the initial ED visit, with the greatest odds of ED revisit within 48 hours. ED revisits resulted in increased health services utilization, including surgery and admission. Patients who revisited also had more overall CT imaging, with 39% undergoing 2 CT scans in the ED within six months. Urology consultation was associated with a 37% lower odds of ED revisit, 68% lower odds of CT utilization, and fewer pain complaints.

Presuming that many ED revisits are preventable, our study adds to the literature on appropriate initial resource utilization to improve health outcomes.¹⁴ This study is the first to evaluate ED revisits for pediatric nephrolithiasis, and has several strengths that distinguish it from prior studies. First, we were able to identify specialist consultation, which is often absent from administrative datasets. We could therefore extend upon prior studies that reported an association between lower urologist density and increased odds of ED revisit in adults.¹⁵ Second, the database is audited for accuracy and completeness, contains unique patient identifiers and includes all patients regardless of payer status. Using the unique identifiers, we tracked patients across all EDs in South Carolina, identifying revisits that occurred at different EDs than the index visit. Including all South Carolina EDs increased generalizability since the majority of care was delivered at general hospitals and 45% of patients were uninsured or publicly insured.

The most likely explanation for the association between urology consultation and decreased ED revisit is that early consultation facilitates early surgical intervention. In this study, 65% of children seen by a urologist at the index ED visit had surgery at the same visit. Early surgery would prevent return visits for failed stone passage and associated pain. However,

surgery may not prevent all future ED visits as prior studies have reported that 15% of adults visit the ED following ureteroscopy.¹⁶ We found that 6% of children who underwent surgery at the index episode revisited the ED. Urologic consultation may also inform medical management of stones. A prior study reported only 13% of pediatric candidates for medical expulsive therapy (MET) receive prescriptions from ED providers and odds of MET utilization was higher in patients seen by urologists than by generalists.¹⁷ This suggests that ED providers may be less aware of the recommendations for MET utilization in children with uncomplicated ureteral stones.¹⁸

Urology consultation may also facilitate outpatient follow-up. This hypothesis is supported by Scales *et al.*, who reported that lower per-capita urology density was associated with a greater odds of ED revisits, suggesting that access to urologists may impact revisit risk.¹⁵ While only 30% of adults with symptomatic stones follow-up with a urologist after ED discharge,¹⁹ the rate of follow-up among children remains unknown, but is presumably higher given cultural hypervigilance with pediatric patients.

We found that, across all stone-related ED visits, children evaluated by a urologist at the index visit were 68% less likely to receive a CT scan than those not seen by a urologist. This represents a substantial reduction in radiation exposure for children with urinary stones, who are also exposed to radiation during surgical treatment and follow-up. Although the AUA recommends ultrasound as the initial imaging study for children with suspected stones, CT remains the most commonly ordered initial diagnostic imaging study in the ED.²⁰ Because emergency medicine professional organizations do not have similar guidelines, urologists may help guide appropriate imaging at the time of initial evaluation. However, imaging decisions may have preceded urology involvement.

We identified several patient-level factors associated with ED revisit. Publicly insured patients were more likely to revisit than privately insured, which is consistent with prior reports that publicly insured patients are less likely to be admitted²¹ and receive opioids²², and are more often denied appointments for outpatient specialists.²³ History of nephrolithiasis was also associated with increased revisit. One explanation is that repeat stone formers may have visceral nervous system hypersensitization,^{24,25} potentially resulting in greater perceived pain for repeat stones. Alternatively, repeat stone formers may seek care more readily if their course diverges from past experience. We also found that older children were more likely to revisit. Prior studies have reported that adult stone formers under 30 years-old have the highest risk of revisit.²⁶ Therefore there may be a convergence of the revisit risk in young adulthood.

Our study has several limitations that could be addressed in future studies. First, we lacked clinical characteristics that are likely determinants of ED revisit risk. Patients for whom urology was consulted would likely be sicker or have more significant stone disease and therefore may be more likely to return to the ED; however, we found that these potentially higher risk patients were less likely to return to the ED. Future studies should determine the clinical characteristics of patients at highest risk of revisit (*e.g.* stone size and location, and pain level), identify those most likely to benefit from urologic consultation, and examine the cost-effectiveness (value) of urologic consultation. Second, we did not account for informal

inpatient consultation (*i.e.* phone call), nor outpatient visits or imaging. We also did not identify patients who had scheduled surgery after the index visit and may have revisited for a reason related to the surgery. Given the steep decline in the odds of ED revisit over time after discharge, it is unlikely that ED visits after interim, scheduled surgery accounted for a substantial number of patients. Future research to evaluate the risk of ED visits after pediatric stone surgery would complement the findings from this study. Third, we lacked pharmacy data for pain medications and/or MET that may explain the processes of care that explain the association between urology consultation and decreased revisits for pain. Fourth, our study may not be generalizable to other states or countries.

Conclusions

Among children who presented to the ED with urinary stones, urology consultation at the index visit was associated with fewer ED revisits, fewer pain complaints, and less CT imaging.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1. Patient Cohort Identification Flowchart

Figure 2. Adjusted odds of ED revisit by days from index ED visit

A discrete time failure model was used to estimate the odds of revisit over the 180 days following the index visit. Time periods were categorized as follows: days 1–2, 3–5, 6–7, 8–14, 15–60, and 61–180. This model is adjusted for patient-level covariates (age, sex, race, insurance status, urban/rural residence, and history of nephrolithiasis), hospital-level covariates (bed number, teaching status, and designation as a children’s hospital) and geographic-level covariates (pediatrician and urologist density defined at the county level).

Table 1**Patient Characteristics (n=5037)**

<i>Sex</i>	No. (%)
Male	2126 (42)
Female	2911 (58)
<i>Age</i>	
< 1 year	9 (0)
1 to 2 years	18 (0)
3 to 5 years	43 (1)
6 to 9 years	252 (5)
10 to 12 years	431 (9)
13 to 15 years	1013 (20)
16 to 18 years	3271 (65)
<i>Race</i>	
White (non-Hispanic)	4462 (89)
African-American	423 (8)
Other	152 (3)
<i>Insurance Status</i>	
Uninsured	636 (13)
Public Insurance	1653 (33)
Private Insurance	2748 (55)
<i>Urban/Rural</i>	
Urban	3712 (74)
Rural	1323 (26)
Not Stated	2 (0)
<i>Prior History of Nephrolithiasis</i>	1195 (24)
<i>Concurrent Complex Chronic Condition(s)</i>	67 (1)
Index Visits Characteristics (n=5642)	
<i>Urology Consultation</i>	

General urologist	480 (9)
Pediatric urologist	42 (1)
No urologic consultation	5120 (90)
<i>Hospital characteristics</i>	
<101 beds	1033 (18)
101–299 beds	2575 (46)
>299 beds	2034 (36)
Children's Hospital	891 (16)
Non-Children's Hospital	4751 (84)
<i>Diagnostic imaging study performed:</i>	
CT scan	4111 (73)
Ultrasound	283 (5)

The total number of patient characteristics and index visit characteristics differ because 483 patients had more than one index episode (eFigure 1), amounting to 5642 analyzable index episodes attributable to 5037 individual patients.

Table 2

Adjusted odds ratio of ED revisit, according to patient- and hospital-characteristics.

	Odds Ratio	95% CI	P-value
Patient-Level Characteristics			
Urology consultation	0.63	(0.44, 0.90)	0.01
Prior history of nephrolithiasis	1.88	(1.50, 2.35)	<0.005
Age (year)	1.05	(1.02, 1.09)	0.003
Male	0.98	(0.82, 1.16)	0.79
Insurance Status			
<i>Uninsured</i>	1.29	(0.98, 1.69)	0.07
<i>Public</i>	1.52	(1.26, 1.84)	<0.005
<i>Private</i>	<i>Referent</i>		
Race			
<i>Black</i>	0.77	(0.54, 1.09)	0.14
<i>Other</i>	1.18	(0.73, 1.89)	0.50
<i>White</i>	<i>Referent</i>		
Hospital-Level Characteristics			
Teaching hospital	0.83	(0.55, 1.26)	0.38
Children's Hospital	1.36	(0.94, 1.97)	0.10
Bed number			
<100	<i>Referent</i>		
101–299	0.99	(0.78, 1.25)	0.90
>=300	0.93	(0.65, 1.34)	0.70

Multivariable logistic regression was used to estimate the association between urology consultation at the index ED visit and ED revisit, adjusting for patient- and hospital-characteristics, and regional density of urologists and pediatricians at the county level.

Table 3

Number of CT scans among patients who revisited, across all stone-related visits

Total number of CT scans	Consultation at Index Visit (n = 37)	No Consultation at Index Visit (n = 547)
0	11 (30)	66 (12)
1	26 (70)	481 (88)

The odds of receiving any CT imaging is 78% lower for those who did receive a urology consultation compared to those who did not receive a urology consultation at the index visit (OR 0.32, 95% CI 0.15–0.69, p=0.01).