HHS Public Access

Author manuscript

J Urol. Author manuscript; available in PMC 2016 May 01.

Published in final edited form as:

J Urol. 2015 May ; 193(5 0): 1855–1859. doi:10.1016/j.juro.2014.09.116.

Estimating the Nationwide, Hospital Based Economic Impact of Pediatric Urolithiasis

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Abstract

Purpose—The incidence of urolithiasis is increasing in children and adolescents but the economic impact of this problem is unclear. We examined 2 large databases to estimate the nationwide economic impact of pediatric urolithiasis.

Materials and Methods—We analyzed the 2009 NEDS and KID, used ICD-9-CM codes to identify children 18 years or younger diagnosed with urolithiasis and abstracted demographic and charge data from each database.

Results—We identified 7,348 weighted inpatient discharges in KID and 33,038 emergency department weighted encounters in NEDS. Of the patients 32% and 36% were male, respectively. Inpatients were younger than those who presented to the ED (mean age 13.9 vs 15.7 years). Most patients had private insurance (52.9% to 57.2%) and the South was the most common geographic region (39.5% to 44.4%). The most common procedures were ureteral stent placement in 20.4% to 24.1% of cases, followed by ureteroscopy in 3.8% to 4.4%. Median charges per admission were $13,922 for a weighted total of $229 million per year. Median emergency department charges were $3,991 per encounter for a weighted total of $146 million per year.

Conclusions—Each day in 2009 in the United States an estimated 20 children were hospitalized and 91 were treated in the emergency department for upper tract stones. A conservative estimate of 2009 annual charges related to pediatric urolithiasis in the United States is at least $375 million. This is likely a significant underestimate of the true economic burden of pediatric urolithiasis because it accounts for neither outpatient management nor indirect costs such as care-giver time away from work.

Keywords

kidney; ureter; urolithiasis; hospitalization; costs and cost analysis

Mounting evidence suggests that urolithiasis is increasing in adults.[1] Among children and adolescents a similar trend toward increased stone prevalence was reported.[2,3] While the exact mechanisms of an increase in pediatric stone disease remains unclear, studies suggest

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[†]Financial interest and/or other relationship with the National Institute of Diabetes and Digestive and Kidney Diseases.

that diet may have a role among other possible etiologies. Proposed mechanisms of these increases include the increased obesity rate and dietary changes in children in recent years.[4–6]

Similar to the epidemiological trend, the economic impact of urolithiasis in adults is increasing.[7,8] Pearle et al reported a 50% increase in annual expenditures from $1.37 to $2.07 billion for adult urolithiasis between 1994 and 2000.[8] Little is known regarding the economic impact of urolithiasis in children and adolescents. We speculated that the economic impact of stone disease in children would be significant, given that the prevalence of stones has been increasing at approximately 10% per year during the last several years.[3] We examined economic data in large, nationally representative databases to estimate the direct economic impact of urolithiasis in children and adolescents.

METHODS

Data Sources

Because children and adolescents with urolithiasis can present in various ways, we used 2 distinct data sources for this study. To capture those who presented to an ED we analyzed the 2009 NEDS, an all-payer database managed by HCUP and sponsored by AHRQ (Agency for Healthcare Research and Quality). Data in NEDS are drawn from a 20% stratified probability sample of hospital based EDs in the United States based on 5 hospital characteristics, including ownership profit status, trauma center designation, teaching status, urban/rural location and hospital region. NEDS contains ED encounters that do not result in hospital admission and data on patients seen in the ED who are subsequently admitted to the same hospital. NEDS captures patient demographics, clinical features such as acute and chronic diagnostic codes and procedures performed in the ED as well as subsequent admission, ED disposition and charge data. HCUP has defined post-stratification discharge weights that may be used to calculate national estimates. Using these weights each discharge in HCUP databases can be adjusted to estimate values from a specific portion of the overall American population.[9]

To capture patients who were directly admitted to a hospital we analyzed the 2009 KID, which is also a HCUP product. KID is a triennial stratified sample of pediatric discharges from community hospitals in participating states. The sampling frame includes pediatric discharges from all nonrehabilitation hospitals in participating states. This hospital set excludes long-term rehabilitation hospitals and federal facilities. Each year the sampling design includes 10% of uncomplicated births and 80% of all other pediatric discharges from hospitals in participating states. Similar to NEDS, all discharges are stratified and weighted based on a comparison to annual AHA (American Hospital Association) survey data, permitting estimation using KID of a nationally representative population. KID includes patient demographics (gender, age, race, socioeconomic status markers and insurance payer), clinical features (length of stay, and diagnostic and procedure codes) and hospital characteristics (geographic location, size, teaching status and pediatric hospital designation). Patient identifiers and other protected health information are not included. The review board at our institution determined that the research was exempt from the requirement for review.

Cohort Definition and Analytical Covariates

We identified patient encounters in NEDS and KID using ICD-9-CM diagnostic codes for kidney or ureteral stones (592.0 or 592.1) and limited the cohort to patients 18 years or younger. The covariates analyzed were basic patient characteristics, including median household income quartiles by ZIP Code™ (with 1 considered the lowest quartile), insurance payer (private vs public), comorbidity using HCUP comorbidity software, disposition (discharged, admitted, transferred, dead or other), length of stay and total charges (for ED in NEDS and for each admission in KID). We also analyzed hospital characteristics such as hospital teaching status (metropolitan nonteaching, metropolitan teaching and nonmetropolitan) and geographic region (Northeast, South, Midwest or West).

NEDS contains charge data on the ED encounter as well as separately reported charge data on inpatient services if the patient was admitted. To avoid double counting post-ED inpatient admissions, which may have been captured by NEDS and KID, we did not include inpatient charge data in our overall charge estimates from NEDS.

NEDS only provided charge data without cost-to-charge ratio information. To appropriately sum the charges in inpatient and ED settings we did not convert the charge to cost data in KID on final analysis.

Statistical Analysis

Missing charge data were treated as missing at random and estimated by multiple imputation methods using other known variables. For ED visits we used patient age, gender, Elixhauser comorbidity score,[10] ultimate disposition after care, insurance status, region and injury status. For inpatient discharges we used patient age, DRG (diagnosis related group) codes and length of stay to impute the inpatient encounter total charges.

All analysis was weighted using HCUP provided estimated weights and estimated covariance matrices to account for the complex survey design of NEDS and KID.[11] We specified a 2-sided type 1 error rate of $\alpha = 0.05$. All analyses were done with SAS®, version 9.2.

RESULTS

Patient Characteristics

We identified 7,348 weighted inpatient discharges with a diagnostic code for kidney stone disease. In addition, 33,038 weighted patients were ED encounters. After the ED encounter 28,328 patients (85.7%) were discharged home, 4,159 (12.6%) were admitted and 472 (1.4%) were transferred elsewhere. In 2009 there were an average of 20 pediatric urolithiasis inpatient admissions and 91 ED encounters per day.

Table 1 lists the patient and hospital characteristics of pediatric urolithiasis encounters. More females were observed in inpatient and ED settings (67.2% and 64.1% respectively). Mean ± SD age was 13.9 ± 0.1 and 15.7 ± 0.1 in the KID and NEDS groups, respectively. Inpatients were younger than ED patients (mean 13.9 vs 15.7 years) with a higher percent younger than 5 years (8.0% vs 1.8%). Most inpatients and ED patients had private insurance

(52.9% and 57.2%, respectively). Quarterly inpatient discharge rates were uniform throughout the year but a higher percent of ED visits occurred in the summer, that is 28.1% from July through September vs 23% to 24% through the rest of the year. In each database the South was the most common geographic region for inpatient and ED encounters (39.5% and 44.4%, respectively).

Stone Related Procedures

Median length of stay was 1.6 days for admitted patients and 1.5 days for patients admitted from the ED. A surgical procedure was performed in 3,517 patients (31%). The most common procedures were ureteral stent placement/removal in 20.4% of all inpatient admissions vs 24.1% of admissions from the ED, followed by URS in 4.4% vs 3.8%. PCNL was not as commonly done in patients admitted from the ED compared to all pediatric urolithiasis inpatient admissions (1.1% vs 4.1%).

Economic Impact

Table 2 lists inpatient charges by surgery type. PCNL was associated with the highest charge in each databases, that is a median of $34,334 per patient for all inpatient admissions and $39,629 per admission from the ED. There was no significant charge difference between URS, SWL or ureteral stent placement.

In 2009 in KID the median charge per pediatric admission was $13,922 (IQR 16,432) and total estimated national inpatient charges were $229,636,006. In 2009 in NEDS the median captured ED charges were $3,991 per encounter (IQR 3,856) for a total of $146,700,230 nationally. When combining inpatient and ED charges, the estimated hospital based charge of pediatric urolithiasis in 2009 was approximately $375 million.

DISCUSSION

To our knowledge this study represents the first national estimate of the economic impact of pediatric urolithiasis in the United States. Annual charges related to a diagnosis of pediatric urolithiasis, including inpatient admissions and ED encounters, was more than $375 million in 2009. As expected given the lower incidence of stones in children compared to adults, this value is less than comparable estimates in adults. Pearle et al estimated a total expenditure of $1.5 billion for inpatient admissions and ED encounters for adult urolithiasis in 2000.[8] The latest data from the Urologic Diseases in America project showed a 2006 annual charge of more than $10 billion.[12]

Our estimate of inpatient charges for pediatric urolithiasis is more impressive considering that the inpatient and ED hospital charges in our analysis were likely a fraction of the total economic impact of pediatric urolithiasis. Specifically our estimate does not include charges for any outpatient physician encounters, radiological imaging or other diagnostic methods, medication or time out of work/school. In adults stone related physician visits and medication were estimated to add approximately an additional 20% to the cost of stone treatment.[13] We suspect that this is much higher in children because in our experience children are more likely than adults to be seen in an outpatient rather than an emergency or inpatient setting. Indirect societal costs such as patient/provider time away from

employment are poorly quantified in children and yet they seem likely to be substantial. Thus, $375 million should be considered a conservative estimate of the total charge of pediatric stone disease.

Although urolithiasis in adults remains a male predominant condition,[14] pediatric series are varied in estimates of which gender is more commonly affected.[2,3,15–18] In KID and NEDS we noted a 2:1 female-to-male ratio in the inpatient and ED settings. The mechanism of this gender distribution in children is still uncertain but the peripubertal hormonal change and metabolism could potentially be a contributing factor to stone formation in young females.[19]

As expected based on the adult literature we also observed a higher percent of summer (July through September) ED presentations. However, interestingly inpatient admissions for stone disease did not seem to show the same seasonal variation. The reasons for this discrepancy are unclear.

The cost-effectiveness of urolithiasis treatment modalities has been explored extensively in the adult literature.[20–23] In the inpatient setting we found no significant charge difference per procedure among URS, SWL and ureteral stent placement. As might be expected, PCNL rendered the highest charge of all stone surgical treatments. Since effectiveness and morbidity differ significantly among modalities, pediatric specific cost-effectiveness studies are warranted to achieve better decision making in children and adolescents.

Our study findings must be interpreted in the context of its limitations. As noted, no nationwide data source provides charge or cost data on out-patient and ambulatory surgery settings. Therefore, procedures usually performed in an ambulatory setting such as SWL were likely underrepresented in our analysis. Additionally, NEDS only provides charge data and not cost data. Because hospital charges may vary due to regional or local marketplace vagaries, these data may be an inflated estimate from the true cost of pediatric urolithiasis. Clearly if the cost-to-charge ratio was available, a more representative estimate would have been calculated.

Furthermore, the indirect costs of stone disease, such as missed child and parent school or work days, are likely to be substantial.[24] However, these data are not available in the data sources that we used. Therefore, the true economic impact of pediatric urolithiasis will likely be significantly larger than these data indicate and $375 million should be considered a conservative estimate of that true societal cost.

KID and NEDS are derived from stratified sampled data. KID includes 10% of uncomplicated births and 80% of all other pediatric discharges, and NEDS represents a 20% stratified sample of American hospital based EDs. Although HCUP has included more hospitals and states with time, these data sets were not wholly representative of all hospitals and regions in the United States in 2009. As such, our reported results may not be generalizable to encounters not in the sample pool. However, HCUP provides meticulous tracking of discharge and hospital weights to minimize the risk of sampling bias in KID and NEDS.

Similarly, KID and NEDS are large, retrospective administrative databases that may be affected by inaccurate or incomplete coding. Our analysis relies on the accuracy of the diagnostic and procedure codes in KID and NEDS. While the accuracy level of KID and NEDS is high for an administrative database, it is possible that at least some portion of our cohort may have been incorrectly coded. However, as noted, KID and NEDS are rigorously monitored and audited for coding accuracy and, therefore, they represent a reasonably reliable panorama of the characteristics of this cohort.

Lastly, because KID and NEDS represent encounter based data rather than patient based data, it is impossible to track a given patient across time. We could not assess any accrued charge estimation beyond each encounter or whether patients may have been accounted for multiple times. However, this lack of longitudinal followup should have had a minimal impact on our conclusions and total estimates. Whether a hospital bill was accrued by 1 patient admitted twice or by 2 who were each admitted once would not change the total charges.

CONCLUSIONS

Each day in 2009 in the United States an estimated 91 children were treated in the ED and 20 were admitted for a kidney or ureteral stone. Based on data from inpatient and ED sources the annual charge of pediatric urolithiasis was at least $375 million in 2009 alone. This is likely a significant underestimate of the true economic burden of stone disease in children because it does not account for non ED outpatient stone management such as outpatient visits, medication and surgery or for indirect costs such as patient and caregiver time away from work and/or school.

Acknowledgments

Supported by National Institute of Diabetes and Digestive and Kidney Diseases Grants K12-DK100024 and K08-DK100534 (JCR).

Abbreviations and Acronyms

ED	emergency department
HCUP	Healthcare Cost and Utilization Project
KID	Kids’ Inpatient Database
NEDS	Nationwide Emergency Department Sample
PCNL	percutaneous nephrostomy
SWL	shock wave lithotripsy
URS	ureteroscopy

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Table 1

Patient and hospital characteristics of pediatric urolithiasis encounters

	No. KID (%)	No. NEDS (%)
Overall	7,348	33,038
Age category (yrs):		
Infant + toddler (0–2)	407 (5.5)	314 (1.0)
Preschool (3–5)	181 (2.5)	254 (0.8)
School (6–12)	1,450 (19.7)	3,729 (11.3)
Adolescent (13–18)	5,272 (71.7)	28,740 (87.0)
Male	2,361 (32.1)	11,871 (36.0)
Female	4,938 (67.2)	21,138 (64.0)
Discharge quarter:		
January–March	1,806 (24.6)	7,739 (23.4)
April–June	1,904 (25.9)	7,971 (24.1)
July–September	1,881 (25.6)	9,281 (28.1)
October–December	1,753 (23.9)	8,033 (24.3)
Insurance:		
Public	2,867 (39.0)	9,961 (30.2)
Private	3,888 (52.9)	18,886 (57.2)
Other	586 (8.0)	4,129 (12.5)
ZIP Code income quartile:		
1	2,016 (27.4)	8,668 (26.2)
2	1,906 (25.9)	9,383 (28.4)
3	1,660 (22.6)	7,701 (23.3)
4	1,591 (21.7)	6,621 (20.0)
Surgery type:		
Ureteral stent placement	1,496 (66.8)	1,003 (78.5)
Extracorporeal shock wave lithotripsy	121 (5.4)	74 (5.8)
URS	324 (14.5)	156 (12.2)
PCNL	299 (13.3)	44 (3.4)
Hospital region:		
Northeast	1,327 (18.1)	5,174 (15.7)
Midwest	1,847 (25.1)	7,646 (23.1)
South	2,899 (39.5)	14,654 (44.4)
West	1,275 (17.4)	5,563 (16.8)

Table 2

Inpatient admission charges by surgery type

Surgery Type	No. Pts (%)	Median $ Charge (IQR)
KID:	7,348	–
Stent only	1,496 (66.8)	18,552 (14,108)
Extracorporeal shock wave lithotripsy	121 (5.4)	19,683 (17,279)
URS	324 (14.5)	17,816 (11,316)
PCNL	299 (13.3)	34,334 (29,990)
NEDS:	4,159	–
Stent only	1,003 (78.5)	19,207 (15,088)
Extracorporeal shock wave lithotripsy	74 (5.8)	17,546 (8,806)
URS	156 (12.2)	14,277 (6,341)
PCNL	44 (3.4)	39,629 (84,607)