Published in final edited form as:

Urology. 2019 July ; 129: 180–187. doi:10.1016/j.urology.2019.04.012.

Pediatric urinary stone disease in the United States: The Urologic Diseases in America Project

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Abstract

Objective: To examine the recent epidemiology of pediatric urinary stone disease (USD) in the United States.

Methods: We utilized the 2004-2016 Optum® Clinformatics® Data Mart database, a de-identified adjudicated administrative health claims database that includes 15-18 million individuals covered annually by commercial insurance in all 50 US states. The analysis included 12,739,125 children aged 0-18 years. We calculated annual rates of USD, ambulatory visits, and procedures, and the prevalence of prescription fills.

Results: The 2005-2016 USD rate was 59.5 cases per 100,000 person-years. The annual rate rose gradually from 2005 to a peak of 65.2 cases per 100,000 person-years in 2011. The USD rate increased with increasing age, and was highest among females compared to males, non-Hispanic Whites compared to other race/ethnic groups, and those residing in the South compared to other geographic regions. The overall 2005-2016 rate in the 120 days following a USD episode was 1.9 for ambulatory visits, 0.24 for surgical procedures, and 1.1 for imaging procedures. Ureteroscopy was the most common surgical procedure and CT scan was the most common imaging procedures, although ultrasound utilization increased over time. Medications were filled in 46.9% of cases, and use was lowest among males (43.1%), Asians (34.8%), and in the Northeast (34.3%). Opiate agonists were the most prevalent prescription (39.9%).

Conclusions: Our study provides one of the most comprehensive examinations of pediatric USD to date, demonstrating shifting rates and treatment patterns over time, as well as differences by age, gender, race/ethnicity, and geographic region.

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Keywords

pediatric; children; urinary stones; kidney stones; United States; incidence

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INTRODUCTION

Urinary stone disease (USD), specifically upper urinary tract calculi, is common and costly. Our understanding of the epidemiology of adult USD has recently been advanced through the Urologic Diseases in America project. Drawing from multiple large-scale datasets, the analyses indicated increasing USD prevalence, that women are more commonly afflicted, and that USD is associated with various comorbidities including diabetes, hypertension, osteoporosis, and osteopenia.¹ These findings built on those previously reported by others.^{2,5}

Compared to our knowledge of adult USD, our understanding of the epidemiology of pediatric USD is more limited. Although a number of investigators have provided high quality investigations of pediatric USD-formers, knowledge gaps remain. For example, the extant literature has employed datasets that may not fully represent the USD treatment process as they tracked only inpatient healthcare utilization; other assessments came from limited geographic areas or specialty centers such as children's hospitals or other single-institution settings.^{5,6} Utilization of large-scale datasets that robustly characterize trends in pediatric USD may help address current knowledge gaps.

Claims-based datasets may be one of the most comprehensive data sources available to improve our understanding of the epidemiology of pediatric USD. Although not without limitations, administrative claims capture healthcare utilization in all settings, including inpatient, outpatient, and emergency, and also permit longitudinal assessments. The occurrence and management of pediatric USD has likely evolved since prior analyses due to evolving surgical, imaging, and prescription drug therapies. Therefore, our study utilized the Optum® Clinformatics® Data Mart dataset—a claims-based dataset—to more comprehensively assess incidence and treatment of pediatric USD from 2005 to 2016.

MATERIAL AND METHODS**Data source**

The Optum® Clinformatics® Data Mart (CDM) database is comprised of de-identified adjudicated administrative health claims for 15-18 million individuals covered annually by commercial insurance in all 50 states. All children 0-18 years of age and residing in the United States were eligible for the analysis (N=12,739,125). All members were covered for medical services and prescription drugs. Member eligibility files, containing birth year, gender, race/ethnicity, geographic region, and eligibility period, were linked with inpatient confinement, medical, and pharmacy claims. Inpatient confinement files summarized services in acute care hospitals or skilled nursing facilities. Medical files included reimbursement claims for healthcare professional services provided in all service locations (e.g., inpatient hospital, outpatient facilities, physician office, and laboratory). Diagnoses

and procedures were identified using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM), ICD-10-CM, and Current Procedural Terminology (CPT) codes from participants' medical and inpatient claims. A full quality control assessment, including a duplicate coding process, was performed to ensure fidelity of the linked data.

The Institutional Review Board at the National Institutes of Health designated our project exempt from review.

Measures

A USD episode was defined as an evaluation and management (E-M) claim with any qualifying ICD-9-CM or ICD-10-CM diagnostic code indicative of USD (Appendix A). All inpatient confinement claims were considered E-M claims. Medical claims were considered E-M if they captured surgery, emergency room, office visit, or consultation services. Claims for USD surgical procedures that had a qualifying diagnosis code were counted as USD events regardless of E-M claim status.

Within individuals, two claims were considered distinct USD events if 120 days passed between the claims; subsequent USD claims within the same 120 day period were considered residual to the initial claim. We selected 120 days based on clinical experience and published literature, which indicated that 120 days was reasonable for excluding ongoing care or complications due to an initial USD event while still permitting ascertainment of additional USD events occurring beyond 120 days.^{1, 7, 8}

Ambulatory visits were defined as E-M claims with a qualifying USD ICD-9-CM or ICD-10-CM diagnostic code that had a place of service of office, outpatient hospital, emergency room, or ambulatory surgical center. Multiple visit claims with the same service date were considered a single visit.

Surgical procedures were defined as claims with both a qualifying USD diagnostic code (Appendix A) and surgical procedure code (Appendix B). Five surgery categories were examined: open stone surgery, laparoscopic removal, percutaneous nephrolithotomy (PCNL), ureteroscopy, extracorporeal shock wave lithotripsy (SWL).

Imaging procedures were defined as claims with both a qualifying USD diagnostic code (Appendix A) and imaging procedure code (Appendix C). The types of imaging procedures examined included: Plain film/Kidney, Ureter, Bladder (KUB) X-ray; Intravenous Pyelography; Ultrasound; Computed Tomography (CT) overall; CT without contrast; CT with contrast; CT without then with contrast; and Magnetic Resonance Imaging (MRI).

Procedure type was summarized for surgical and imaging procedure rates, and service site (inpatient or ambulatory) was described for surgical procedures. Multiple claims matching on service date, service place, and procedural code were considered a single procedure.

Seven medication classes were examined using pharmacy files (Appendix D): alkalinization agents, ammonia detoxicants, opiate agonists, alpha blockers, calcium channel blockers, and other.

Statistical analysis

We primarily examined rates for this analysis, calculated as the frequency of the event of interest (i.e., USD, ambulatory visits, surgical procedures, or imaging procedures) divided by person-time at risk (defined in the sections below for each analysis). We examined rates for all analyses except medication use analyses because rates allow for the utilization of all available participant data without limiting the study population to those enrolled for the entire 12-year study period and because they allow for the occurrence of repeat events in the same individual. It was assumed that capturing repeat prescription fills for a single USD event would provide minimal additional information, and we therefore opted to examine percentages for the medication use analyses to aid in the interpretation of results. Analyses were conducted overall and stratified by age (0-2, 3-10, and 11-17 years), gender (female or male), race/ethnicity (Non-Hispanic White, Non-Hispanic Black, Hispanic, or Asian), and geographical region (Northeast, West, Midwest, or South). All analyses were conducted in SAS 9.4 (SAS Institute, Inc., Cary, NC).

To calculate annual USD rates, the total number of USD episodes occurring in each year was divided by the total person-time contributed to that year. Enrollees started contributing person-time to the USD rate denominator after completing 120 days without a USD claim following enrollment or after completing 120 days following a prior USD episode. Thus, the look-back period dated as far back as October 1, 2004, to allow person-time to begin accumulating on January 1, 2005. An individual stopped contributing person-time to a given year at disenrollment, the occurrence of a USD event, their 18th birthday, or December 31 of that year, whichever occurred first. Participants regaining coverage after a disenrollment period could contribute person-time again after 120 days passed without a USD claim following re-enrollment. Similarly, enrollees experiencing a USD event could contribute person-time again after 120 days. Annual USD rates were scaled and reported per 100,000 person-years.

Annual rates of ambulatory visits, surgical procedures, and imaging procedures were calculated per 120 person-day risk periods following an initial USD claim. As described above, a 120-day risk period was selected to correspond to the potential duration of ongoing care or complications for an index USD episode.^{1, 7, 8} USD cases began contributing person-time to the rate denominator following an index USD claim. Cases stopped contributing person-time to a given year upon reaching the 120th day post USD episode, disenrollment, their 18th birthday, or reaching December 31, whichever occurred first. Procedure type was summarized for surgical and imaging procedure rates, and site of service was described for surgical procedures.

Among USD cases with continuous enrollment for the 120 days following the USD event, we calculated the percentage with a filled USD-related prescription. Continuous enrollment during the 120-day follow-up period was required. Medication use was assessed overall and stratified by the medication classes described above.

RESULTS

Children contributed 28,242,279 person-years at risk for developing USD and reported 16,815 USD events from 12,308 individuals. The overall rate of USD was 59.5 cases per 100,000 person-years (Table 1). The rate increased with increasing age (18.1, 24.4, and 111.0 cases per 100,000 person-years for those aged 0-2, 3-10, and 11-17 years, respectively). Females consistently had a higher rate than males (70.7 vs. 48.9). White enrollees had higher rates than other race/ethnicity groups (68.7 vs. 19.4-49.2). There was a progressive change in USD rates over time, with the overall rate gradually increasing from 52.8 cases per 100,000 person-years in 2005 to as high as 65.2 cases per 100,000 person-years in 2011. The rate dropped again in subsequent years, and was down to 54.1 cases per 100,000 person-years in 2016. This temporal trend was consistent across age, gender, race/ethnicity, and region.

Among children who experienced at least one USD episode, a total of 29,228 ambulatory visits (Supplementary Table 1), 3,369 surgical procedures (Table 2), and 15,477 imaging procedures (Table 3) occurred during the 1,818,554 person-days of follow-up. The overall 2005-2016 rate of ambulatory visits in the 120 days following a USD episode was 1.9 per 120 person-days (Supplementary Table 1). Ambulatory visit rates were largely consistent across age, gender, race/ethnicity, and region groups, although those aged 11-17 years, females, Whites, and those residing in the South had slightly higher rates compared to other groups. Over time, the overall rates remained relatively stable, ranging from 1.8-2.2 visits per 120 person-days.

The overall 2005-2016 rate of surgical procedures in the 120 days following a USD episode was 0.24 per 120 person-days (Table 2). Most surgical procedures occurred in an ambulatory setting, and the most common surgery was ureteroscopy (0.16 per 120 person-days). The surgical procedure rate was highest among those aged 11-17 years compared to other age groups (0.25 vs. 0.13-0.22 per 120 person-days). Females and Whites had higher procedure rates than other groups, and the Northeast had lower procedure rates than other regions. Surgery rates peaked in 2005 (0.33 per 120 person-days), then largely remained stable from 2006 through 2016, ranging from 0.19-0.26.

The overall 2005-2016 rate of imaging procedures in the 120 days following USD episode was 1.1 per 120 person-days. Non-contrast CT scans were the most common imaging procedure (0.4 per 120 person-days). Those aged 11-17 years, females, and those residing in the South and Midwest had higher rates than other age, gender, and region groups. Imaging rates decreased consistently over time, from 1.5 to 0.7 per 120 person-days in 2005 and 2016, respectively. This decrease occurred in all groups except Asians, whose imaging procedure rate increased from 0.3 per 120 person-days in 2005 to 1.0 per 120 person-days in 2015. Rates of all imaging types decreased over time except for ultrasound, which comprised 13.8% of the overall imaging rate in 2005 and 41.7% in 2016.

Regarding medication use, 46.9% of USD cases filled a medication prescription from one of the seven medication classes examined within the 120-day period following the USD event (Supplementary Table 2). Those aged 11-17 years, females, and Whites had higher

prevalences of filled USD prescriptions than other groups, and the Northeast had a lower prevalence than other regions. Medication use increased from 2005 to 2013, followed by a slight decrease in 2016. Use of alkalizing agents and alpha blockers in particular steadily increased over time. Opiate agonists were the most prevalent medication class prescribed over the study period, followed by alpha blockers and then alkalizing agents (Table 4).

COMMENT

Our project examined the recent epidemiology of pediatric USD in a large, geographically diverse, claims-based dataset. Overall, we found shifting rates of USD and its medical management overtime, as well as differences by age, gender, race/ethnicity, and geographic region. The geographical diversity and longitudinal nature of our data help address some of the knowledge gaps of prior USD investigations. Unlike previous studies, we were able to assess USD rates over time, finding that rates were steadily increasing until recent years. Our longitudinal methods also allowed us to follow individual USD cases over time and assess treatment patterns with regard to ambulatory visits, surgical and imaging procedures, and medication use.

Broadly, our results are consistent with previous findings. Utilizing the Kids Inpatient Database (KID), a large-scale national pediatric dataset of hospital service use, Novak et al. found that USD rates increased with increasing age.⁶ Additionally, they found higher rates among boys in the first decade of life and among girls in the second. However, KID only captured inpatient visits and lacked information from office-based or ambulatory healthcare interactions.

Tasian et al. previously evaluated USD prevalence among children in South Carolina.⁵ Consistent with our findings, they found increasing prevalence from 1997-2012, with larger increases among adolescents and females. While the claims-based nature of our analysis precluded examination of the mechanisms underlying these time trends, others have suggested that the increasing prevalence may be due to changing dietary habits and increased sodium intake.^{9, 10} Alternatively, given the association between USD and obesity, shared risk factors may promote both conditions.¹¹ These questions warrant future investigations. It should also be noted that our analysis captured more recent years of data (through 2016) compared to the Tasian paper, and suggested that the rate of USD may be starting to decline. It will be important to continue monitoring these trends in the future.

Our study also provides novel information about USD-related procedures. USD is typically diagnosed with imaging studies. Exposure of USD-formers to imaging studies requiring ionizing radiation, such as CT imaging, has health professionals increasingly concerned.¹² Prior investigators, utilizing the Marketscan commercial claims dataset, assessed the utilization of imaging studies for pediatric USD-formers and found that CT imaging use was highly prevalent and the most commonly performed imaging study in the pediatric population.¹³ Consistent with our findings among the CDM population, the Marketscan study also demonstrated a declining trend in recent years in CT utilization. Conversely, Routh and associates reported increasing CT utilization among children with a USD diagnosis from 1999-2008.¹⁴ They also noted a marked variation from hospital to hospital,

suggesting undesired variability in clinical practice. Our study also found increasing utilization of ultrasound imaging for pediatric USD patients, a finding in contrast with that of the previous study of Marketscan data.¹⁵ It should be noted that our study captures data through the year 2016, which serves to update data from these previous studies. Practice patterns may have changed in recent years, reflecting education advances among the medical community and a push toward non-ionizing radiation-based imaging modalities.

Examination of USD-related surgical procedures demonstrated that ureteroscopy was the most common in our population, followed by SWL. The SWL decline is notable, as it remains a recommended therapy in the American Urological Association's Surgical Management of Stones Guidelines.^{16,17} Although there is heterogeneity among the literature, the Guidelines note that complication rates are low for children treated with SWL, and USD-free rates >80% have been reported, far better than typically seen in adults. In contrast, ureteroscopy can be more complex in the pediatric population: ureteral access is sometimes difficult or even impossible due to a diminutive ureterovesical junction, oftentimes requiring pre-stenting.¹⁸

Our results regarding pediatric medication usage are among our study's most novel contributions. Nearly half of pediatric USD patients filled a USD-related prescription, the majority for Opioid Agonists. Previous analyses found similar results among adult USD patients.¹ However, the apparent decline in Opioid Agonist use among this population in recent years is encouraging, given the potential for abuse accompanying these agents.

Our study had several limitations. First, although CDM richly describes healthcare utilization among an insured population, we lacked data on uninsured or Medicaid populations. Low-income populations have been found to have higher USD prevalence than high-income populations, possibly due to the higher prevalence of known USD risk factors, such as obesity, among low-income populations.⁴ Therefore, our findings may underestimate the USD rates in the overall US pediatric population. It should also be noted that because not all participants were followed from birth, it is not possible to know whether USD events represent a first-time or recurrent USD event. Additionally, limitations inherent to administrative datasets may be present in our analysis, such as the inability to distinguish with certainty whether a USD claim represented a new event or a follow-up visit for a prior event. We attempted to address this limitation by including a 120-day washout period between claims, which may inadvertently over- or under-estimate the number of USD events due to the variability in follow-up between providers; however, this value was selected based on predicates in the published literature^{1, 78} and the large majority of USD events documented in this analysis (73%) represented unique individuals. Finally, our USD definition relies on accuracy of the coding system. We did not restrict USD diagnosis codes to the primary diagnosis code field, which could lead to an overestimation of USD events if events are more likely to be incorrectly coded in later diagnosis fields. Nevertheless, previous studies have also employed this methodology.¹⁹

CONCLUSIONS

Our present study serves to advance our understanding of the burden of pediatric USD, how it is diagnosed, and how it is treated both from a pharmacotherapy and surgical standpoint. Until recent years, there has been a continued increase in the rate of this condition among children over the past two decades. Although defining the etiology of this increase is beyond the scope of the administrative dataset utilized in this study, given the increasing burden of pediatric USD, further investigations into its possible causes are warranted. Although CT remains a common imaging modality among children, our study provides evidence that its use is beginning to decline in conjunction with an increased ultrasound utilization. This favorable development represents an evolution that will serve to reduce the exposure of pediatric USD-formers to ionizing radiation. Although SWL is still commonly utilized, ureteroscopy is the most common approach for children requiring USD treatment. Increasing reliance on endoscopic surgery likely stems from advances in the surgical technology utilized in these procedures. Further efforts to better select patients for SWL or ureteroscopy will be clinically useful, as each approach has its own relative advantages and disadvantages. The reliance on opioid agents in the pediatric USD population is concerning, but the apparent decline in opioid use over the study period provides some reassurance. Nevertheless, future efforts to optimize pain management and further reduce reliance on opioids will be important.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGEMENTS

We would like to thank Dr. Paul W. Eggers for his feedback on this project and Jesse Wilkerson for his assistance with drafting portions of the results text. The Urological Diseases in America project was funded by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) through a contract to Social & Scientific Systems (HHSN276201500204U). Dr. Julia Ward and Dr. Lydia Feinstein are employed by Social & Scientific Systems, and Dr. Brian Matlaga of John's Hopkins University has a subcontract with the company. Dr. Matlaga also serves as a consultant for Boston Scientific.

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Table 1. Claim-based rate of kidney stones among children < 18 years of age, overall and by year, 2005-2016^{*}

Demographic characteristics	All years			Annual Rates [†]											
	Total person-years	Kidney stone events	Rate [†]	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Overall	28,242,279	16,815	59.5	52.8	56.9	57.7	59.7	63.9	64.8	65.2	63.0	60.5	56.8	60.5	54.1
Age (years)															
0 to 2	4,142,231	748	18.1	18.6	19.7	16.9	21.8	20.5	19.0	17.4	15.6	15.4	15.7	15.4	18.7
3 to 10	12,329,769	3,005	24.4	26.7	26.1	26.6	25.8	28.5	26.1	26.2	23.4	21.6	18.8	19.7	19.1
11 to 17	11,770,279	13,062	111.0	95.0	102.3	104.8	109.4	117.0	121.5	121.9	120.0	116.0	110.1	117.5	101.9
Gender															
Male	14,431,477	7,051	48.9	44.3	48.2	46.8	49.3	51.5	52.3	57.7	51.1	48.9	45.6	47.6	43.5
Female	13,810,802	9,764	70.7	61.7	66.1	69.2	70.7	76.8	77.8	72.9	75.3	72.7	68.5	73.9	65.2
Race/ethnicity															
White	18,588,468	12,77A	68.7	61.1	66.5	66.4	69.7	75.7	73.0	74.0	71.0	68.8	64.9	67.1	66.2
Black	2,327,831	11,074	46.1	33.9	50.6	43.0	44.4	44.6	51.1	49.4	47.2	51.5	39.7	54.6	42.2
Hispanic	3,230,030	1,370	42.4	35.2	32.3	38.4	41.8	42.4	53.9	49.6	45.7	42.3	47.0	47.7	36.6
Asian	1,391,997	270	19.4	16.9	10.5	19.8	17.0	17.3	15.4	23.6	22.8	18.3	19.6	23.4	29.4
Unknown	2,703,953	1,330	49.2	47.1	48.4	52.7	46.7	45.5	56.8	55.6	63.8	54.1	45.9	57.4	39.6
Region															
Northeast	2,660,013	1,456	54.7	55.5	59.3	57.8	55.8	55.9	58.2	55.2	44.5	51.9	58.8	51.5	50.5
Midwest	7,186,637	4,203	58.5	56.9	61.8	54.8	58.5	61.3	56.5	65.8	64.1	59.5	54.6	59.1	49.0
South	12,070,227	8,964	74.3	64.0	71.3	75.5	73.6	80.7	82.2	78.3	80.4	75.9	69.1	73.5	65.0
West	6,325,403	2,192	34.7	28.1	27.2	28.9	36.1	34.3	38.3	39.6	34.1	36.2	37.2	42.6	42.2

^{*} Source: De-identified Optum® Clinformatics® Data Mart, 2004-2016[†] Per 100,000 person-years

Table 2.

Claim-based rate of surgical procedures (SP) among children < 18 years of age with kidney stones, overall and by year, 2005-2016*

	All years			Annual Rates [†]											
	Total person-days	Total SP	Rate [‡]	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Overall	1,818,554	3,639	0.24	0.33	0.25	0.25	0.21	0.24	0.24	0.24	0.22	0.23	0.23	0.26	0.19
Age (years)															
0 to 2	78,708	86	0.13	0.14	0.22	0.13	0.09	0.11	0.11	0.09	0.32	0.05	0.05	0.08	0.14
3 to 10	329,488	605	0.22	0.30	0.20	0.22	0.16	0.24	0.30	0.16	0.18	0.20	0.23	0.23	0.24
11 to 17	1,410,358	2,948	0.25	0.35	0.27	0.27	0.23	0.20	0.19	0.21	0.16	0.22	0.26	0.24	0.20
Female	1,051,105	2,283	0.26	0.35	0.29	0.30	0.21	0.26	0.28	0.26	0.26	0.24	0.21	0.27	0.18
Race/ethnicity															
White	1,381,962	2,898	0.25	0.33	0.27	0.26	0.23	0.26	0.24	0.26	0.22	0.25	0.25	0.26	0.19
Black	115,403	215	0.22	0.35	0.26	0.28	0.16	0.24	0.22	0.21	0.18	0.24	0.14	0.34	0.10
Hispanic	149,229	225	0.18	0.24	0.10	0.23	0.14	0.11	0.20	0.16	0.23	0.14	0.17	0.26	0.21
Asian	30,095	27	0.11	0.00	0.08	0.00	0.04	0.14	0.18	0.08	0.08	0.09	0.17	0.27	0.09
Unknown	141,865	274	0.23	0.38	0.25	0.25	0.17	0.14	0.27	0.23	0.21	0.18	0.14	0.18	0.22
Region															
Northeast	157,791	232	0.18	0.26	0.16	0.30	0.12	0.17	0.16	0.24	0.16	0.06	0.11	0.19	0.12
Midwest	454,615	968	0.26	0.34	0.32	0.22	0.22	0.25	0.19	0.21	0.23	0.29	0.26	0.31	0.22
South	971,525	1,999	0.25	0.34	0.24	0.27	0.22	0.23	0.26	0.25	0.23	0.23	0.22	0.27	0.18
West	234,623	440	0.23	0.30	0.21	0.18	0.21	0.26	0.26	0.24	0.16	0.22	0.27	0.19	0.22
Site of procedure [‡]															
Inpatient	1,818,554	1,369	0.09	0.13	0.12	0.09	0.08	0.09	0.09	0.10	0.07	0.07	0.09	0.09	0.04
Ambulatory	1,818,554	2,270	0.15	0.19	0.13	0.16	0.13	0.14	0.15	0.14	0.14	0.16	0.14	0.17	0.15
Type of procedure [‡]															
Open stone surgery	1,818,554	61	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Laparoscopic removal	1,818,554	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCNL	1,818,554	134	0.01	0.02	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.02	0.00
Ureteroscopy	1,818,554	2,483	0.16	0.18	0.17	0.17	0.14	0.16	0.16	0.17	0.14	0.17	0.17	0.19	0.15
SWL	1,818,554	960	0.06	0.12	0.06	0.08	0.06	0.06	0.07	0.06	0.06	0.05	0.05	0.05	0.03

* Source: De-identified Optum® Clinformatics® Data Mart, 2004-2016

[†] Per 120 person-days, which is meant to represent a single kidney stones event

[‡] The "Total Person-Days" for each subcategory will match the "Total Person-Days" in the "Overall" row

Abbreviations: SP: surgical procedure; PCNL: percutaneous nephrolithotomy; SWL extracorporeal shock wave lithotripsy

Table 3.

Claim-based rate of imaging procedures (IP) among children < 18 year of age with kidney stones, overall and by year, 2005-2016*

	All years			Annual Rates [†]											
	Total person-days	Total IP	Rate [‡]	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Overall	1,818,554	16,300	1.1	1.5	1.2	1.3	1.2	1.3	1.2	0.9	0.9	0.9	0.9	0.8	0.7
Age (years)															
0 to 2	78,708	372	0.6	0.6	0.9	0.5	0.5	0.5	0.4	0.7	1.0	0.2	0.3	0.4	0.8
3 to 10	329,488	2,222	0.8	1.3	0.9	0.9	0.9	0.9	0.9	0.7	0.6	0.5	0.6	0.7	0.6
11 to 17	1,410,358	13,706	1.2	1.6	1.4	1.5	1.3	1.4	1.3	1.0	0.9	1.0	0.9	0.9	0.7
Gender															
Male	767,449	6,249	1.0	1.4	1.1	1.1	1.1	1.2	1.1	0.8	0.8	0.8	0.8	0.7	0.7
Female	1,051,105	10,051	1.2	1.5	1.3	1.5	1.2	1.3	1.3	0.9	0.9	0.9	0.9	0.9	0.8
Race/ethnicity															
White	1,381,962	12,759	1.1	1.6	1.3	1.3	1.2	1.3	1.2	0.9	0.9	0.9	0.9	0.8	0.8
Black	115,403	1,017	1.1	1.3	1.4	1.3	1.2	1.1	1.2	1.1	1.0	0.8	0.8	0.8	0.7
Hispanic	149,229	1,113	0.9	1.3	0.8	1.4	0.8	1.0	1.1	0.8	0.8	0.9	0.8	0.7	0.5
Asian	30,095	143	0.6	0.3	0.6	0.6	0.5	0.6	0.4	0.4	0.7	0.6	0.6	1.0	0.5
Unknown	141,865	1,268	1.1	1.5	1.4	1.4	1.3	1.1	1.1	0.6	0.8	0.9	0.6	0.7	0.7
Region															
Northeast	157,791	1,117	0.9	1.2	0.9	1.0	0.6	0.9	0.9	0.8	0.9	0.7	0.6	0.9	0.7
Midwest	454,615	4,149	1.1	1.7	1.3	1.4	1.2	1.3	1.1	0.9	0.8	0.8	0.9	0.8	0.7
South	971,525	9,342	1.2	1.5	1.3	1.4	1.3	1.3	1.3	0.9	1.0	1.0	0.9	0.8	0.8
West	234,623	1,692	0.9	1.2	0.8	1.1	1.1	1.1	1.1	0.8	0.5	0.7	0.8	0.7	0.6
Type of image [‡]															
Plain film/KUB	1,818,554	4,354	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2
Intravenous pyelography	1,818,554	388	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ultrasound	1,818,554	3,577	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3
CT, without contrast	1,818,554	6,815	0.4	0.7	0.6	0.7	0.5	0.6	0.5	0.3	0.3	0.3	0.3	0.3	0.2
CT, with contrast	1,818,554	824	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0
CT, both contrasts	1,818,554	257	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CT, unspecified contrast	1,818,554	79	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MRI	1,818,554	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

* Source: De-identified Optum® Clinformatics® Data Mart, 2004-2016

[†]Per 120 person-days, which is meant to represent a single kidney stones event

[‡]The “Total Person-Days” for each subcategory will match the “Total Person-Days” in the “Overall” row

Abbreviations: IP: imaging procedure; KUB: Kidney, Ureter, Bladder X-ray; CT: Computed Tomography; MRI: Magnetic Resonance Imaging

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Table 4.

Claim-based prevalence of kidney stones medication use by medication class among children with kidney stones and with continuous enrollment in private insurance for 120 days following the kidney stone event, overall and by year, 2005-2016*

	All years	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total kidney stone events													
Prevalence by medication class	16,815	1,432	1,581	1,577	1,569	1,576	1,486	1,462	1,377	1,308	1,130	1,200	1,117
Any medication class	46.9	41.1	43.6	46.7	45.6	47.1	48.1	49.2	49.8	51.5	49.1	49.3	42.7
Any medication class except opioids	17.9	7.7	8.0	11.4	13.2	13.1	16.3	21.3	23.3	27.5	28.0	28.5	26.1
Alkalizing agent	7.4	5.7	5.6	7.4	7.2	6.5	7.8	7.7	8.9	9.7	8.0	8.1	6.5
Ammonia detoxicant	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Heavy metal antagonist	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0
Opiate agonist	39.9	36.7	39.3	41.4	40.5	41.8	41.1	41.3	41.5	42.1	40.7	38.8	32.0
Alpha blockers	10.6	1.5	1.8	4.2	5.9	6.7	8.8	13.8	14.6	17.9	20.4	20.8	20.1
Calcium channel blockers	0.5	0.6	0.5	0.1	0.4	0.3	0.4	0.6	0.7	0.7	0.8	1.2	0.6
Other	0.3	0.2	0.1	0.6	0.4	0.4	0.5	0.1	0.3	0.3	0.1	0.0	0.0

* Source: De-identified Optum® Clinformatics® Data Mart, 2004-2016