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Urologic Diseases in America

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ANNUAL DATA REPORT

Chapter 3: Urinary Stone Disease

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Note

This chapter is the third of four chapters in the 2023 *Urologic Diseases in America: Annual Data Report (ADR)*. It reports and discusses findings on urinary stone disease (USD). Other chapters in the 2023 ADR are Chapter 1: Introduction and Methods; Chapter 2: Benign Prostatic Hyperplasia and Associated Lower Urinary Tract Symptoms (BPH/LUTS) in Men; and Chapter 4: Urinary Incontinence (UI). These chapters are available under separate links on the UDA website. Chapter 1 introduces the 2023 ADR and describes the methodology underlying this chapter. Additional details on the methodology and data sources are provided in Appendices A and B, respectively, that accompany Chapter 1.

Suggested citation

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3 Urinary Stone Disease

Main Takeaways

- The claims-based prevalence of USD among persons aged 18-64 was 1% annually from 2012 to 2021, while for those aged 65 and above, it was 3-5%.
- USD often co-occurred with obesity, hypertension, diabetes, and urinary tract infections. Among persons aged 65 and older, 83%, 38%, and 36% of patients with USD had hypertension, diabetes, and urinary tract infections, respectively, in 2021.
- CT remains the predominant imaging modality used to identify patients with USD. In 2020, 70% of patients underwent a CT scan within 15 months surrounding their diagnosis.
- Between 2012 and 2021, the percentage of patients with USD who filled an opioid prescription within the year decreased from 71% to 56% among patients aged 18-64 years and from 56% to 40% among those aged 65 years and older.
- From 2012-2021, there was a decline in the percentage of patients with USD who underwent ESWL, from 9% to 6% among those aged 18-64 and 5% to 3% among those aged 65 and above.

3.1 Overview

Urinary stone disease (USD), also known as kidney stones or nephrolithiasis, is a condition in which stones form in the kidneys and/or bladder, leading to a range of symptoms such as pain and hematuria. Risk factors for USD include a family history of the condition, certain medical conditions, and diet. USD can significantly impact patients' quality of life by causing physical pain, depression, and anxiety.[1] This section summarizes the basic evaluation and management of USD. Section 3.2 shows results on prevalence, incidence, comorbidities, and diagnostic testing; prescription drugs filled and procedure use; and resource use, based on contemporary data on the two age cohorts (see Chapter 1 for details on databases and related methods). Section 3.3 discusses our results relative to the literature.

For the surgical and medical management of USD, the American Urological Association (AUA) guidelines outline various diagnostic tests that should be considered for the initial evaluation, preoperative planning, and follow-up of patients with USD.[2] In the initial evaluation of patients with USD, clinicians may obtain laboratory tests such as serum electrolytes, calcium, creatinine, and uric acid, which may indicate underlying medical conditions associated with USD. A urinalysis can also be obtained to evaluate urine pH and indicators of infection. For preoperative planning, a non-contrast

computerized tomography (CT) scan is typically obtained to determine the appropriate type of surgery. For follow-up of patients, clinicians may periodically obtain imaging studies such as plain abdominal imaging, renal ultrasonography, 24 hour urine collection for metabolic analysis, or CT to assess for stone growth or new stone formation. Furthermore, functional imaging studies of the kidneys (e.g., diethylenetriaminepentaacetic acid [DTPA] or mercaptoacetyltriglycine [MAG3] nuclear medicine tests) may be considered if clinically significant loss of renal function is suspected.[3]

Prescription drugs play a crucial role in the treatment of USD. Persons with an acute stone episode may use nonsteroidal anti-inflammatory drugs, opioids and alpha-blockers to control pain and help with stone passage. To prevent stones, all patients are encouraged to monitor their fluid intake and adjust their diet. In addition to these preventative measures, some patients use pharmacological therapies such as thiazide diuretics, potassium citrate, allopurinol, cystine-binding thiol drugs, or acetohydroxamic acid, depending on their risk factors and the composition of their stones.

Surgery may be considered for patients who are experiencing symptoms or for those who are asymptomatic but have a significant stone burden. Treatment options for kidney stones include extracorporeal shock wave lithotripsy (ESWL), ureteroscopy, and percutaneous nephrolithotomy (PCNL), with the best option depending on the size and location of the stone. Procedures and pharmacological classes considered for USD analysis are shown in Table 3.1 below.

Table 3.1. Procedures and pharmacological classes considered for USD analysis

Procedures	Pharmacological Classes
• Cystolithalopaxy • Extracorporeal shock wave lithotripsy (ESWL) • Laparoscopic stone surgery • Nephrostomy tube • Open stone surgery • Percutaneous nephrolithotomy (PCNL) • Ureteral stent placement • Ureteroscopy	• Alkalinizing agents • Allopurinol • Alpha blocker • Acetohydroxamic acid • Calcium channel blocker • Cholestyramine • Opioid • Opioid / Antimuscarinic • Thiazide • Cystine-binding thiols drugs

3.2 Results

➔ Study population

Table 3.2 shows the total number of patients with USD as well as the total population in each cohort in 2021.

Table 3.2. Total number of patients with USD, 2021

	Age 18-64		Age 65+	
	Male	Female	Male	Female
Total Population	2,865,943	2,776,873	10,779,115	13,694,802
Patients with USD	36,181	28,460	687,575	418,273

➔ Prevalence

The claims-based period prevalence of USD among persons aged 18-64 was about 1% annually from 2012 to 2021. For persons aged 65 and older, the prevalence of USD was approximately 3.1-4.5% (Figure 3.1a). Our findings reveal that the prevalence of USD among older persons (65 and older) was higher in men, and increased from 4.3% to 6.4% between 2012 and 2021. In contrast, the prevalence among women in the same age group only increased from 2.1% to 3.1% over the same period. The gender disparities in older persons were less pronounced among those aged 18-64. The prevalence of USD was generally higher for older age brackets, with the exception of persons 80 years and older, who had a slightly lower prevalence of USD compared to the 75-79 age bracket (Figure 3.1b).

Figure 3.1a. Claims-based prevalence of USD, by year and gender-age group (2012-2021)

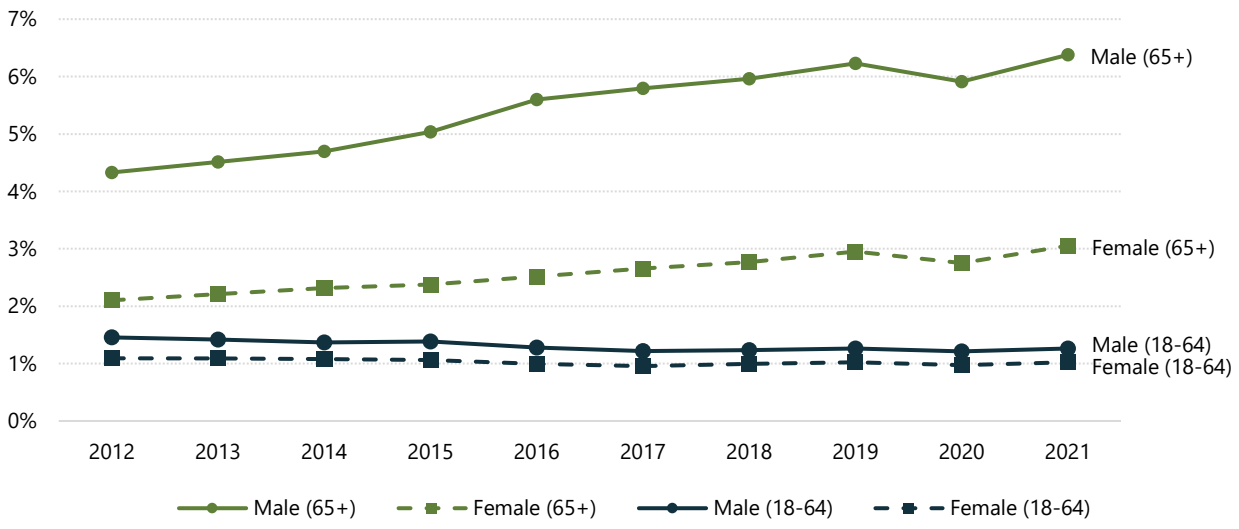
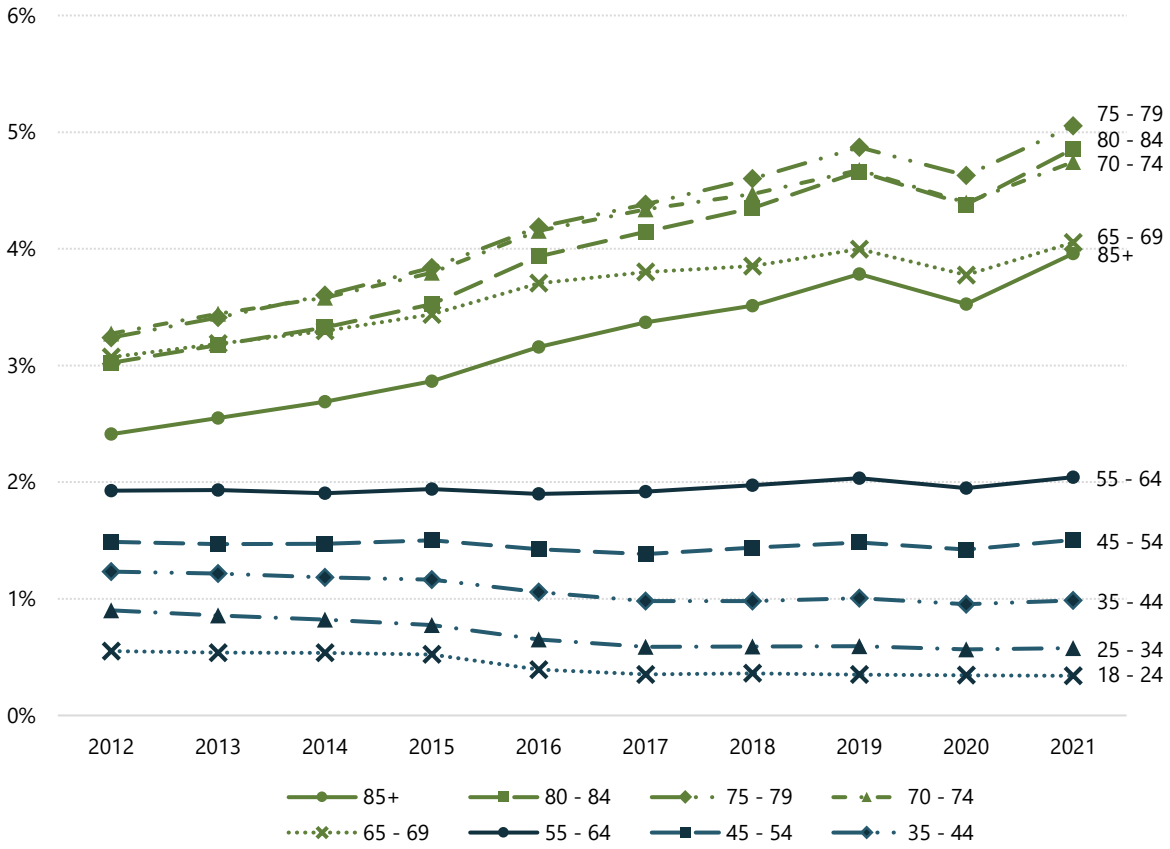


Figure 3.1b. Claims-based prevalence of USD, by year and age (2012-2021)



Notes: For ages 65 and older, denominator denotes number of restricted Medicare FFS beneficiaries in each age/gender group. For ages 18-64, denominator denotes number of restricted privately insured CDM enrollees in each age/gender group.

By race/ethnicity, the prevalence of USD was generally highest among Non-Hispanic Whites, with a rate of 4.7% in 2021 for those aged 65 and older, and 1.3% for those aged 18 to 64. We also observed regional differences in prevalence of USD. In 2021, prevalence of USD was the highest in the South for persons aged 18-64 (1.3%) and in the Northeast for persons aged 65 and older (5.1%). Prevalence rates were similar between those who were dually eligible for Medicare and Medicaid compared with those who were not.

➔ Incidence

The average annual incidence of USD was approximately 170 per 10,000 persons (or 1.7%) from 2015 through 2021 among persons 65 years and older. This translates to an average of approximately 390,000 newly identified cases of USD among the age 65 and older cohort. Similar to 2021 claims-based prevalence, we found that incidence among persons aged 65 years and older was generally associated with age.

➔ Comorbidities

Our analysis shows that the two age-based cohorts shared several common comorbid conditions. For patients aged 18-64, common comorbidities in 2021 were hypertension (44%), obesity (32%), and diabetes mellitus (18%) (Figure 3.2a). In those aged 65 and older, common comorbidities were hypertension (83%), diabetes mellitus (38%), and urinary tract infections (UTI, 36%) (Figure 3.2b). Among common comorbidities, their prevalence among patients with USD was substantially higher compared to all persons (including those without USD) in the same age group.

Figure 3.2a. Common comorbidities among patients with USD, age 18-64 (2021)

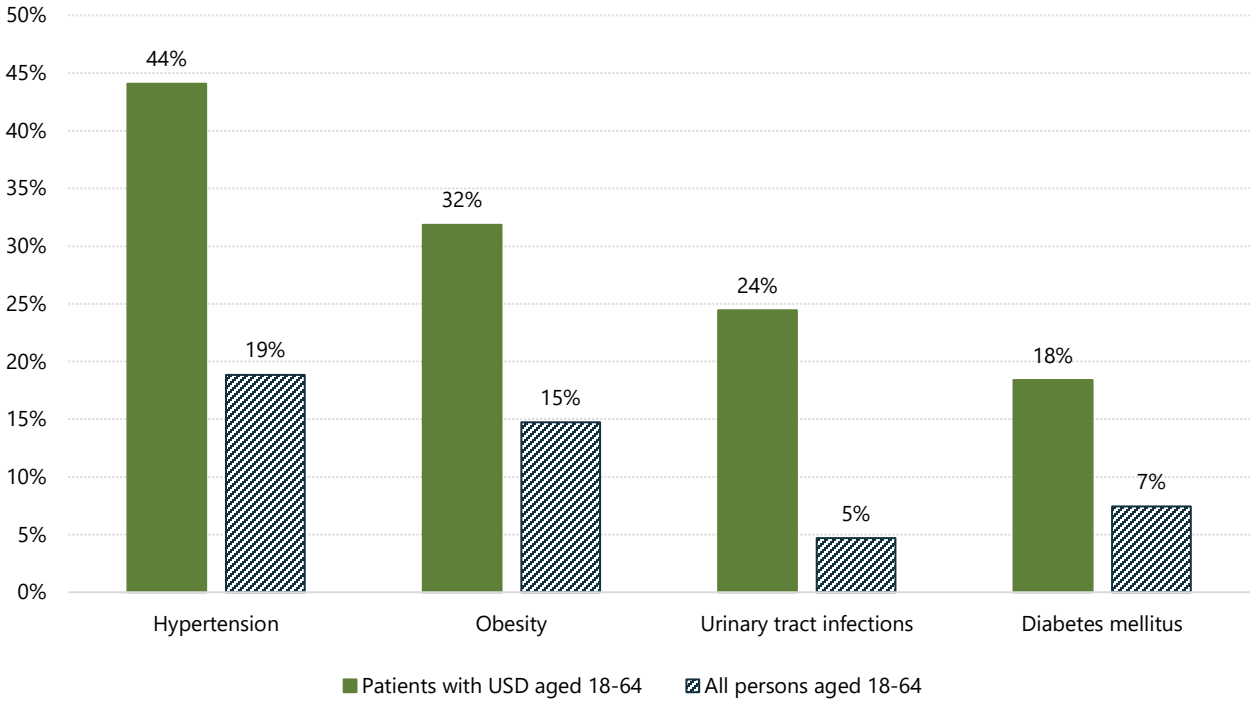
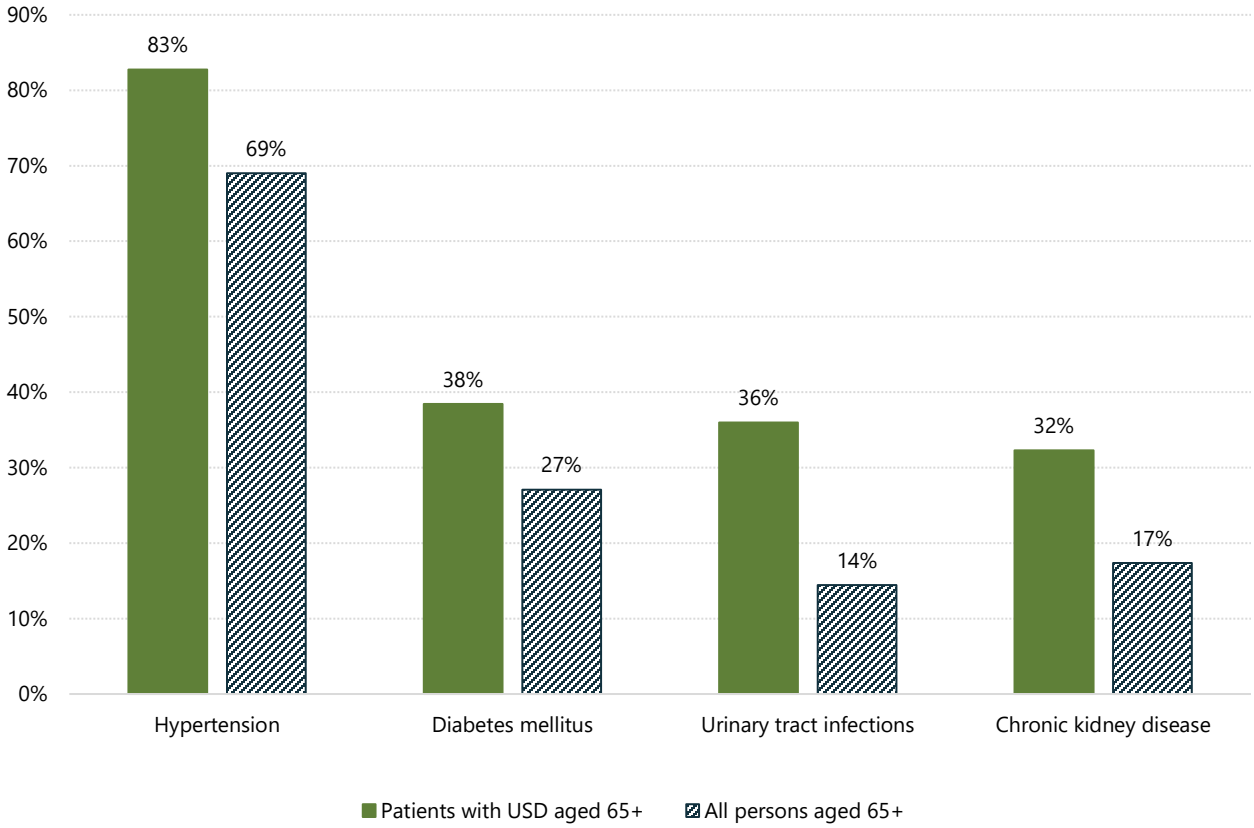


Figure 3.2b. Common comorbidities among patients with USD, age 65+ (2021)



Notes: Columns in solid denote percentage of patients with USD who are also identified with the comorbidity referenced. Columns in patterns denote the analogous metric for all persons (including those without USD) in each referenced age cohort.

➔ Diagnostic tests

Nearly all patients with incident USD received some diagnostic test within 3 prior and 12 subsequent months to initial diagnosis. There was minimal change in the use of diagnostic testing from 2015 through 2020. Among those aged 65 and older, serum creatinine and urinalysis were the most frequently ordered laboratory tests (Figure 3.3a). 97% had a serum creatinine test and 84% had a urinalysis ordered within 3 prior and 12 subsequent months to initial diagnosis.[4]

For imaging, we found that in 2020 for those aged 65 and older, 70% of patients newly identified with USD underwent a CT scan and 40% had a renal ultrasound. Abdominal X-ray (25%), retrograde pyelogram (8%), and pelvic ultrasound (5%) were less common (Figure 3.3b). Abdominal magnetic resonance imaging (MRI), pelvic MRI, intravenous pyelogram (IVP), and antegrade pyelogram were used by less than 5% of patients in our cohort.

Figure 3.3a. Percent of patients aged 65+ with incident USD who had a laboratory diagnostic test within 3 prior and 12 subsequent months to initial diagnosis (2015-2020)

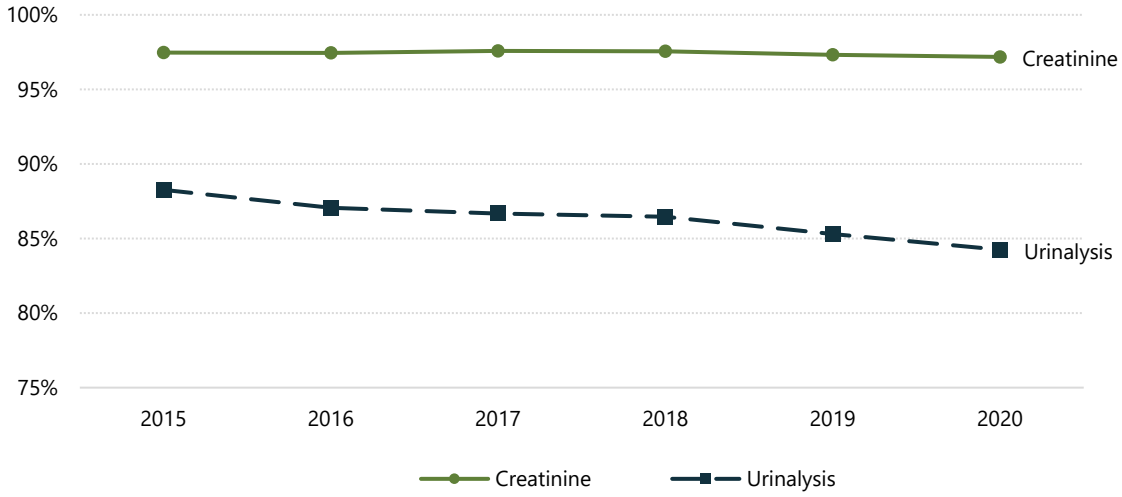
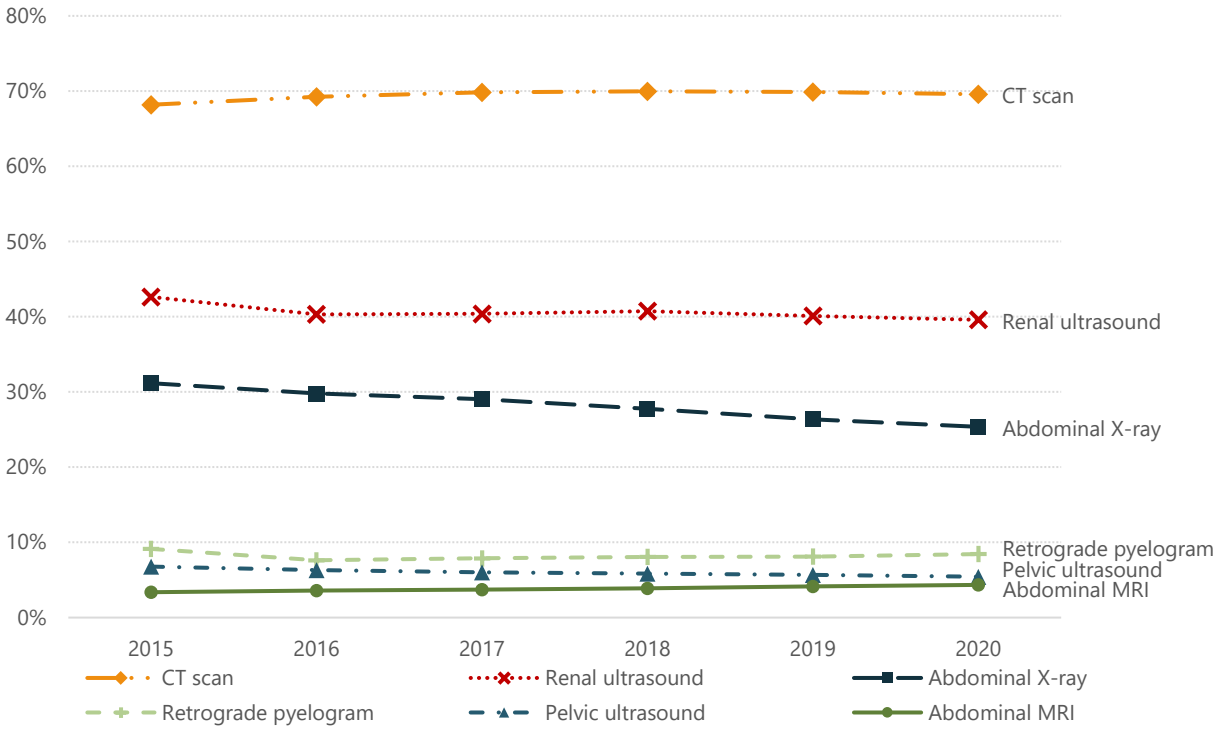


Figure 3.3b. Percent of patients aged 65+ with incident USD who had an imaging diagnostic test within 3 prior and 12 subsequent months to initial diagnosis (2015-2020)



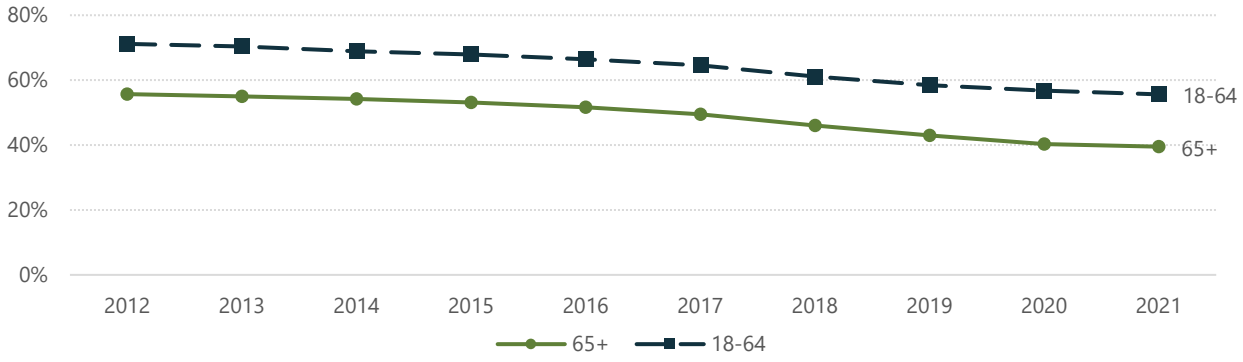
Notes: Numerator denotes number of patients with incident USD in each year who received each referenced diagnostic test within 3 prior and 12 subsequent months to initial diagnosis. Denominator denotes number of patients with incident USD in each year.

➔ Prescription drugs

We examined drugs used for stone prevention, such as thiazides, alkalinizing agents, and allopurinol. Our findings showed that thiazides were the most commonly filled preventive prescription. In 2012, 23% of patients aged 18-64 and 11% of patients aged 65 and older with USD filled a prescription for a thiazide. In contrast, other prescriptions used for stone prevention were much less frequently filled. For example, in 2021, only 5% of patients aged 65 and older with USD filled a prescription for alkalinizing agents, and this percentage was consistent with previous years. Similarly, only about 10% of patients aged 65 and older with USD filled a prescription for allopurinol. Drugs like cystine-binding thiol drugs were even less commonly filled, with less than 1% of patients with USD filling a prescription for them. It is worth noting our analysis was unable to determine whether these prescriptions were for stone prevention or other indications, such as hypertension in the case of thiazides.

We also evaluated drugs that are used to manage acute stone episodes such as alpha blockers, calcium channel blockers, and opioids. Opioids were the most commonly filled USD-related drug for both patient cohorts. In 2021, 56% of USD patients aged 18-64 and 40% of those aged 65 and older filled a prescription for an opioid. Notably, between 2012 and 2021, the percentage of patients with USD who filled an opioid prescription within the year decreased from 71% to 56% among patients aged 18-64 years and from 56% to 40% among those aged 65 years and older (Figure 3.4). In 2021, 42% of patients aged 18-64 and 34% of patients aged 65 and older used alpha blockers. The same year, calcium channel blockers were filled by 3.4% of patients aged 18-64 and 1.6% of those aged 65 and older.

Figure 3.4. Percent of patients with USD who filled an opioid prescription during the calendar year, by age (2012-2021)



Notes: Denominator denotes number of patients with USD who were aged 65 and older and had full-time Part D enrollment in each year (Medicare FFS) or aged 18-64 (CDM).

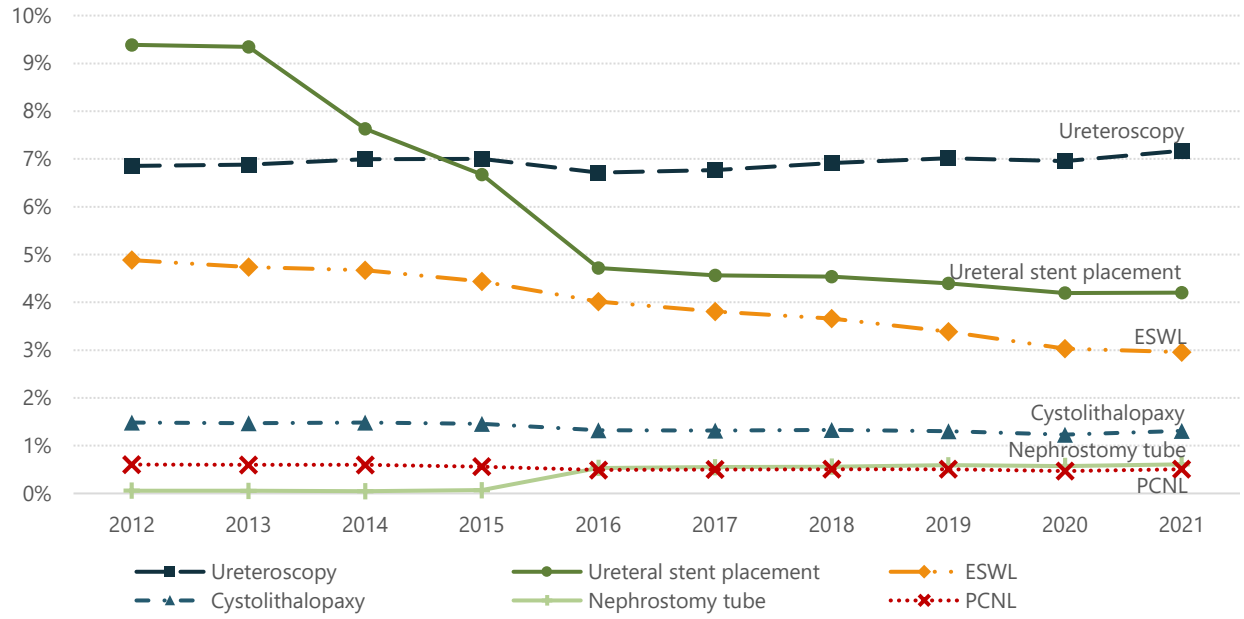
Among the 2015 incident cohort, 90% of patients aged 65 and older with USD filled any disease-related prescription within 5 years after initial diagnosis. The most common prescription filled

soonest after diagnosis was an opioid, accounting for 64% of patients' first filled prescription. The next most common ones were alpha blockers (21%) and thiazide (8%).

➔ Procedures

On average, between 2012 and 2021, 19% of patients aged 18 to 64 with USD underwent a procedure related to USD, while 11% of those aged 65 and older did the same. In both of our populations, ureteroscopy was the most common procedure performed for USD. In patients aged 18-64, 13% underwent at least one ureteroscopy and in patients aged 65 years and older, 7% underwent a ureteroscopy. Both the younger (13% to 6%) and older (9% to 4%) patient cohorts experienced a sharp decline in ureteral stent placement rates between 2013 and 2016. However, this decline may be an artificial result of the 2014 bundling of the ureteral stent procedure code with the ureteroscopy procedure code, rather than a reflection of a change in ureteral stenting behavior. [5] Extracorporeal shock wave lithotripsy (ESWL) exhibited a decline as well, from 9% to 6% among those aged 18-64 and 5% to 3% among those aged 65 and older (Figure 3.5).

Figure 3.5. Percent of patients aged 65+ with USD who underwent each USD-related procedure, by procedure type (2012-2021)



Notes: This figure shows the percent of patients aged 65 and older with USD who underwent each referenced procedure during 2012 - 2021.

Among the incident cohort aged 65 and older, 25% of patients with incident USD underwent any disease-related procedure within 5 years after initial diagnosis in 2015. 41% of the first procedures during this period were ureteral stent placement, while ureteroscopy and ESWL accounted for 22% and 20%, respectively. The average time to first procedure within 5 years after initial diagnosis in 2015 was 10 months.

➔ Service utilization

On average, patients aged 65 and older with an incident diagnosis of USD between 2015 and 2020 had 2.3 E&M visits within 12 months. During the same period, 2.6% of the same group had an inpatient hospitalization, 2.0% had an observation stay, and 14% had an emergency department visit with a primary diagnosis of USD within 12 months after initial diagnosis.

➔ Expenditure

Among patients aged 65 and older with incident USD, total expenditure (in nominal dollars) associated with a primary diagnosis of USD within 12 months after initial diagnosis amounted to approximately $378 million annually during 2015-2020. Expenditure per patient with incident USD 12 months after initial diagnosis was stable during 2015-2020, averaging $1,177 annually.

3.3 Discussion

USD remains a prevalent disease, particularly among those aged 65 and older. USD often co-occurred with obesity, hypertension, diabetes, and urinary tract infections. There was a notable decline in the percentage of patients with USD filling prescriptions for opioids from 2012 to 2021. Additionally, for the same years, there was a decline in the percentage of patients undergoing ESWL.

The claims-based prevalence of USD among persons aged 18-64 was estimated at 1% from 2012 to 2021, while for those aged 65 and above, it was 3-5%. While these prevalence rates are comparable to those cited in the 2018 ADR, the prevalence of USD tends to be lower in studies that rely on claims for diagnosis. For example, according to self-reported data from the 2017-2018 cycle of the National Health and Nutrition Examination Survey (NHANES), an estimated 1 in 10 persons had USD.[6] Several reasons contribute to this discrepancy. Survey questions in NHANES assess lifetime prevalence of stones, whereas claims-based studies have a more limited time frame. Additionally, claims-based prevalence rates are based on patients seeking care, and some patients may pass kidney stones without seeking medical attention. Likewise, some stones may be asymptomatic and discovered incidentally on imaging, and patients may not seek care for them.

The relatively high prevalence of USD found in the South is consistent with prior studies. First identified in a 1989 study, the Southeast United States was termed the "stone belt" for its heightened USD prevalence, which some researchers indicated may in part be due to the region's relatively warm and wet climate that poses additional thermoregulatory burdens.[7] However, it appears that the Northeast has since surpassed the South in prevalence of USD among persons aged 65 and older. This finding requires further investigation to understand factors that influence geographic variation in USD.

USD often co-occurred with obesity, hypertension, diabetes, and urinary tract infections, a finding that is consistent with previous studies that showed a strong association between USD and obesity, hypertension, and diabetes.[8] A number of factors resulting from these diseases have been linked to

kidney stone formation, including alterations in urine composition, insulin resistance, metabolic derangements, and dietary factors.

The percentage of patients with USD filling prescriptions for opioids declined from 2012 to 2021. This finding is consistent with the growing literature on the efforts to reduce opioid consumption.[9]

The most common imaging test used during the first year of USD diagnosis was CT scan. Approximately two out of three patients had a CT scan performed either for diagnosis or within 15 months surrounding it. Use of CT for diagnosing USD has grown in recent decades due to its increased sensitivity to detect stones. Some researchers have indicated that the rise in USD prevalence may in part be explained by more common utilization of CT.[10]

The percentage of patients undergoing ESWL saw a notable decrease, from 9% to 6% among the younger population and 5% to 3% among those aged 65 and older. This finding is consistent with the literature. For example, one study using IBM Marketscan data showed that between 2007-2014, there was a declining trend in the use of ESWL and a growing use of ureteroscopy. Our analysis of contemporary data indicated that the declining trend in the use of ESWL continued through 2021, while the use of ureteroscopy remained relatively stable. This trend could be attributed in part to the literature supporting the use of ureteroscopy for higher stone-free rates, especially for ureteral stones.[11] This is a worthwhile area for future research.

[1] New, Francesca and Bhaskar K. Somani. 2016. "A Complete World Literature Review of Quality of Life (QOL) in Patients with Kidney Stone Disease (KSD)." *Current Urology Reports* 17 (12): 88. https://doi.org/10.1007/s11934-016-0647-6.

[2] Pearle, Margaret S., David S. Goldfarb, Dean G. Assimos, et al. 2014. "Medical Management of Kidney Stones: AUA Guideline." *Journal of Urology* 192 (2): 316–324. https://doi.org/10.1016/j.juro.2014.05.006.

[3] Assimos, Dean, Amy Krambeck, Nicole L. Miller, et al. 2016. "Surgical Management of Stones: American Urological Association/Endourological Society Guideline, Part I." *Journal of Urology* 196 (4): 1153–1160. https://doi.org/10.1016/j.juro.2016.05.090.

[4] For comparative perspective, the percentage of patients with chronic kidney disease with evidence of serum creatinine test results among VA patients was around 65-75% during 2005-2018. See Centers for Disease Control and Prevention. "Chronic Kidney Disease (CKD) Surveillance System." https://nccd.cdc.gov/ckd/detail.aspx?Qnum=Q642.

[5] Prior to 2014, ureteroscopy and stent placement in the same setting could be billed separately. However, in 2014, Current Procedural Terminology (CPT) code 52356 was introduced, which bundles ureteroscopy with stent placement. Therefore, after 2014, we saw a drop in ureteral stent placement that are billed alone in claims.

[6] Abufaraj, Mohammad, Tianlin Xu, Chao Cao, et al. 2021. "Prevalence and Trends in Kidney Stone Among Adults in the USA: Analyses of National Health and Nutrition Examination Survey 2008-2018 Data." *European Urology Focus* 7 (6): 1468–1475. https://doi.org/10.1016/j.euf.2020.08.011.

[7] Dallas, Kai B., Simon Conti, Joseph C. Liao, Mario Sofer, Alan C. Pao, John T. Leppert, and Christopher S. Elliott. 2017 "Redefining the Stone Belt: Precipitation Is Associated with Increased Risk of Urinary Stone Disease." *Journal of Endourology* 31 (11): 1203–1210. https://doi.org/10.1089/end.2017.0456.

[8] Scales, Charles D. Jr., Alexandria C. Smith, Janet M. Hanley, and Christopher S Saigal. 2012. "Prevalence of Kidney Stones in the United States." *European Urology* 61 (1): 160–165. https://doi.org/10.1016/j.eururo.2012.03.052; Taylor, Eric N., Meir J. Stampfer, and Gary C. Curhan. 2005 "Diabetes Mellitus and the Risk of Nephrolithiasis." *Kidney International* 68 (3): 1230–1235. https://doi.org/10.1111/j.1523-1755.2005.00516.x; Taylor, Eric N., Meir J. Stampfer, and Gary C. Curhan. 2005. "Obesity, Weight Gain, and the Risk of Kidney Stones." *JAMA*, 293 (4): 455–462. https://doi.org/10.1001/jama.293.4.455.

[9] Krughoff, Kevin and Vernon M. Pais Jr. 2021. "Kidney Stones and the Opioid Epidemic: Recent Developments and Review of the Literature." *Current Opinion in Urology* 30 (2): 159–165. https://doi.org/10.1097/MOU.0000000000000705

[10] Fwu, Chyng-Wen, Paul W. Eggers, Paul L. Kimmel, John W. Kusek, and Ziya Kirkali. 2013 "Emergency Department Visits, Use of Imaging, and Drugs for Urolithiasis Have Increased in the United States." *Kidney International* 83 (3):479–486. https://doi.org/10.1038/ki.2012.419.

[11] Aboumarzouk, Omar M., Slawomir G. Kata, Francis X. Keeley, Samuel McClinton, and Ghulam Nabi. 2012. "Extracorporeal Shock Wave Lithotripsy (ESWL) Versus Ureteroscopic Management for Ureteric Calculi." *Cochrane Database of Systematic Reviews* 16 (5): 2–24. https://doi.org/10.1002/14651858.CD006029.pub4.