CHAPTER 8

Urolithiasis

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INTRODUCTION

It has been estimated that up to 10% of males and 5% of females in the United States will form a kidney stone (i.e., experience urolithiasis) at some time during their lives (1, 2). These figures would be slightly higher if stones that form in other parts of the urinary tract were included. While rarely fatal, urolithiasis causes substantial morbidity. In addition to the pain and suffering of an acute stone event, treatment incurs substantial costs, and additional costs result from time lost from work, as many individuals are affected during their working years.

DEFINITION AND DIAGNOSIS

Urolithiasis denotes stones originating anywhere in the urinary tract, including the kidneys and bladder. However, the pathophysiologic bases for the formation of kidney and bladder stones are entirely different. Kidney stones form as a result of physicochemical or genetic derangements leading to supersaturation of the urine with stone-forming salts or, less commonly, from recurrent urinary tract infection with urease-producing bacteria. Stasis in the upper urinary tract due to local anatomic anomalies may also promote or enhance stone formation in susceptible individuals. In contrast, bladder stones form almost exclusively as a result of urinary stasis and/or recurrent infection due to bladder outlet obstruction or neurogenic bladder. The patient populations at risk for different locations of stones are disparate, with kidney stones occurring most often in otherwise healthy individuals and bladder stones occurring in those with neurologic and/or anatomic abnormalities. For the purposes of this chapter, we have tried to distinguish upper urinary tract stones (kidney and ureteral stones) from lower urinary tract stones (bladder stones), although in some cases the data for the two sites are combined. Table 1 presents diagnosis codes associated with urolithiasis.

Although obstructing urinary tract stones are typically associated with symptoms, a definitive diagnosis of urolithiasis cannot be based on symptoms alone. Because of the embryonic development of the kidneys and genital system, as well as the close nerve and vascular supply, pain due to stones may be referred to the gonads or confused with gastrointestinal pathology such as cholecystitis, appendicitis, gastric ulcer, or diverticulitis. Likewise, cystitis and pyelonephritis may mimic acute renal colic. Musculoskeletal pain, particularly over the flanks, may also be incorrectly attributed to stone pain.

A definitive diagnosis of a stone requires either direct stone retrieval after spontaneous passage or surgical intervention, or identification by radiologic imaging. Although an abdominal x-ray of the kidneys-ureters-bladder (KUB) is simple and requires no preparation, it can fail to reveal small or radiolucent stones. Excretory urography, also known as intravenous pyelography (IVP), is more sensitive than KUB and provides more anatomic information, but IVP can still miss small or radiolucent nonobstructing stones. Ultrasound has the advantage of avoiding exposure to radiation or contrast and can detect

Table 1. Codes used in the diagnosis and management of urolithiasis

Upper Tract	
Individuals with one of the following ICD-9 codes:	
270.0	Disturbance of amino-acid transport
274.11	Uric acid nephrolithiasis
592.0	Calculus of kidney
592.1	Calculus of ureter
592.9	Urinary calculus, unspecified
Individuals with the following ICD-9 disease code and any one of the following procedure codes, or the procedure code alone:	
271.8	Other specified disorders of carbohydrate transport and metabolism
and	
ICD-9 Procedure Code	
55.03	Percutaneous nephrostomy without fragmentation
55.04	Percutaneous nephrostomy with fragmentation
55.92	Percutaneous aspiration of kidney (pelvis)
56.0	Transurethral removal of obstruction from ureter and renal pelvis
56.2	Ureterotomy
59.8	Ureteral catheterization
59.95	Ultrasonic fragmentation of urinary stones
98.51	Extracorporeal shockwave lithotripsy (ESWL) of the kidney, ureter and/or bladder
CPT-4 Procedure Codes	
50060	Nephrolithotomy; removal of calculus
50065	Nephrolithotomy; secondary surgical operation for calculus
50070	Nephrolithotomy; complicated by congenital kidney abnormality
50075	Nephrolithotomy; removal of large staghorn calculus filling renal pelvis and calyces (includes anatrophic pyelolithotomy)
50080	Percutaneous nephrostolithotomy or pyelostolithotomy, with or without dilation, endoscopy, lithotripsy, stenting, or basket extraction; up to 2 cm
50081	Percutaneous nephrostolithotomy or pyelostolithotomy, with or without dilation, endoscopy, lithotripsy, stenting, or basket extraction; over 2 cm
50125	Pyelotomy; with drainage, pyelostomy
50590	Lithotripsy, extracorporeal shock wave
50610	Ureterolithotomy; upper one-third of ureter
50620	Ureterolithotomy; middle one-third of ureter
50630	Ureterolithotomy; lower one-third of ureter
52320	Cystourethroscopy (including ureteral catheterization); with removal of ureteral calculus
52325	Cystourethroscopy (including ureteral catheterization); with fragmentation of ureteral calculus (e.g., ultrasonic or electro-hydraulic technique)
52330	Cystourethroscopy (including ureteral catheterization): with manipulation, without removal of ureteral calculus
52351	Cystourethroscopy, with ureteroscopy and/or pyeloscopy; diagnostic (prior to 2001 was 52335)
52352	Cystourethroscopy, with ureteroscopy and/or pyeloscopy; with removal or manipulation of calculus (ureteral catheterization is included (prior to 2001 was 52336)
52353	Cystourethroscopy, with ureteroscopy and/or pyeloscopy; with lithotripsy (ureteral catheterization is included) (prior to 2001 was 52337)
Lower Tract	
Individuals with one of the following ICD-9 codes:	
594.0	Calculus in diverticulum of bladder
594.1	Other calculus in bladder
594.2	Calculus in urethra
594.8	Other lower urinary tract calculus
594. 9	Calculus of lower urinary tract unspecified

most renal calcifications, but it is less sensitive in delineating stone size and number and cannot detect most ureteral stones. Magnetic resonance imaging is not a recommended modality because stones do not generate a signal, although medium to large stones will be seen as signal voids within the collecting system.

The most sensitive imaging modality for the diagnosis of renal, ureteral, and bladder calculi is non-enhanced, thin-cut helical computed tomography (CT), which can detect stones as small as 1 mm in diameter, regardless of composition, with the exception of indinavir stones. In recent years, non-contrast helical CT has emerged as the imaging study of choice for the evaluation of acute flank pain because of its high sensitivity and specificity in detecting renal and ureteral calculi, rapid acquisition time (less than a breath hold), and avoidance of intravenous contrast. Indeed, data derived from the Centers for Medicare and Medicaid Services (CMS) show that although IVP was still used more commonly than CT in 1998, there was a 31% decrease in the use of excretory urography and a threefold increase in the use of non-contrast CT for the diagnosis of urolithiasis between 1992 and 1998 (Table 2).

Individuals with persistent crystalluria may never form a stone, and these individuals are unlikely to be given a diagnosis of urolithiasis unless they form one. There is no clear definition that distinguishes crystalluria (or the passage of *sludge*) from urolithiasis, so the diagnosis depends on the resolution of the imaging method used. Occasionally, calcifications in the renal parenchyma are distinguished from calcifications in the urinary collecting system. Recent work suggests that intrarenal calcifications may be important precursors to stone formation (3), although further studies are needed to clarify this issue. Of the various stone compositions that occur in the urinary tract, each has specific risk factors. Most upper tract stones are composed of calcium oxalate, calcium phosphate, uric acid, struvite, or cystine; most bladder stones are composed of uric acid or calcium phosphate. Less common stones include those made of xanthine, indinavir, ephedrine, and 2,8-dihydroxyadenine.

RISK FACTORS

Risk factors for urolithiasis include age, sex, diet, geographic location, systemic and local medical conditions, genetic predisposition, and urinary composition. Urinary composition determines stone formation based on three factors: exceeding the formation product of stone forming components, the quantity of inhibitors (e.g., citrate, glycosaminoglycans, etc.) and promoters (e.g., sodium, urates, etc.) in the urine. The anatomy of the upper and lower tracts may also influence the likelihood of stone formation by predisposing to urinary tract infection or stasis. The reader is referred to major urology textbooks for additional details.

TREATMENT

The indications for surgical intervention for upper tract stones include recurrent pain, high-grade obstruction, associated infection, growth of stones despite medical therapy, and large size of stones. Treatment options include shock wave lithotripsy (SWL), ureteroscopy, percutaneous nephrostolithotomy (PCNL), and open or laparoscopic stone removal. SWL is the most commonly employed treatment modality for renal and ureteral calculi and for stones associated with some anatomic abnormalities, specifically obstruction (e.g., ureteropelvic junction obstruction, ureteric stricture, etc.) and the only completely non-invasive treatment option. Ureteroscopy is primarily used to treat ureteral stones but is increasingly being used to treat renal calculi for which SWL has failed or is ill-advised. Percutaneous nephrostolithotomy is indicated for large-volume renal calculi and for stones associated with some anatomic abnormalities. Finally, open and laparoscopic surgery are reserved for stones that have not been treatable with less invasive treatment options or are associated with extensive anatomic abnormalities that require simultaneous repair. However, open or laparoscopic therapy for urolithiasis is indicated in fewer than 2% of patients today.

Bladder stones are predominantly treated with endoscopic fragmentation, and less commonly with SWL or open procedures. Rarely, these stones have been approached laparoscopically. Because of the underlying anatomic predisposition to bladder stones,

Table 2. Use of imaging procedures in evaluation of urolithiasis among Medicare beneficiaries, count[a], rate[b]

	1992		1995		1998	
	Count	Rate	Count	Rate	Count	Rate
Total	131,200	81,466	166,580	91,546	184,320	97,825
Intravenous pyelogram	36,600	22,682	38,820	21,334	31,460	16,697
Ambulatory surgery center	1,720	1,066	1,860	1,022	1,540	817
Inpatient	13,020	8,069	11,820	6,496	7,960	4,225
Hospital outpatient	520	322	620	341	480	255
Physician office	21,340	13,225	24,520	13,475	21,480	11,400
Plain film/KUB	70,760	43,852	93,100	51,165	107,700	57,160
Ambulatory surgery center	13,220	8,193	16,380	9,002	18,220	9,670
Inpatient	15,560	9,643	13,280	7,298	13,640	7,239
Hospital outpatient	1,860	1,153	1,820	1,000	1,940	1,030
Physician office	40,120	24,864	61,620	33,865	73,900	39,221
Ultrasound (renal)	18,320	11,353	27,440	15,080	32,460	17,227
Ambulatory surgery center	520	322	500	275	800	425
Inpatient	6,020	3,731	7,660	4,210	9,800	5,201
Hospital outpatient	240	149	220	121	240	127
Physician office	11,540	7,152	19,060	10,475	21,620	11,474
Magnetic resonance imaging, abdomen	60	37	60	33	100	53
Ambulatory surgery center	0	0	0	0	0	0
Inpatient	40	25	40	22	40	21
Hospital outpatient	0	0	0	0	20	11
Physician office	20	12	20	11	40	21
CT abdomen/pelvis with contrast	1,180	731	1,640	901	2,280	1,210
Ambulatory surgery center	60	37	220	121	160	85
Inpatient	920	570	1,060	583	1,560	828
Hospital outpatient	0	0	0	0	0	0
Physician office	200	124	360	198	560	297
CT abdomen/pelvis without contrast	1,160	719	1,660	912	5,980	3,174
Ambulatory surgery center	60	37	200	110	420	223
Inpatient	640	397	1,020	561	3,320	1,762
Hospital outpatient	20	12	0	0	80	42
Physician office	440	273	440	242	2,160	1,146
CT abdomen/pelvis with and without contrast	1,400	892	2,080	1,143	2,560	1,359
Ambulatory surgery center	200	124	180	99	140	74
Inpatient	720	446	920	506	1,120	594
Hospital outpatient	0	0	60	33	100	53
Physician office	520	322	920	506	1,200	637
CT scan abdomen, unspecified						
Inpatient	1,720	1,200	1,780	978	1,780	945

[a]Unweighted counts were multiplied by 20 to arrive at values in the table.

[b]Rate per 100,000 based on number of Medicare beneficiaries with diagnosis of urolithiasis.

NOTE: Counts less than 600 should be interpreted with caution.

SOURCE: Centers for Medicare and Medicaid Services, 5% Carrier and Outpatient Files, 1992, 1995, 1998.

simultaneous treatment of bladder outlet obstruction is commonly performed, combining either open prostatectomy or transurethral prostate resection with stone removal or fragmentation.

Improvements in the instrumentation and technique for endoscopic stone removal and refinements in the indications for SWL treatment have improved success rates and reduced the morbidity associated with stone treatment. As a result, treatment selection has changed over time to accommodate the new technology. These changes, along with changes in prevalence, have altered the economic impact of stone disease. A trend toward less invasive treatment options that require shorter hospital stays and enable quicker convalescence has reduced hospital costs and lessened the burden of lost workdays. Nevertheless, the costs of stone disease—both direct medical expenditures and the costs of missed work and lost wages—are difficult to ascertain. This chapter provides data from a variety of sources to assist in estimating the financial burden of urolithiasis in terms of expenditures by the payor.

While this chapter presents the best available information regarding the financial burden of stone disease, some important limitations should be kept in mind when viewing the tabular data. Although there are clear differences in some rates by age and sex, the rates for many of the factors of interest are age-adjusted only in certain tables, and none of the data were sex-adjusted. This may have an impact on the interpretation of the rates, as indicated later in the chapter. There is no new information available on rates for specific stone types and sizes or for first-time versus recurrent stone formers; nor is there new information on incidence rates in the strict epidemiologic sense (first event). Finally, because of the structure of the databases that were used to collect the information, we cannot draw causal inferences about risk factors.

PREVALENCE AND INCIDENCE

Because stones in the urinary tract may be present but asymptomatic, prevalence estimates based on questionnaires or medical encounters are likely to be underestimates. For clarity of interpretation, it is important to distinguish between *prevalent stones* (stones that are actually in the patient) and *prevalent stone disease* (patients with a history of stone disease but who may not currently have a stone). For this chapter, the term *prevalence* refers to prevalent stone disease unless otherwise noted.

Several factors have hampered our understanding of the prevalence and incidence of urolithiasis. Lack of comprehensive data has led to a variety of beliefs regarding the frequency of stone disease. Because a number of factors, including age and sex, influence prevalence and incidence, care must be taken when interpreting results and comparing studies. Demographic factors that are traditionally believed to

Table 3. Percent prevalence[a] of a history of kidney stones (±SE) in United States adults by gender, age group, and time period (NHANES II, 1976 to 1980; NHANES III, 1988 to 1994)

	Males			Females		
Age	1976 to 1980	1988 to 1994	Difference (95% CI)[b]	1976 to 1980	1988 to 1994	Difference (95% CI)[b]
20–29	0.9 ± 0.31	1.3 ± 0.42	0.4 (–0.6, 1.4)	1.4 ± 0.36	2.0 ± 0.51	0.6 (–0.6, 1.9)
30–39	4.2 ± 0.51	3.6 ± 0.75	–0.6 (–2.4, 1.1)	2.0 ± 0.37	3.0 ± 0.57	1.0 (–0.8, 2.8)
40–49	6.9 ± 0.99	9.5 ± 1.45	2.6 (–0.8, 6.1)	2.2 ± 0.40	4.2 ± 0.70	2.0 (0.4, 3.5)
50–59	7.5 ± 1.26	9.6 ± 1.17	2.1 (–1.3, 5.4)	5.3 ± 0.64	7.0 ± 1.10	1.7 (–0.7, 4.3)
60–69	8.3 ± 0.66	11.1 ± 1.68	2.8 (–0.8, 6.3)	4.2 ± 0.48	5.6 ± 0.88	1.4 (–0.6, 3.3)
70–74	6.7 ± 0.86	13.3 ± 1.81	6.6 (2.7, 10.5)	3.7 ± 0.68	6.9 ± 1.38	3.2 (0.2, 6.3)
All ages[c]	4.9 ± 0.42	6.3 ± 0.56	1.4 (0.05, 2.8)	2.8 ± 0.17	4.1 ± 0.27	1.3 (0.7, 1.5)

[a]Crude unadjusted prevalence.

[b]Difference is prevalence in 1988 to 1994 minus prevalence in 1976 to 1980; 95% CI denotes the lower limit, upper limit of the 95% CI estimate of the difference. Bold type indicates that the difference was statistically significant at $P < 0.05$.

[c]Persons 20 to 74 years of age.

SOURCE: Reprinted from Stamatelou KK, Francis ME, Jones CA, Nyberg LM, Curhan GC, Time trends in reported prevalence of kidney stones in the United States: 1976–1994, Kidney International, 63, 1,817–1,823, Copyright 2003, with permission from Blackwell Publishing Ltd.

be associated with risk of upper tract stone disease but are by no means proven include sex (the ratio of male: female incidence is 2:1 to 3:1), age (peak incidence occurs between 20 and 60 years of age), race, and geography (North–South and West–East gradients). The data presented here shed considerable light on the relative importance of these factors.

A recent study based on data from National Health and Nutrition Examination Survey (NHANES) II (1976 to 1980) and NHANES III (1988 to 1994) suggests that kidney stone disease is becoming more common (4) (Table 3 and Figure 1). Prevalence of the disease in US adults increased from 3.8% to 5.2% between the two time periods; it increased across all age groups and in both sexes (Table 4), and in both African Americans and Caucasians in all age groups (Figure 2) (5). Stamatelou et al. also found that a history of kidney stone disease was most common among non-Hispanic Caucasians; prevalence among non-Hispanic African Americans was approximately 70% lower, and among Mexican Americans it was approximately 35% lower. In the 1988–1994 period, the age-adjusted prevalence was highest in the South (6.6%) and lowest in the West (3.3%).

Few studies contain information on true incidence rates for urolithiasis, where incidence is defined as the first stone-related event. Factors that influence incidence rates are sex, age, race, and geographic region. Population-based estimates have ranged from 1 to 3 per 1,000 per year for men and 0.6 to 1.0 per 1,000 per year for women (1, 2, 6, 7). Overall, the age-specific rates for males seem to rise in the early 20s, peak in the 40- to 59-year age group, and then

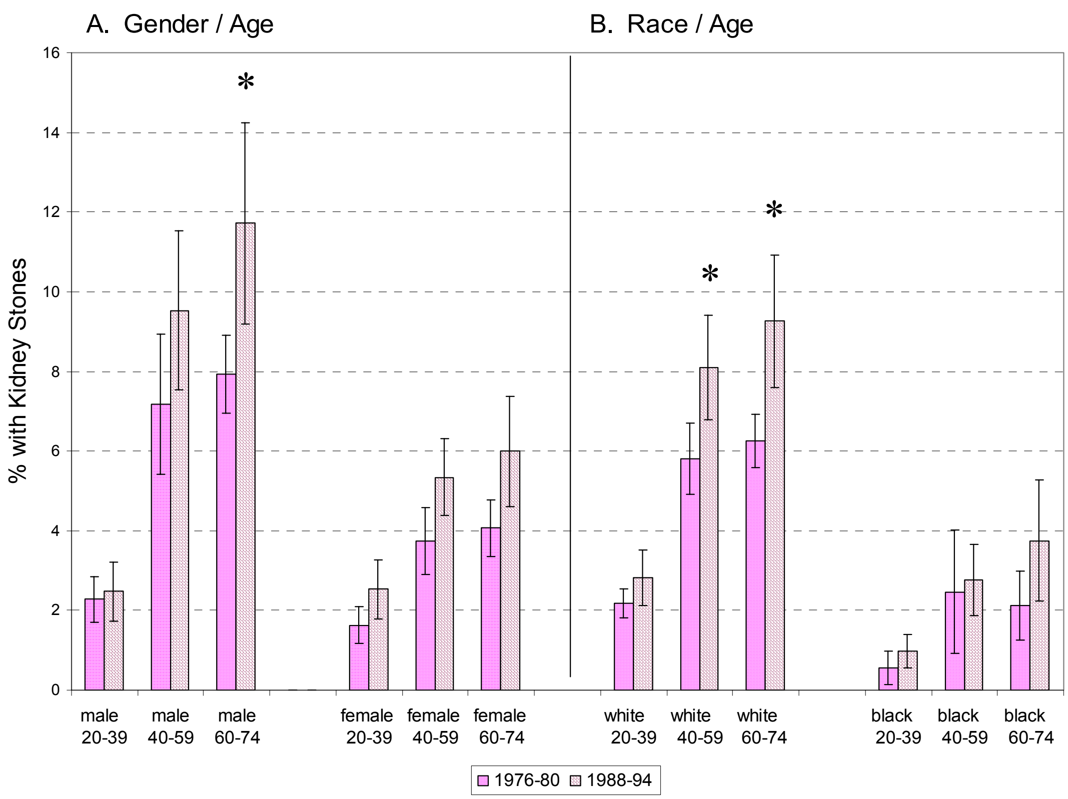

Figure 1. Percent prevalence of history of kidney stones for 1976 to 1980 and 1988 to 1994 in each age group for each gender (A) and each race group (B) . Error bars denote the 95% confidence interval. *Statistically significant time period difference.

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Table 4. Age-, race-, and gender-specific prevalence of kidney stones in CPS II and NHANES II

		CPS II								NHANES II	
		White		Black		Hispanic		Asian		White	
Gender	Age	N	Prev.	N	Prev.	N	Prev.	N	Prev.	N	Prev.
Male	30–39	16,920	4.2	1,264	2.0	405	3.0	226	2.2	921	4.7
	40–49	83,914	7.7	3,746	3.2	1,213	6.2	674	4.3	775	7.4
	50–59	178,442	9.2	6,334	4.3	1,672	6.3	1,257	6.4	755	8.3
	60–69	137,643	10.1	4,854	4.6	780	8.6	877	6.6	1,780	8.8
	70+	60,928	9.2	2,583	4.4	328	6.1	320	5.3	608	7.2
	All[a]	477,847	8.9	18,781	4.1	4,398	6.7	3,354	5.7	4,839	7.5
Prevalence ratio[b]		1.0		0.44 (0.41–0.48)		0.70 (0.63–0.79)		0.63 (0.55–0.72)			
Female	30–39	30,661	2.4	2,902	1.2	822	1.8	441	1.1	1,061	2.1
	40–49	136,597	3.0	7,644	1.7	2,081	2.8	1,114	1.6	852	2.5
	50–59	214,096	3.4	10,575	2.3	2,231	3.3	1,692	2.3	883	5.4
	60–69	161,021	3.7	7,644	2.7	1,019	3.6	917	2.1	2,080	4.6
	70+	83,763	3.7	4,408	2.6	537	3.2	316	1.0	829	4.0
	All[a]	626,138	3.4	33,173	2.3	6,690	3.2	4,480	1.7	5,705	4.1
Prevalence ratio[b]		1.0		0.65 (0.60–0.70)		0.88 (0.77–1.01)		0.55 (0.44–0.68)			

CPS, Cancer Prevention Study; NHANES, National Health and Nutrition Examination Survey; Prev, prevalence.
[a] Prevalences are standardized to the age distribution (5-year age groups) of all CPS II participants.
[b] Ratio of the prevalence for race relative to whites (CPS II only).

SOURCE: Reprinted from Soucie JM, Thun MJ, Coates RJ, McClellan W, Austin H, Demographic and geographic variability of kidney stones in the United States, Kidney International, 46, 893–899, Copyright 1994, with permission from Blackwell Publishing Ltd.

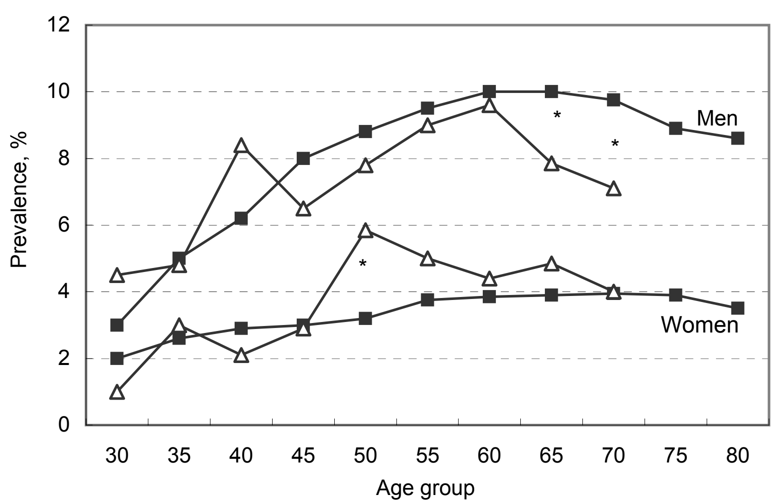

Figure 2. Age-specific prevalence of kidney stones among white men and women in CPS II (■) and NHANES II (∆). No partipants in NHANES II were older than 74 years.

***Prevalence extimates differ significantly between studies (P<0.05).**

SOURCE: Adapted from Soucie JM, Thun MJ, Coates RJ, McClellan W, & Austin H, Demographic and geographic variability of kidney stones in the United States, Kidney International, 46, 893–899, Copyright 1994, with permission from Blackwell Publishing Ltd.

decrease. The rates in women appear to be relatively constant across age groups.

Scant population-based information is available on recurrence rates, which depend on a variety of factors, including how recurrence is defined and how treatments are implemented. New data in this chapter focus on *office* or *hospital outpatient visits* and *procedures*, which cannot be extrapolated to determine the true prevalence of stone disease. In addition, these new data cannot be used to determine incidence or recurrence rates.

TRENDS IN HEALTHCARE RESOURCE UTILIZATION

Inpatient Care

Inpatient hospitalizations consist of admissions for surgical treatment of stones and hospitalization for management of acute stone events. Patients admitted for acute management generally receive hydration, analgesics, and antiemetics. Management may also include temporizing procedures prior to definitive stone treatment such as placement of a ureteral stent or percutaneous nephrostomy to relieve obstruction, especially in an infected kidney.

Upper Tract Stones: Hospitalization Rates

According to the Healthcare Cost and Utilization Project (HCUP), the rate of national inpatient hospitalizations for upper tract stones in 2000 was 62 per 100,000 population, with the number of admissions totaling 170,316—a 15% decrease since 1994, when the hospitalization rate was 73 per 100,000 and the total number of admissions was 183,322 (Table 5). The steady decline in the rate of hospitalization for patients with upper tract stones between 1994 and 2000 likely reflects the greater efficiency and reduced morbidity of surgical treatment for upper tract stones that have resulted in more procedures being performed in the outpatient setting, rather than a reduction in admissions for acute stone events; in particular, advances in ureteroscopy and percutaneous nephrostolithotomy have reduced hospital admissions and shortened hospital stays.

According to HCUP, hospitalization rates were highest in the 55- to 64-year age groups in 1994, 1998, and 2000, but were equally high in the 45 to 54, 55 to 64, and 65 to 74 age groups in 1996 (Figure 3). The high rate of inpatient hospitalization for the older age groups likely reflects the lower threshold for admission for an acute stone event or after surgical treatment due to the greater number of comorbidities in these older patients.

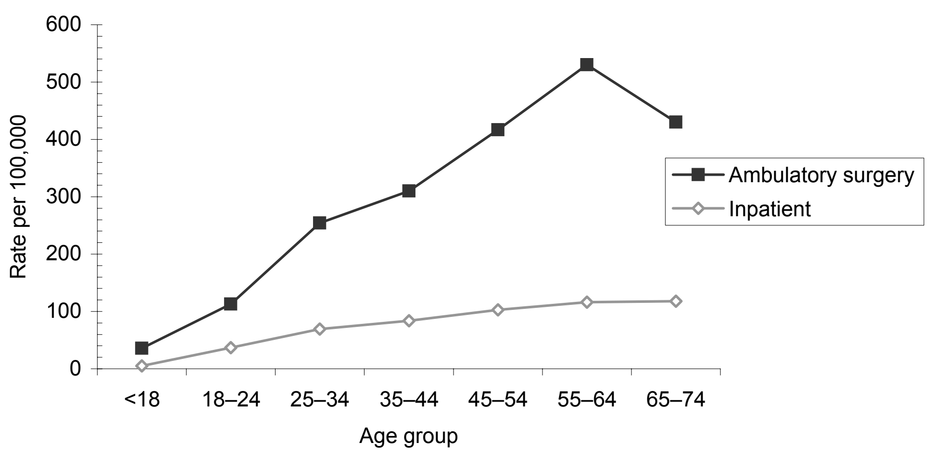

Figure 3. **Rates of inpatient and ambulatory surgery visits for urolithiasis by age group, 2000.**

SOURCE: Center for Health Care Policy and Evaluation (Ambulatory Surgery); Healthcare Cost and Utilization Project (Inpatient), 2000.

Table 5. Inpatient hospital stays by individuals with upper tract urolithiasis listed as primary diagnosis, count, rate[a] (95% CI)

	1994		1996		1998		2000	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate
Total[b]	183,322	73 (69–76)	170,218	65 (62–67)	165,296	62 (59–64)	170,316	62 (60–65)
Age								
< 18	2,931	4.3 (3.7–4.9)	2,565	3.6 (3.2–4.1)	2,962	4.1 (3.7–4.6)	3,419	4.7 (4.2–5.3)
18–24	10,541	43 (39–46)	9,935	40 (37–43)	9,152	37 (34–39)	9,478	36 (33–39)
25–34	29,608	73 (68–77)	28,370	70 (66–75)	26,402	68 (63–72)	25,511	68 (63–73)
35–44	40,906	102 (96–108)	38,541	90 (84–95)	37,583	85 (80–90)	36,956	83 (78–88)
45–54	37,438	130 (123–138)	35,468	112 (106–118)	34,698	102 (96–107)	36,935	101 (96–107)
55–64	27,009	134 (126–141)	23,513	112 (106–118)	24,283	109 (103–116)	26,138	112 (106–117)
65–74	22,700	128 (121–135)	20,601	113 (107–119)	18,563	104 (98–109)	18,955	107 (101–112)
75–84	10,403	108 (101–115)	9,454	89 (84–94)	9,791	87 (81–92)	10,684	91 (86–96)
85+	1,777	64 (55–73)	1,755	63 (55–71)	1,845	64 (56–71)	2,236	72 (64–79)
Race/ethnicity								
White	122,566	66 (63–69)	111,036	58 (56–61)	106,437	56 (53–58)	107,087	55 (53–58)
Black	6,737	21 (19–23)	6,709	20 (19–22)	6,905	21 (18–23)	6,497	19 (17–21)
Asian/Pacific Islander	1,562	22 (17–27)	1,589	17 (14–19)	1,733	17 (13–21)	1,804	17 (14–20)
Hispanic	8,816	34 (29–39)	9,453	33 (27–39)	9,915	32 (27–37)	11,855	36 (32–40)
Gender								
Male	117,165	95 (90–100)	105,187	82 (78–86)	100,550	77 (73–80)	99,214	74 (71–78)
Female	66,146	51 (49–53)	65,026	48 (46–50)	64,746	47 (45–49)	71,087	51 (49–53)
Region								
Midwest	47,638	79 (72–86)	42,645	69 (63–75)	40,537	65 (60–69)	43,700	69 (64–73)
Northeast	45,722	89 (82–97)	40,272	78 (72–84)	38,591	75 (67–84)	36,159	70 (63–77)
South	67,950	80 (73–86)	66,582	72 (67–78)	64,728	69 (64–73)	66,628	70 (64–75)
West	22,012	39 (36–43)	20,719	36 (32–39)	21,439	36 (32–39)	23,828	38 (35–42)
MSA								
Rural	40,136	63 (58–68)	38,484	65 (60–69)	35,737	59 (55–63)	39,373	65 (61–70)
Urban	142,429	75 (71–79)	131,392	64 (61–68)	128,366	62 (59–65)	130,651	61 (58–64)

MSA, metropolitan statistical area.

[a]Rate per 100,000 based on 1994, 1996, 1998, 2000 population estimates from Current Population Survey (CPS), CPS Utilities, Unicon Research Corporation, for relevant demographic categories of US civilian non-institutionalized population.

[b]Persons of missing age, other races, missing or unavailable race and ethnicity, missing gender, and missing MSA are included in the totals.

NOTE: Counts may not sum to totals due to rounding.

SOURCE: Healthcare Cost and Utilization Project Nationwide Inpatient Sample, 1994, 1996, 1998, 2000.

When hospitalization rates were stratified by ethnicity, Caucasians had the highest rate. Admission rates for Hispanics were one-half to two-thirds those of Caucasians throughout the periods of observation. Strikingly little regional variation was observed, with the exception of the West, where hospitalization rates were consistently half the rates in the other geographic areas (Northeast, Midwest, and South). Admission rates were similar in urban and rural areas. When rates in HCUP were age-adjusted (Table 6), the geographic variations remained stable; however the ethnic/racial differences were narrower and male-to-female ratios were slightly narrower. In both the age-unadjusted and the age-adjusted data, the male-to-female ratios also fell slightly over time.

Medicare data from the Centers for Medicare and Medicaid Services (CMS) for 1992, 1995, and 1998 (Table 7) indicate that inpatient hospitalization rates for upper tract stones were 2.5 to 3 times higher in this patient population than in the population studied in HCUP. Total admission rates decreased over time, from 194 per 100,000 in 1992 to 188 per 100,000 in 1995 and 184 per 100,000 in 1998, representing an overall 5% reduction in hospitalization rates, compared with a 15% decrease between 1994 and 2000 in the HCUP population (Figure 4). Admission rates of Medicare beneficiaries were consistently higher in the ≥65 age group than in the <65 age group, peaking in the 75- to 84-year group in each year of study. Likewise, the geographic distribution was similar to that seen in the HCUP database, with the highest rates of admission in the Northeast and South and the lowest in the West. In 1995, when CMS racial categories were modified, age-unadjusted admission rates were highest among Caucasians and lowest among Asians; in 1998 the age-unadjusted admission rate was highest in North American Natives, but the relatively small count in this group should lead to caution in interpreting this difference. Age-adjustment did not affect regional differences in admission rates, but it did slightly widen the gender gap. Age-adjustment did not affect admission rates in Caucasians or African Americans, but it did raise the rates in Hispanics and lower the rates in Asians.

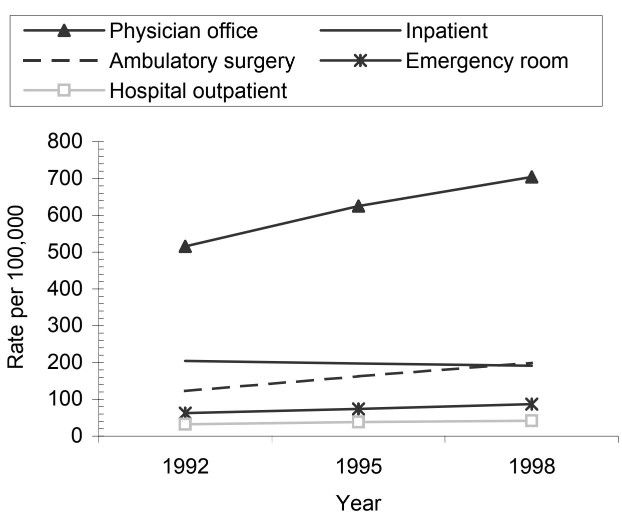

Figure 4. Rates of visits for urolithiasis, by visit setting and year.

SOURCE: Centers for Medicare and Medicaid Services, 1992, 1995, 1998.

Upper Tract Stones: Length of Stay

According to the HCUP data, the mean hospital length of stay (LOS) associated with admission for upper tract stones as a primary diagnosis declined steadily from 1994 to 2000, dropping from a mean of 2.6 days in 1994 to 2.2 days in 2000 (Table 8). Starting at age 18, there was a steady rise in LOS with age, peaking in the 85+ age group. Indeed, in 2000, the mean LOS in the 18- to 24-year age group was 1.8 days, compared with 4.4 days in the 85+ age group. Although a longer LOS in the elderly population is understandable due to the overall poorer health of this group, reasons for the higher LOS in the pediatric population (<18 years of age) compared with that in the youngest adult group (18 to 24 years) are less clear. However, the disparity in the LOS between these groups narrowed over time, and by 2000 the mean LOS was comparable for the two groups at 1.9 and 1.8 days, respectively.

Using the National Association of Children's Hospitals and Related Institutions (NACHRI) database of pediatric inpatients with a primary diagnosis of urolithiasis (both upper and lower tract stones) (Table 9), during 1999, 2000, and 2001, the mean LOS was nearly twice as high during each of the years of observation for the 0- to 2-year age group as it was in the 3 to 10 or 11 to 17 age group, most likely because stones occurring in infants are often associated with other systemic illnesses, and treatment

Table 6. Inpatient hospital stays by individuals with upper tract urolithiasis listed as primary diagnosis, age-adjusted count, age-adjusted rate[a] (95% CI)

	1994		1996		1998		2000	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate
Total[b]	199,638	79 (75–83)	193,325	73 (70–77)	190,129	71 (68–74)	193,699	71 (68–74)
Race/ethnicity								
White	131,957	71 (67–75)	124,173	65 (62–68)	120,284	63 (60–66)	119,745	62 (59–65)
Black	7,772	25 (22–27)	7,957	24 (22–26)	8,272	25 (22–28)	7,643	22 (20–24)
Asian/Pacific Islander	1,818	26 (19–32)	1,831	19 (16–22)	2,038	20 (14–26)	2,068	20 (16–23)
Hispanic	10,205	40 (34–45)	11,366	40 (33–47)	12,153	40 (33–46)	14,724	45 (40–50)
Gender								
Male	123,765	100 (95–106)	116,243	91 (86–95)	112,690	86 (81–91)	108,937	82 (78–86)
Female	75,857	59 (56–61)	77,074	57 (54–60)	77,439	56 (54–59)	84,744	60 (58–63)
Region								
Midwest	51,727	86 (77–94)	48,167	78 (71–85)	46,514	74 (69–80)	49,578	78 (72–84)
Northeast	49,834	97 (88–107)	45,182	88 (81–95)	44,119	86 (76–96)	40,210	78 (69–86)
South	73,657	86 (78–94)	76,193	83 (76–90)	74,548	79 (73–85)	76,661	80 (73–87)
West	24,420	44 (39–48)	23,782	41 (36–45)	24,947	41 (37–46)	27,250	44 (39–48)
MSA								
Rural	43,444	68 (62–74)	43,931	74 (68–80)	41,353	68 (63–74)	45,093	75 (70–80)
Urban	155,363	82 (77–87)	149,002	73 (69–77)	147,378	71 (67–75)	148,257	70 (66–73)

MSA, metropolitan statistical area.

[a]Rate per 100,000 based on 1994, 1996, 1998, 2000 population estimates from Current Population Survey (CPS), CPS Utilities, Unicon Research Corporation, for relevant demographic categories of US civilian non-institutionalized population; age-adjusted to the 2000 US Census.

[b]Persons of missing age, other races, missing or unavailable race and ethnicity, and missing MSA are included in the totals.

NOTE: Counts may not sum to totals due to rounding.

SOURCE: Healthcare Cost and Utilization Project Nationwide Inpatient Sample, 1994, 1996, 1998, 2000.

Table 7. Inpatient stays by Medicare beneficiaries with upper tract urolithiasis listed as primary diagnosis, count[a], rate[b] (95% CI), age-adjusted rate[c] (95% CI)

	1992			1995			1998		
	Count	Rate	Age-Adjusted Rate	Count	Rate	Age-Adjusted Rate	Count	Rate	Age-Adjusted Rate
Total[d]	67,080	194 (193–196)	194	66,460	188 (186–189)	188	61,540	184 (182–185)	184
Total < 65	9,000	164 (161–168)		10,140	165 (162–169)		9,400	151 (148–154)	
Total 65+	58,080	200 (198–201)		56,320	192 (191–194)		52,140	191 (189–192)	
Age									
65–74	34,300	209 (207–211)		30,360	188 (185–190)		25,640	179 (177–181)	
75–84	19,880	211 (208–214)		20,080	208 (205-211)		20,920	220 (217–223)	
85–94	3,660	128 (124–132)		5,520	180 (175–184)		5,280	171 (166–175)	
95+	240	72 (63–80)		360	99 (88–109)		300	75 (67–84)	
Race/ethnicity									
White	58,400	200 (198–202)	199	59,420	196 (194–197)	195	54,560	192 (190–194)	192
Black	4,580	155 (150–159)	158	4,800	149 (145–153)	152	4,320	139 (135–144)	141
Asian	…	…	…	120	72 (59–84)	48	360	115 (103–126)	108
Hispanic	…	…	…	640	160 (148–173)	175	1,180	168 (158–177)	179
N. American Native	…	…	…	60	165 (124–207)	221	120	222 (183–261)	222
Gender									
Male	38,440	261 (258–264)	267	38,200	251 (248–254)	256	33,320	230 (228–233)	234
Female	28,640	145 (143–146)	140	28,260	140 (138–142)	136	28,220	148 (146–150)	145
Region									
Midwest	16,720	192 (189–194)	191	16,120	179 (176–182)	179	15,460	179 (176–182)	176
Northeast	16,980	220 (217–224)	219	17,400	227 (223–230)	225	13,400	200 (197–203)	196
South	26,020	213 (210–215)	216	25,180	198 (196–201)	200	24,600	199 (196–201)	203
West	6,680	131 (128–134)	125	7,280	140 (137–144)	137	7,420	150 (146–153)	149

… data not available.
[a]Unweighted counts were multiplied by 20 to arrive at values in the table.
[a]Rate per 100,000 Medicare beneficiaries in the same demographic stratum.
[c]Age-adjusted to the US Census-derived age distribution of the year under analysis.
[d]Persons of other races, unkown race and ethnicity, and other region are included in the totals.
NOTE: Counts less than 600 should be interpreted with caution.
SOURCE: Centers for Medicare and Medicaid Services, MedPAR and 5% Carrier File, 1992, 1995, 1998.

Table 8. Trends in mean inpatient length of stay (days) for individuals hospitalized with upper tract urolithiasis listed as primary diagnosis

	Length of Stay			
	1994	1996	1998	2000
Total	2.6	2.4	2.3	2.2
Age				
< 18	2.5	2.4	2.2	1.9
18–24	2.2	2.0	1.9	1.8
25–34	2.2	2.0	1.9	1.9
35–44	2.3	2.1	2.1	2.0
45–54	2.4	2.3	2.1	2.1
55–64	2.7	2.4	2.3	2.3
65–74	3.4	3.1	2.8	2.6
75–84	4.3	3.7	3.5	3.3
85+	4.7	4.3	4.6	4.4
Race/ethnicity				
White	2.6	2.4	2.2	2.1
Black	3.5	3.4	3.1	3.1
Asian/Pacific Islander	2.8	3.1	2.6	2.7
Hispanic	2.9	2.7	2.6	2.4
Other	3.9	2.4	2.5	2.3
Region				
Midwest	2.4	2.2	2.1	1.9
Northeast	3.1	2.7	2.5	2.4
South	2.6	2.3	2.3	2.3
West	2.4	2.4	2.2	2.3
MSA				
Rural	2.4	2.1	2.0	1.9
Urban	2.7	2.5	2.4	2.3
Primary payor				
Medicare	3.9	3.3	3.1	3.0
Medicaid	3.5	3.2	2.9	2.7
Private insurance/HMO	2.2	2.0	2.0	1.9
Self-pay	2.2	2.1	2.0	2.0
No charge	*	2.3	2.6	2.7
Other	2.6	2.3	2.3	2.3

MSA, metropolitan statistical area; HMO, health maintenance organization.
*Figure does not meet standard for reliability or precision.
SOURCE: Healthcare Cost and Utilization Project Nationwide Inpatient Sample, 1994, 1996, 1998, 2000.

is more challenging than it is in the older pediatric population. As in the adult population, mean LOS of African Americans was consistently longer than that of other racial/ethnic groups.

When stratified by ethnicity, mean LOS in the HCUP database was consistently lowest for Caucasians and highest for African Americans (Table 8). Geographic variation was less pronounced, but mean LOS was marginally highest in the Northeast for all years analyzed and lowest in the Midwest in 1996, 1998, and 2000. Mean LOS was consistently higher in urban than in rural areas.

When LOS was stratified by payor, private insurance/HMO and self-pay groups were associated with the shortest LOS (Table 8). Moreover, these two groups with comparable LOS showed little variation in mean LOS over the years studied. The Medicare group had the highest LOS in each of the years analyzed, likely due to their more advanced age. However, Medicare patients demonstrated the most-pronounced reduction in LOS over time, dropping 23% between 1994 (3.9 days) and 2000 (3.0 days); the Medicaid group likewise showed a similar reduction in LOS, but their overall LOS was shorter than that of the Medicare group.

Lower Tract Stones: Procedures

During hospital admission for urolithiasis, a variety of procedures may be performed, including radiographic studies, drainage procedures for relief of obstruction (i.e., placement of a ureteral stent or percutaneous nephrostomy), or surgical procedures to remove stones. Although most surgical interventions for stone disease are minimally invasive treatments performed on an outpatient basis, some procedures typically used for outpatients may be performed during inpatient admission for an acute stone event to provide definitive treatment after the patient is stabilized. Alternatively, some procedures for stone removal, such as percutaneous nephrostolithotomy, are associated with a short hospital stay. The numbers and rates of procedures performed during inpatient hospitalization on patients with a primary diagnosis of urolithiasis (both upper and lower tract stones) in 1994, 1996, 1998, and 2000, derived from the Center for Health Care Policy and Evaluation, are shown in Table 10. Although the total number of procedures increased from 1994 to 1998, the rate decreased (from

Table 9. Trends in mean inpatient length of stay (days) for children hospitalized with urolithiasis listed as primary diagnosis (95% CI)

	1999		2000		2001	
	Count	Length of Stay	Count	Length of Stay	Count	Length of Stay
Total	461	3.1 (2.7–3.6)	553	2.8 (2.6–3.1)	619	3.2 (2.7–3.8)
Age						
0–2	43	7.5 (3.8–11.2)	45	4.8 (3.2–6.4)	37	6.2 (4.2–8.2)
3–10	193	2.8 (2.4–3.2)	198	2.6 (2.3–2.9)	225	2.9 (2.4–3.4)
11–17	225	2.6 (2.3–2.9)	310	2.7 (2.3–3.1)	357	3.1 (2.2 - 4.1)
Race/ethnicity						
White	338	3.1 (2.6–3.6)	385	2.7 (2.4–3.0)	447	2.8 (2.5–3.1)
Black	31	3.4 (1.9–5.0)	34	3.7 (2.5–4.8)	38	4.1 (1.8–6.3)
Asian	1	4.0	3	1.3 (0–2.8)	2	1.5 (0–7.8)
Hispanic	36	3.1 (2.4–3.8)	51	2.8 (2.0–3.5)	78	3.4 (2.6–4.1)
N. American Native	0		3	2.7 (0–5.5)	1	2.0
Other	17	2.4 (1.2–3.5)	21	2.4 (1.5–3.3)	32	8.6 (0–18.6)
Missing	38	3.6 (2.5–4.6)	56	3.6 (2.4–4.7)	21	2.9 (2.1–3.6)
Gender						
Male	261	3.0 (2.5–3.6)	280	2.8 (2.4–3.2)	312	3.0 (2.5–3.4)
Female	200	3.3 (2.6–4.0)	273	2.8 (2.4–3.2)	307	3.5 (2.4–4.5)
Region						
Midwest	160	3.3 (2.4–4.3)	197	2.7 (2.2–3.2)	199	3.2 (1.6–4.8)
Northeast	24	2.5 (1.7–3.2)	39	2.5 (2.0–3.0)	56	2.6 (2.1–3.1)
South	203	3.0 (2.5–3.5)	246	2.8 (2.4–3.2)	287	3.0 (2.6–3.4)
West	61	3.2 (2.4–4.2)	50	3.3 (2.0–4.7)	77	4.4 (3.0–5.7)
Missing	13	3.9 (2.0–5.8)	21	3.9 (2.5–5.3)	0	

SOURCE: National Association of Children's Hospitals and Related Institutions, 1999–2001.

25 per 100,000 to 22 per 100,000) but then increased in 2000 to the 1994 level. The reasons for these trends in the rates of procedures are not clear from these data; further analysis of the types of procedures performed is required. In all years of study, the rates of procedures increased with age to a maximum in the 55- to 64-year age group. Beyond that age, procedure counts in this database were too small to be reliable. Also, differences in sampling strategies in the datasets analyzed may have contributed to differences in estimates of the burden of stone disease.

Lower Tract Stones: Hospitalization Rates

Inpatient hospitalizations for lower tract stones, primarily bladder stones, demonstrated greater stability over time than did those for upper tract stones. According to data derived from HCUP, the absolute number and the rate of inpatient hospitalizations both remained stable from 1994 to 2000, with rates of 2.5 to 3.3 hospitalizations per 100,000 population (Table 11). For all years of study, hospitalization rates were highest in the 85+ age group, although they increased substantially after age 64—by 2.5 to 5 times—likely reflecting the higher prevalence of bladder stones in the older male population with bladder outlet obstruction. When rates in HCUP were age-adjusted, they remained fairly stable across racial/ethnic, geographic, and rural/urban groups; however, male-to-female ratios dropped from 2:3 to 3:4. (Table 12).

The Medicare population represented in the CMS database experienced a 30% decrease in hospitalization rate for lower tract stones between 1992 and 1998 (from 10 per 100,000 to 7 per 100,000), with a 43% to 60% higher rate of hospitalization in the

Table 10. Inpatient procedures for individuals having commercial health insurance with urolithiasis listed as primary diagnosis, count[a], rate[b]

	1994		1996		1998		2000	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate
Total	272	25	375	24	539	22	682	25
Age								
< 3	1	*	1	*	3	*	4	*
3–10	2	*	0	0	4	*	7	*
11–17	2	*	1	*	7	*	10	*
18–24	7	*	22	*	34	15	46	18
25–34	47	25	69	25	104	25	133	30
35–44	61	28	112	34	144	28	160	29
45–54	93	59	105	43	145	36	175	37
55–64	49	65	54	46	79	39	126	52
65–74	10	*	10	*	17	*	16	*
75–84	0	0	1	*	2	*	5	*
85+	0	0	0	0	0	0	0	0
Gender								
Male	172	33	230	29	323	26	394	29
Female	100	18	145	18	216	18	288	21
Region								
Midwest	177	27	226	25	237	20	325	24
Northeast	31	20	29	*	44	22	42	26
Southeast	53	27	113	26	243	26	305	28
West	11	*	7	*	15	*	10	*

*Figure does not meet standard for reliability or precision.
[a]Counts less than 30 should be interpreted with caution.
[b]Rate per 100,000 based on member months of enrollment in calendar year for individuals in the same demographic stratum.
SOURCE: Center for Health Care Policy and Evaluation, 1994, 1996, 1998, 2000.

≥65 age group than in the <65 age group (Table 13). Given the higher frequency of bladder stones in men, the rate of hospitalization, not surprisingly, was 6 to 9 times higher in men than in women. Geographic variation was also evident, with rates highest in the Northeast and lowest in the West. Racial/ethnic variation was less consistent, with the highest rates occurring among Hispanics in 1995 and among African Americans in 1998. When the CMS data were age-adjusted, hospitalization rates among Hispanics dropped by 33% in 1995 and rose by 50% in 1998, underscoring the inconsistency in racial/ethnic group differences. Age-adjustment did not affect gender or geographic group comparisons.

Lower Tract Stones: Length of Stay

Similar to the trend observed with upper tract stones, the mean LOS for lower tract stones declined steadily over time, decreasing by 15% from a mean of 3.4 days in 1994 to 2.9 days in 2000 (Table 14). No clear trends with regard to age-specific LOS were discerned except that mean LOS was highest in the 85+ age group. Stratification of LOS by geographic region revealed that the lowest mean LOS occurred in the West. As observed with the upper tract stone data, LOS for lower tract stones was lower in the private pay/HMO and self-pay groups than in the Medicare groups.

Table 11. Inpatient hospital stays by individuals with lower tract urolithiasis listed as primary diagnosis, count, rate[a] (95% CI)

	1994		1996		1998		2000	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate
Total[b]	8,280	3.3 (3.0–3.5)	7,852	3.0 (2.7–3.2)	6,700	2.5 (2.3–2.7)	7,180	2.6 (2.4–2.8)
Age								
< 18	*	*	*	*	*	*	*	*
18–24	166	0.7 (0.4–0.9)	237	1.0 (0.6–1.4)	*	*	164	0.6 (0.4–0.8)
25–34	511	1.3 (1.0–1.6)	325	0.8 (0.6–1.0)	303	0.8 (0.6–1.0)	335	0.9 (0.7–1.1)
35–44	598	1.5 (1.2–1.8)	562	1.3 (1.0–1.6)	460	1.0 (0.8–1.3)	425	1.0 (0.8–1.2)
45–54	798	2.8 (2.2–3.4)	627	2.0 (1.6–2.3)	638	1.9 (1.5–2.3)	598	1.6 (1.4–1.9)
55–64	1,094	5.4 (4.6–6.3)	1,022	5.0 (4.1–5.7)	904	4.1 (3.5–4.7)	950	4.1 (3.4–4.7)
65–74	2,565	14 (13–16)	2,347	13 (11–15)	1,775	9.9 (8.7–11)	1,883	11 (9–12)
75–84	1,767	18 (16–21)	2,015	19 (17–21)	1,851	16 (15–18)	2,055	18 (16–19)
85+	585	21 (17–26)	613	22 (17–27)	507	17 (14–21)	662	21 (17–25)
Race/ethnicity								
White	5,538	3.0 (2.7–3.2)	5,551	2.9 (2.6–3.2)	4,212	2.2 (2.0–2.4)	4,521	2.3 (2.1–2.6)
Black	488	1.5 (1.2–1.9)	473	1.4 (1.1–1.8)	393	1.2 (0.9–1.4)	403	1.2 (0.9–1.5)
Asian/Pacific Islander	*	*	*	*	*	*	*	*
Hispanic	435	1.7 (1.3–2.1)	441	1.6 (1.1–2.0)	443	1.4 (1.1–1.8)	451	1.4 (1.0–1.8)
Gender								
Male	6,784	5.5 (5.0–6.0)	6,735	5.2 (4.7–5.8)	5,700	4.4 (4.0–4.7)	6,151	4.6 (4.2–5.0)
Female	1,495	1.2 (1.0–1.3)	1,110	0.8 (0.7–1.0)	999	0.7 (0.6–0.8)	1,029	0.7 (0.6–0.8)
Region								
Midwest	1,796	3.0 (2.6–3.4)	1,315	2.1 (1.8–2.4)	1,591	2.5 (2.2–2.9)	1,654	2.6 (2.3–2.9)
Northeast	2,259	4.4 (3.6–5.2)	2,332	4.5 (3.7–5.4)	1,727	3.4 (2.9–3.9)	1,928	3.7 (3.1–4.3)
South	3,032	3.6 (3.2–4.0)	2,865	3.1 (2.7–3.6)	2,300	2.4 (2.2–2.7)	2,356	2.5 (2.1–2.8)
West	1,192	2.1 (1.7–2.6)	1,340	2.3 (1.9–2.7)	1,082	1.8 (1.5–2.1)	1,242	2.0 (1.6–2.4)
MSA								
Rural	1,469	2.3 (1.9–2.7)	1,171	2.0 (1.6–2.3)	914	1.5 (1.2–1.8)	1,142	1.9 (1.5–2.3)
Urban	6,803	3.6 (3.3–3.9)	6,673	3.3 (3.0–3.6)	5,763	2.8 (2.6–3.0)	6,038	2.8 (2.6–3.1)

*Figure does not meet standards for reliability or precision.

MSA, metropolitan statistical area.

[a]Rate per 100,000 based on 1994, 1996, 1998, 2000 population estimates from Current Population Survey (CPS), CPS Utilities, Unicon Research Corporation, for relevant demographic categories of US civilian non-institutionalized population.

[b]Persons of other races, missing or unavailable race and ethnicity, and missing MSA are included in the totals.

NOTE: Counts may not sum to totals due to rounding.

SOURCE: Healthcare Cost and Utilization Project Nationwide Inpatient Sample, 1994, 1996, 1998, 2000.

Table 12. Inpatient hospital stays by individuals with lower tract urolithiasis listed as primary diagnosis, age-adjusted count, age-adjusted rate[a] (95% CI)

	1994		1996		1998		2000	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate
Total[b]	5,852	2.3 (2.1–2.5)	5,379	2.0 (1.8–2.2)	4,725	1.8 (1.6–1.9)	4,842	1.8 (1.6–1.9)
Race/ethnicity								
White	3,795	2.0 (1.8–2.2)	3,619	1.9 (1.7–2.1)	2,789	1.5 (1.3–1.6)	2,907	1.5 (1.4–1.7)
Black	390	1.2 (0.9–1.5)	378	1.2 (0.8–1.5)	347	1.0 (0.8–1.3)	297	0.9 (0.6–1.1)
Asian/Pacific Islander	*	*	*	*	*	*	*	*
Hispanic	390	1.5 (1.1–1.9)	409	1.4 (1.0–1.9)	375	1.2 (0.9–1.5)	415	1.3 (0.9–1.6)
Gender								
Male	4371	3.6 (3.2–3.9)	4194	3.3 (2.9–3.5)	3,672	2.8 (2.6–3.0)	3,785	4.6 (4.2–5.0)
Female	1480	1.1 (1.0–1.3)	1181	0.9 (0.7–1.0)	1,053	0.8 (0.6–0.9)	1,058	0.7 (0.6–0.8)
Region								
Midwest	1,287	2.1 (1.8–2.5)	893	1.4 (1.2–1.7)	1,137	1.8 (1.5–2.1)	1,131	1.8 (1.5–2.0)
Northeast	1,538	3.0 (2.4–3.6)	1,513	2.9 (2.4–3.5)	1,192	2.3 (1.9–2.7)	1,176	2.3 (1.9–2.6)
South	2,167	2.5 (2.2–2.9)	2,034	2.2 (1.9–2.6)	1,627	1.7 (1.5–1.9)	1,661	1.7 (1.5–2.0)
West	860	1.5 (1.1–1.9)	938	1.6 (1.3–1.9)	769	1.3 (1.0–1.6)	874	1.4 (1.1–1.7)
MSA								
Rural	1,081	1.7 (1.3–2.0)	812	1.4 (1.0–1.7)	662	1.1 (0.9–1.3)	826	1.4 (1.1–1.7)
Urban	4,761	2.5 (2.3–2.8)	4,556	2.2 (2.0–2.5)	4,046	2.0 (1.8–2.1)	4,017	1.9 (1.7–2.0)

*Figure does not meet standards for reliability or precision.

MSA, metropolitan statistical area.

[a]Rate per 100,000 based on 1994, 1996, 1998, 2000 population estimates from Current Population Survey (CPS),CPS Utilities, Unicon Research Corporation, for relevant demographic categories of US civilian non-institutionalized population; age-adjusted to the 2000 US Census.

[b]Persons of other races, missing or unavailable race and ethnicity, and missing MSA are included in the totals.

NOTE: Counts may not sum to totals due to rounding.
SOURCE: Healthcare Cost and Utilization Project Nationwide Inpatient Sample, 1994, 1996, 1998, 2000.

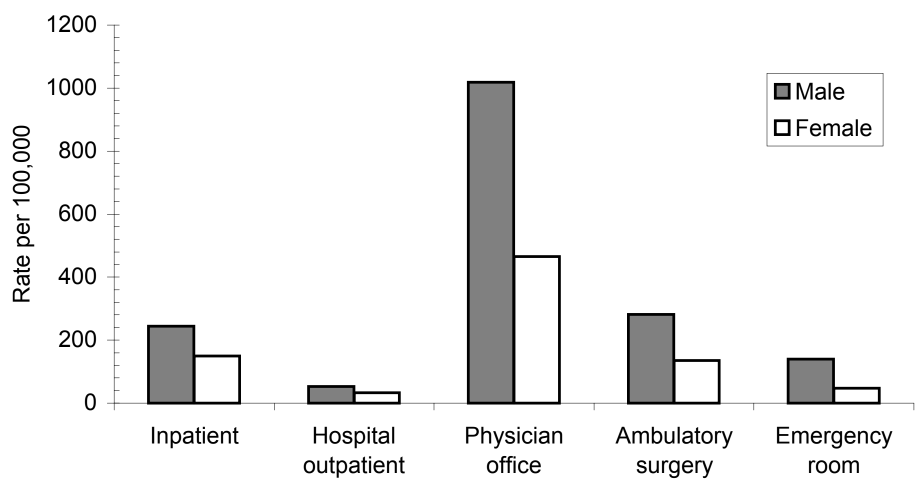

Figure 5. Rates of visits for urolithiasis by gender and site of service, 1998.

SOURCE: Centers for Medicaid and Medicare Services, 1998.

Table 13. Inpatient stays by Medicare beneficiaries with lower tract urolithiasis listed as primary diagnosis, count[a], rate[b] (95% CI), age-adjusted rate[c] (95% CI)

	1992			1995			1998		
	Count	Rate	Age-Adjusted Rate	Count	Rate	Age-Adjusted Rate	Count	Rate	Age-Adjusted Rate
Total[d]	3,460	10 (9.7–10)	10	3,280	9.3 (8.9–9.6)	9.3	2,360	7.0 (6.8–7.3)	7.0
Total < 65	380	6.9 (6.2–7.6)		400	6.5 (5.9–7.2)		280	4.5 (4.0–5.0)	
Total 65+	3,080	11 (10–11)		2,880	9.8 (9.5–10)		2,080	7.6 (7.3–7.9)	
Age									
65–74	1,760	11 (10–11)		1,280	7.9 (7.5–8.3)		800	5.6 (5.2–6.0)	
75–84	1,080	11 (11–12)		1,220	13 (12–13)		1,080	11 (11–12)	
85–94	240	8.4 (7.3–9.4)		380	12 (11–14)		180	5.8 (5.0–6.7)	
95+	0	0		0	0		20	5.0 (2.8–7.3)	
Race/ethnicity									
White	2,880	9.9 (9.5–10)	10	2,840	9.4 (9.0–9.7)	9.4	2,020	7.1 (6.8–7.4)	7.0
Black	300	10 (9.0–11)	9.5	320	9.9 (8.8–11)	11	280	9.0 (8.0–10.1)	9.7
Asian	…	…	…	20	12 (6.6–17)	12	0	0	0
Hispanic	…	…	…	60	15 (11–19)	10	40	5.7 (4.0–7.4)	8.5
N. American Native	…	…	…	0	0	0	0	0	0
Gender									
Male	2,840	19 (19–20)	20	2,920	19 (18–20)	19	2,020	14 (13–15)	14
Female	620	3.1 (2.9–3.4)	2.8	360	1.8 (1.6–2.0)	1.8	340	1.8 (1.6–2.0)	1.8
Region									
Midwest	620	7.1 (6.5–7.7)	7.3	720	8.0 (7.4–8.6)	7.1	640	7.4 (6.8–8.0)	7.4
Northeast	960	12 (12–13)	12	960	13 (12–13)	12	520	7.8 (7.1–8.4)	7.5
South	1,340	11 (10–12)	12	1,220	9.6 (9.1–10)	10	900	7.3 (6.8–7.7)	7.3
West	500	9.8 (8.9–11)	8.6	300	5.8 (5.1–6.4)	6.2	240	4.8 (4.2–5.4)	4.8

… data not available.
[a]Unweighted counts multiplied by 20 to arrive at values in the table.
[b]Rate per 100,000 Medicare beneficiaries in the same demographic stratum.
[c]Age-adjusted to the US Census-derived age distribution of the year under analysis.
[d]Persons of other races, unknown race and ethnicity, and other region are included in the totals.
NOTE: Counts less than 600 should be interpreted with caution.
SOURCE: Centers for Medicare and Medicaid Services, MedPAR and 5% Carrier File, 1992, 1995, 1998.

Table 14. Trends in mean length of stay (days) for individuals hospitalized with lower tract urolithiasis listed as primary diagnosis

	Length of Stay			
	1994	1996	1998	2000
Total	3.4	3.3	3.2	2.9
Age				
< 18	*	*	*	*
18–24	3.5	2.7	*	2.3
25–34	2.8	2.7	2.5	2.4
35–44	2.4	2.3	2.8	2.6
45–54	2.9	3.6	3.0	2.5
55–64	2.8	2.5	2.7	2.2
65–74	3.5	3.0	3.1	2.8
75–84	3.6	3.6	3.4	3.4
85+	5.3	5.7	4.7	4.0
Race/ethnicity				
White	3.4	3.2	3.1	2.9
Black	3.5	4.2	4.8	4.1
Asian/Pacific Islander	*	*	*	*
Hispanic	3.2	4.3	3.2	3.6
Other	*	*	*	*
Region				
Midwest	3.4	3.2	3.3	2.7
Northeast	4.0	3.7	3.3	3.1
South	3.2	3.2	3.2	3.1
West	2.5	2.9	2.8	2.7
MSA				
Rural	3.2	2.9	3.2	2.9
Urban	3.4	3.4	3.2	3.0
Primary payor				
Medicare	3.8	3.7	3.6	3.2
Medicaid	3.9	3.8	4.3	3.5
Private insurance/HMO	2.7	2.3	2.3	2.2
Self-pay	2.6	2.5	2.6	2.7
No charge	*	…	*	*
Other	3.3	*	*	3.0

… data not available.

*Figure does not meet standard for reliability or precision.

MSA, metropolitan statistical area; HMO, health maintenance organization.

SOURCE: Healthcare Cost and Utilization Project Nationwide Inpatient Sample, 1994, 1996, 1998, 2000.

Outpatient Care

An individual may be seen in the outpatient setting as part of the diagnosis of urolithiasis, during urologic treatment (pre- and/or post-procedure), or for medical evaluation and prevention. We have chosen to focus on visits for which urolithiasis (upper and lower tract stones) was the primary diagnosis, except where noted.

Hospital Outpatient Visits: NHAMCS Data

The rates for hospital outpatient visits by patients with urolithiasis as the primary reason for the visit, based on National Hospital Ambulatory Medical Care Survey (NHAMCS) data for the period 1994 to 2000, are presented in Table 15. The estimated rate in 2000 was 40% higher than that in 1994 (63 vs 45 per 100,000); however, the overlapping confidence intervals preclude definitive inferences. The rate for 1996 seems implausibly low. Overall, the absolute number of hospital outpatient visits during this period increased from 114,687 to 171,784.

Information on hospital outpatient visits is also available from Medicare data for 1992, 1995, and 1998 (Table 16). The Medicare data provide more detail than do the NHAMCS data. The visit rate in Medicare patients increased slightly from 1992 to 1998, both for those under 65 and for those 65 years of age and older. For example, in the older group, the rate increased from 28 per 100,000 in 1992 to 36 per 100,000 in 1998. The visit rate decreased with increasing age, and the rates were approximately twice as high in men as in women (Figure 5). Rates were lowest in the South in 1992 and 1995 and in the West in 1998. Rates were

Table 15. Hospital outpatient visits by individuals with urolithiasis, count, rate[a] (95% CI)

	Primary Reason for Visit		Any Reason for Visit	
	Count	Rate	Count	Rate
1994	114,687	45 (29–62)	130,704	52 (34–69)
1996	31,666	12 (6–18)	68,343	26 (13–40)
1998	83,383	31 (14–48)	138,576	52 (30–74)
2000	171,784	63 (34–92)	300,073	110 (69–151)

[a]Rate per 100,000 based on 1994, 1996, 1998, 2000 population estimates from Current Population Survey (CPS), CPS Utilities, Unicon Research Corporation, for relevant demographic categories of US civilian non-institutionalized population.

SOURCE: National Hospital Ambulatory Medical Care Survey—Outpatient, 1994, 1996, 1998, 2000.

Table 16. Outpatient hostpial visits by Medicare beneficiaries with upper and/or lower tract urolithiasis listed as primary diagnosis, count[a], rate[b] (95% CI), age-adjusted rate[c] (95% CI)

	1992			1995			1998		
	Count	Rate	Age-Adjusted Rate	Count	Rate	Age-Adjusted Rate	Count	Rate	Age-Adjusted Rate
Total[d]	10,980	32 (31–32)	32	13,320	38 (37–38)	38	13,920	42 (41–42)	42
Total < 65	2,700	49 (47–51)		3,480	57 (55–59)		4,020	65 (63–67)	
Total 65+	8,280	28 (28–29)		9,840	34 (33–34)		9,900	36 (36–37)	
Age									
65–74	5,100	31 (30–32)		5,960	37 (36–38)		6,660	46 (45–48)	
75–84	2,840	30 (29–31)		3,280	34 (33–35)		2,780	29 (28–30)	
85–94	300	10 (9.3–12)		560	18 (17–20)		360	12 (10–13)	
95+	40	12 (8.3–16)		40	11 (7.7–14)		100	25 (20–30)	
Race/ethnicity									
White	8,060	28 (27–28)	28	10,440	34 (34–35)	34	10,560	37 (36–38)	37
Black	1,920	65 (62–68)	65	1,900	59 (56–62)	57	1,820	59 (56–61)	59
Asian	…	…	…	120	72 (59–84)	72	220	70 (61–79)	70
Hispanic	…	…	…	320	80 (71–89)	80	620	88 (81–95)	85
N. American Native	…	…	…	…	…	…	80	148 (115–181)	148
Gender									
Male	5,780	39 (38–40)	41	8,020	53 (52–54)	53	7,620	53 (51–54)	52
Female	5,200	26 (26–27)	25	5,300	26 (26–27)	26	6,300	33 (32–34)	33
Region									
Midwest	3,460	40 (38–41)	39	3,580	40 (38–41)	40	3,800	44 (43–45)	44
Northeast	2,500	32 (31–34)	33	3,860	50 (49–52)	52	3,720	56 (54–57)	53
South	2,560	21 (20–22)	22	3,660	29 (28–30)	28	4,560	37 (36–38)	37
West	2,040	40 (38–42)	39	1,880	36 (35–38)	37	1,720	35 (33–36)	36

… data not available.
[a]Unweighted counts were multiplied by 20 to arrive at values in the table.
[b]Rate per 100,000 Medicare beneficiaries in the same demographic stratum.
[c]Age-adjusted to the US Census-derived age distribution of the year under analysis.
[d]Persons of other races, unknown race and ethnicity, and other region are included in the totals.
NOTE: Counts less than 600 should be interpreted with caution.
SOURCE: Centers for Medicare and Medicaid Services, 5% Carrier and Outpatient Files, 1992, 1995, 1998.

Table 17. Physician office visits by individuals with urolithiasis, count, rate[a] (95% CI)

	1992		1994		1996		1998		2000	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate	Count	Rate
					Primary Reason for Visit					
Total	949,581	379 (234–524)	1,002,487	397 (265–528)	924,895	351 (236–466)	1,289,692	481 (321–641)	1,825,123	668 (464–871)
Age										
< 54	669,280	337 (172–501)	630,282	311 (176–447)	554,821	263 (159–367)	661,079	309 (184–434)	1,184,522	545 (319–771)
55+	*	*	372,205	738 (366–1,111)	*	*	*	*	640,601	1,143 (677–1,610)
					Any Reason for Visit					
Total	1,242,509	496 (334–658)	1,275,273	504 (361–647)	1,374,098	521 (370–673)	1,497,817	558 (391–725)	2,382,217	872 (641–1,102)
Age										
< 54	748,240	376 (203–550)	797,164	394 (247–541)	751,502	356 (223–490)	745,868	349 (217–481)	1,582,354	728 (467–989)
55+	494,269	956 (540–1,371)	478,109	948 (542–1,355)	622,596	1,184 (643–1,725)	751,949	1,385 (743–2,026)	799,863	1,428 (941–1,914)

*Figure does not meet standard for reliaiblity or precision.

[a]Rate per 100,000 based on 1992, 1994, 1996, 1998, 2000 population estimates from Current Population Survey (CPS), CPS Utilities, Unicon Research Corporation, for relevant demographic categories of US adult civilian non-institutionalized population.

NOTE: Counts may not sum to totals due to rounding.

SOURCE: National Ambulatory Medical Care Survey, 1992, 1994, 1996, 1998, 2000.

highest for Hispanics in 1995; in 1998 North American Natives appeared to have a substantially higher rate, but this difference is so dramatic that it must be interpreted with caution. Age-adjustment of the CMS data did not alter the relative differences in racial/ethnic, gender, or geographic group comparisons.

Physician Office Visits: NAMCS Data

Physician office visit rates for patients with a primary diagnosis of urolithiasis were determined from National Ambulatory Medical Care Survey (NAMCS) data for the even years between 1992 and 2000 (Table 17). The rates were stable between 1992 and 1996, then increased in 1998 and 2000. The visit rate was 43% higher in 2000 than it was in 1992. Small cell sizes preclude interpretation of age-specific rates, and no gender-specific information is available. The total number of visits nearly doubled between 1992 and 2000, increasing from 950,000 to 1,825,000.

Physician Office Visits: Medicare Data

In the Medicare data for 1992, 1995, and 1998, physician office visit rates increased 41% between 1992 to 1998 for those <65 years of age and 25% for those ≥65 (Table 18). The rates peaked in the 65-to 74-year age group and then declined. Rates were highest in the South. In 1995 and 1998, the rates were higher for Hispanics than for Asians and Caucasians, and rates were lowest for African Americans. When the CMS data were age-adjusted, the gender gap in physician office visit rates slightly widened in all three years of study, but the relative differences in geographic and racial/ethnic group comparisons did not change.

Physician Office Visits: VA Data—Adult Outpatients

A few general comments are in order before discussing the Veterans Health Administration (VA) data. Despite the clear differences in rates by age and race indicated by the data, the data have not been age- or race-standardized (see Methods chapter), except where indicated. Although we use the term rate for the VA data, the data represent the number of cases being seen for the specified condition per 100,000 unique VA outpatients; 95% confidence intervals are not available for the VA rates reported here.

The rates for outpatient visits by VA patients with a primary diagnosis of urinary tract stones decreased between 1999 and 2001 (Table 19). This decrease occurred for both upper tract and lower tract stones; the rate for upper tract stones was nearly 10 times that for lower tract stones.

The visit rate was highest in the 55- to 64-year age group for upper tract stones. The rate in the 85+ group is impressive, but it is not simply a reflection of bladder stones being more common (Table 19). The rate for males was 50 percent higher than that for females, and Hispanics as a group had the highest rates. There were also regional differences, with the highest rates occurring in the South.

The VA is one of the few sources that provides information specifically for bladder stones. The visit rate for a primary diagnosis of bladder stones decreased slightly, from 45 per 100,000 in 1999 to 38 per 100,000 in 2001 (Table 20). Two-thirds of the visits for lower tract stones in 2001 were for bladder stones. The visit rate was higher in the 55+ group than in the <55 group, but there was no further increase with age. No regional differences were observed.

Physician Office and Hospital Outpatient Visits Combined

Combined NAMCS and NHAMCS data revealed nearly 2 million visits in 2000 by patients with urolithiasis as the primary reason for the visit. This translates into a rate of 731 per 100,000 population. There were 2.7 million visits by patients with urolithiasis listed as any of the reasons for the visit (982 per 100,000 population). Thus, the vast majority of visits for urolithiasis (74%) are for urolithiasis as the primary diagnosis (Tables 15 and 17).

Ambulatory Surgery Procedures

Visits to an ambulatory surgery center by individuals with commercial insurance who had a primary diagnosis of urolithiasis (upper or lower tract stones) were tabulated for 1994, 1996, 1998, and 2000 from the Center for Health Care Policy and Evaluation Database (Table 21). The total number of visits increased more than fourfold between 1994 and 1998, and the rate of visits increased by 58% (from 117 to 185 per 100,000). These findings reflect the trend of moving outpatient surgical treatment from hospitals to ambulatory care centers to avoid the high overhead cost associated with hospital-based outpatient surgery. However, the data do not represent all outpatient procedures performed in a population, since many

Table 18. Physician office visits by Medicare beneficiaries with upper and/or lower tract urolithiasis listed as primary diagnosis, count[a], rate[b] (95% CI), age-adjusted rate[c] (95% CI)

	1992			1995			1998		
	Count	Rate	Age-Adjusted Rate	Count	Rate	Age-Adjusted Rate	Count	Rate	Age-Adjusted Rate
Total[d]	178,320	516 (514–519)	516	221,220	625 (622–627)	625	235,920	704 (701–706)	704
Total < 65	20,800	380 (375–385)		34,000	554 (549–560)		39,680	639 (632–645)	
Total 65+	157,520	542 (539–545)		187,220	640 (637–643)		196,240	718 (715–721)	
Age									
65–74	106,340	647 (643–651)		123,640	764 (760–768)		122,760	857 (852–862)	
75–84	44,400	471 (466–475)		55,440	575 (570–580)		63,460	668 (663–673)	
85–94	6,560	229 (223–234)		7,920	258 (252–263)		9,480	307 (301–313)	
95+	220	66 (57–74)		220	60 (52–68)		540	136 (124–147)	
Race/ethnicity									
White	157,460	539 (537–542)	538	200,800	662 (659–664)	661	209,780	738 (735–742)	738
Black	9,660	326 (320–333)	321	10,440	324 (318–330)	316	11,840	382 (375–389)	375
Asian	…	…	…	1,020	610 (573–647)	646	2,560	815 (784–847)	828
Hispanic	…	…	…	3,100	776 (749–803)	821	5,840	830 (809–852)	845
N. American Native	…	…	…	120	331 (273–389)	276	260	481 (422–540)	481
Gender									
Male	109,560	744 (740–748)	756	139,220	915 (910–920)	925	147,360	1,018 (1,013–1,023)	1,031
Female	68,760	347 (344–350)	338	82,000	406 (404–409)	399	88,560	465 (462–468)	454
Region									
Midwest	37,560	430 (426–435)	430	46,920	521 (516–525)	523	51,180	593 (588–598)	594
Northeast	37,700	489 (484–494)	482	47,600	620 (615–626)	612	47,560	710 (704–717)	704
South	72,240	591 (587–595)	596	88,220	694 (689–699)	699	100,020	808 (803–813)	814
West	26,500	520 (514–526)	518	32,580	629 (622–635)	624	30,060	607 (600–614)	597

… data not available.
[a]Unweighted counts were multiplied by 20 to arrive at values in the table.
[b]Rate per 100,000 Medicare beneficiaries in the same demographic stratum.
[c]Age-adjusted to the US Census-derived age distribution of the year under analysis..
[d]Persons of other races, unknown race and ethnicity, and other region are included in the totals.
NOTE: Counts less than 600 should be interpreted with caution.
SOURCE: Centers for Medicare and Medicaid Services, 5% Carrier and Outpatient Files, 1992, 1995, 1998.

Table 19. Frequency of upper and/or lower tract urolithiasis[a] listed as primary diagnosis in VA patients seeking outpatient care, count[b], rate[c]

	Upper Tract Stones						Lower Tract Stones					
	1999		2000		2001		1999		2000		2001	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate	Count	Rate	Count	Rate
Total	18,584	611	19,246	587	20,717	561	2,051	67	2,113	64	2,107	54
Age												
18–24	66	261	69	293	77	334	5	20	3	13	3	13
25–34	790	524	736	518	774	570	44	29	35	25	50	37
35–44	1,909	578	1,786	572	1,661	554	121	37	119	38	86	29
45–54	5,224	758	5,492	766	5,636	748	355	52	357	50	361	48
55–64	4,080	813	4,406	795	5,167	796	392	78	411	74	438	68
65–74	4,222	556	4,326	524	4,596	483	614	81	625	76	599	63
75–84	2,165	404	2,294	357	2,602	325	474	88	511	79	520	65
85+	128	261	137	235	204	260	46	94	52	89	50	64
Race/ethnicity												
White	11,484	841	11,692	794	12,268	762	1,406	103	1,338	91	1,312	81
Black	1,482	444	1,538	449	1,667	470	205	61	243	71	254	72
Hispanic	1,222	1,068	1,295	1,057	1,183	918	108	94	112	91	127	99
Other	143	739	126	622	151	692	10	52	14	69	9	41
Unknown	4,253	353	4,595	348	5,448	346	322	27	406	31	405	26
Gender												
Male	18,079	624	18,682	598	20,088	570	1,998	69	2,068	66	2,061	58
Female	505	358	564	374	629	381	53	38	45	30	46	28
Region												
Midwest	3,717	541	3,790	509	3,799	459	432	63	505	68	424	51
Northeast	3,890	530	3,934	505	4,251	489	575	78	503	65	533	61
South	7,179	705	7,565	678	8,099	626	654	64	701	63	737	57
West	3,798	632	3,957	623	4,568	653	390	65	401	63	413	59
Insurance status												
No insurance/self-pay	11,434	626	11,574	639	12,186	640	1,108	61	1,085	60	1,063	56
Medicare/Medicare supplemental	4,059	583	4,575	500	5,382	455	650	93	729	80	793	67
Medicaid	41	828	61	772	61	679	6	121	6	76	7	78
Private insurance/ HMO/PPO	2,849	587	2,786	546	2,833	512	275	57	270	53	226	41
Other insurance	186	736	237	824	236	708	10	40	19	66	17	51
Unknown	15	785	13	529	19	210	2	105	4	163	1	11

HMO, health maintenance organization; PPO, preferred provider organization.

[a]Represents diagnosis codes for urolithiasis.

[b]The term count is used to be consistent with other UDA tables; however, the VA tables represent the population of VA users and thus are not weighted to represent national population estimates.

[c]Rate is defined as the number of unique patients with each condition divided by the base population in the same fiscal year x 100,000 to calculate the rate per 100,000 unique outpatients.

NOTE: Race/ethnicity data from clinical observation only, not self-report; note large number of unknown values.

SOURCE: Outpatient Clinic File (OPC), VA Austin Automation Center, 1999–2001.

Table 20. Frequency of bladder stones[a] listed as primary diagnosis in VA patients seeking outpatient care, count[b], rate[c]

	1999		2000		2001	
	Count	**Rate**	**Count**	**Rate**	**Count**	**Rate**
Total	1,188	45	1,282	44	1,255	38
Age						
40–44	26	14	37	21	20	12
45–54	186	28	179	26	174	24
55–64	242	49	258	48	262	41
65–74	387	52	426	52	412	44
75–84	315	61	347	55	352	45
85+	32	70	35	62	35	46
Race/ethnicity						
White	847	68	815	61	792	53
Black	102	36	155	53	152	50
Hispanic	55	53	64	57	82	69
Other	5	29	9	50	7	36
Unknown	179	18	239	21	222	16
Region						
Midwest	274	45	348	52	292	39
Northeast	355	54	331	47	317	40
South	343	39	390	40	414	36
West	216	42	213	39	232	38
Insurance status						
No insurance/self-pay	579	38	625	41	583	36
Medicare/Medicare supplemental	423	62	480	54	533	46
Medicaid	4	93	3	43	4	50
Private insurance/HMO/PPO	172	40	164	36	127	25
Other insurance	8	38	6	25	7	25
Unknown	2	127	4	193	1	13

HMO, health maintenance organization; PPO, preferred provider organization.
[a]Represents diagnosis codes for bladder stones (no coexisting benign prostatic hyperplasia).
[b]The term count is used to be consistent with other UDA tables; however, the VA tables represent the population of VA users and thus are not weighted to represent national population estimates.
[c]Rate is defined as the number of unique patients with each condition divided by the base population in the same fiscal year x 100,000 to calculate the rate per 100,000 unique outpatients.
NOTE: Race/ethnicity data from clinical observation only, not self-report; note large number of unknown values.
SOURCE: Outpatient Clinic File (OPC), VA Austin Automation Center, 1999–2001.

Table 21. Visits to ambulatory surgery centers for urolithiasis procedures listed as primary procedure by individuals having commercial health insurance, count, rate[a]

	1994		1996		1998		2000	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate
Total	1,254	117	2,389	150	4,535	185	6,755	246
Age								
<3	1	*	2	*	7	*	8	*
3–10	7	*	7	*	22	*	36	11
11–17	11	*	21	*	49	18	74	25
18–24	56	57	102	72	220	99	291	113
25–34	194	103	410	147	811	195	1,123	254
35–44	363	166	689	211	1,170	230	1,731	310
45–54	380	243	705	286	1,293	321	1,997	417
55–64	190	250	369	316	800	398	1,295	530
65–74	51	323	72	321	141	438	175	430
75–84	1	*	10	*	21	*	21	*
85+	0	0	2	*	1	*	4	*
Gender								
Male	784	149	1,478	187	2,916	236	4,107	298
Female	470	86	911	114	1,619	132	2,648	193
Region								
Midwest	775	119	1,383	153	2,191	182	3,228	237
Northeast	107	71	164	102	253	126	324	197
South	303	155	742	170	1,902	202	2,952	271
West	69	91	100	110	189	174	251	188

*Figure does not meet standard for reliability or precision.
[a]Rate per 100,000 based on member months of enrollment in calendar year for individuals in the same demographic stratum.
SOURCE: Center for Health Care Policy and Evaluation, 1994, 1996, 1998, 2000.

are still done in a hospital setting. Although the ambulatory surgery visits in this dataset were not stratified by upper tract versus lower tract stones, the impact of bladder stone treatment should be minimal, since relatively few procedures for such treatment are performed in ambulatory care centers, and the overall incidence of bladder stones is much lower than that of kidney stones. Bladder stones are usually treated in conjunction with prostate surgeries in an inpatient setting.

During the years studied, the male-to-female ratio varied from 1.5 to 1.8—a bit lower than expected in view of the ratio of incidence rates for stone disease. The peak age for visits was between 65 and 74 for 1994, 1996, and 1998, but it dropped to 55 to 64 in 2000 (Figure 3). Regional differences were apparent: the highest rates were consistently seen in the South; the lowest rates were seen in the Northeast in 1994–1998 and in the West in 2000.

The CMS database revealed that ambulatory surgery visits by Medicare patients with a primary diagnosis of urolithiasis also increased over time, from 42,320 total visits in 1992 to 66,580 in 1998; likewise, the visit rate increased from 123 to 199 per 100,000 (Table 22). The male-to-female ratio remained stable at approximately 2 to 1 (Figure 5).

The available data regarding ambulatory surgery for urolithiasis in children are too scant to provide reliable estimates of utilization.

Table 22. Visits to ambulatory surgery centers by Medicare beneficiaries with upper and/or lower tract urolithiasis listed as primary diagnosis, count[a], rate[b] (95% CI)

	1992		1995		1998	
	Count	Rate	Count	Rate	Count	Rate
Total[c]	42,320	123 (121–124)	57,580	163 (161–164)	66,580	199 (197–200)
Total < 65	4,480	82 (79–84)	8,040	131 (128–134)	8,480	136 (134–139)
Total 65+	37,840	130 (129–132)	49,540	169 (168–171)	58,100	213 (211–214)
Age						
65–74	23,460	143 (141–145)	30,060	186 (184–188)	33,500	234 (231–236)
75–84	12,600	134 (131–136)	16,800	174 (172–177)	20,580	217 (214–220)
85–94	1,720	60 (57–63)	2,520	82 (79–85)	3,980	129 (125–133)
95+	60	18 (13–22)	160	44 (37–51)	40	10 (7.0–13)
Race/ethnicity						
White	37,820	130 (128–131)	51,840	171 (169–172)	59,760	210 (209–212)
Black	2,500	84 (81–88)	3,600	112 (108–115)	4,380	141 (137–146)
Asian	…	…	200	120 (103–136)	460	146 (133–160)
Hispanic	…	…	500	125 (114–136)	820	117 (109–125)
N. American Native	…	…	40	110 (77–143)	80	148 (115–181)
Gender						
Male	25,900	176 (174–178)	35,880	236 (233–238)	40,860	282 (279–285)
Female	16,420	83 (82–84)	21,700	108 (106–109)	25,720	135 (133–137)
Region						
Midwest	11,800	135 (133–138)	16,840	187 (184–190)	18,920	219 (216–222)
Northeast	7,180	93 (91–95)	10,120	132 (129–134)	13,160	197 (193–200)
South	18,320	150 (148–152)	23,040	181 (179–184)	26,680	215 (213–218)
West	4,980	98 (95–100)	7,380	142 (139–146)	7,480	151 (148–154)

…data not available.
[a]Unweighted counts were multiplied by 20 to arrive at values in the table.
[b]Rate per 100,000 Medicare beneficiaries in the same demographic stratum.
[c]Persons of other races, unknown race and ethnicity, and other region are included in the totals.
NOTE: Counts less than 600 should be interpreted with caution.
SOURCE: Centers for Medicare and Medicaid Services, 5% Carrier and Outpatient Files, 1992, 1995, 1998.

Surgical Trends

A variety of datasets was used to establish trends in the surgical management of upper tract stones. Although no completely new technology for stone treatment has been introduced since extracorporeal shock wave lithotripsy (ESWL) was developed in the 1980s, improvements in endoscopic technique and instrumentation have increased efficacy, reduced morbidity, and increased patient tolerance of the procedures. For example, although ureteroscopy has been used for the treatment of ureteral stones for more than two decades, advances in ureteroscope design and instrumentation have expanded the indications for the procedure to increasingly include lower calyceal renal calculi (8, 9), stones in calyceal diverticuli (10), and large-volume renal stones (11, 12). Likewise, refinements in the indications for ESWL have the potential to improve success rates, but they have also expanded the role of endoscopic management of stones in subgroups of patients who have poor outcomes with ESWL (i.e., those with lower calyceal stones (13).

In Medicare patients with a diagnosis of urolithiasis, rates of ESWL, ureteroscopy, and PCNL treatment of stones remained relatively stable over 1992, 1995, and 1998, with rates of 10,943 to 11,738 per 100,000 population with urolithiasis for ESWL; 8,372 to 8,839 per 100,000 for ureteroscopy; and 665 to 882 per 100,000 for PCNL (Table 23). One of the reasons that the frequency of ESWL has risen slightly may be

Table 23. Procedures for nephrolithiasis among Medicare beneficiaries, count[a], rate[b]

	1992		1995		1998	
	Count	Rate	Count	Rate	Count	Rate
Total	46,280	21,496	52,880	21,965	54,080	20,942
PCNL	1,900	882	1,600	665	2,180	844
Ambulatory surgery center	0	0	0	0	0	0
Hospital outpatient	300	139	220	91	520	201
Inpatient	1,580	734	1,340	557	1,660	643
Physician office	20	9.3	40	17	0	0
Other	0	0	0	0	0	0
ESWL	23,560	10,943	28,260	11,738	29,420	11,393
Ambulatory surgery center	1,000	464	1,160	482	1,400	542
Hospital outpatient	15,300	7,106	22,100	9,179	23,680	9,170
Inpatient	5,580	2,592	3,700	1,537	2,960	1,146
Physician office	860	399	840	349	1,000	387
Other	820	381	460	191	380	147
Uteroscopy	18,840	8,751	21,280	8,839	21,620	8,372
Ambulatory surgery center	120	56	640	266	740	287
Hospital outpatient	5,440	2,527	9,080	3,771	12,100	4,686
Inpatient	12,700	5,899	11,120	4,619	8,440	3,268
Physician office	440	204	340	141	280	108
Other	140	65	100	42	60	23
Open stone surgery	1,980	920	1,740	723	860	333
Ambulatory surgery center	0	0	0	0	0	0
Hospital outpatient	60	28	160	66	120	46
Inpatient	1,800	836	1,480	615	720	279
Physician office	60	28	80	33	20	7.7
Other	60	28	20	8.3	0	0
Laparoscopic removal	0	0	0	0	0	0
Ambulatory surgery center	0	0	0	0	0	0
Hospital outpatient	0	0	0	0	0	0
Inpatient	0	0	0	0	0	0
Physician office	0	0	0	0	0	0
Other	0	0	0	0	0	0

ESWL, extracorporeal shock wave lithotripsy; PCNL, percutaneous nephrolithotomy.
[a]Unweighted counts were multiplied by 20 to arrive at values in the table.
[b]Rate per 100,000 Medicare beneficiaries with a diagnosis of nephrolithiasis.
NOTE: Counts less than 600 should be interpreted with caution.
SOURCE: Centers for Medicare and Medicaid, 5% Carrier and Outpatient Files, 1992, 1995, 1998.

Table 24. Urolithiasis procedures for individuals having commercial health insurance, count[a], rate[b]

	1994		1996		1998		2000	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate
Total	1,074	100	2,042	128	3,514	143	5,180	188
ESWL								
Ambulatory surgery	515	48	1,069	67	1,853	75	2,765	101
Emergency room	0	0	0	0	0	0	1	*
Inpatient	16	*	25	*	44	1.8	47	1.7
Open stone								
Ambulatory surgery	5	*	7	*	20	*	19	*
Inpatient	17	*	16	*	22	*	29	*
PCNL								
Ambulatory surgery	5	*	21	*	28	*	56	2.0
Inpatient	60	5.6	89	5.6	134	5.5	190	6.9
Uteroscopy								
Ambulatory surgery	258	24	545	34	1068	43	1,627	59
Emergency room	1	*	0	0	1	*	1	*
Inpatient	197	18	270	17	344	14	445	16

ESWL, extracorporeal shock wave lithotripsy; PCNL, percutaneous nephrolithotomy.
*Figure does not meet standard for reliability or precision.
[a]Counts less than 30 should be interpreted with caution.
[b]Rate per 100,000 based on member months of enrollment in calendar year.
SOURCE: Center for Health Care Policy and Evaluation, 1994, 1996, 1998, 2000.

the fact that today's lithotriptors are less effective than the original HM3, resulting in multiple retreatments for the same stone. Given the significant advances in the ureteroscopic management of calculi in the very late 1990s and early 2000s, it is not surprising that the improvement in technology is not reflected by an increase in ureteroscopy up to 1998. The introduction of the Holmium laser in 1995 rendered virtually all stones amenable to fragmentation if they could be accessed endoscopically (14); however, this new technology may have not yet reached widespread use by 1998. Only open stone surgery showed a clear-cut trend, decreasing in use from 920 per 100,000 in 1992 to 333 per 100,000 in 1998.

According to Medicare data, the distribution of procedures changed surprisingly little over the years studied. ESWL has traditionally been the most frequently performed procedure, comprising 51% of the procedures in 1992 and 54% in 1998. PCNL remained relatively stable at 3% to 4% of procedures, and ureteroscopy comprised 40% to 41% of the procedures.

The distribution of procedures was remarkably similar between commercially insured individuals (reported in the Center for Health Care Policy and Evaluation database) and Medicare patients (reported in the CMS database). Among the commercially insured population, PCNL comprised 5% to 6% of procedures and remained stable from 1994 to 2000 (Table 24). ESWL comprised 49% of the procedures in 1994, increasing to 54% in 2000. Ureteroscopy remained stable over time and comprised 40% to 42% of the procedures. Open stone surgery made up only 2% of the total procedures in 1994 and dropped to less than 1% in 2000. As numerous studies in the literature have demonstrated, open surgery should be considered a salvage procedure to be used only when endoscopic or shock wave treatment fails, and its use should be indicated in well under 5% of cases (15). Indeed, CMS data revealed a 64% decline in the use of open stone surgery from 1992 to 1998, and in 1998 this modality comprised less than 2% of all stone procedures performed.

Kerbl and colleagues also reviewed the distribution of surgical procedures over time, using data from the Health Care Financing Administration (the federal agency now known as CMS) (16). They found that although ESWL remained relatively stable

Table 25. Emergency room visits by individuals with urolithiasis listed as primary diagnosis, count, rate[a] (95% CI)

	1994		1996		1998		2000	
	Count	Rate	Count	Rate	Count	Rate	Count	Rate
Total	368,667	146 (110–181)	331,758	126 (93–159)	399,403	149 (112–186)	617,647	226 (175–277)
Gender								
Male	246,375	200 (140–260)	189,647	148 (99–196)	268,193	205 (142–267)	406,137	305 (225–385)
Female	122,292	94 (55–134)	142,111	105 (61–149)	131,210	96 (55–136)	211,510	151 (88–214)

[a]Rate per 100,000 based on 1994, 1996, 1998, and 2000 population estimates from Current Population Survey (CPS), CPS Utilities, Unicon Research Corporation, for relevant demographic categories of US civilian non-institutionalized population.

SOURCE: National Hospital Ambulatory Medical Care Survey— ER, 1994, 1996, 1998, 2000.

at 70% to 80% of the procedures from 1992 to 2000, ureteroscopy increased from 14% in 1992 to 22% in 2000, still less than half the proportion observed in the Center for Health Care Policy and Evaluation database of commercially insured patients (Table 24). PCNL use remained stable at 4% to 6%, which is comparable to the proportion seen in the Medicare and commercially insured populations. The reason for the differences in the distribution of procedures among the different datasets is unclear.

Emergency Room Care

Between 1994 and 1998, emergency room visits by individuals with a primary diagnosis of urolithiasis remained relatively stable, according to NHAMCS data; however, there was a 50% increase in 2000 (Table 25). Future studies will be needed to determine whether this represented a sharp increase or simply year-to-year variability. In general, the rate for males was twice that for females. It is noted that the confidence intervals for these estimates are wide, and no information is available on geographic variation in rates.

Emergency room visits were less common in the Medicare population (Table 26) than in the NHAMCS population. Among Medicare beneficiaries, the rate increased between 1992 and 1998 for the <65 and ≥65 age groups (53% and 31%, respectively), for both males and females, and in all regions. The visit rate was lower in those 65 and older, and it decreased with increasing age. Males were three times more likely than females to visit an emergency room for urolithiasis. This ratio is higher than that seen in the NHAMCS population (Table 25) and was consistent in age-unadjusted and age-adjusted CMS data; it may be related to different age distributions by sex in the two data sources. There were clear regional variations, with rates highest in the South. The visit rate was higher among Caucasians than African Americans (no data on Hispanics were available for 1992). In both 1995 and 1998, the rates were highest among Hispanics. When the CMS data were age-adjusted, the geographic and racial/ethnic differences did not change.

ECONOMIC IMPACT

The economic impact of urolithiasis includes both the direct medical costs of treating the condition (emergency room visits, office visits, inpatient hospitalizations, ambulatory surgery, and prescription medications) and indirect costs associated with lost work time. Each inpatient or outpatient encounter involves a variety of cost sources, including physician professional fees, radiographic studies, room and board, laboratory, pharmacy, and operating room costs. The distinction between cost, representing the actual cost to the hospital, pharmacy, or laboratory of providing a service, and the charge to the patient or payor, which is related to cost but not necessarily in a predictable manner, is important, although it cannot always be easily arrived at or consistently applied. For the purposes of this chapter, we use the terms *costs* and *expenditures* to reflect total payments made by the patient (co-insurance, co-payments, deductibles, and uncovered expenses) and by all third-party payors (primary and secondary coverage, when available). Using data from the Ingenix dataset for 1999, we estimated that the average annual expenditure for privately insured individuals between the ages of 18 and 64 was $7,656 for those with a medical claim corresponding to a diagnosis of urolithiasis and $3,184 for those without a claim relating to urolithiasis (Table

Table 26. Emergency room visits by Medicare beneficiaries with upper and/or lower tract urolithiasis listed as primary diagnosis, count[a], rate[b] (95% CI), age-adjusted rate[c] (95% CI)

	1992			1995			1998		
	Count	Rate	Age-Adjusted Rate	Count	Rate	Age-Adjusted Rate	Count	Rate	Age-Adjusted Rate
Total[d]	21,840	63 (62–64)	63	26,060	74 (73–75)	74	29,200	87 (86-88)	87
Total < 65	4,900	89 (87–92)		6,700	109 (107–112)		8,460	136 (133-139)	
Total 65+	16,940	58 (57–59)		19,360	66 (65–67)		20,740	76 (75-77)	
Age									
65–74	11,960	73 (71–74)		13,720	85 (83–86)		13,760	96 (94–98)	
75–84	4,200	45 (43–46)		4,920	51 (50–52)		5,980	63 (61–65)	
85–94	720	25 (23–27)		660	21 (20–23)		960	31 (29–33)	
95+	60	18 (13–22)		60	16 (12–21)		40	10 (7.0–13)	
Race/ethnicity									
White	19,200	66 (65–67)	65	23,480	77 (76–78)	78	25,800	91 (90–92)	91
Black	940	32 (30–34)	32	1,460	45 (43–48)	43	1,580	51 (48–54)	51
Asian	…	…	…	100	60 (48–72)	60	260	83 (73–93)	76
Hispanic	…	…	…	360	90 (81–99)	90	720	102 (95–110)	102
N. American Native	…	…	…	0	0	0	20	37 (20–54)	37
Gender									
Male	14,920	101 (100–103)	104	18,160	119 (118–121)	122	20,260	140 (138–142)	141
Female	6,920	35 (34–36)	33	7,900	39 (38–40)	37	8,940	47 (46–48)	46
Region									
Midwest	5,180	59 (58–61)	60	6,880	76 (75–78)	77	7,860	91 (89–93)	92
Northeast	4,040	52 (51–54)	52	3,720	48 (47–50)	47	4,440	66 (64–68)	65
South	8,980	73 (72–75)	73	11,300	89 (87–91)	89	13,000	105 (103–107)	105
West	3,220	63 (61–65)	64	3,800	73 (71–76)	74	3,280	66 (64–68)	66

… data not available.
[a]Unweighted counts were multiplied by 20 to arrive at values in the table.
[b]Rate per 100,000 Medicare beneficiaries in the same demographic stratum.
[c]Age-adjusted to the US Census-derived age distribution of the year under analysis..
[d]Persons of other races, unknown race and ethnicity, and other region are included in the totals.
NOTE: Counts less than 600 should be interpreted with caution.
SOURCE: Centers for Medicare and Medicaid Services, 5% Carrier and Outpatient Files, 1992, 1995, 1998.

Table 27. Estimated annual expenditures of privately insured employees with and without a medical claim for urolithiasis in 1999[a]

	Annual Expenditures (per person)			
	Persons without Urolithiasis (N=276,064)	Persons with Urolithiasis (N=2,886)		
	Total	Total	Medical	Rx Drugs
Total	$3,184	$7,656	$6,498	$1,158
Age				
18–34	$2,776	$7,243	$6,411	$831
35–44	$2,953	$7,506	$6,386	$1,120
45–54	$3,262	$8,379	$7,113	$1,265
55–64	$3,362	$7,172	$6,032	$1,140
Gender				
Male	$2,776	$7,376	$6,263	$1,113
Female	$3,889	$8,619	$7,321	$1,299
Region				
Midwest	$3,066	$8,747	$7,440	$1,306
Northeast	$3,068	$6,918	$5,846	$1,072
South	$3,397	$8,352	$7,132	$1,219
West	$3,221	$7,489	$6,105	$1,384

Rx, prescription.
[a]The sample consists of primary beneficiaries ages 18 to 64 having employer-provided insurance who were continuously enrolled in 1999. Estimated annual expenditures were derived from multivariate models that control for age, gender, work status (active/retired), median household income (based on zip code), urban/rural residence, medical and drug plan characteristics (managed care, deductible, co-insurance/co-payments), and 26 disease conditions.
SOURCE: Ingenix, 1999.

Table 28. Expenditures for urolithiasis and share of costs, by site of service (% of total)

	Year							
Service Type	1994		1996		1998		2000	
Total[a]	$1,373,900,000		$1,233,900,000		$1,518,500,000		$2,067,400,000	
Inpatient	$785,900,000	(57.2%)	$811,900,000	(65.8%)	$862,500,000	(56.8%)	$971,700,000	(47.0%)
Physician Office	$151,100,000	(11.0%)	$154,200,000	(12.5%)	$236,900,000	(15.6%)	$363,900,000	(17.6%)
Hospital Outpatient	$233,600,000	(17.0%)	$58,000,000	(4.7%)	$135,100,000	(8.9%)	$244,000,000	(11.8%)
Emergency Room	$204,700,000	(14.9%)	$209,800,000	(17.0%)	$285,500,000	(18.8%)	$490,000,000	(23.7%)

[a]Total unadjusted expenditures exclude spending on outpatient prescription drugs for the treatment of urolithiasis. Average drug spending for urolithiasis-related conditions is estimated at $4 million to $14 million annually for the period 1996 to 1998.

SOURCES: National Ambulatory Medical Care Survey, National Hospital Ambulatory Medical Care Survey, Healthcare Cost and Utilization Project, Medical Expenditure Panel Survey, 1994, 1996, 1998, 2000.

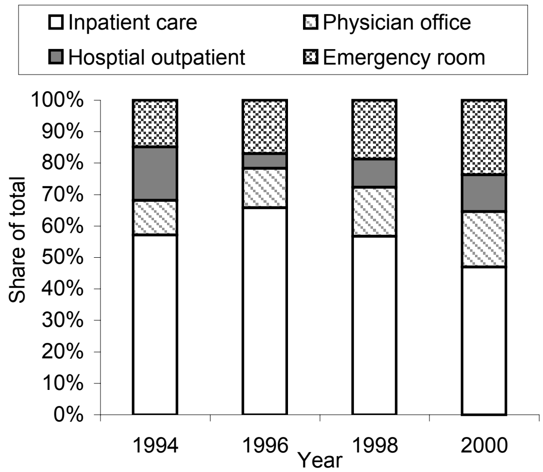

Figure 6. Percent share of costs for urolithiasis by type of service, 1994–2000.

SOURCE: National Ambulatory Medical Care Survey; National Hospital Ambulatory Medical Care Survey; Healthcare Cost and Utilization Project; Medical Expenditure Panel Survey, 1994, 1996, 1998, 2000.

27). Hence, a $4,472 difference per covered individual should be accounted for by expenditures either directly or indirectly related to stone disease (indirect expenditures are those for treatment of systemic illnesses that are associated with stone disease, such as primary hyperparathyroidism, chronic diarrheal syndrome due to bowel disease, etc.). This difference in expenditures may be mitigated by unmeasured differences (such as comorbidities) between those with and without stone disease.

The annual expenditures for those with a medical claim for urolithiasis include the sum of the expenditures for medical care ($6,498) and those for prescription drugs ($1,158). When stratified by age, the expenditures of those without a urolithiasis-related claim rose steadily to a maximum of $3,362 in the 55 to 64 age group. In contrast, the peak total medical expenditure for the group with a urolithiasis-related claim, $8,379, occurred in the 45 to 54 age group, perhaps reflecting the peak incidence of stone disease in this group.

Women have higher medical expenditures than men in both groups, although the difference was slightly larger among those with urolithiasis-related claims. However, given the higher incidence of stone disease in men (a factor of 2 to 3), one might expect a greater impact of gender in the group with stones. It should be noted, however, that the diagnosis of stones may be made incidentally, without necessarily prompting or requiring any intervention. Evaluation of regional differences in medical expenditures suggests that overall higher expenditures for the group without urolithiasis-related claims were found in the South and West, whereas in the urolithiasis group, expenditures were highest in the Midwest and South. As prescription drug costs showed little regional variation, the geographic differences in expenditures are likely related to direct medical expenditures or possibly due to differences in the age distributions of the regions.

National estimates of annual medical expenditures suggest that slightly more than $2 billion was spent on treating urolithiasis in 2000, based solely on inpatient and outpatient claims of individuals with a primary diagnosis of urolithiasis. This estimate includes $971 million for inpatient services, $607 million for physician office and hospital outpatient services, and $490 million for emergency room services (Table 28). That these figures are somewhat lower than the $1.83 billion estimated annual cost of urolithiasis for 1993 reported by Clark and colleagues (17) may be related to our more restrictive definition of hospitalization. Total expenditures (excluding outpatient prescription drug costs) increased by 50% from $1.37 billion to $2.07 billion, between 1994 and 2000. During that time period, non-inpatient services (including physician office visits, emergency room visits, and hospital outpatient services) accounted for an increasing proportion of the total expenditures—43% of the total in 1994 and 53% in 2000 (Figure 6). Interestingly, the relative proportion of total expenditures for emergency room services also increased, from 15% in 1992 to 24% in 2000.

Urolithiasis-related treatment costs for the Medicare population also increased significantly over time. Total expenditures for Medicare beneficiaries 65 and older increased 36% (from $613 million in 1992 to $834 million in 1998), with outpatient services accounting for an increasingly larger share of the total (31% in 1992, 38% in 1998) (Table 29).

According to Medical Expenditure Panel Survey (MEPS) data, annual estimates of spending on outpatient prescription drugs for the treatment of urolithiasis in 1996–1998 ranged from $4 million

Table 29. Expenditures for Medicare beneficiaries age 65 and over for treatment of urolithiasis, by site of service (% of total)

	Year					
	1992		1995		1998	
Total	$613,400,000		$779,400,000		$834,400,000	
Inpatient	$423,700,000	(69.1%)	$513,800,000	(65.9%)	$518,900,000	(62.2%)
Outpatient	$179,200,000	(29.2%)	$250,600,000	(32.2%)	$296,100,000	(35.5%)
Physician Office	$56,700,000	(9.2%)	$81,600,000	(10.5%)	$96,100,000	(11.5%)
Hospital Outpatient	$5,500,000	(0.9%)	$5,100,000	(0.7%)	$4,800,000	(0.6%)
Ambulatory Surgery	$117,000,000	(19.1%)	$163,900,000	(21.0%)	$195,200,000	(23.4%)
Emergency Room	$10,500,000	(1.7%)	$14,900,000	(1.9%)	$19,400,000	(2.3%)

NOTE: Percentages may not add to 100% because of rounding.
SOURCE: Centers for Medicare and Medicaid Services, 1992, 1995, 1998.

to $14 million (Table 28). Furthermore, MEPS data suggest that 29% of men and 24% of women with urolithiasis filled a prescription for the treatment of the condition, with mean annual expenditures for outpatient prescriptions being $43 for men and $48 for women (Table 30).

In addition to the direct medical costs of treatment, the economic effects of urolithiasis include labor market outcomes such as absenteeism and work limitations. It is estimated that 30% of employed individuals with an inpatient or outpatient claim for upper tract stones missed 19 hours of work time per year in association with their claim (Table 31). Lower tract stones, presumably bladder stones, were also associated with lost workdays for 32% of employees with a medical claim for the condition, but the mean number of hours of lost work was substantially lower (6.1 hours per year).

The medical costs of treating children with urolithiasis are difficult to estimate, largely because of the paucity of data. However, some data are available in the medical and financial records of the National Association of Children's Hospitals and Related Institutions (NACHRI). According to NACHRI data, in 1999–2001, the average inpatient cost per child was $7,355 in 2001, a 32% to 36% increase over the cost in the two previous years (Table 32). Expenditures in 2001 were nearly twice as high among infants (0 to 2 years of age) as they were among children ages 3 to 10 or 11 to 17 and twice as high among African Americans as among Caucasians and Hispanics. However, there were no significant differences in costs across gender.

CONCLUSIONS

Urolithiasis is common in the US population, and its prevalence is increasing. The available data on urolithiasis support the important influences of age, sex, region, and race/ethnicity. The setting for both the acute care and the surgical management of

Table 30. Annual use of outpatient prescription drugs for the treatment of urolithiasis, 1996–1998

	All Persons with Urolithiasis		Conditional on Rx Use	
Gender	Number with Urolithiasis	Percent with Rx Claim for Urolithiasis	Mean Number of Prescriptions	Mean Rx Expenditures
Male	676,144	29.2%	3.6	$43.19
Female	408,948	24.2%	3.9	$47.89
Total	1,085,092	27.3%	3.7	$44.96

Rx, prescription.
SOURCE: Medical Expenditure Panel Survey, 1996–1998.

Table 31. Average annual work loss of persons treated for urolithiasis, 1999 (95% CI)

	Number of Workers[a]	% Missing Work	Average Work Absence (hrs) Inpatient[b]	Outpatient[b]	Total
Upper tract urolithiasis	834	30%	4.4 (2.5–6.3)	14.6 (11.5–17.7)	19.0 (14.5–23.5)
Lower tract urolithiasis	60	32%	0.3 (0–0.8)	5.8 (3.0–8.6)	6.1 (3.2–9.0)

[a]Individuals with an inpatient or outpatient claim for urolithiasis and for whom absence data were collected. Work loss is based on reported absences contiguous to the admission and discharge dates of each hospitalization or the date of the outpatient visit.

[b]Inpatient and outpatient include absences that start or stop the day before or after a visit.

SOURCE: MarketScan, 1999.

Table 32. Mean inpatient cost per child admitted with urolithiasis listed as primary diagnosis, count, mean cost[a] (95% CI)

	1999		2000		2001	
	Count	Mean Cost	Count	Mean Cost	Count	Mean Cost
Total[b]	461	$5,582 (4,806–6,358)	553	$5,374 (4,790–5,958)	619	$7,355 (5,695–9,015)
Age						
0–2	43	$11,311 (4,717–17,905)	45	$7,811 (5,178 –10,443)	37	$13,875 (7,982–19,767)
3–10	193	$5,253 (4,430–6,076)	198	$5,067 (4,368– 5,766)	225	$7,041 (4,899–9,183)
11–17	225	$4,769 (4,103–5,435)	310	$5,217 (4,354 –6,080)	357	$6,877 (4,405–9,349)
Race/ethnicity						
White	338	$5,925 (4,928–6922)	385	$5,687 (4,947–6,427)	447	$6,252 (5,344–7,160)
Black	31	$4,699 (3,205–6,192)	34	$6,083 (4,806–7,360)	38	$12,627 (1,211–24,042)
Asian	1	$4,222	3	$3,969 (0–12,517)	2	$2,322 (518–4,126)
Hispanic	36	$5,089 (3,799–6,379)	51	$4,561 (3,495–5,628)	78	$5,598 (4,199–6,998)
N.American Native	0	...	3	$4,109 (921–7,297)	1	...
Gender						
Male	261	$5,524 (4,486–6,561)	280	$5,455 (4,500– 6,409)	312	$7,206 (5,418–8,995)
Female	200	$5,658 (4,479–6,836)	273	$5,292 (4,621 –5,963)	307	$7,506 (4,685–10,327)
Region						
Midwest	160	$6,096 (4,280–7,913)	197	$5,568 (4,666 –6,471)	199	$7,895 (3,539–12,250)
Northeast	24	$3,130 (2,239–4,021)	39	$4,685 (3,677– 5,694)	56	$6,321 (5,179–7,462)
South	203	$5,547 (4,737–6,357)	246	$5,788 (4,787 –6,789)	287	$6,221 (5,084–7,357)
West	61	$6,502 (4,445–8,560)	50	$5,369 (3,427–7,312)	77	$10,940 (5,050–16,831)

[a]Calculated using adjusted ratio of costs to charges, including variable and fixed cost among participating children's hospitals.

[b]Persons of other races and missing race and ethnicity are included in the totals.

SOURCE: National Association of Children's Hospitals and Related Institutions, 1999–2001.

patients with stones has changed over time: inpatient admissions and length of stay have decreased as outpatient treatment has burgeoned. The trends in distribution of surgical treatment modalities show some inconsistency among various databases; however, shock wave lithotripsy remains the most commonly performed procedure for upper tract stones, followed by ureteroscopy and percutaneous nephrostolithotomy. The one consistent trend identified by all datasets is a dramatic decrease in the use of open surgery, which is now less than 2% of the procedures. The cost of urolithiasis is estimated at nearly $2 billion annually and appears to be increasing over time, despite the shift from inpatient to outpatient procedures and the shorter length of hospital stays, perhaps because the prevalence of stone disease is increasing.

RECOMMENDATIONS

Although the current ICD and CPT codes seem acceptable for the basic diagnostic and therapeutic management of individuals with urolithiasis and the associated procedures, it would be helpful to researchers if ureteroscopy, like ureterolithotomy, were codified as upper, middle, or lower, dependent upon the site of pathology in the ureter. Additional specificity of the ICD coding is unlikely to be useful for research purposes; such detail must be obtained from the medical record.

From a clinical perspective, prevention is essential to reduce costs and morbidity. Primary prevention is not practical at this time, but aggressive prevention of recurrent stone formation is likely to reduce morbidity and costs.

The *Urologic Diseases in America* project expended a great deal of time and effort to obtain the best data available on urolithiasis and identified a number of knowledge gaps that need to be filled. We propose the following topics for investigation to improve the understanding of urolithiasis.

Medical evaluation of patients with upper tract urolithiasis

- How frequently are metabolic evaluations performed for patients with urolithiasis?
- What is the range of evaluations performed?
- Should first-time stone formers undergo a medical evaluation to determine the etiology of stone formation?
- How frequently are preventive measures recommended?
- What is the rate of adherence to medical recommendations, and how does this change over time?
- What are the national recurrence rates, and how are they affected by demographic factors?

Imaging modalities in the diagnosis and follow-up of patients with upper tract urolithiasis

- What is the optimal imaging modality for monitoring patients with a history of urolithiasis?
- Can imaging studies be used to predict stone composition and consequently affect treatment?

Surgical issues in the management of patients with upper tract urolithiasis

- What is the optimal urological management of acute renal colic?
- When should asymptomatic stones be treated?
- How have practice patterns evolved in the balance between ESWL and flexible ureteroscopy as primary management for upper ureteral stones?
- How have practice patterns evolved in the balance between ureteroscopy vs percutaneous nephrostomy in the management of upper ureteral stones?

Miscellaneous

- Is upper tract urolithiasis a risk factor for other conditions (e.g., end-stage renal disease)?

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