

Incidence and Cost of Potentially Avoidable Emergency Department Visits for Urolithiasis

Sara Jordan Chadwick, MD, MPH; Om Dave, BS; James Frisbie, MD; Charles D. Scales Jr, MD, MSHS; Matthew E. Nielsen, MD, MS; and David F. Friedlander, MD, MPH

Renal colic, commonly caused by urolithiasis (also known as urinary stones), accounts for approximately 2 million emergency department (ED) presentations per year and contributes approximately \$10 billion to annual US health expenditures.^{1,2} Although the severity of underlying disease and subsequent care pathways vary significantly, virtually all index stone encounters occur in the ED and are often associated with imaging studies that introduce significant cost.³⁻⁵ The high prevalence of urinary stone disease—identified in approximately 10% of American adults annually—and severity of associated pain symptoms contribute to high ED presentation rates, with renal colic ranking within the top 10 most common conditions treated in US EDs.^{6,7}

However, less than 10% of patients presenting to EDs for urolithiasis require hospitalization, and outpatient workup is often available in sufficiently resourced communities.⁸ Both ED and outpatient management consists largely of analgesic and antiemetic medications for symptomatic alleviation, some of which are available as oral formulations and accessible outside hospital-based settings; further, less than a quarter of cases warrant antibiotics.⁹ Traditionally, avoidable ED presentations often represent 1 of 2 types of conditions: (1) acute presentations of chronic conditions for which effective outpatient management may prevent these exacerbations and (2) presentations of conditions for which outpatient management is often available.¹⁰ Through a more comprehensive view of preventable ED usage, current literature describes a pathway of events leading up to a potentially avoidable admission, where intervention at any point along the pathway may avoid reliance on ED resources.¹¹ Within this more comprehensive framework of avoidable ED usage,¹² we hypothesize that certain ED presentations for urinary stone disease, such as in patients with a previous diagnosis of urolithiasis, may be amenable to outpatient management. Consequently, developing standardized, ambulatory-based care pathways may represent an effective strategy to shift care for urinary stone disease to outpatient settings and, in doing so, reduce costs without compromising care. Although not traditionally considered an ambulatory care-sensitive condition—a set of conditions for which effective and timely

ABSTRACT

OBJECTIVES: Urolithiasis represents a leading cause of emergency department (ED) presentation nationally, affecting approximately 10% of Americans. However, most patients require neither hospital admission nor surgical intervention. This study investigates patient and facility factors associated with potentially avoidable ED visits and their economic consequences.

STUDY DESIGN: Retrospective analysis.

METHODS: Patients presenting to the ED for index urolithiasis events were selected using Florida and New York all-payer data from the 2016 Healthcare Cost and Utilization Project state databases. Avoidable visits were defined as subsequent ED encounters following initial ED presentation that did not result in intervention, admission, or referral to an acute care facility. Utilizing multivariable logistic and linear regression, researchers discerned patient and facility factors predictive of avoidable ED presentations and associated costs.

RESULTS: Of the 167,102 ED encounters for urolithiasis, 7.9% were potentially avoidable, totaling \$94,702,972 in potential yearly cost savings. Mean encounter-level costs were higher for unavoidable vs avoidable visits (\$5885 vs \$2098). In contrast, mean episode-based costs were similar for avoidable and unavoidable episodes (\$7200 vs \$7284). Receiving care in small metropolitan (vs large metropolitan) communities was associated with potentially avoidable visits, whereas increased comorbidities and Hispanic ethnicity were protective against avoidable visits.

CONCLUSIONS: The incidence of ED use for subsequent urolithiasis care reveals opportunity for enhanced outpatient availability to reduce hospital-based costs. Several nonclinical factors are associated with potentially avoidable ED visits for urolithiasis, which, if appropriately targeted, may represent an opportunity to reduce health care spending without compromising the quality of care delivery.

Am J Manag Care. 2023;29(11):e322-e329. doi:10.37765/ajmc.2023.89458

outpatient management could theoretically prevent hospitalization¹³—urolithiasis may share features of these conditions.

Such an approach is particularly appealing in the context of recent US policy efforts to move away from traditional fee-for-service models toward alternative payment methods for discrete episodes of care.¹⁴ Unfortunately, there are limited data on the incidence of potentially avoidable ED visits for urinary stone disease, much less predictors of these episodes and the cost savings borne by redirecting patients toward the ambulatory setting for the treatment of urolithiasis. In this context, we use all-payer claims data to identify urolithiasis presentations to the ED following an index encounter that did not result in inpatient admission or procedural intervention. Although these presentations are not uniformly preventable, we aim to categorize them as “potentially avoidable” to denote a group of patients of whom a certain portion may theoretically have been safely managed in the outpatient setting, thereby avoiding cost-intensive emergency services. We aimed to identify patient factors and costs associated with potentially avoidable ED visits for stone events. We hypothesize that both clinical (eg, comorbidity status) and nonclinical (eg, socioeconomic status) drivers influence rates of avoidable ED visits for urolithiasis.

METHODS

Data Source

This study utilized the 2016 Healthcare Cost and Utilization Project (HCUP) state emergency department databases from Florida and New York. HCUP is a collection of national and state health care databases containing all-payer, encounter-level data sponsored through the Agency for Healthcare Research and Quality.¹⁵ Florida and New York were selected for analysis because they represent 2 of the largest, most socioeconomically diverse states that contain patient-specific identification numbers that track patients across care settings over the calendar year.

Study Population

International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes (eAppendix Table [available at ajmc.com]) were used to identify patients 18 years and older presenting to the ED for an index episode of acute urolithiasis between January 1, 2016, and December 31, 2016.^{16,17} Index episodes were defined as the first encounter at a hospital-affiliated ED for a diagnosis of urolithiasis over a calendar year.

The following patient and hospital factors were compiled for multivariate analysis: age, total health encounters, episode-based days, interval procedure type (if any), gender, Elixhauser Comorbidity Index score, type of insurance, race/ethnicity, income (categorized by county-level median household income quartiles), education

TAKEAWAY POINTS

Given the incidence of urolithiasis as a top contributor to emergency department presentations, this study explores what proportion of visits may have been safely conducted in outpatient or urgent care settings and their associated costs.

- ▶ Annual costs of potentially avoidable visits for urolithiasis total more than \$94 million in New York and Florida.
- ▶ Our findings support investment in outpatient diagnostic and procedural alternatives to divert patients to lower-acuity care settings.
- ▶ Management of urinary calculus disease may be amenable to care standardization measures such as bundled payment models to reduce variation in intensity/cost of clinical care.

level (categorized by median county-level rate of less than high school education quintiles), geographic setting of encounter (large metropolitan, small metropolitan, micropolitan, or rural area), and encounter state (Florida or New York). Patients missing any of the abovementioned covariates were excluded as all variables were considered to be missing at random.

Outcomes

Patients with a qualifying index stone event were then separated into those presenting to the ED for potentially avoidable vs unavoidable visits. Potentially avoidable visits were defined as ED visits with a primary or secondary diagnosis of acute urolithiasis that met 1 or more of the following criteria: (1) did not result in subsequent hospital admission, (2) did not result in transfer to another health care facility, or (3) resulted in observation admission without any associated procedure/urological intervention or subsequent admission (eAppendix Table). From this pool of patients, we further restricted our cohort of potentially avoidable encounters to individuals with multiple treat-and-release ED encounters ($n > 1$) as these individuals should have familiarity with urinary stone-related symptomatology and ambulatory analgesic regimens and in theory have access to ambulatory care triage lines afforded through their initial ED encounter. All other encounters (including index encounters) were defined as unavoidable. We used *ICD-10-CM* diagnosis codes to identify patients with urolithiasis complicated by urinary tract infection (UTI) (A41, A419, N390) and/or acute kidney injury (AKI) (N17.9, N18, N18x) to further stratify our analyses.

Statistical Analysis

Statistical analyses were performed using Stata release 19 (StataCorp) with a significance level of $P < .05$. Distribution of covariables between patients experiencing avoidable and unavoidable ED visits for index stone events was examined through comparing medians and IQRs for continuous covariables and proportions for categorical variables. Wilcoxon rank-sum tests for continuous data and Pearson χ^2 tests for categorical data were used as bivariate analysis to assess the initial comparability of the 2 groups. Multivariable logistic regression accounting for facility clustering was performed to demonstrate the association between the aforementioned covariables and presentation for an avoidable encounter.

CLINICAL

To understand costs associated with these visits, mean total and index episode costs were computed through merging HCUP data with cost-to-charge ratio files.¹⁸ Mean costs were compared between unavoidable and potentially avoidable urolithiasis-related presentations across full episodes and for individual encounters. After generating initial cost comparisons between avoidable and unavoidable ED visits, a post hoc analysis was performed to examine the impact of the presence of AKI and/or UTI on analyses and assess the validity of our initial criteria, as obstructive urolithiasis in the setting of AKI and/or UTI constitutes indication for urgent urological intervention and thus should be treated in hospital-based settings.¹⁹ Progressively more conservative definitions of unavoidable ED visits were generated by reclassifying all patients with concomitant (1) AKI and (2) AKI and/or UTI as unavoidable, based on aforementioned ICD-10-CM diagnosis codes for these conditions. The present study was conducted in accordance with all policies and protocols of the University of North Carolina (UNC) Office of Human Research Ethics and granted exemption by the UNC Institutional Review Board.

RESULTS

We identified 167,102 unique presentations to EDs for urolithiasis, of which 7.9% (n = 13,154) met criteria for being potentially avoidable. Patients in 5.1% of visits (n = 7789) who met criteria for unavoidable presentation required inpatient hospitalization or transfer to an acute care facility. Bivariate differences between the avoidable and unavoidable cohorts are presented in Table 1. Subgroup analyses for all patients with diagnosed AKI (n = 18,261) found that only 0.9% (n = 173) of presentations met criteria for being potentially avoidable ED presentations, compared with 5.1% (n = 1187) of encounters associated with concomitant UTI (n = 23,060).

In multivariable analyses, factors associated with higher odds of avoidable ED presentation for urolithiasis included receiving care from a small metropolitan facility (small metropolitan vs large metropolitan: odds ratio [OR], 1.87; 95% CI, 1.04-3.37; P = .04) and longer duration between index and subsequent ED visits for urolithiasis (31-60 days vs ≤ 30 days: OR, 2.03; 95% CI, 1.13-3.65; P = .02; > 60 days vs ≤ 30 days: OR, 2.01; 95% CI, 1.30-3.10; P = .002) (Table 2). Conversely, patient factors protective against avoidable visits included increased number of comorbidities (Elixhauser Comorbidity Index score ≥ 3 vs 0: OR, 0.17; 95% CI, 0.11-0.28; P < .001) and Hispanic ethnicity (Hispanic vs White: OR, 0.51; 95% CI, 0.30-0.88; P = .02) (Table 2).

Mean episode-based costs were similar for unavoidable (\$7284; 95% CI, \$7035-\$7532) vs avoidable (\$7200; 95% CI, \$7157-\$7242) presentations (P < .001) (Table 3 and Figure). Analysis of mean encounter-level costs revealed higher costs associated with unavoidable urolithiasis-related encounters (\$5885; 95% CI, \$5676-\$6093) compared with avoidable encounters (\$2098; 95% CI, \$2085-\$2111) (P < .001) (Table 3 and Figure). Cumulative annual costs associated with avoidable ED visits for urolithiasis amounted to \$94,702,927 for the 2 states studied. Through post hoc analysis, expansion of the definition of unavoidable ED visits to include patients presenting with (1) AKI and (2) AKI and/or UTI reduced the total costs of avoidable ED visits to \$91,501,426 and \$83,396,849, respectively.

DISCUSSION

Our findings support growing literature suggesting that the majority of ED presentations for urolithiasis do not result in hospital admission or acute urologic intervention.⁸ Likewise, we elucidate that a significant portion of these patients continue to receive

TABLE 1. Patient and Facility Characteristics Among Patients Experiencing Avoidable vs Unavoidable ED Visits

| | Whole cohort | | | AKI present | | | UTI present | | |
|--|----------------------------|-------------------------|-------|---------------------------|----------------------|-------|---------------------------|-----------------------|-------|
| | Unavoidable n = 153,948 | Avoidable n = 13,154 | P | Unavoidable n = 18,088 | Avoidable n = 173 | P | Unavoidable n = 21,873 | Avoidable n = 1187 | P |
| Age in years, median (IQR) | 52 (38-65) | 43 (32-54) | <.001 | 69 (58-79) | 52 (41-63) | <.001 | 60 (44-74) | 41 (31-54) | <.001 |
| Total health encounters, median (IQR) | 1 (1-1) | 2 (2-3) | <.001 | 1 (1-1) | 3 (2-5) | <.001 | 1 (1-1) | 3 (2-4) | <.001 |
| Episode-based days, ^a n (%) | | | <.001 | | | <.001 | | | <.001 |
| Within 30 days | 142,697 (92.7%) | 6211 (47.2%) | | 15,155 (83.8%) | 54 (31.2%) | | 18,819 (86.0%) | 425 (35.8%) | |
| 31-60 days | 4263 (2.8%) | 1581 (12.0%) | | 983 (5.4%) | 18 (10.4%) | | 1112 (5.1%) | 136 (11.5%) | |
| > 60 days | 6988 (4.5%) | 5362 (40.8%) | | 1950 (10.8%) | 101 (58.4%) | | 1942 (8.9%) | 626 (52.7%) | |
| Interval procedure, n (%) | | | <.001 | | | <.001 | | | <.001 |
| None | 115,602 (75.1%) | 9068 (68.9%) | | 8488 (46.9%) | 68 (39.3%) | | 13,369 (61.1%) | 771 (65.0%) | |
| PCNL | 429 (0.3%) | 62 (0.5%) | | 104 (0.6%) | ≤10 ^b | | 160 (0.7%) | 12 (1.0%) | |
| URS | 9038 (5.9%) | 1890 (14.4%) | | 1515 (8.4%) | 49 (28.3%) | | 1679 (7.7%) | 166 (14.0%) | |
| SWL | 3595 (2.3%) | 612 (4.7%) | | 538 (3.0%) | ≤10 ^b | | 684 (3.1%) | 57 (4.8%) | |
| Stent | 23,031 (15.0%) | 1480 (11.3%) | | 6171 (34.1%) | 43 (24.9%) | | 5091 (23.3%) | 164 (13.8%) | |
| PCN | 2253 (1.5%) | 42 (0.3%) | | 1272 (7.0%) | ≤10 ^b | | 890 (4.1%) | 17 (1.4%) | |

(continued)

TABLE 1. (Continued) Patient and Facility Characteristics Among Patients Experiencing Avoidable vs Unavoidable ED Visits

| | Whole cohort | | | AKI present | | | UTI present | | |
|---|-----------------|--------------|-------|----------------|------------------|-------|----------------|-------------|-------|
| | Unavoidable | Avoidable | P | Unavoidable | Avoidable | P | Unavoidable | Avoidable | P |
| | n = 153,948 | n = 13,154 | | n = 18,088 | n = 173 | | n = 21,873 | n = 1187 | |
| Gender, n (%) | | | <.001 | | | .011 | | | <.001 |
| Male | 83,091 (54.0%) | 7308 (55.6%) | | 10,818 (59.8%) | 120 (69.4%) | | 8032 (36.7%) | 351 (29.6%) | |
| Female | 70,857 (46.0%) | 5846 (44.4%) | | 7270 (40.2%) | 53 (30.6%) | | 13,841 (63.3%) | 836 (70.4%) | |
| Elixhauser Comorbidity Index score, n (%) | | | <.001 | | | <.001 | | | <.001 |
| 0 | 75,361 (49.0%) | 8815 (67.0%) | | 755 (4.2%) | 23 (13.3%) | | 6006 (27.5%) | 758 (63.9%) | |
| 1-2 | 47,788 (31.0%) | 3805 (28.9%) | | 3684 (20.4%) | 76 (43.9%) | | 6444 (29.5%) | 338 (28.5%) | |
| ≥3 | 30,799 (20.0%) | 534 (4.1%) | | 13,649 (75.5%) | 74 (42.8%) | | 9423 (43.1%) | 91 (7.7%) | |
| Payer, n (%) | | | <.001 | | | <.001 | | | <.001 |
| Private | 63,280 (41.1%) | 5218 (39.7%) | | 3622 (20.0%) | 42 (24.3%) | | 5773 (26.4%) | 346 (29.1%) | |
| Medicare | 44,195 (28.7%) | 1936 (14.7%) | | 11,608 (64.2%) | 54 (31.2%) | | 10,063 (46.0%) | 211 (17.8%) | |
| Medicaid | 25,483 (16.6%) | 3407 (25.9%) | | 1761 (9.7%) | 39 (22.5%) | | 3557 (16.3%) | 348 (29.3%) | |
| Uninsured | 15,398 (10.0%) | 1976 (15.0%) | | 583 (3.2%) | ≤10 ^b | | 1729 (7.9%) | 217 (18.3%) | |
| Other | 5592 (3.6%) | 617 (4.7%) | | 514 (2.8%) | ≤10 ^b | | 751 (3.4%) | 65 (5.5%) | |
| Race, n (%) | | | <.001 | | | .32 | | | .022 |
| White | 100,531 (65.3%) | 8740 (66.4%) | | 12,340 (68.2%) | 110 (63.6%) | | 14,631 (66.9%) | 800 (67.4%) | |
| Black | 14,298 (9.3%) | 975 (7.4%) | | 2359 (13.0%) | 26 (15.0%) | | 2191 (10.0%) | 95 (8.0%) | |
| Hispanic | 26,849 (17.4%) | 2515 (19.1%) | | 2332 (12.9%) | ≤10 ^b | | 3595 (16.4%) | 223 (18.8%) | |
| Other | 12,270 (8.0%) | 924 (7.0%) | | 1057 (5.8%) | ≤10 ^b | | 1456 (6.7%) | 69 (5.8%) | |
| Income, ^c n (%) | | | <.001 | | | .15 | | | <.001 |
| \$1-\$39,999 | 44,388 (28.8%) | 4254 (32.3%) | | 5469 (30.2%) | 64 (37.0%) | | 6998 (32.0%) | 446 (37.6%) | |
| \$40,000-\$50,999 | 45,772 (29.7%) | 4126 (31.4%) | | 5186 (28.7%) | 51 (29.5%) | | 6646 (30.4%) | 366 (30.8%) | |
| \$51,000-\$65,999 | 33,763 (21.9%) | 2694 (20.5%) | | 4007 (22.2%) | 29 (16.8%) | | 4541 (20.8%) | 237 (20.0%) | |
| ≥\$66,000 | 30,025 (19.5%) | 2080 (15.8%) | | 3426 (18.9%) | 29 (16.8%) | | 3688 (16.9%) | 138 (11.6%) | |
| Education level, ^d n (%) | | | .35 | | | .87 | | | .98 |
| ≤9.6% | 36,156 (23.5%) | 3104 (23.6%) | | 4090 (22.6%) | 36 (20.8%) | | 4814 (22.0%) | 261 (22.0%) | |
| 9.7%-11.6% | 35,298 (22.9%) | 3097 (23.5%) | | 4197 (23.2%) | 40 (23.1%) | | 5025 (23.0%) | 270 (22.7%) | |
| 11.7%-12.9% | 35,572 (23.1%) | 2999 (22.8%) | | 4437 (24.5%) | 41 (23.7%) | | 5263 (24.1%) | 282 (23.8%) | |
| ≥13% | 46,922 (30.5%) | 3954 (30.1%) | | 5364 (29.7%) | 56 (32.4%) | | 6771 (31.0%) | 374 (31.5%) | |
| Urban/rural status, n (%) | | | <.001 | | | .44 | | | <.001 |
| Large metropolitan area (≥1,000,000) | 102,384 (66.5%) | 8020 (61.0%) | | 12,415 (68.6%) | 111 (64.2%) | | 14,343 (65.6%) | 665 (56.0%) | |
| Small metropolitan area (<1,000,000) | 41,521 (27.0%) | 3967 (30.2%) | | 4767 (26.4%) | 53 (30.6%) | | 6157 (28.1%) | 416 (35.0%) | |
| Micropolitan | 6513 (4.2%) | 745 (5.7%) | | 559 (3.1%) | ≤10 ^b | | 905 (4.1%) | 67 (5.6%) | |
| Rural | 3530 (2.3%) | 422 (3.2%) | | 347 (1.9%) | ≤10 ^b | | 468 (2.1%) | 39 (3.3%) | |
| State, n (%) | | | .18 | | | .003 | | | <.001 |
| New York | 66,137 (43.0%) | 5571 (42.4%) | | 6780 (37.5%) | 46 (26.6%) | | 8173 (37.4%) | 378 (31.8%) | |
| Florida | 87,811 (57.0%) | 7583 (57.6%) | | 11,308 (62.5%) | 127 (73.4%) | | 13,700 (62.6%) | 809 (68.2%) | |

AKI, acute kidney injury; ED, emergency department; PCN, percutaneous nephrostomy; PCNL, percutaneous nephrolithotomy; SWL, shockwave lithotripsy; URS, ureteroscopy; UTI, urinary tract infection.

^aNumber of days between first and last stone-related health encounter.

^bCells with < 10 individuals are suppressed per Healthcare Cost and Utilization Project reporting requirements. Additionally, row totals of the effected cells were also suppressed so as to preclude deriving the number of patients within the cell containing < 10 observations.

^cCounty-level median household income quartiles.

^dMedian county-level rate of less than high school education quintiles.

CLINICAL

TABLE 2. Multivariate Logistic Regression Analysis Predicting Experiencing an Avoidable ED Encounter

| Characteristic | OR | 95% CI | P |
|--------------------------------------|-----------|------------|-------|
| Age | 0.98 | 0.98-1.01 | .6 |
| Episode-based days ^a | | | |
| ≤30 days | Reference | | |
| 31-60 days | 2.03 | 1.13-3.65 | .02 |
| >60 days | 2.01 | 1.30-3.10 | .002 |
| Interval procedure type | | | |
| None | Reference | | |
| PCNL | 0.10 | 0.01-0.84 | .03 |
| URS | 0.06 | 0.03-0.12 | <.001 |
| SWL | 0.22 | 0.06-0.83 | .03 |
| Stent | 0.07 | 0.03-0.17 | <.001 |
| PCN | 0.01 | 0.004-0.04 | <.001 |
| Gender | | | |
| Male | Reference | | |
| Female | 1.09 | 0.75-1.57 | .7 |
| Elixhauser Comorbidity Index score | | | |
| 0 | Reference | | |
| 1-2 | 0.56 | 0.37-0.86 | .008 |
| ≥3 | 0.17 | 0.11-0.28 | <.001 |
| Payer | | | |
| Private | Reference | | |
| Medicare | 0.88 | 0.49-1.59 | .7 |
| Medicaid | 1.08 | 0.68-1.73 | .7 |
| Uninsured | 1.44 | 0.62-3.31 | .4 |
| Unknown | 0.64 | 0.29-1.43 | .3 |
| Race | | | |
| White | Reference | | |
| Black | 1.12 | 0.47-2.66 | .8 |
| Hispanic | 0.51 | 0.30-0.88 | .02 |
| Other | 1.63 | 0.47-5.66 | .4 |
| Income ^b | | | |
| \$1-\$39,999 | Reference | | |
| \$40,000-\$50,999 | 1.14 | 0.68-1.93 | .6 |
| \$51,000-\$65,999 | 1.48 | 0.78-2.83 | .2 |
| ≥\$66,000 | 1.48 | 0.71-3.07 | .3 |
| Education level ^c | | | |
| <9.7% | Reference | | |
| 9.7%-11.6% | 0.88 | 0.49-1.57 | .7 |
| 11.7%-12.9% | 1.23 | 0.68-2.22 | .5 |
| ≥13% | 1.32 | 0.68-2.57 | .4 |
| Urban/rural status | | | |
| Large metropolitan area (≥1,000,000) | Reference | | |
| Small metropolitan area (<1,000,000) | 1.87 | 1.04-3.37 | .04 |
| Micropolitan | 0.95 | 0.41-2.23 | .9 |
| Rural | 1.50 | 0.31-7.36 | .6 |

(continued)

hospital-based care in the ED following initial diagnosis without definitive procedural treatment. These findings are timely in the setting of value-based purchasing reforms aimed at maximizing clinical outcomes achieved per dollar expended for condition-specific encounters. Although the treatment of urinary stones is not currently explicitly targeted by alternative payment models (eg, bundled payments), our current findings as well as those of prior studies conducted by this group suggest that the high prevalence of disease and the variability in the intensity and duration of care make urinary stone disease a logical target for the aforementioned reforms. We suggest that transitioning urolithiasis care away from cost-intensive EDs to ambulatory-based clinics, when appropriate, may accrue millions in annual cost savings with minimal impact on clinical outcomes.

Cost analyses demonstrated nearly equivalent total episode-based costs between visits classified as potentially avoidable vs unavoidable (\$7200 vs \$7284, respectively). However, encounter-level mean costs of potentially avoidable visits were approximately one-third those of unavoidable visits (\$2098 vs \$5885, respectively). Although these findings are unsurprising as our criteria for classifying visits as potentially avoidable or unavoidable were predicated on cost-incurring outcomes (eg, hospital admission/transfer, urological intervention), repetitive encounters for potentially avoidable ED use drive costs to nearly equivalent levels over an entire care episode. Individual encounter-level costs for potentially avoidable presentations amount to less than one-third of total episode-based costs, whereas individual encounters represent more than 80% of episode-based costs for unavoidable visits. Considering that avoidable stone episodes are made up of multiple lower-cost encounters, we posit that improved outpatient utilization for follow-up encounters may facilitate hospital-based cost containment of more than two-thirds of total costs.

With recent estimates of between \$4.4 billion and \$8.3 billion spent annually on preventable ED visits in the United States,^{20,21} the number of these visits likely contributes significantly to total financial burden. In summing the costs of our final sample of 13,154 potentially avoidable visits, potentially preventable costs amounted to \$94,702,927 for these 2 states over 1 calendar year. After post hoc analyses considering more conservative definitions of avoidable ED visits, aggregate costs remained above \$80 million. Although associated expenses are not necessarily all preventable, a shift to outpatient care offers the potential for significant cost savings.^{5,22} Diagnostic imaging often facilitates workup; however, imaging accounts for only 16% of the costs for episodes of urinary stone disease,²³ leaving ample opportunity for cost reduction. For uncomplicated urinary calculi without indication for admission, outpatient management consists of low-cost, supportive measures including observation, symptom management, straining urine, and α-blocker therapy.²⁴ Given the natural history of nephrolithiasis, 83% of stones achieve spontaneous passage without intervention.²⁵

We found that individuals with fewer comorbid conditions experienced higher rates of avoidable visits. Without further

analysis, it is unclear whether this association can be attributed to disease severity—assuming patients with higher comorbidity index scores experience severe disease and meet criteria for an unavoidable visit—or whether lower comorbidity scores are a proxy for other patient factors. For example, lower comorbidity scores may represent healthier patients with limited prior exposure to primary care and therefore less familiarity navigating the health care system. Whereas previous literature confirms higher rates of avoidable hospital-based care among the uninsured, who face barriers accessing primary care,²⁶ our findings did not reproduce previous trends that correlate hospital-based care for ambulatory care-sensitive conditions with low-income populations and economic deprivation.²⁶

Although prior literature has linked hospital-based care for potentially avoidable emergency admissions to urban areas,^{10,27} our findings suggest that nonurban settings carry greater association with avoidable ED use. Previous studies were conducted exclusively in Europe; we expect the United States to have different wealth and facility distribution between urban and rural communities. Although outside the scope of our analysis, we believe this trend holds true for urolithiasis. Our findings may reflect ambulatory care shortages and lack of access to alternative care settings outside the ED in nonurban areas in the United States, concordant with other trends in US rural care such as increases in overall ED utilization in rural areas (despite population decline) and increases in lower-acuity visits in rural EDs.²⁸ Limited access to observation units in nonurban areas,²⁹ established geographical barriers to care,³⁰ and difficulty achieving follow-up care³¹ may help contextualize this finding with known urban-rural health disparities. Even with sufficient primary care, these providers may rely on referral to emergency services because of the relative scarcity of urologists in nonurban communities.³²

Elucidating the number of patients with a diagnosis of urolithiasis who seek follow-up care in the ED without hospitalization or procedural intervention and the cost associated with these visits reveals potential for improved outpatient follow-up in this population—an especially important resource given the recurrent nature of urinary calculi. Previous research data have shown that less than 60% of patients who receive a diagnosis of urolithiasis in the ED achieve outpatient follow-up with a primary care physician or urologist within 60 days of discharge,³³ revealing gaps in patients' ability to access timely outpatient care for urinary stone disease. Burgeoning interventions for ED-based care such as care transition interventions^{34,35} and hospital-at-home models³⁶ may facilitate ambulatory care access for patients who receive a diagnosis of urolithiasis in the ED and help prevent subsequent ED presentations. Our data also support the application of models that divert lower-acuity patients to the outpatient setting: "Discharge to medical home" models of care allow triage of low-acuity ED patients appropriate for ambulatory care to same-day, walk-in appointments with adjacent primary care clinics.³⁷

Based on recent trends in urology practice, we expect that outpatient management of urinary stone disease will become more

TABLE 2. (Continued) Multivariate Logistic Regression Analysis Predicting Experiencing an Avoidable ED Encounter

| Characteristic | OR | 95% CI | P |
|----------------|-----------|-----------|-----|
| State | | | |
| New York | Reference | | |
| Florida | 0.63 | 0.37-1.06 | .08 |

ED, emergency department; OR, odds ratio; PCN, percutaneous nephrostomy; PCNL, percutaneous nephrolithotomy; SWL, shockwave lithotripsy; URS, ureteroscopy.

*Number of days between first and last stone-related health encounter.

†County-level median household income quartiles.

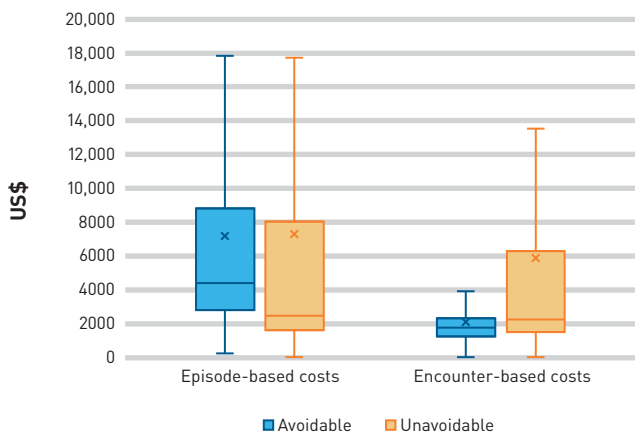
‡Median county-level rate of less than high school education quintiles.

TABLE 3. Mean Episode-Based and Encounter-Level Costs of Patients Experiencing an Avoidable vs Unavoidable ED Visit

| Visit | Mean | 95% CI | P |
|------------------------------|--------|---------------|-------|
| Episode-based costs | | | |
| Unavoidable | \$7283 | \$7034-\$7532 | <.001 |
| Avoidable | \$7199 | \$7157-\$7242 | |
| Encounter-level costs | | | |
| Unavoidable | \$5884 | \$5675-\$6092 | <.001 |
| Avoidable | \$2098 | \$2085-\$2111 | |

ED, emergency department.

FIGURE. Total Episode and Encounter-Related Costs Among Patients Experiencing an Avoidable vs Unavoidable ED Visit for Nephrolithiasis



*P < .001.

ED, emergency department.

available. Even for patients who do not improve with conservative management and require procedural intervention, recent literature demonstrates noninferiority of outpatient extracorporeal shockwave lithotripsy for single ureteric stones compared with ureteroscopy, suggesting the feasibility of shockwave lithotripsy as first-line therapy for select patients.³⁸ Further, several interventions historically

performed in the inpatient setting have proved safe and successful on an outpatient basis, including both flexible ureteroscopy³⁹ and percutaneous nephrolithotomy.⁴⁰ As outpatient management becomes a safer alternative for patients, diverting follow-up care to outpatient settings after initial diagnosis offers an emerging strategy to reduce costs associated with urinary stone disease.

Limitations

It is important to consider these findings in the context of the study's limitations. The retrospective design obscures temporal relationships, making it difficult to establish causality. Further, our rigid definition of potentially avoidable vs unavoidable ED visits does not capture the nuanced clinical judgment involved in the decision to pursue aggressive inpatient or conservative outpatient management of urinary stone disease. Experts caution against the use of ambulatory care-sensitive conditions as the sole determinant of quality of care.¹³ Although the patient/facility factors suggest certain patient sociodemographic populations are more susceptible to using pathways that incur greater costs, these variables do not fully depict the complexity and uniqueness of each patient. Rather, the study provides an estimate of the volume of potentially avoidable ED visits as well as the magnitude of costs incurred by patients and insurers from low-acuity visits. As the data source lacks further information on diagnostic workup and medication use during an encounter, we are unable to exclude patients who did not have an inpatient admission or procedure but did require other services from the ED that would warrant emergency care. For future research, more granular data may allow for further exclusion of patients who require intravenous hydration, intravenous analgesia, or immediate diagnostic workup that would be unavailable in outpatient settings. These data would allow for selection of truly avoidable ED usage from our larger pool of patients with potentially avoidable ED presentation.

Although the total costs suggest potential cost savings, we have not accounted for the cost of replacing these services with ambulatory-based treatment, which would detract from cost savings. Although the use of emergency services magnifies costs for stone episodes, use of imaging in diagnosis represents a barrier to lowering cumulative costs of this condition. Nevertheless, these findings offer important insight into the associated costs of urolithiasis care through the ED, particularly in the context of burgeoning advances in value-based payment models, which may offer promising incentives for providers to utilize increasingly available ambulatory-based care.

CONCLUSIONS

Our study elucidates various patient clinical and sociodemographic factors associated with higher rates of potentially avoidable ED presentation for urolithiasis, which may suggest specific populations that may benefit from facilitated access to outpatient care following initial diagnosis. Regardless of the factors influencing patients'

decision to pursue emergency care, we propose that these results substantiate the value of recent trends in the field to expand availability of outpatient procedural interventions for stone extraction. Avoidable ED visits contribute millions of dollars to annual health care expenditures in the 2 states studied. Given that more than 80% of costs associated with episodes of urinary stone disease in the ED are accrued from spending outside diagnostic imaging,²³ we assert that our proposed cost-saving measures have the potential to alleviate significant financial burden. It is paramount that we address avoidable ED presentations to reduce ED saturation and control the rising costs of US health care. ■

Author Affiliations: Department of Urology, University of North Carolina Medical Center (SJC, OD, JF, MEN, DFF), Chapel Hill, NC; Departments of Surgery (Urology) and Population Health Science, Duke Clinical Research Institute, Duke University Medical Center (CDS), Durham, NC.

Source of Funding: Dr Friedlander is supported by an American Urological Association Early Career Investigator Research Scholars Award.

Author Disclosures: The authors report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

Authorship Information: Concept and design (SJC, OD, CDS, DFF); acquisition of data (OD, DFF); analysis and interpretation of data (SJC, CDS, MEN, DFF); drafting of the manuscript (SJC, OD, JF, DFF); critical revision of the manuscript for important intellectual content (SJC, OD, JF, CDS, MEN, DFF); statistical analysis (SJC, DFF); provision of patients or study materials (DFF); obtaining funding (DFF); administrative, technical, or logistic support (SJC, JF, MEN, DFF); and supervision (CDS, DFF).

Address Correspondence to: David F. Friedlander, MD, MPH, Department of Urology, University of North Carolina at Chapel Hill, POB 170 Manning Dr, CB# 7235, Chapel Hill, NC 27599-7235. Email: dave_friedlander@med.unc.edu.

REFERENCES

1. Table 14-47. Economic impact of urologic disease. In: Litwin MS, Saigal CS, eds. *Urologic Diseases in America*. HHS, Public Health Service, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2012:486. NIH publication No. 12-7865.
2. Hyams ES, Korley FK, Pham JC, Mattlaga BR. Trends in imaging use during the emergency department evaluation of flank pain. *J Urol*. 2011;186(6):2270-2274. doi:10.1016/j.juro.2011.07.079
3. Gottlieb M, Long B, Koyfman A. The evaluation and management of urolithiasis in the ED: a review of the literature. *Am J Emerg Med*. 2018;36(4):699-706. doi:10.1016/j.ajem.2018.01.003
4. Fulgham PF, Assimos DG, Pearle MS, Preminger GM. Clinical effectiveness protocols for imaging in the management of ureteral calculous disease: AUA technology assessment. *J Urol*. 2013;189(4):1203-1213. doi:10.1016/j.juro.2012.10.031
5. Friedlander DF, Krimphove MJ, Cole AP, et al. Care setting as a modifiable predictor of perioperative cost and outcomes following elective urinary stone surgery. *Urol Pract*. 2020;7(4):259-265. doi:10.1097/UJP.000000000000107
6. Favus MJ, Feingold KR. Kidney stone emergencies. In: Feingold KR, Anawalt B, Boyce A, et al, eds. *Endotext*. MDText.com, Inc; 2018. Accessed October 23, 2023. <https://www.ncbi.nlm.nih.gov/books/NBK278956/>
7. Caldwell N, Srebotnjak T, Wang T, Hsia R. "How much will I get charged for this?" patient charges for top ten diagnoses in the emergency department. *PLoS One*. 2013;8(2):e55491. doi:10.1371/journal.pone.0055491
8. Schoenfeld EM, Pekow PS, Shieh MS, Scales CD Jr, Lagu T, Lindenauer PK. The diagnosis and management of patients with renal colic across a sample of US hospitals: high CT utilization despite low rates of admission and inpatient urologic intervention. *PLoS One*. 2017;12(1):e0169160. doi:10.1371/journal.pone.0169160
9. Brown J. Diagnostic and treatment patterns for renal colic in US emergency departments. *Int Urol Nephrol*. 2006;38(1):87-92. doi:10.1007/s11255-005-3622-6
10. Lynch B, Fitzgerald AP, Corcoran P, Buckley C, Healy O, Browne J. Drivers of potentially avoidable emergency admissions in Ireland: an ecological analysis. *BMJ Qual Saf*. 2019;28(6):438-448. doi:10.1136/bmjqs-2018-008002
11. Clubbs Coldron B, MacRury S, Coates V, Khamis A. Redefining avoidable and inappropriate admissions. *Public Health*. 2022;202:66-73. doi:10.1016/j.puhe.2021.11.004
12. Billings J, Parikh N, Mijanovich T. Emergency department use: the New York story. *Issue Brief (Commonw Fund)*. 2000;(434):1-12.
13. Hodgson K, Deeny SR, Steventon A. Ambulatory care-sensitive conditions: their potential uses and limitations. *BMJ Qual Saf*. 2019;28(6):429-433. doi:10.1136/bmjqs-2018-008820
14. Agarwal R, Liao JM, Gupta A, Navathe AS. The impact of bundled payment on health care spending, utilization, and quality: a systematic review. *Health Aff (Millwood)*. 2020;39(1):50-57. doi:10.1377/hlthaff.2019.00784
15. SEDD overview. Healthcare Cost and Utilization Project. September 2021. Accessed October 23, 2023. <https://www.hcup-us.ahrq.gov/seddoverview.jsp>
16. Friedlander DF, Krimphove MJ, Cole AP, et al. Care setting as a modifiable predictor of perioperative cost and outcomes following elective urinary stone surgery. *Urol Pract*. 2020;7(4):259-265. doi:10.1097/UJP.000000000000107
17. French WW, Scales CD, Viprakasit DP, Sur RL, Friedlander DF. Predictors and cost comparison of subsequent urinary stone care at index versus non-index hospitals. *Urology*. 2022;164:124-132. doi:10.1016/j.urology.2022.01.023

18. Klabunde CN, Potosky AL, Legler JM, Warren JL. Development of a comorbidity index using physician claims data. *J Clin Epidemiol*. 2000;53(12):1258-1267. doi:10.1016/s0895-4356(00)00256-0
19. Assimos D, Krambeck A, Miller NL, et al. Surgical management of stones: American Urological Association/Endourological Society Guideline, part II. *J Urol*. 2016;196(4):1161-1169. doi:10.1016/j.juro.2016.05.091
20. Daly R. Preventable ED use costs \$8.3 billion annually: analysis. Healthcare Financial Management Association. February 11, 2019. Accessed December 13, 2021. <https://www.hfma.org/topics/news/2019/02/63247.html>
21. Weinick RM, Burns RM, Mehrotra A. Many emergency department visits could be managed at urgent care centers and retail clinics. *Health Aff (Millwood)*. 2010;29(9):1630-1636. doi:10.1377/hlthaff.2009.0748
22. Roberson D, Spertling C, Shah A, Ziemba J. Economic considerations in the management of nephrolithiasis. *Curr Urol Rep*. 2020;21(5):18. doi:10.1007/s11934-020-00971-6
23. Medicare Payment Advisory Commission. Table 4-2: share of total dollars spent on imaging (all modalities), 2005. In: *Report to the Congress: Improving Incentives in the Medicare Program*. Medicare Payment Advisory Commission; 2009:91. Accessed October 23, 2023. https://www.medpac.gov/wp-content/uploads/import_data/scrape_files/docs/default-source/reports/Jun09_EntireReport.pdf
24. Curhan GC, Aronson MD, Preminger GM. Kidney stones in adults: diagnosis and acute management of suspected nephrolithiasis. UpToDate. Updated August 10, 2023. Accessed January 14, 2022. <https://www.uptodate.com/contents/kidney-stones-in-adults-diagnosis-and-acute-management-of-suspected-nephrolithiasis>
25. Miller OF, Kane CJ. Time to stone passage for observed ureteral calculi: a guide for patient education. *J Urol*. 1999;162(3 Pt 1):688-691. doi:10.1097/00005392-199909010-00014
26. Wallar LE, De Prophetis E, Rosella LC. Socioeconomic inequalities in hospitalizations for chronic ambulatory care sensitive conditions: a systematic review of peer-reviewed literature, 1990-2018. *Int J Equity Health*. 2020;19(1):60. doi:10.1186/s12939-020-01160-0
27. O'Chain A, Knowles E, Maheswaran R, et al. A system-wide approach to explaining variation in potentially avoidable emergency admissions: national ecological study. *BMJ Qual Saf*. 2014;23(1):47-55. doi:10.1136/bmjqs-2013-002003
28. Greenwood-Erickson MB, Kocher K. Trends in emergency department use by rural and urban populations in the United States. *JAMA Netw Open*. 2019;2(4):e191919. doi:10.1001/jamanetworkopen.2019.1919
29. Greenwood-Erickson MB, Macy ML, Ham J, Nypaver MM, Zochowski M, Kocher KE. Are rural and urban emergency departments equally prepared to reduce avoidable hospitalizations? *West J Emerg Med*. 2019;20(3):477-484. doi:10.5811/westjem.2019.2.42057
30. Frazee TK, Lewis VA, Wood A, Newton H, Colla CH. Configuration and delivery of primary care in rural and urban settings. *J Gen Intern Med*. 2022;37(12):3045-3053. doi:10.1007/s11606-022-07472-x
31. Toth M, Holmes M, Van Houtven C, Toles M, Weinberger M, Silberman P. Rural Medicare beneficiaries have fewer follow-up visits and greater emergency department use postdischarge. *Med Care*. 2015;53(9):800-808. doi:10.1097/MLR.0000000000000401
32. Odisho AY, Fradet V, Cooperberg MR, Ahmad AE, Carroll PR. Geographic distribution of urologists throughout the United States using a county level approach. *J Urol*. 2009;181(2):760-766. doi:10.1016/j.juro.2008.10.034
33. Schoenfeld EM, Shieh M, Pekow PS, Scales CD, Munger JM, Lindenauer PK. Association of patient and visit characteristics with rate and timing of urologic procedures for patients discharged from the emergency department with renal colic. *JAMA Netw Open*. 2019;2(12):e1916454. doi:10.1001/jamanetworkopen.2019.16454
34. Seidenfeld J, Ramos K, Bruening RA, Sperber NR, Stechuchak KM, Hastings SN. Patient experiences of a care transition intervention for veterans to reduce emergency department visits. *Acad Emerg Med*. 2023;30(4):388-397. doi:10.1111/acem.14661
35. Edgren G, Anderson J, Dolk A, et al. A case management intervention targeted to reduce healthcare consumption for frequent emergency department visitors: results from an adaptive randomized trial. *Eur J Emerg Med*. 2016;23(5):344-350. doi:10.1097/MEJ.0000000000000280
36. Paulson MR, Eldaly AS, Avila FR, et al. Small bowel obstruction conservatively managed in hospital-at-home. *Case Rep Gastrointest Med*. 2022;2022:1969040. doi:10.1155/2022/1969040
37. Zager K, Taylor YJ. Discharge to medical home: a new care delivery model to treat non-urgent cases in a rural emergency department. *Healthc (Amst)*. 2019;7(1):7-12. doi:10.1016/j.hjdsi.2018.08.001
38. Dasgupta R, Cameron S, Aucutt L, et al. Shockwave lithotripsy versus ureteroscopic treatment as therapeutic interventions for stones of the ureter (TISU): a multicentre randomised controlled non-inferiority trial. *Eur Urol*. 2021;80(1):46-54. doi:10.1016/j.eururo.2021.02.044
39. Bosquet E, Peyronnet B, Mathieu R, et al. Faisabilité de l'urétéroscopie souple en ambulatoire pour la prise en charge des calculs urinaires: une étude rétrospective monocentrique. Abstract in English. *Prog Urol*. 2017;27(16):1043-1049. doi:10.1016/j.purol.2017.07.246
40. Bechis SK, Han DS, Abbott JE, et al. Outpatient percutaneous nephrolithotomy: the UC San Diego Health experience. *J Endourol*. 2018;32(5):394-401. doi:10.1089/end.2018.0056

Visit ajmc.com/link/89458 to download PDF and eAppendix

eAppendix Table. Procedure and Diagnosis Codes

| Procedure | CPT codes | ICD-10-PCS codes |
|--|--|--|
| Percutaneous nephrolithotomy | 50081, 50080 | 0TF33ZZ, 0TF43ZZ, 0TF44ZZ, 0TF34ZZ, 0TC03ZZ, 0TC04ZZ, 0TC13ZZ, 0TC14ZZ, 0TC43ZZ, 0TC44ZZ |
| Percutaneous nephrostomy tube placement | 50432, 50433, 50392, 52005, 52332, 74475 | 0T9030Z, 0T9040Z, 0T9130Z, 0T9140Z |
| Ureteral stent placement | 50392, 52005, 52332 | 0T747DZ, 0T748DZ, 0T737DZ, 0T738DZ, 0T767DZ, 0T768DZ, 0T777DZ, 0T778DZ, 0T787DZ, 0T788DZ |
| Ureteroscopy | 52337, 52352, 52353, 52356 | 0TC37ZZ, 0TC38ZZ, 0TC47ZZ, 0TC48ZZ, 0TC67ZZ, 0TC68ZZ, 0TC77ZZ, 0TC78ZZ |
| Shockwave lithotripsy | 50590 | 0TF6XZZ |
| Inclusion criteria | CPT codes | ICD-10-CM codes |
| Calculus of kidney | n/a | N20.0 |
| Calculus of ureter | | N20.1 |
| Calculus of kidney with calculus of ureter | | N20.2 |
| Urinary calculus, unspecified | | N20.9 |
| Calculus of urinary tract in diseases classified elsewhere | | N22 |
| Unspecified renal colic | | N23 |