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The impact of unplanned postprocedure visits in the management of patients with urinary stones

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Abstract

Background—Unplanned follow-up care is the focus of intense health policy interest, as evidenced by recent financial penalties imposed under the Affordable Care Act. To date, however, unplanned postoperative care remains poorly characterized, particularly for patients with kidney stones. Our objective was to describe the frequency, variation, and financial impact of unplanned, high-acuity, follow-up visits in the treatment of patients with urinary stone disease.

Methods—We identified privately insured patients undergoing percutaneous nephrostolithotomy, ureteroscopy, or shock-wave lithotripsy for stone disease. The primary outcome was occurrence of an emergency department visit or hospital admission within 30 days of the procedure. Multivariable models estimated the odds of an unplanned visit and the incremental cost of those visits, controlling for important covariates.

Results—We identified 93,523 initial procedures to fragment or remove stones. Overall, 1 in 7 patients had an unplanned postprocedural visit. Unplanned visits were least common after shock-wave lithotripsy (12%) and occurred with similar frequency after ureteroscopy and percutaneous nephrostolithotomy (15%). Procedures at high-volume facilities were substantially less likely to result in an unplanned visit (odds ratio 0.80, 95% confidence interval [95% CI] 0.74–0.87, P < . 001). When an unplanned visit occurred, adjusted incremental expenditures per episode were

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greater after shock-wave lithotripsy ($32,156 [95% CI $30,453–33,859]) than after ureteroscopy ($23,436 [95% CI $22,281–24,590]).

Conclusion—Patients not infrequently experience an unplanned, high-acuity visit after low-risk procedures to remove urinary stones, and the cost of these encounters is substantial. Interventions are indicated to identify and reduce preventable unplanned visits.

Kidney stones impose a substantial and increasing burden of disease in the United States. Their prevalence has nearly doubled in the past 15 years,[1,2] and they now affect almost 1 in 11 persons. Health care use for treating patients with urinary stone disease has increased in parallel.[3,4] Recent estimates from the Urologic Diseases in America project suggest that aggregate expenditures for treating patients with kidney stones exceed $10 billion annually, making kidney stones one of the most expensive urologic conditions.[4] Little is known about what impels these expenditures, although charges appear to be greatest for ambulatory surgery and inpatient care.[4]

Driven by high costs, variability in hospital readmissions and incorporation into Medicare payment policy under the Affordable Care Act, unplanned follow-up care has become an area of intense focus for hospitals, providers, and policy makers.[5-9] To date, however, few studies have examined the frequency and potential impact of readmissions or other unplanned care after urologic surgical procedures. After a complex procedure such as radical cystectomy, up to 1 in 4 patients experience hospital readmission within 30 days.[10] Immediate hospital admission after low-risk urologic office or ambulatory procedures appears much less common (<1%).[11] However, 30-day readmission rates and other unplanned care, such as postprocedure visits to the emergency department (ED), remain poorly characterized as a potential quality marker and health policy issue in the treatment of patients with kidney stones. Unplanned care within 30 days of a stone procedure may occur after either inpatient or ambulatory/outpatient interventions. Patients who undergo inpatient procedures, such as percutaneous nephrostolithotomy (PNL), may be readmitted to hospital or require ED visits for potential complications of operation. Likewise, patients who undergo ambulatory/outpatient procedures (ie, ureteroscopy [URS] or shock-wave lithotripsy [SWL]) may require hospital admission or ED care for potential complications in the postoperative period.

Given this context, we sought to determine the frequency of unplanned hospital admissions and ED visits after procedures to fragment or remove urinary stones. In addition, we sought to test the hypothesis that unplanned postprocedural care would vary importantly with clinical and nonclinical factors. Finally, we sought to estimate the potential financial impact of unplanned postprocedural encounters in the treatment of patients with urinary stones.

METHODS

Data source

We analyzed data from Marketscan, which includes more than 170 million beneficiaries covered by private insurance in the United States. The dataset contains deidentified information regarding beneficiary demographics, diagnoses, health care services, physician

and facility identifiers, and payments. The institutional review board at RAND determined that the study design was exempt from the review requirement.

Study population

The study population comprised individuals who underwent SWL, URS, or PNL for the fragmentation or removal of a renal or ureteral stone in 2003–2011. We identified diagnoses and procedures using established claims algorithms.[12] Exclusion criteria included age younger 18 years, less than 1 year of continuous enrollment before the initial procedure, and less than 30 days of continuous enrollment after the procedure date (or date of hospital discharge if the procedure was performed on an inpatient basis).

Outcomes

Our study had two aims: (1) to describe the incidence of and variation in unplanned episodes of care after procedural intervention for a renal or ureteral stone; and (2) to characterize the incremental costs resulting from episodes of unplanned care. The primary outcome for the first aim was the occurrence of an unplanned visit after the initial procedure. Unplanned care can occur in many settings, such as an outpatient clinic, the ED, or as inpatient care. We elected to focus on ED and inpatient encounters for two reasons. First, these two care settings imply a greater degree of acuity than an outpatient clinic visit, and from the health policy perspective are likely much more expensive than care in an ambulatory clinic setting. Second, differentiating unplanned versus planned outpatient follow-up visits in a claims-based analysis is unreliable. For the purposes of our analysis, we therefore defined an unplanned visit as either an ED encounter or a hospital admission within 30 days of the initial procedure. Because some surgeons stage or perform “second-look” procedures after PNL, we did not consider follow-up hospital admissions where a PNL occurred to constitute an unplanned visit. To understand the potential financial impact of unplanned care, we examined the difference in total health care expenditures in the 30 days after the initial procedure, conditional on an unplanned episode of care. Expenditures included facility and provider payments, patient deductibles, coinsurance, copayments, and coordination of benefit payments, as recorded in the Marketscan dataset.

Covariates

Patient-level covariates included age and sex as reported in the Marketscan database. We identified comorbid conditions using established claims-based algorithms and summarized these as a Charlson score.[13,14] We categorized patients according to Charlson score of 0, 1, or ≥2. We included median household income and the percentage of the population with at least a high school diploma as reported in the Area Resource File to adjust for the potential influence of socioeconomic status. The inclusion of the year of the initial procedure controlled for potential changes in secular patterns of care or patient follow-up. Given well-established variations in regional patterns of care, we included census region as a covariate. For analyses related to cost, we included the type of health insurance plan (ie, health maintenance organization, high-deductible health plan, etc). Finally, we determined provider and facility volume an on an annual basis, and classified as high-volume those providers or facilities at or greater than the 90th percentile. Previous analysis of claims data suggests that

certain providers and facilities may focus on specific stone procedures,[15] and therefore volume was calculated on a procedure-specific basis.

Statistical analysis

The frequency of unplanned visits was calculated for each procedure. We compared the frequency and care setting of unplanned visits according to patient characteristic using the χ^2 test. We examined frequency distributions of primary diagnoses to ascertain reasons for the unplanned visit. We then modeled the probability of an unplanned visit using a multivariable logistic regression framework, controlling for procedure, age, sex, procedure year, comorbid conditions, census region, household income, education level, and facility volume. Our initial models did not reveal any statistically significant relationship between provider volume and the likelihood of an unplanned visit, and therefore we did not include high provider volume as a covariate in the final model. The models accounted for clustering of outcomes at the facility level.

To estimate the incremental health care expenditures for an unplanned visit, we created a two-part multivariable model with an indicator variable for the unplanned visit, and controlled for patient age, sex, comorbidity score, procedure year, census region, plan type, household income, education level, procedure type, and hospital volume. The two-part model produces estimates conditional on an unplanned visit. We used a log transform of expenditures.

For ease of interpretation, we report predicted expenditures from the two-part model. We constructed separate models for each procedure type (eg, SWL, URS, and PNL), because the cost of an unplanned visit could vary importantly depending on the initial procedure. All statistical testing was two-sided, with a Type 1 error rate set to 0.05. We used SAS 9.2 (Cary, NC) for all analyses.

RESULTS

The study population comprised 93,523 patients who underwent an initial procedure for removal or fragmentation of a renal or ureteral stone during the study period (Table I). Among these, 54,267 (58%) were male, and most (71%) were aged between 31 and 55 years. The overall population was very healthy, with 85% having a Charlson score of 0. Most patients underwent either SWL (52%) or URS (45%).

Within 30 days of the initial procedure, 12,478 (13%) patients had either an ED visit or hospital admission (Table I). The most common diagnoses included pain (16%), infection (10%), bleeding (1.5%), and renal failure (1.4%). The proportion of patients undergoing unplanned visits was the smallest after SWL (12%). Patients undergoing PNL or URS had the same probability (15%) of unplanned care. Patients undergoing the initial procedure at a high-volume facility were less likely to experience an unplanned visit (11% vs 14%, $P < .001$). Those patients with Charlson score of 2 or greater were substantially more likely to experience an unplanned visit within 30 days of the initial procedure (20%, $P < .001$). The majority (71%) of unplanned care occurred in the ED. The subjects who were treated as inpatients tended to be older and less healthy (data not shown).

Differences in the probability of unplanned visits persisted after we controlled for important covariates (Table II). The odds of an unplanned visit were lowest for SWL (odds ratio [OR] 0.74, 95% confidence interval [95% CI] 0.65–0.84, $P < .001$) compared with PNL. The odds of an unplanned visit after URS were not substantially different from PNL. The odds of an unplanned postprocedure visit were 20% lower among patients receiving treatment at a high-volume facility. Patients with more comorbidity were increasingly likely to experience an unplanned visit: those with 2 or more comorbid conditions were at highest risk (OR 1.81, 95% CI 1.65–1.99), followed by those with 1 comorbid condition (OR 1.32, 95% CI 1.25–1.40). Regional variation also existed in the odds of an unplanned visit.

The incremental expenditures attributable to unplanned postprocedure visits were substantial (Table III). Excluding any expenditure from "second-look" procedures within 30 days, the median incremental expenditure for an unplanned visit after PNL was $13,763 (IQR $5,318–27,404). Overall, the median incremental expenditures per unplanned visit were fairly similar between URS and SWL.

Conditional estimates, adjusted for co-morbid conditions, facility volume and other covariates, revealed important variation (Table III). The estimated cost of an episode of unplanned care after PNL was the greatest, at $47,618 (95% CI $36,476–58,761). Although unplanned care was least frequent after SWL, the estimated expenditure when unplanned care did occur was $32,156 (95% CI $30,453–33,859), substantially more than a post-URS episode of unplanned care ($23,436; 95% CI $22,281–24,590).

DISCUSSION

We report the novel finding that unplanned postprocedural visits affect up to one in seven patients undergoing procedures to fragment or remove urinary stones. On multivariable analysis, the probability of an unplanned visit is associated with both clinical (ie, comorbidity) and nonclinical factors, such as facility volume. Health care expenditures for these unplanned visits are substantial. These key findings suggest that unplanned care after interventions for patients with urinary stones is an important problem and a potential marker of quality of operative care for patients with urinary stone disease.

From the patient perspective, an unplanned ED visit or hospital admission after a low-risk ambulatory procedure (ie, URS or SWL) is a significant event. Previous work examining hospital admissions after low-risk urologic interventions found a low frequency of direct admissions after the procedure but did not exclusively focus on stone-related procedures.[11] Our results suggest that by expanding the window of observation to 30 days, and including visits to the ED, the burden of unplanned postprocedural care is relevant. The acuity of encounters requiring evaluation in the ED or inpatient admission presumably represent clinically important deviations from the expected postoperative course and are likely inconsistent with patient expectations for the outcome of low-risk procedures.

Unplanned ED and inpatient encounters are also important from the health care policy perspective. Aggregate expenditures for treating patients with kidney stones are among the greatest for any urologic condition, exceeding $10 billion annually.[4] The largest proportion

of this spending is related to procedures and inpatient admissions.[4] Our results demonstrate that when an unplanned postprocedural visit occurs, the average expenditure approaches $30,000, depending on the initial intervention. When up to 15% of patients experience this outcome, the aggregate expense of unplanned care becomes substantial. As a result of financial penalties instituted under the Affordable Care Act, health care systems now measure and actively try to reduce hospital readmissions for conditions such as acute myocardial infarction, heart failure, and pneumonia.[7] Although not currently in place, penalties for unplanned admissions after operative intervention are a potential expansion of current payer policies as part of a transition away from a payment system focused on volume rather than outcomes.[10,16]

Given the lack of data regarding the incidence and impact of unplanned care after procedures to treat patients with urinary stones, our objective was to characterize the broad strokes of this outcome. Understanding the reasons for these unplanned follow-up visits will be an important next step in optimizing care for patients with urinary stone disease. Pain and infection were the most common diagnoses in this cohort. Presumptively, at least some unplanned visits for pain or infection are preventable. For example, if a patient develops sepsis after failing to receive appropriate preoperative antibiotic prophylaxis, use of a preoperative checklist could potentially prevent this outcome. Other potential clinical reasons for unplanned care after stone removal procedures could include uncontrolled pain, gross hematuria, or other medical complications. For many medical conditions, lack of care coordination may be an important contributor to hospital readmissions[7,17,18]; it is unclear to what extent lack of care coordination would contribute to our findings, because presumably surgeons assume responsibility for follow-up care after a procedure. Other factors, such as community socioeconomic status and health care resources, may also contribute to variation in unplanned care.[9,19] Once surgeons identify causes of unplanned follow-up care, our findings strongly support implementation of interventions to reduce the burden of preventable high-acuity, high-cost postprocedural encounters.

We found an inverse association between facility volume and the frequency of unplanned postprocedure visits, suggesting that mutable factors, such as processes of care, contribute to this phenomenon. For major inpatient urologic procedures, differences in hospital capacity, staffing, and available health services account for a substantial proportion of variation in the volume-outcome relationship.[20,21] Similarly, differences in preoperative and perioperative processes of care explain 23% of variation in the volume-mortality relationship for patients undergoing radical cystectomy.[22] It is unclear to what extent these results generalize to low-risk, ambulatory procedures, but identification of these factors contributing to the volume-outcome relationship suggests that opportunities for optimizing processes of care may also exist for low-risk operative interventions.

That we found a greater frequency of unplanned visits after URS compared with SWL is noteworthy. On average, SWL requires more procedures to clear a stone than URS, and the direct costs for the procedure are greater for SWL.[15,23,24] This incremental cost may be balanced to a certain degree by the lower frequency of unplanned visits following SWL, although the results of our expenditure models suggest that unplanned visits after SWL are significantly more expensive than after URS. Although we did not explicitly quantify this

tradeoff, additional analysis of payment policy for these first-line procedures[23] could more accurately weigh advantages and disadvantages of each intervention.

Our findings must be interpreted in light of important limitations. Our claims-based analysis lacks important clinical detail regarding the complexity of the intervention and other factors (eg, stone size or location) that may drive treatment selection, and also be associated with risk of unplanned visits. Although many visits were presumably procedure-related (eg, pain, infection), others may not have been directly related (eg, myocardial infarction 3 weeks after intervention). However, any complication occurring within 30 days of a operative intervention is traditionally attributed to the intervention, and our analysis is consistent with this principle. We controlled for socioeconomic status at the geographic level, which is imperfect due to the heterogeneity of population within large geographic regions. Although we excluded admissions for “second-look” PNL procedures, some postprocedural admissions may have been planned for other reasons. Bias from this misclassification is likely to be low.

Nonetheless, our findings highlight a previously unmeasured outcome of procedural care for patients with urinary stones. Our results suggest that unplanned, high-acuity visits after procedures are not uncommon in this patient population and can be quite costly. Furthermore, the identification of a volume-outcome relationship suggests that mutable factors, such as processes of care, may influence the risk of unplanned postprocedure visits. These results should prompt efforts to identify preventable causes of unplanned care, and design interventions to reduce the occurrence of this complication of stone procedures.

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Table I

Characteristics of study population

Characteristic	*No unplanned visit* (n = *81,045)*	*Unplanned visit* (n = *12,478)*	P *value*
Age, y			
18–30	8,607 (11)	1,602 (13)	
31–45	28,444 (35)	4,581 (37)	<.001
46–55	29,370 (36)	4,178 (33)	
>55	14,624 (18)	2,117 (17)	
Female	33,748 (42)	5,508 (44)	<.001
Charlson score			
0	69,122 (85)	10,113 (81)	
1	9,468 (12)	1,740 (14)	<.001
≥2	2,455 (3)	625 (5)	
Income*			
≤$25,000	682 (1)	117 (1)	
$25,000–40,000	19,496 (24)	2,995 (24)	
$40,001–50,000	27,930 (34)	4,245 (34)	.40
$50,001–60,000	16,690 (21)	2,530 (20)	
>$60,000	16,247 (20)	2,591 (21)	
Education†			
<75%	10,036 (12)	1,443 (12)	
75–85%	32,829 (41)	5,006 (40)	.0238
85–90%	25,721 (32)	4,069 (33)	
>90%	12,459 (15)	1,960 (16)	
Region			
Northeast	7,519 (9)	1,406 (11)	
North Central	13,932 (17)	2,438 (20)	
South	50,101 (62)	7,189 (58)	<.001
West	9,085 (11)	1,375 (11)	
Unknown	408 (1)	70 (1)	
Procedure			
SWL	43,206 (53)	5,800 (46)	
Ureteroscopy	35,941 (44)	6,339 (51)	<.001
PNL	1,898 (2)	339 (3)	
High-volume facility‡	11,546 (14)	1,431 (11)	<.001

PNL, Percutaneous nephrostolithotomy; *SWL*, shock wave lithotripsy; *URS*, ureteroscopy.

*Median household income.

†Percent of population with at least high school diploma.

‡Procedure-specific: ≥ 90th percentile for the procedure.

Table II

Results of multivariable logistic regression model predicting unplanned postprocedural visit

Characteristic	*Odds ratio (95% CI)*	P *value*
Procedure		
PNL	Reference	—
SWL	0.74 (0.65–0.84)	<.001
URS	0.95 (0.84–1.07)	.39
Age	0.99 (0.988–0.992)	<.001
Male	0.94 (0.91–0.98)	.004
Year	1.01 (1.00–1.02)	.02
Charlson score		
0	Reference	—
1	1.32 (1.25–1.40)	<.001
≥2	1.81 (1.65–1.99)	<.001
Income[*]		
<$25,000	Reference	—
$25,000–40,000	0.83 (0.58–1.18)	.30
$40,001–50,000	0.78 (0.55–1.11)	.18
$50,001–60,000	0.78 (0.54–1.11)	.17
>$60,000	0.83 (0.57–1.18)	.30
Education[†]		
<75%	Reference	—
75–85%	1.07 (0.98–1.18)	.07
85–90%	1.08 (0.98–1.18)	.12
>90%	1.04 (0.93–1.16)	.46
Region		
Northeast	Reference	—
North Central	0.97 (0.88–1.06)	.44
South	0.80 (0.73–0.87)	<.001
West	0.84 (0.76–0.93)	.001
Unknown	0.81 (0.53–1.24)	.33
High-volume facility[‡]	0.80 (0.74–0.87)	<.001

PNL, Percutaneous nephrostolithotomy; *SWL*, shock wave lithotripsy; *URS*, ureteroscopy.

[*] Median household income.

[†] Percent of population with at least high school diploma.

[‡] Procedure-specific: ≥ 90th percentile for the procedure.

Table III

Incremental expenditures for unplanned postprocedural visit, by procedure

Procedure	Incremental expenditure ($)		
	Mean	Median	Adjusted conditional mean* (95% CI)
SWL	11,668	8,578	32,156 (30,453-33,859)
URS	12,379	7,426	23,436 (22,281-24,590)
PNL	19,370	13,763	47,618 (36,476-58,761)

PNL, Percutaneous nephrostolithotomy; *SWL*, shock wave lithotripsy; *URS*, ureteroscopy.

*Adjusted for age, sex, procedure year, comorbid conditions, region, education, income, plan type, and facility volume and conditional on unplanned visit (eg, estimated expenditure when an unplanned visit occurs).