HHS Public Access

Author manuscript

J Urol. Author manuscript; available in PMC 2017 January 03.

Published in final edited form as:

J Urol. 2016 July ; 196(1): 124–130. doi:10.1016/j.juro.2016.01.056.

Early Intervention during Acute Stone Admissions: Revealing "The Weekend Effect" in Urological Practice

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Abstract

Purpose—Obstructing nephrolithiasis is a common condition that can require urgent intervention. In this study we analyze patient factors that contribute to delayed intervention during acute stone admission.

Materials and Methods—We retrospectively reviewed the HCUP SID (Healthcare Cost and Utilization Project State Inpatient Database) for Florida and California from 2007 to 2011. Patients who were admitted urgently with nephrolithiasis and an indication for decompression (urinary tract infection, acute renal insufficiency and/or sepsis) were included in the study. Intervention was timely or delayed, defined as a procedure that occurred within or after 48 hours, respectively. Adjusted multivariate models were fit to assess factors that predicted a delayed procedure as well as mortality.

Results—Overall 10,301 patients were admitted urgently for nephrolithiasis with indications for decompression. Early intervention occurred in 6,689 patients (65%) and was associated with a decrease in mortality (11, 0.16%), compared to delayed intervention (17 of 3,612, 0.47%, p=0.002). On multivariate analysis timely intervention significantly decreased the odds of inpatient mortality (OR 0.43, p=0.044). Weekend day admission significantly influenced time to intervention, decreasing patient odds of timely intervention by 26% (p <0.001). Other factors decreasing patient odds of timely intervention included non-Caucasian race and nonprivate insurance. Presenting medical diagnoses of urinary tract infection, sepsis and acute renal failure did not appear to influence time to intervention.

Conclusions—Delayed operative intervention for acute nephrolithiasis admissions with indications for decompression results in increased patient mortality. Nonmedical factors such as the "weekend effect," race and insurance provider exerted the greatest influence on the timing of intervention.

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No direct or indirect commercial incentive associated with publishing this article.

The corresponding author certifies that, when applicable, a statement(s) has been included in the manuscript documenting institutional review board, ethics committee or ethical review board study approval; principles of Helsinki Declaration were followed in lieu of formal ethics committee approval; institutional animal care and use committee approval; all human subjects provided written informed consent with guarantees of confidentiality; IRB approved protocol number; animal approved project number.

Keywords

urinary calculi; outcome assessment (health care); urologic surgical procedures; socioeconomic factors

The prevalence of nephrolithiasis is rapidly increasing in the United States, and has been estimated to have doubled in the last 15 years, with approximately 10% of the population experiencing an episode of nephrolithiasis in their lifetime.[1] While it is well accepted that not all acute stone disease must be treated operatively and/or in a timely manner,[2] patients with obstructing stones in the setting of infection and/or sepsis should receive decompressive intervention urgently.[3] Failure of timely operative intervention in this setting has been shown to contribute to serious complications, including an increase in patient mortality.[4]

At present there is a paucity of data examining whether patients with indications for urgent decompressive intervention undergo procedures in a timely fashion. Borofsky et al suggest that there is a significant number of such patients who fail to receive timely intervention in whom worse outcomes are the result.[4] To date no study has examined the patient factors that contribute to this disparity, and we hypothesize that socioeconomic factors and timing of patient presentation contribute to delays in intervention.

In this context our study is designed to examine patients who were urgently or emergently hospitalized and underwent operative decompressive intervention during their inpatient stay. We characterized the medical sequelae of a delay in treatment and determined the presenting patient factors associated with a delay in time to intervention.

PATIENTS AND METHODS

A cross-sectional, retrospective review of patients admitted urgently or emergently with a primary diagnosis of nephrolithiasis was conducted using the HCUP SID for Florida and California between 2007 and 2011. The HCUP provides inpatient hospitalization records for all payers in a de-identified, publicly available database.[5] Patient demographic information as well as acute and chronic medical diagnoses are provided based on administrative discharge records. Diagnoses may be designated as present on hospital admission,[6] allowing for the differentiation of conditions developing during the course of a patient's hospitalization. In addition, the date of procedures relative to hospital admission is recorded, allowing researchers to determine the time from admission to procedure. This study was deemed exempt from institutional review board approval.

To identify patients for inclusion in this study ICD-9-CM codes were used to identify patients admitted with renal (592.0) or ureteral (592.1) calculi as 1 of their first 2 diagnoses. Of these patients only those with an indication for decompression present on admission including urinary tract infection (599.0), acute renal insufficiency (584.5–584.9) and/or sepsis (995.9×) were included in the final cohort. Furthermore, patients were excluded from analysis if they were not admitted in an urgent or emergent fashion. Additional demographic variables included age at presentation, race (Caucasian, African-American, Hispanic, Asian,

other/unknown) and primary insurance provider (public insurance [Medicare or Medicaid], private insurance or uninsured/self-pay).

Procedures and the day performed relative to the date of admission were noted, and the admission date was indicated as a weekday or weekend day. Decompressive procedures included in the study were ureteral stent placement (59.8), percutaneous renal aspiration (55.92) and percutaneous nephrostomy tube placement (55.02). Only patients who underwent procedural decompressive intervention were included in the study to exclude those who were treated with a nonoperative technique (eg symptomatic management with a planned outpatient procedure, medical expulsive therapy etc) or those who may have spontaneously passed their stone. Patients were excluded from study if they underwent definitive management of a stone during their admission, including ureteroscopy (56.31), percutaneous nephrolithotomy (55.03, 55.04) or extracorporeal shock wave lithotripsy (98.51).

To define a cutoff for early vs delayed intervention the median length of stay for patients admitted urgently or emergently for a stone and ultimately discharged without procedural intervention was determined to be 2 days (IQR 1–3). As such, procedures performed within the first 48 hours of hospital admission were considered timely and those performed after that point were considered delayed.

Several statistical analytic steps were performed. Charlson comorbidity indices were calculated for each patient based on medical diagnoses as a baseline measure of general health.[7] Descriptive statistics were performed on the baseline patient cohort. Continuous variables are reported as means (SD). Univariate analysis was performed comparing patients undergoing intervention within 48 hours and after. Student's independent t-test and Pearson's chi-squared test were used for continuous and categorical variables, respectively. To assess mortality a multivariate logistic regression model was fit, adjusted for patient age, gender, race, primary insurance provider, medical comorbidities and Charlson comorbidity index. We then fit a predictive multivariate logistic regression model to assess covariates associated with procedural intervention within 48 hours of admission, adjusted for patient medical comorbidities and Charlson comorbidity index. All significance tests were 2-sided with an α of 0.05 considered statistically significant. All statistical analyses were performed using STATA® version 13.

RESULTS

Between 2007 and 2011, 10,301 patients were admitted urgently or emergently for a primary diagnosis of nephrolithiasis, an indication for decompression, and underwent a decompressive intervention for their stone. Mean patient age was 55.9 years (SD 17.6) and 47% were male. Patient race was 66% Caucasian, 7% African-American, 20% Hispanic, 3% Asian and 4% other/unknown. Primary insurance provider was public (50%) or private (35%), with 15% classified as uninsured or self-pay. Weekend hospital admission occurred in 2,810 (27%) cases (table 1).

Overall 6,689 of 10,301 (65%) patients underwent decompressive intervention within 48 hours of admission. On univariate analysis patients who underwent delayed intervention were older, more likely to be nonCaucasian race, to carry public insurance, to be admitted on a weekend and to have higher rates of medical comorbidity (table 2). Patients with delayed intervention had lower rates of sepsis on presentation (2.7% vs 3.6%, p=0.02) but higher presenting rates of urinary tract infection (80.9% vs 79.1%, p=0.03) and acute renal insufficiency (43.0% vs 40.1%, p=0.004). Patients who underwent an interventional radiology procedure were more likely to have a delayed procedure compared to those who underwent a urological intervention (p <0.001).

Patients who underwent decompressive intervention within 48 hours had improved outcomes. On univariate analysis there were decreased rates of new renal insufficiency (1% vs 1.8%, p=0.001) and inpatient mortality (0.16% vs 0.47%, p=0.002, table 2). To assess which factors independently contributed to these adverse outcomes while controlling for medical comorbidities, we fit an adjusted multivariate model (table 3). The adjusted multivariate logistic regression model for new onset acute renal insufficiency demonstrated that the only independent predictor was a presenting diagnosis of sepsis. For mortality the adjusted multivariate model demonstrated that intervention within 48 hours improved the risk of inpatient mortality (OR 0.43, 95% CI 0.19–0.98) as did intervention from a urologist (ureteral stent OR 0.1, 95% CI 0.01–0.87).

To confirm that the impact of timely intervention was true and not secondary to the overall worse medical comorbidities in the delayed intervention group, propensity score matching was performed. The patients with delayed intervention were matched to those with a timely intervention in a one-to-one fashion without replacement. Analysis of the comorbidities between the matched groups demonstrated resolution of differences in age and demographic and baseline medical comorbidities. Univariate and logistic regression on the matched sample confirmed the relationship between improved inpatient mortality with timely decompressive intervention in this patient cohort (data not shown).

To determine which factors predict timely vs delayed decompressive intervention, we performed a multivariate analysis adjusted for age, gender and medical comorbidities. This demonstrated that aside from the intervening service, weekend admission was the most significant modifiable covariate influencing time to intervention, which decreased patient odds of a timely intervention by 26% (beta coefficient −0.32, OR 0.73, 95% CI 0.66–0.80, p <0.001, table 4). African-American race also decreased the odds of early intervention (OR 0.77, 95% CI 0.66–0.91, p=0.002), as did Hispanic race (OR 0.74, 95% CI 0.67–0.83, p <0.001) and other/unknown race (OR 0.73, 95% CI 0.59–0.90, p=0.003). Compared to private insurance, carrying public insurance decreased the odds of intervention within 48 hours (OR 0.67, 95% CI 0.60–0.76, p <0.001) as did uninsured/self-pay status (OR 0.78, 95% CI 0.68–0.89, p <0.001). Interestingly none of the diagnoses used as indications for intervention (urinary tract infection, acute renal insufficiency and sepsis) was independently associated with timing of decompressive intervention.

DISCUSSION

In a large cohort of patients who underwent operative decompressive intervention during acute stone admission, a delay in intervention greater than 48 hours was associated with an increased risk of inpatient mortality. Furthermore, patient specific factors that increased the probability of undergoing a delayed intervention included inpatient admission on a weekend day, nonCaucasian race and a nonprivate insurance provider. To our knowledge this is the first report of such health care discrepancies in the care of a general urological population.

The finding of increased mortality with delayed decompressive intervention is in direct agreement with those of Borofsky et al.[4] In their study surgical decompression was studied specifically in patients with ureteral calculi and associated sepsis,[4] whereas in the present study we investigated acute stone admissions with indications for decompressive intervention including urinary tract infection, acute renal insufficiency and sepsis. While fortunately the overall mortality rate was low (0.26%), there was a significant threefold increase in patients who underwent delayed decompressive intervention (0.47% vs 0.16%, p=0.002) and this relationship persisted on multivariate analysis. This represents a statistically and clinically significant finding as decompressive procedures can be performed quickly and in a minimally invasive fashion.

The influence of the day of the week of patient admission was striking in this report, as the impact of this factor in the multivariate model was significant while medical conditions on presentation including acute renal failure, urinary tract infection and/or sepsis were not. This phenomenon, known as “the weekend effect,” has been well documented across specialties in the medical and surgical literature. Although the exact definition varies from study to study, it generally represents a delay in time to intervention (eg endoscopy with upper gastrointestinal hemorrhage[8] or operative intervention for small bowel obstruction[9]) and has been associated with an increased length of stay[10–12] or an increase in patient mortality[11,13–16] for patients admitted on a weekend vs during the traditional work week.

To our knowledge, this study is the first to demonstrate the weekend effect in acute stone disease. The only other study in the urological literature to investigate the weekend effect focused on patients with metastatic prostate cancer, and demonstrated an increase in odds of mortality of 1.2 (95% CI 1.14–1.27) when admission occurred on a weekend compared to a weekday.[15] The implication of these findings is that hospitals and clinicians should strive to deliver the same prompt, high quality care during the weekend as during the work week.

While the availability of specialists to perform the necessary procedures has been implicated in delays in acute stone intervention in prior studies,[17,18] Kothari et al recently investigated hospital level factors that contribute to the weekend effect.[19] In their study of urgent general surgery procedures including appendectomy, cholecystectomy and hernia repair, hospital level factors such as higher nurse-to-bed ratios, a fully implemented electronic medical record and pain management programs were associated with hospitals that overcame the weekend effect.

Notably the intervening clinician (interventional radiologist vs urologist) was the most influential predictor of intervention occurring more than 48 hours after hospital admission.

Prior studies have documented that the availability of an on-call radiologist contributes to delays in intervention in the United Kingdom,[18] which may be the cause of this discrepancy in the present study. However, of the decompressive interventions 98.8% were performed by a urologist, leaving only a small proportion impacted by the availability of an interventional radiologist. As prior prospective studies have demonstrated no difference in patient outcomes with percutaneous nephrostomy tube placement compared to retrograde ureteral stent placement,[20] in patients with indications for urgent intervention (eg infection and an obstructed upper tract) the proper management strategy remains the intervention that can be performed most expeditiously.

It was also enlightening to find that after weekend admission, race and primary insurance provider were more influential in determining the timing of decompressive intervention than medical conditions, with nonCaucasian patients and those with non-private insurance having lower rates of intervention within 48 hours (table 4). To our knowledge this is the first study to demonstrate socioeconomic disparities in the acute operative management of nephrolithiasis. Comparable results have been demonstrated in other surgical specialties, including cardiovascular surgery, for which African-American patients have been shown to have decreased rates of coronary angiography and coronary artery bypass graft when admitted for acute chest pain,[21] and gastroenterology, for which minorities have delayed time to endoscopy.[22] Further study is warranted to determine why race and insurance status contribute significantly to delays in care.

With an increasing emphasis on improving patient outcomes and cost containment, it is important to identify modifiable factors affecting outcomes. As 98.8% of patients undergoing intervention do so with a urologist, additional improvement in time to interventional radiologic procedure will have a minimal impact on overall patient care. However, our data show that among patients who undergo intervention during acute stone admission, the most significant factor to target for improvement is weekend admission, as quicker intervention in the 27% presenting on the weekend could substantially improve outcomes.

Our analysis has limitations which warrant mention. Our results are derived from administrative data, which do not include several patient level variables that may impact care. As such, factors such as stone size and location, laboratory data such as white blood cell count and serum creatinine, and vital signs were unavailable for review. Therefore, we attempted to classify presenting diagnoses of urinary tract infection, sepsis and acute renal failure on admission using ICD-9-CM codes, although these are dependent on the accuracy of the coding. Furthermore, physician documentation of the rationale for the timing and type of operative intervention was unavailable, mandating the assumption in our study that for patients to have warranted intervention they must have had worsening symptomatology, vital signs, laboratory values, failed medical expulsive therapy or a low likelihood of spontaneous stone passage. Finally, extracorporeal shock wave lithotripsy, ureteroscopy and percutaneous stone surgery were actively excluded as possible interventions in the study. While this was done intentionally to include patients who underwent urinary decompressive procedures as opposed to definitive management, this cohort of patients is missing from our analysis. However, the results should not be negatively impacted as patients who require urinary

decompression, especially in the setting of infection, should be captured by our inclusion criteria and definitive stone procedures would generally be contraindicated in this setting.

CONCLUSIONS

Delayed operative decompressive intervention for acute nephrolithiasis admissions with indications for decompression results in an increase in overall inpatient mortality. Despite the importance of timely operative intervention in patients with obstructing stones and concomitant urinary tract infection and/or sepsis, nonmedical factors such as the weekend effect, race and insurance provider exerted the greatest influence on the timing of intervention. Clinicians should be aware of these discrepancies to improve patient care related to acute stone admissions.

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Table 1

Baseline patient characteristics

	No. (%)
Pt demographics	
Male	4,851 (47.2)
Race:	
Caucasian	6,872 (66.7)
African-American	712 (6.9)
Hispanic	2,019 (19.6)
Asian	269 (2.6)
Other/unknown	429 (4.2)
Primary insurance provider:	
Public insurance	5,121 (49.7)
Private insurance	3,662 (35.6)
Self-pay/uninsured	1,518 (14.7)
Weekend admission	2,810 (27.3)
Medical comorbidities[*]	
Diabetes mellitus, type II	2,192 (21.3)
Hypertension	4,285 (41.6)
Congestive heart failure	448 (4.4)
Coronary artery disease	1,375 (13.4)
Chronic renal insufficiency	1,452 (14.1)
Chronic lung disease	1,224 (11.9)
Presenting diagnoses	
Stone location:	
Kidney	1,713 (16.6)
Ureter	8,588 (83.4)
Urinary tract infection	6,814 (66.2)
Hydronephrosis	8,215 (79.8)
Sepsis	336 (3.3)
Acute renal insufficiency	4,232 (41.1)
Primary intervention	
Urological intervention	10,175 (98.8)
Interventional radiology intervention	126 (1.2)

[*] Mean Charlson comorbidity index 1.

Table 2

Univariate analysis to assess predictors of timely procedural intervention

	First Intervention within 48 hrs	First Intervention after 48 hrs	p Value
	Pt demographics		
Mean pt age (SD)	54.9 (17.3)	57.7 (18.1)	<0.001
No. male (%)	3,062 (45.9)	1,789 (49.6)	<0.001
No. race (%):			
Caucasian	4,575 (68.4)	2,297 (63.6)	<0.001
African-American	428 (6.4)	284 (7.9)	
Hispanic	1,231 (18.4)	788 (21.8)	
Asian	190 (2.8)	79 (2.2)	
Other/unknown	265 (4.0)	164 (4.5)	
No. primary insurance provider (%):			
Public insurance	3,063 (45.8)	2,085 (57.0)	<0.001
Private insurance	2,621 (39.2)	1,041 (28.8)	
Self-pay/uninsured	1,005 (15.0)	513 (14.2)	
No. weekend admission (%)	1,672 (25.0)	1,138 (31.5)	<0.001
	Medical comorbidities		
No. diabetes mellitus, type II (%)	1,339 (20.0)	853 (23.6)	<0.001
No. hypertension (%)	2,630 (39.3)	1,655 (45.8)	<0.001
No. congestive heart failure (%)	231 (3.5)	217 (6.0)	<0.001
No. coronary artery disease (%)	802 (12.0)	573 (15.9)	<0.001
No. chronic renal insufficiency (%)	816 (12.2)	636 (17.6)	<0.001
No. chronic lung disease (%)	747 (11.2)	477 (13.2)	0.002
Mean Charlson comorbidity index (SD)	0.9 (1.3)	1.2 (1.6)	<0.001
	Presenting diagnoses		
No. stone location (%):			
Kidney	1,008 (15.1)	705 (19.5)	<0.001
Ureter	5,681 (84.9)	2,907 (80.5)	
No. urinary tract infection (%)	4,432 (66.3)	2,382 (66.0)	0.8
No. hydronephrosis (%)	5,292 (79.1)	2,923 (80.9)	0.03
No. sepsis (%)	238 (3.6)	98 (2.7)	0.02
No. acute renal insufficiency (%)	2,679 (40.1)	1,553 (43.0)	0.004
	Primary intervention		
No. urological intervention (%)	6,628 (99.1)	3,547 (98.2)	<0.001
No. interventional radiology intervention (%)	61 (0.9)	65 (1.8)	

	First Intervention within 48 hrs	First Intervention after 48 hrs	p Value
	Outcomes		
No. new onset acute renal insufficiency (%)	69 (1.0)	64 (1.8)	0.001
No. new onset sepsis (%)	58 (0.9)	37 (1.0)	0.4
No. inpatient mortality (%)	11 (0.16)	17 (0.47)	0.002

Table 3

Multivariate analysis for predictors of adverse outcomes

	OR	95% CI	p Value
New onset acute renal insufficiency:			
Intervention within 48 hrs	0.74	0.51–1.07	0.1
Presenting diagnosis of sepsis	3.7	1.6 –8.3	0.001
Inpatient mortality:			
Intervention within 48 hrs	0.43	0.19–0.98	0.044
Intervening service (urology)	0.1	0.01–0.87	0.037
Stone location (ureter)	7.8	0.97–63	0.053

Adjusted for patient age, gender, race, primary insurance provider, medical comorbidities and Charlson comorbidity index.

Table 4

Multivariate analysis for predictors of intervention within 48 hours

	Beta Coefficient	OR	95% CI	p Value
Age (65 yrs or greater)	0.08	1.03	0.91–1.16	0.62
Race:				
Caucasian	Referent			
African-American	−0.26	0.77	0.66–0.91	0.002
Hispanic	−0.3	0.74	0.67–0.83	<0.001
Asian	−0.3	1.19	0.91–1.56	0.2
Other/unknown	−0.33	0.73	0.59–0.90	0.003
Primary insurance provider:				
Private insurance	Referent			
Public insurance	−0.39	0.67	0.60–0.76	<0.001
Uninsured/self-pay	−0.25	0.78	0.68–0.89	<0.001
Weekend admission	−0.32	0.73	0.66–0.80	<0.001
Presenting diagnosis:				
Urinary tract infection	−0.14	0.87	0.75–1.00	0.0588
Acute renal insufficiency	−0.03	0.97	0.84–1.12	0.7
Sepsis	0.23	1.25	0.97–1.62	0.0
Intervening service:				
Interventional radiology	−0.58	0.56	0.39–0.80	0.002

Adjusted for patient medical comorbidities and Charlson comorbidity index.