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Publication Date
2023-02-01

DOI
10.1016/j.urology.2022.09.004

Peer reviewed

HHS Public Access
Author manuscript
Urology. Author manuscript; available in PMC 2023 February 14.

Published in final edited form as:
Urology. 2023 February ; 172: 61–68. doi:10.1016/j.urology.2022.09.004.

Underinsurance And Multiple Surgical Treatments for Kidney Stones

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Abstract

OBJECTIVE—To further elucidate the relationship between low socioeconomic status (SES) and larger, more complex stones requiring staged surgical interventions. Specifically, we aimed to determine if underinsurance (Medicaid, Medicare, and self-pay insurance types) is associated with multiple surgeries within 1 year.

METHODS—We performed a retrospective longitudinal analysis of prospectively collected data from the California statewide Department of Health Care Access and Information (HCAI) dataset. We included adult patients who had their first recorded kidney stone encounter between 2009 and 2018 and underwent at least 1 urologic stone procedure. We followed these patients within the dataset for one year after their initial surgery to assess for factors predicting multiple surgical treatments for stones.

RESULTS—A total of 156,319 adults were included in the study. The proportions of individuals in private insurance, Medicaid, Medicare and self-pay/indigent groups differed by the presence or absence of additional surgeries (64.0%, 13.5%, 19.4%, and 0.1%, vs 70.3%, 10.1%, 16.6%, and 0.1%, respectively). Compared to private insurance, Medicaid (1.46 [1.40–1.53] $P < .001$) and

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Financial Disclosure: *The authors declare that they have no relevant financial.*

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.urology.2022.09.004.

Medicare (1.15 [1.10–1.20] $P < .001$) insurance types were associated with significantly greater odds of multiple surgeries, whereas no significant association was seen in the self-pay/indigent insurance type (1.35 [0.83–2.19], $P = 1.0$).

CONCLUSION—In a statewide, California database from 2009 to 2018, underinsured adults had higher odds of undergoing a second procedure for kidney stones within 1 year of initial surgical treatment. This study adds to the expanding body of literature linking suboptimal healthcare access and disparate outcomes for kidney stone patients.

Urolithiasis affects approximately 9% of the United States population.[1] Furthermore, it is associated with high recurrence rates and healthcare costs.[2,3] The need for staged or multiple interventions for kidney stone disease in an acute period is more common among individuals with large stones.[4,5] Adults from communities of lower socioeconomic status (SES) are more likely to present with large, complex stones and to undergo staged stone interventions.[6,7] This may be partially explained by the lower SES patients experiencing more risk factors for stone formation including diet and occupation,[7] however, the mechanisms by which SES is associated with an increased stone burden and stone complexity remain poorly understood.

Another potential explanation is that individuals of lower SES have less extensive health insurance coverage relative to other groups.[8] Uninsured individuals receive less preventative care, encounter more delays in care, and experience increased all-cause mortality.[9,10] Recent literature also has shown a higher prevalence of renal stones among those with government-assisted insurance.[11] Additionally, individuals with urinary stones without insurance or on Medicaid are less likely to be admitted for definitive surgical care[12] and experience longer wait times to definitive surgical treatment.[11]

The objective of this study is to explore the relationship between the health insurance coverage and the need for multiple surgeries to treat kidney stones. We hypothesize that patients with government-sponsored insurance are more likely to require multiple surgeries for clearance of their stones and, as a result, are more likely to have staged surgeries for their stone disease over the course of one year.

METHODS

Data Source

This is a retrospective cohort analysis of longitudinal statewide data from ambulatory, emergency room, and inpatient encounters using claims data from the Department of Health Care Access and Information (HCAI), formerly California Office of Statewide Health Planning and Development (OSHPD), between 2009 and 2019.[13] This study was approved by the California Protection of Human Subjects (CPHS) Committee [project number 2020–232]. Our institution's local institutional review board (IRB) also provided project approval. The dataset included patient characteristics, the International Classification of Disease codes (ICD-10 and ICD-9 codes), Current Procedural Terminology codes (ICD-10 procedure codes and CPT codes) and other key location-specific parameters of the patient and the healthcare facility.

Study Design

This study included adults aged 18 or older having a kidney stone diagnosis identified using ICD codes with first recorded encounter between 2009 and 2018 (see Appendix for specific diagnosis codes). We excluded all patients with first surgery in the dataset prior to 2009, dating back to January 1, 2008, to ensure the patient had no prior surgeries for up to 365 days before index procedure. All index procedures occurring up to Dec 31, 2018 were included and any patients with first surgical procedure occurring after January 1, 2018 were excluded to ensure all patients were followed for at least 365 days after their index procedure. Additional inclusion criteria included undergoing at least one urologic stone procedure identified using ICD-10 procedure codes and CPT codes. Surgical procedures were identified as ureteroscopy (URS), shockwave lithotripsy (SWL), or percutaneous nephrolithotomy (PCNL). Stenting and nephrostomy tube placement without concurrent codes for the above procedures were not considered index procedures and were included as a separate variable for analysis when occurring prior to index surgical procedures. Subjects with any documented history of urothelial carcinoma based on ICD codes were excluded to prevent inclusion of cancer-related urologic procedures.

Covariates

Subject characteristics selected for analysis included age, gender, race, spoken language, payer at first surgery, and Charlson Comorbidity Index (CCI) as defined by ICD codes. Payer type at the time of first surgery were categorized as: private insurance, Medicaid, Medicare, self-pay/indigent, and other based on the payer information available in the dataset. To account for experiences of racial inequity we adjusted for race and ethnicity using the following self-identified categories: White/Hispanic, White/Non-Hispanic, Asian/Pacific Islander, Black/Hispanic, Black/Non-Hispanic, Native American, other, and unknown. Stent placement and/or nephrostomy tube placement prior to index surgical procedure was recorded as a separate variable to evaluate the effect of prior decompression procedure on surgical outcome.

Definition of Multiple Surgeries

Subjects were considered to have had a single stone surgery if they had no additional urologic stone procedures for up to 1 year (365 days) following their initial surgery (URS, SWL, or PCNL). Individuals with at least 1 additional stone procedure (URS, SWL, PCNL, or stent/nephrostomy tube placement) within 1 year of the initial stone procedure were defined as subjects with multiple surgeries for a single stone event.

Statistical Analysis

All univariate tests were performed with Chi-squared test or Student's *t*-test. Subjects were then stratified by procedure type (URS, SWL, and PCNL) at initial surgery and payer type for analysis of repeat surgery characterization. To estimate odds of having multiple surgeries within 1 year versus not having multiple surgeries within 1 year, a multivariate logistic model with all covariates listed above as independent variables was used. *P*-values from the multivariate model were adjusted using Holm method to account for multiple comparisons. All data analyses were conducted using R version 4.0.[14]

RESULTS

A total of 156,319 subjects were included in the study population. The cohort was stratified by those who did and did not undergo a second stone intervention within 365 days following initial surgical stone intervention. There were 24,539 participants (15.7 %) who had at least 1 additional stone intervention completed within the first year. The mean time to second procedure for this group was 60 days (median 35, standard deviation 74.59). The mean number of procedures in the multiple surgery group was 3.6 (median 3, SD 1.96), including the index procedure. Participants with and without additional stone interventions in the first year differed on the basis of race, first surgery type, decompressive procedure prior to first definitive intervention, insurance status, age, English proficiency, and Charlson comorbidity score ($P < .001$). We found that individuals with private insurance were 8.9% ([64.0%-70.3%]/70.3%) less likely to undergo a second procedure, while patients with Medicaid, Medicare, self-pay/indigent, and other were 33.4%, 17.0%, 10.7%, and 3.2% more likely to undergo a second procedure, respectively (Table 1). Subjects who had at least 1 additional stone intervention had a higher frequency of PCNL (4.0% vs 2.0%) and SWL (52.0% vs 38.2%), but a lower frequency of URS as the initial surgical intervention (43.9% vs 59.8%; Table 1).

Individuals with private insurance had higher rates of URS (57.6%) and lower rates of PCNL (1.9%) compared to the other insurance types (Fig. 1). Rates of SWL, however, were similar between patients with private insurance (40.5%) and Medicaid (40.2%). The overall rate of second surgery was highest in those undergoing PCNL and relatively high in those undergoing SWL as their first intervention when compared to patients undergoing URS across all insurance types (Fig. 2A-C). Within the PCNL cohort, repeat surgery was highest among Medicaid patients (32.7%) and self-pay/Indigent patients (40%) (Fig. 2C).

On multivariate analysis, odds ratios for multiple surgical interventions within 1 year of initial stone procedure illustrated that Medicaid (1.46 [1.40–1.53] $P < .001$) and Medicare (1.15 [1.10–1.20] $P < .001$) insurances were associated with significantly greater odds of second surgery relative to private insurance (Table 2). Additionally, PCNL (2.59 [2.39–2.79] $P < .001$) and SWL (2.05 [1.99–2.12] $P < .001$) were also associated with higher odds of multiple surgeries in reference to URS (Table 2). Non-Hispanic Black adults (1.14 [1.05–1.23] $P < .001$) were found to have statistically significant differences in odds of multiple surgeries compared to Non-Hispanic White adults. Age ≥65, Non-English speaking, and more comorbidities similarly corresponded to greater odds of multiple surgeries. There were no differences in likelihood of multiple surgeries observed between subjects of different genders.

DISCUSSION

This study shows that in a statewide dataset, adults with Medicaid and Medicare insurance types had significantly higher odds of undergoing multiple surgeries to treat their stone disease within a 365-day period. This effect remained present even after controlling for procedure type, history of decompression procedure, age, gender, race, spoken language, and CCI. In addition, this study revealed interesting differences in frequency of multiple procedures based on initial surgery procedure type, and small but significant differences in frequency of multiple procedures based on race and CCI.

In support of our hypothesis, participants with Medicare (OR 1.15, $P < .001$) and Medicaid (OR 1.46, $P < .001$) insurance types had significantly greater odds of a second stone surgery within 365-day of their initial procedure even after full adjustment. Previous investigators who have published their findings using this dataset defined "underinsurance" as Medicare, Medicaid, and self-pay/Indigent insurance categories.[15] Underinsurance may represent a key social determinant of health that contributes to kidney stone disease severity at presentation and, ultimately, surgical outcomes. Several studies have demonstrated that having private insurance is associated with decreased urinary risk factors and lower odds of stone formation compared to state-sponsored insurance.[11,16] It is also known that underinsured adults are less likely to utilize the healthcare system, including both preventive and acute care.[17] Therefore, our findings may be explained by the possibility that Medicare patients are somewhat more likely to forgo prompt evaluation and treatment of kidney stones due to less access to providers or an inability to pay given gaps in coverage relative to individuals with private insurance. Delayed workup may then result in more advanced disease at initial presentation, requiring staged procedures for definitive treatment. This effect seems to be more pronounced in Medicaid patients who are generally even more financially vulnerable and have less robust coverage compared to Medicare patients. This is supported by prior literature showing that underinsured adults have an increase in time to surgical treatment after diagnosis of kidney stones.[15,18] Kirschenbaum et al found that uninsured and publicly insured individuals had lower odds of undergoing upfront URS at time of their hospital admission for kidney stones and were more likely to be treated with stents alone.[19] Thus, even when individuals are admitted for kidney stones, surgical treatment may be delayed resulting in progression of stone disease, requiring more invasive, complex surgical treatment. Of note, the number of self-pay/indigent patients (n = 117) in the data set was small resulting in low power. However, we suspect that similar trends in multiple surgeries may exist within this population and future studies with larger cohorts should address this question.

In this study, undergoing a PCNL as the initial intervention also predicted for multiple procedures. It is possible that this effect is not completely explained by insurance status. PCNL is typically reserved for patients with more advanced disease.[20] Large stone burden has been shown to positively correlate with need for multiple surgeries and decreased stone clearance rate for those undergoing PCNL.[4,21] This is largely consistent with our findings and supports our hypothesis that patients requiring repeat procedures likely had substantial stone burden requiring PCNL for initial surgical management. Given that privately insured individuals had the lowest rates of PCNL, it is reasonable to conclude that these patients presented with lesser stone burden more easily managed with less invasive procedures, relative to other groups. Additionally, SWL was also associated with higher odds of multiple procedures, consistent with previous data showing decreased rates of stone clearance compared to URS and PCNL.[22] Importantly, however, the association between underinsurance and multiple procedures remained even after correcting for procedure type. Our results showed that patients who had a history of a decompression procedure, specifically a nephrostomy tube or stent, within 365 prior to their index stone surgery had higher odds of multiple subsequent surgeries within 365 days. One possible explanation is that these patients have stones that are larger and more complex at initial presentation, requiring more extensive interventions.

We also found that when controlling for other covariates, Non-Hispanic Black adults were more likely to undergo repeat surgery compared to White adults (OR 1.14, $P < .001$). This highlights known health disparities as it is well reported that communities of color have higher rates of chronic illnesses and experience worse outcomes from these illnesses.[23,24] We suspect that the same social factors that put Black and Hispanic adults at higher risk of chronic diseases similarly contribute to increased severity of kidney stone disease and thereby increase the risk of multiple procedures. These factors include: greater barriers to accessing care (limited insurance coverage, transportation, or healthcare literacy), racial bias within and outside of the healthcare system, and economic inequality.[25,26] Health literacy, for example, has been shown to mediate the relationship between the social and health-related disparities, and ethnic minorities have higher odds of limited health literacy.[27] The same studies showing increased time to surgery and decreased odds of initial URS based on insurance status, all additionally found similar treatment delays among Black and Hispanic adults.[15,18,19] This is consistent with our findings showing that Black adults had increased odds of second surgery, potentially explained in part by a greater likelihood of deferred primary treatment. These findings also highlight the racial and ethnic disparities in treatment of stone disease that have been cited in other studies,[28] and suggest that unconscious bias may play a role.

The multivariate model and ANOVA analysis (Supplemental Table 1) on the deviance showed surgical and procedure history had the highest contribution to the model, followed by insurance and comorbidities. Among other clinical covariates, with the exception of surgery, insurance contributed the most to determining requiring multiple surgeries more so than comorbidities index, race, age, spoken language, and gender. To assess for potential unmeasured confounding, we calculated E-values for all of the insurance categories. With private insurance as reference, the E-values for Medicaid, Medicare, self-pay, and other were 1.71, 1.35, 1.60, and 1.41, respectively. These values are high relative to the calculated odds ratios in our multivariate analysis (Table 2) suggesting a small potential for unaccounted confounding to explain the odds ratios for insurance observed in our model.

These results add to the growing body of literature linking sociodemographic factors, healthcare access, and surgical outcomes for kidney stone disease. Repeat surgeries for kidney stones have significant implications for patient morbidity and health care costs, and it is therefore crucial to understand risk factors associated with this outcome. Our findings suggest that underinsurance may be an important predictor for needing multiple stone procedures, perhaps in part due to delays or impediments in obtaining insurance clearance for referrals for urologist specialty care, or perhaps because these patients are likely to be low income they face additional barriers in obtaining care due to more generalized lack of resources. Our findings can also be interpreted on the basis of healthcare value, which is defined as the measured improvement in patient outcomes for the cost of achieving these outcomes.[29] In our study, individuals with Medicaid and Medicare experienced worse outcomes (multiple surgeries) and utilized more healthcare resources resulting in lower healthcare value compared to privately insured individuals. Similarly, these findings speak to the quality of care received by kidney stone patients. Per the 2021 National Healthcare Quality and Disparities Report, healthcare quality is assessed based on measures of processes, outcomes, and perceptions of care.[30] Our data suggest that underinsured patients are not receiving care early on in the natural history of their stone disease. This delay in care may then result in increasingly large stone burdens and multiple surgeries, which impact both outcomes and patient perceptions of care. More broadly, this study highlights the shortcomings of our current health insurance/healthcare system, in which the most disadvantaged populations (eg the poor, the underinsured, and racial minorities) often experience worse healthcare outcomes and are most burdened by chronic diseases, including stone disease.

This study has several limitations which should be outlined. First, the dataset is de-identified which prohibits identifying patient-level factors that may be associated with outcomes of interest. Second, multiple stone interventions could represent stone persistence (residual stone burden after surgery) or stone recurrence (newly formed stones). However, given the mean time to second surgery in patients who required more than one procedure was 60 days, these procedures are more likely staged procedures rather than surgeries for newly formed stones. Another potential limitation of this study is that we did not account for changes of insurance type over time, instead relying on insurance status on the date of the initial surgery. However, the short 365 days interval between interventions likely minimizes the impact that changing one's insurance has on undergoing additional procedures. Another limitation is the quality of race information in the HCAI database, as demonstrated by the considerable proportions of patients identified as "other" or "unknown." It should also be noted that while the dataset includes information from ambulatory surgery centers, it does not include data from privately owned surgery centers. As such, there may be a significant number of patients with stone disease not included in our analysis. An additional limitation is that the HCAI database is a California database, and therefore our findings may not be generalizable to the greater United States. Lastly, we acknowledge that interactions between the sociodemographic characteristics and health are complex, and the influence of insurance status on stone outcomes may be confounded by other factors that we did not control for. However, we maintain that insurance status is an important measure of healthcare access on its own and represents a potential area for further investigation, future policy changes, and supportive interventions for individuals at greatest risk.

CONCLUSION

This study demonstrates that underinsurance was associated with undergoing multiple stone-related interventions for a single stone episode using a statewide database. Sub-analyses found that the need for multiple surgeries was also more likely among patients with prior decompressive procedures, PCNL or SWL at index surgery, Non-Hispanic Black adults, Non-English speakers, and individuals with additional comorbidities. This study adds to the expanding body of literature linking SES and disparate outcomes for individuals with kidney stones and suggests factors affecting access to health care, such as health insurance coverage, are potentially key contributors to these disparities. Additional research is needed to further elucidate the relationship between the health insurance status and kidney stone treatment outcomes, as well as support systems that can improve care for the most at-risk patients.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding Support:

NIH − NIDDK (K12DK111028).

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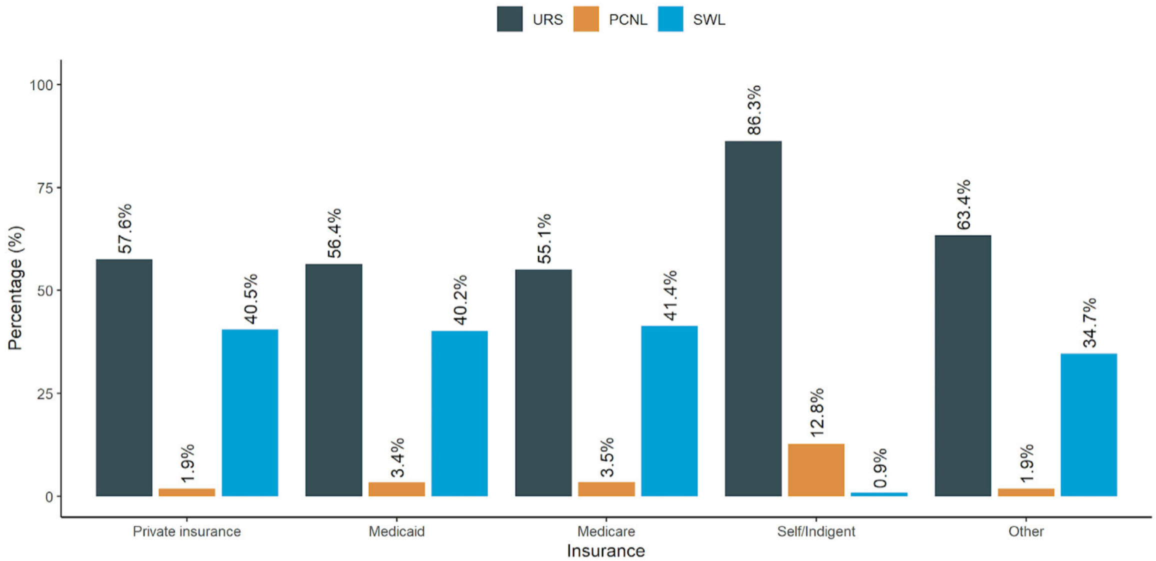

Figure 1.

Surgery at first encounter by payer type.

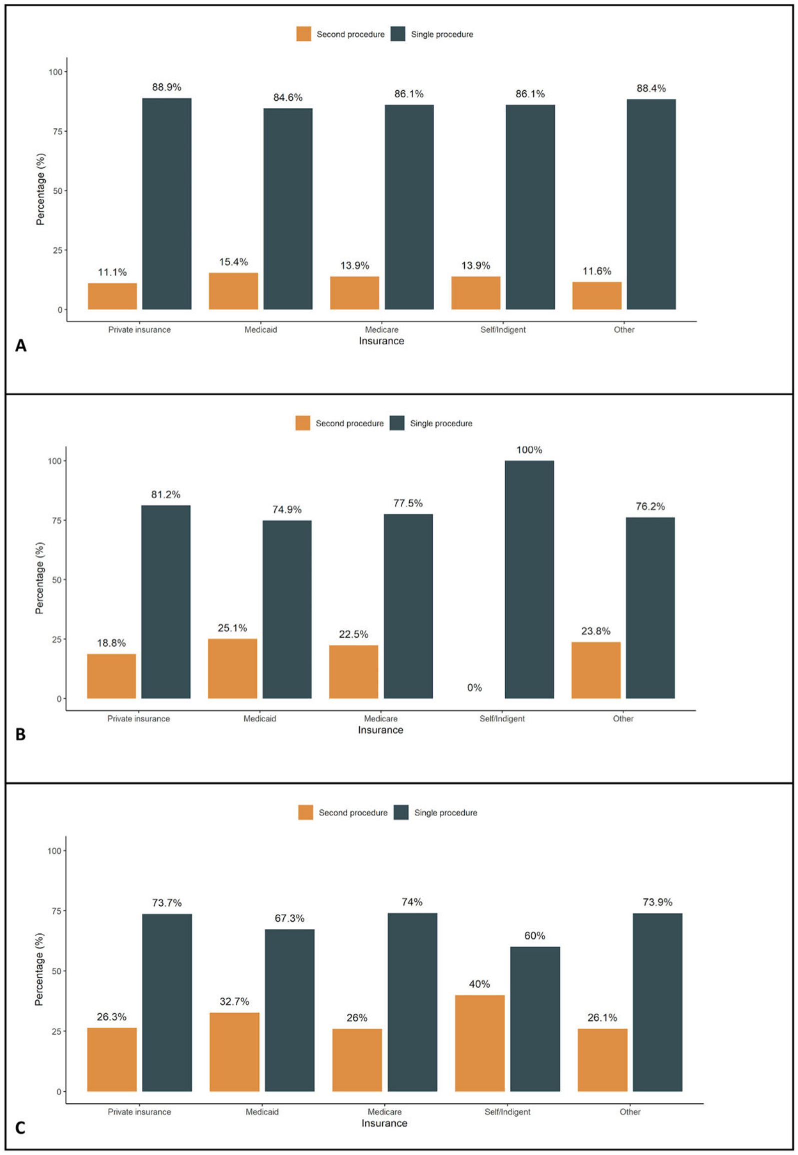

Figure 2.

Incidence of multiple surgeries following initial surgery (A) URS, (B) SWL, (C) PCNL.

Table 1.

Patient characteristics

	Patients With 2nd Surgery Within 365 Days	Patients With Out 2nd Surgery Within 365 Days	*P*-Value
N	**24,539**	**131,780**	
Gender			.292
Male	13,678 (55.7%)	73,936 (56.1%)	
Female	10,861 (44.3%)	57,844 (43.9%)	
Race			<.001
White/Non-Hispanic	15,514 (63.2%)	82,807 (62.8%)	
White/Hispanic	2,142 (8.7%)	10,445 (7.9%)	
Black/Non-Hispanic	910 (3.7%)	4,286 (3.3%)	
Black/Hispanic	14 (0.1%)	97 (0.1%)	
Asian/Pacific	2,457 (10.0%)	13,125 (10.0%)	
Native American	96 (0.4%)	449 (0.3%)	
Other	3,052 (12.4%)	18,004 (13.7%)	
Unknown	354 (1.4%)	2,567 (1.9%)	
Initial surgery type			<.001
SWL	12,769 (52.0%)	50,397 (38.2%)	
URS	10,780 (43.9%)	78,745 (59.8%)	
PNL	990 (4.0%)	2,638 (2.0%)	
Prior stent or nephrostomy tube			<.001
Yes	12,076 (49.2%)	59,625 (45.2%)	
No	12,463 (50.8%)	72,155 (54.8%)	
English speaker			<.001
Yes	18,824 (76.7%)	103,859 (78.8%)	
No	5,715 (23.3%)	27,921 (21.2%)	
Insurance type			<.001
Private insurance	15,717 (64.0%)	92,699 (70.3%)	
Medicaid	3,312 (13.5%)	13,332 (10.1%)	
Medicare	4,760 (19.4%)	21,855 (16.6%)	
Self-Pay/Indigent	20 (0.1%)	97 (0.1%)	
Other	730 (3.0%)	3,797 (2.9%)	

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	Patients With 2nd Surgery Within 365 Days	Patients With Out 2nd Surgery Within 365 Days	*P*-Value
N	**24,539**	**131,780**	
Age			<.001
65 +	7,499 (30.6%)	36,995 (28.1%)	
<65	17,040 (69.4%)	94,785 (71.9%)	
Charlson comorbidity index (mean, sd)	0.86, 1.51	0.74, 1.42	<.001

Table 2.

Odds ratio for multiple surgeries within 1 year following first stone surgery. Sample size (N = 156,319) includes 24,539 subjects *with* a second stone surgery within 1 year, and 131,780 subjects *without* a second stone surgery within 1 year.

	Odds for second Procedure Within 365 Days	95% Confidence Interval	*P*-Value (Adjusted)
Surgery			
URS	Ref	Ref	Ref
SWL	2.05	1.99, 2.12	<.001
PNL	2.59	2.39, 2.79	<.001
Prior stent or nephrostomy tube			
No	Ref	Ref	Ref
Yes	1.37	1.33, 1.41	<.001
Insurance type			
Private insurance	Ref	Ref	Ref
Medicaid	1.46	1.40, 1.53	<.001
Medicare	1.15	1.10, 1.20	<.001
Self-Pay/Indigent	1.35	0.83, 2.19	1.00
Other	1.19	1.09, 1.29	<.001
Race			
White/Non-Hispanic	Ref	Ref	Ref
White/Hispanic	1.03	0.98, 1.09	1.00
Black/Non-Hispanic	1.14	1.05, 1.23	.006
Black/Hispanic	0.73	0.42, 1.29	1.00
Asian/Pacific	0.98	0.93, 1.03	1.00
Native American	1.13	0.90, 1.41	1.00
Other	0.91	0.87, 0.95	<.001
Unknown	0.71	0.63, 0.79	<.001
English Speaker			
Yes	Ref	Ref	Ref
No	1.06	1.03, 1.10	.003
Age			
<65	Ref	Ref	Ref
65+	1.08	1.04, 1.12	.001

	Odds for second Procedure Within 365 Days	95% Confidence Interval	*P*-Value (Adjusted)
Gender			
Female	Ref	Ref	Ref
Male	1.03	1.00, 1.05	.472
Charlson comorbidity index	1.07	1.06, 1.08	<.001

Multivariate logistic model was used for Odds Ratio (OR) calculation and their respective 95% Confidence Intervals. Holm method was used to adjust *P*-values to account for multiple comparisons