University of Nebraska Medical Center
Nebraska Medicine

Graduate Medical Education Research Journal

Volume 6 | Issue 1 Article 8

May 2024

Impact of Frailty on Patient Morbidity and Outcomes Following Surgery for Urolithiasis: A NSQIP Analysis

David Fu
University of Nebraska Medical Center

Kaeli Samson
University of Nebraska Medical Center

Bryant Van Leeuwen
University of Nebraska Medical Center

Andrew J. Blazek
University of Nebraska Medical Center

Andrew Christiansen
University of Nebraska Medical Center

Impact of Frailty on Patient Morbidity and Outcomes Following Surgery for Urolithiasis: A NSQIP Analysis

Abstract

Background: Kidney stones are prevalent, and surgical treatment is based on multiple factors. Frailty is the collective decline of organ systems that can lead to adverse events and is considered prior to surgery for risk-benefit analysis. The National Surgical Quality Improvement Program (NSQIP) utilizes risk-adjusted data to monitor outcomes, provide quality benchmarks, and decrease complications. The impact of frailty with the modified 5-item frailty index has not previously been evaluated for patients undergoing urolithiasis procedures.

Methods: Data was collected from 1329 patients who underwent surgery for urolithiasis. The primary outcome was 30-day all-cause morbidity. Associations between variables, including those within the 5-item modified frailty index (history (hx) of diabetes, CHF, COPD, antihypertensive usage, functional status), and all-cause morbidity were assessed. Additional analysis looked at two specific outcomes: readmissions and return to OR.

Results: A total of 1329 patients were assessed. Of the variables in the frailty index, COPD and HTN requiring medications were not associated with higher morbidity. Dependent functional status (OR = 2.47, $p = 0.006$), hx of CHF (OR = 4.69, $p = 0.02$), and insulin-dependent diabetes (OR = 1.89, $p = 0.02$) were associated with higher morbidity. Type of procedure was highly linked with morbidity, with percutaneous procedure (OR = 4.72, $p < 0.001$) and open procedures (OR = 2.43, $p < 0.001$) being associated with patient morbidity. Age was the only variable associated with increased return to OR and readmission rates.

Conclusion: Urologists should consider patient age and comorbidities when selecting the surgical route for urolithiasis.

Keywords

urolithiasis, frailty, morbidity, complications, readmission

Cover Page Footnote

Author Disclosure/Conflict of Interest Statement: We have no conflicts of interest to disclose for the research performed in this manuscript. Funding Statement: We did not receive any outside funds for the research performed in this manuscript.

Impact of Frailty on Patient Morbidity and Outcomes Following Surgery for Urolithiasis: A NSQIP Analysis

David Fu[1], Kaeli Samson[1], Bryant Van Leeuwen[1], Andrew J. Blazek[1], Andrew J. Christiansen[1]
[1]Division of Urologic Surgery, University of Nebraska Medical Center, Omaha, NE, USA

https://doi.org/10.32873/unmc.dc.gmerj.6.1.007

Abstract

Background: Kidney stones are prevalent, and surgical treatment is based on multiple factors. Frailty is the collective decline of organ systems that can lead to adverse events and is considered prior to surgery for risk-benefit analysis. The National Surgical Quality Improvement Program (NSQIP) utilizes risk-adjusted data to monitor outcomes, provide quality benchmarks, and decrease complications. The impact of frailty with the modified 5-item frailty index has not previously been evaluated for patients undergoing urolithiasis procedures.

Methods: Data was collected from 1329 patients who underwent surgery for urolithiasis. The primary outcome was 30-day all-cause morbidity. Associations between variables, including those within the 5-item modified frailty index (history (hx) of diabetes, CHF, COPD, antihypertensive usage, functional status), and all-cause morbidity were assessed. Additional analysis looked at two specific outcomes: readmissions and return to OR.

Results: A total of 1329 patients were assessed. Of the variables in the frailty index, COPD and HTN requiring medications were not associated with higher morbidity. Dependent functional status (OR = 2.47, p = 0.006), hx of CHF (OR = 4.69, p = 0.02), and insulin-dependent diabetes (OR = 1.89, p = 0.02) were associated with higher morbidity. Type of procedure was highly linked with morbidity, with percutaneous procedure (OR = 4.72, p < 0.001) and open procedures (OR = 2.43, p < 0.001) being associated with patient morbidity. Age was the only variable associated with increased return to OR and readmission rates.

Conclusion: Urologists should consider patient age and comorbidities when selecting the surgical route for urolithiasis.

Keywords

urolithiasis, frailty, morbidity, complications, readmission

Abbreviations

NSQIP - National Surgical Quality Improvement Program
CHF - congestive heart failure
COPD - chronic obstructive pulmonary disease
OR - operating room
HTN - hypertension
PCNL - percutaneous nephrolithotomy
CPT - current procedural terminology
BMI - body mass index
CI - confidence interval
TURP - transurethral resection of the prostate
LOS - length of stay
AUA - American Urologic Association

Introduction

Kidney stones are a common medical problem in the United States, with a prevalence of 8.8%.[1] If surgical treatment for urolithiasis is indicated, a variety of techniques can be utilized (shock wave lithotripsy, percutaneous nephrolithotomy, ureteroscopy, open surgery) based on stone location, size, and patient comorbidities, among other factors.[2] Frailty is the collective decline of organ systems due to aging and medical comorbidities that can lead to adverse events after stressors, such as surgery.[3] Because frailty is prevalent in older individuals and about two-thirds of urological procedures are performed on patients ≥65 years old4, it is imperative to assess frailty when considering surgical procedures, like stone surgery, for risk-benefit analysis. Previous studies have linked preoperative frailty to postoperative complications, such as increased mortality, rate of return to the operating room, and hospital readmissions.[4] Specifically, in urology, more complications arose in frailer patients after major urological surgeries.[5] Frailty is a useful prognostic indicator when classifying risk for surgeries and has been shown to predict mortality from many procedures in many fields, including urologic oncology.[6]

The National Surgical Quality Improvement Program (NSQIP) utilizes risk-adjusted data to monitor and track surgical outcomes to provide quality benchmarks and help decrease complications.[7] The NSQIP frailty index was initially developed to measure patient frailty (physiological vulnerability) using 11 measures of impairment. More recently, these 11 criteria were modified into a 5-item frailty index (diabetes mellitus, history of CHF, functional status, history of COPD, history of antihypertensive usage),[8] which has shown to predict adverse effects in areas such as trauma surgery,[9] neurosurgery,[10] and orthopaedics.[11,12] Pertaining to urolithiasis, only individual risk factors have been analyzed for post-operative complications, morbidity, and mortality. For example, studies have shown that diabetes mellitus, cardiovascular disease, and obesity are associated with increased complications after ureteroscopy.[13,14] Moreover, diabetes, hypertension, and fasting plasma glucose are independent risk factors for increased complications after PCNL.[15-17] However, many of the components of the modified 5-item frailty index have never been evaluated in patients undergoing any surgical management for urolithiasis. Utilizing NSQIP data, we analyzed associations between the components of frailty as well as other variables of interest and stone surgery outcomes and, in turn, hope the results can help inform urologists of these risks when considering different surgical procedures for the management of urolithiasis.

Methods

Data was collected from the NSQIP database between 2012 and 2018. Surgical procedures were categorized into procedure types (open, percutaneous, or retrograde endoscopic) based on the Current Procedural Terminology (CPT) codes. Patients undergoing concurrent procedures involving other organ systems or more involved urologic surgery (cyst decortication, liver biopsy, cholecystectomy, etc.) were excluded from our study. The primary research outcome was all-cause morbidity, such as infection, renal impairment, and cardiovascular events within 30 days. Variables analyzed included body mass index (BMI), diabetes mellitus (insulin-dependent, insulin-independent, or no history), history of chronic obstructive pulmonary disease (COPD), history of congestive heart failure (CHF), hypertension (HTN) requiring medication, functional status (dependent or independent), smoking within the last year, chronic steroid usage, dialysis, and age.

Descriptive statistics are presented as counts and percentages or means and standard deviations. Associations between variables,

including those within the 5-item modified frailty index (diabetes mellitus, history of CHF, functional status, history of COPD, history of antihypertensive usage), and the outcome variable of all-cause morbidity were assessed using Chi-Square or Fisher's Exact tests for categorical variables of interest, and independent samples t-tests for continuous variables of interest. In addition, associations between each variable and two specific morbidity criteria (return to OR and readmission) were assessed. Variables with a p-value less than 0.20 were then entered into a logistic regression for each outcome. Odds ratios are presented with 95% confidence intervals (CIs). All analyses were performed using SAS software version 9.4 (SAS Institute Inc., Cary, NC).

Results

Our initial NSQIP data collection from 2015-2018 revealed a total of 2666 patients. After removing 66 patients with emergent procedures, 5 patients who underwent concurrent, more involved urologic procedures (TURP, nephrectomy, etc.), and 1,266 patients who had other non-urologic procedures, there were a total of 1,329 patients in our final sample. The sample consisted of 50.1% males. The average age in the group with no morbidity was 55.5, while the average age of the group with at least one morbidity was 57.9 (p = 0.15). Most patients were white, 84.2% (**Table 1**). The breakdown of procedures was as follows: retrograde endoscopic (60.1%), open (36.0%), and percutaneous endoscopic (3.9%), and were performed equally over the years analyzed.

The different variables present in the 5-item frailty index were each assessed individually.

Table 1. Demographic Data from the NSQIP Data Set for Surgical Interventions for Urolithiasis.

	Overall N (%)
Gender	
Male	669 (50.3)
Female	660 (49.7)
Race	
American Indian or Alaska Native	8 (0.7)
Asian	66 (5.5)
Black or African American	106 (8.8)
Native Hawaiian or Pacific Islander	11 (0.9)
White	1014 (84.1)
Year	
2015	225 (26.3)
2016	233 (27.2)
2017	206 (24)
2018	193 (22.5)

Patients with a dependent functional status had statistically significantly more morbidity (18.75%) than independent patients (6.74%, p = 0.006). Those with a history of CHF had significantly more negative outcomes (33.33%) vs. patients without a history of CHF (6.89%, p = 0.02). When looking at diabetes, Insulin-dependent diabetes mellitus patients had more negative outcomes (14.46%) than non-diabetics (6.43%) and insulin-independent diabetics (7.51%, p = 0.02). Patients with a history of COPD (p = 0.54) or hypertension requiring medication (p = 0.25) use did not have any associated difference in morbidity. When looking at the association between morbidity and the type of surgical procedure performed (open vs. Retrograde endoscopic vs. Percutaneous endoscopic), percutaneous endoscopic surgery (17.3%) and open surgery (10.7%) had statistically significantly more prevalent negative outcomes compared to retrograde endoscopic (4.6%) surgery with a p-value of <0.0001. Several other common variables associated with morbidity were also analyzed. BMI (p = 0.33), chronic steroid use (p = 0.48), and current smoking status (p = 0.16) were all not associated with an increase in morbidity (**Table 2**).

Among the variables assessed in the univariable analysis, those that had a p < 0.20 were analyzed further using logistic regression. In the adjusted logistic regression model, the surgical type was associated with all cause morbidity (p < 0.0001), where the adjusted odds of having a morbidity was 4.72 (95% CI: 2.10, 10.60) for patients with percutaneous stone procedures and a 2.43 (95% CI: 1.54, 3.85) for patients with open procedures, both relative to patients with retrograde endoscopic procedures. After adjusting for the other

Table 2. Risk Factors and Their Associated All-Cause Morbidity in Procedures for Urolithiasis.

Outcome: All-Cause Morbidity	**No Morbidity N = 1235 (%)**	**>/= 1 Morbidity N = 94 (%)**	**p-Value**
Functional Status*			p = 0.006
Dependent	39 (81.3)	9 (18.7)	
Independent	1177 (93.3)	85 (6.7)	
Diabetes*			p = 0.02
Insulin-Dependent	71 (85.5)	12 (14.5)	
Non-Insulin Dependent	160 (92.5)	13 (7.5)	
No	1004 (93.6)	69 (6.4)	
Hx of COPD*			p = 0.54
Yes	39 (90.7)	4 (9.3)	
No	1196 (93)	90 (7.0)	
Hx of CHF*			p = 0.02
Yes	6 (66.7)	3 (33.3)	
No	1229 (93.1)	91 (6.9)	
HTN Requiring Medication*			p = 0.25
Yes	568 (92.1)	49 (7.9)	
No	667 (93.7)	45 (6.3)	
Type of Surgery			p < 0.0001
Percutaneous Endoscopic Surgery	43 (82.7)	9 (17.3)	
Retrograde Endoscopic Surgery	764 (95.7)	34 (4.26)	
Open Surgery	428 (89.3)	51 (10.7)	
Age (mean +/- std dev)	55.5 +/- 15.6	57.9 +/- 16.5	p = 0.15
BMI			p = 0.32
<25	264 (90.4)	28 (9.6)	
25-29.9	377 (93.6)	26 (6.4)	
30-34.9	303 (93.8)	20 (6.2)	
35+	279 (93.3)	20 (6.7)	
Smoking Status			p = 0.16
Current	217 (90.8)	22 (9.2)	
Not Current	1018 (93.4)	72 (6.6)	
Chronic Steroid Use			p = 0.48
Yes	28 (90.3)	3 (9.7)	
No	1207 (93)	91 (7.0)	

* Denotes variable in a 5-item frailty index
BMI, body mass index; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; Hx, history; std dev, standard deviation.

variables in the model, dependent patients have 2.47 (95% CI: 1.11, 5.48) times the odds of experiencing a negative outcome relative to independent patients ($p = 0.03$). Patients with a history of CHF had an adjusted OR of 4.69 (95% CI: 1.05, 21.02) relative to patients without a history of CHF. Age, presence of diabetes (insulin or non-insulin dependent), and smoking all showed no statistically significant increase in all-cause morbidity (**Table 3**). Interestingly, patients who had all five conditions that define frailty had an odds ratio of 4.79 for having any morbidity compared to those who had zero conditions ($p < 0.01$).

Outside of all-cause morbidity, a secondary analysis was performed, which looked at the relationship between each of these variables and two common clinical measures, "return to the OR" and "readmission rates." There was no statistically significant relationship between "return to OR" and any examined variables (history of diabetes, CHF, or COPD, BMI, HTN requiring medication, functional status, smoking status, chronic steroid usage, or age), except for age ($p = 0.014$). Similarly, age was the only variable significantly associated with "readmission" ($p = 0.032$); there was no statistically significant relationship between readmission and any other examined variable mentioned above. In addition, the analysis revealed that older patients are frailer ($p < 0.001$) and frailer patients have increased hospital LOS ($p < 0.01$).

Table 3. Adjusted Odds Ratios for Morbidity for Each Risk Factor in Urolithiasis Procedures.

Outcome: All-Cause Morbidity	Adjusted Odds Ratio	95% Confidence Interval	p-value
Age	1.01	0.99-1.02	p = 0.25
Diabetes			p = 0.19
Insulin vs. None	1.89	0.95-3.78	
Non-Insulin vs None	1.06	0.56-2.00	
Hx of CHF			
Yes vs. No	4.69	1.05-21.02	p = 0.04
Functional Status			
Dependent vs. Independent	2.47	1.11-5.48	p = 0.03
Smoking			
Yes vs. No	1.45	0.86-2.45	p = 0.17
Surgery Group			p < 0.0001
Open vs. Retrograde Endoscopic	2.43	1.54-3.85	
Percutaneous vs. Retrograde Endoscopic	4.72	2.10-10.60	

CHF, congestive heart failure; Hx, history.

Discussion

Percutaneous endoscopic and open surgery were both found to be statistically significantly associated with all-cause morbidity than retrograde ureteroscopy for surgical intervention for urolithiasis. This corroborates existing literature showing that PCNL led to an increase in negative outcomes compared to ureteroscopy.[18,19] Given previous data and the data presented here, urologists must consider the surgical method selected and its associated morbidity for the treatment of urolithiasis in all patients. AUA guidelines allow significant flexibility to both providers and patients when selecting the type of surgery appropriate for a procedure, especially for larger stones. Thus, it is important that the provider thoroughly discuss the risks and morbidities associated with each procedure versus the different benefits (operative times and stone-free rates). The data presented here may suggest that retrograde endoscopic procedures for urolithiasis, even if requiring a second look or procedure, could provide morbidity benefits over either percutaneous or open surgical options. This is especially true as modern medicine and surgical tools, including lasers, are constantly improving. A recent study revealed that a high-powered MOSES laser was associated with significantly less stone fragmentation time and procedural time when compared to a regular holmium laser.[20]

Of the modified 5-item frailty index, only insulin-dependent diabetes mellitus, history of congestive heart failure, and dependent functional status were significantly associated with increased morbidity. Of the three, after adjusting for other variables, a history of CHF had the highest odds ratio, followed by dependent functional status and then insulin-dependent diabetes, which was not statistically significant. Each of these pieces in the 5-item frailty index does not similarly contribute to all-cause morbidity, as it specifically relates to surgical intervention for urolithiasis. Thus, emphasis should be placed on assessing their individual utility, along with other potential morbidity predictors, rather than using the summed frailty score. In fact, a logistic regression model performed slightly better when considering only the 5-item frailty variables individually (c-statistic of 0.60) rather than as a summed frailty score (c-statistic of 0.58), and the performance was better in the model used in this study which excluded some components of the original frailty items, and included other predictors of all-cause morbidity, like surgical type (c-statistic = 0.69).

The secondary analysis looked at two common clinically measured outcomes, "return to OR" and "readmission", and their association with our variables of interest. Both "return to the OR" and "readmission" were only significantly associated with age. This suggests that age may be an important frailty variable to consider, especially when considering "readmission" rates, which is a commonly used clinical indicator that is highly associated with increasing healthcare costs and possibly even physician reimbursement. Aggregate expenditures for treating patients with urolithiasis are among the highest for any urologic condition, with costs exceeding $10 billion annually. With a recent study showing that an unplanned "readmission" after surgical intervention for urolithiasis costs an average of nearly $30,000, age may be an important variable to consider when considering the route of surgical intervention. Although not currently instituted, penalties for readmissions after operative intervention are a potential expansion of current payer policies as part of a transition away from a system focused on volume rather than clinical outcomes.[21]

With the common incidence and increased prevalence of urolithiasis worldwide, surgical interventions are going to continue to be performed at a high rate. Thus, inherent morbidity and surgical complications are going to occur despite any preventative actions from urologic surgeons. With the significant health and financial costs of these morbidities, it is important to optimize potential surgical outcomes and minimize risk as much as possible in the preoperative setting. Thus, it is essential to use all tools available to help select the proper surgical intervention for each patient based on their age, morbidities, and specific stone size and location. The data presented above shows that the different components of the 5-item frailty index, age, and other comorbidities should all be considered and weighed appropriately when considering a certain route of surgery. It also highlights the importance of discussing the potential morbidity of each surgical type with the patient in an informed consent manner to help them select the best surgical intervention for them.

This study has several limitations. Even with a total assessment of 1,329 patients, there were few negative outcomes (94 patients), which caused the logistic regression to become too specific, potentially introducing significant errors. The data obtained via NSQIP revealed that 36.0% of surgical interventions were "open" surgeries, which may not be a true representation of the surgical interventions commonly selected for urolithiasis; thus, it may be skewing our data. Next, NSQIP data is retrospectively obtained and is only tracked for 30 days post-operatively, which limits full assessment of patient morbidity and mortality and our secondary variables, readmission, and return to the OR.

Conclusion

With the common incidence and increased prevalence of urolithiasis worldwide, surgical interventions are going to continue to be performed at a high rate. Thus, inherent morbidity and surgical complications are going to occur despite any preventative actions from urologic surgeons. With the significant health and financial costs of these morbidities, it is important to optimize potential surgical outcomes and minimize risk as much as possible in the preoperative setting. Thus, it is essential to use all tools available to help select the proper surgical intervention for each patient based on their age, morbidities, and specific stone size and location. The data presented above shows that the different components of the 5-item frailty index, age, and other comorbidities should all be considered and weighed appropriately when considering a certain route of surgery. It also highlights the importance of discussing the potential morbidity of each surgical type with the patient in an informed consent manner to help them select the best surgical intervention for them. ■

Acknowledgement

No significant acknowledgement will be made from this research project.

Conflicts of Interest

We have no conflicts of interest to disclose for the research performed in this manuscript.

Funding Statement

We did not receive any outside funds for the research performed in this manuscript.

Author Contributions

David Fu: writing – original draft; Kaeli Samson: software, formal analysis, investigation, data curation; Bryant Van Leeuwen: writing – original draft, visualization. Andrew Blazek: writing – review & editing, visualization, supervision; Andrew Christiansen: conceptualization, methodology, writing – review and editing, project administration.

References

1 Scales CD Jr, Smith AC, Hanley JM, et al. Prevalence of kidney stones in the United States. *Eur Urol.* 2012;62(1):160-5. doi:10.1016/j.eururo.2012.03.052.

2 Zumstein V, Betschart P, Abt D, et al. Surgical management of urolithiasis - a systematic analysis of available guidelines. *BMC Urol.* 2018;18(1):25. doi:10.1186/s12894-018-0332-9.

3 Drach GW, Griebling TL. Geriatric urology. *J Am Geriatr Soc.* 2003;51(7 Suppl):S355-8. doi:10.1046/j.1365-2389.2003.51348.x.

4 Isharwal S, Johanning JM, Dwyer JG, et al. Preoperative frailty predicts postoperative complications and mortality in urology patients. *World J Urol.* 2017;35(1):21-26. doi:10.1007/s00345-016-1845-z.

5 Moro FD, Morlacco A, Motterle G, et al. Frailty and elderly in urology: Is there an impact on post-operative complications? *Cent European J Urol.* 2017;70(2):197-205. doi:10.5173/ceju.2017.1321.

6 Revenig LM, Canter DJ, Kim S, et al. Report of a Simplified Frailty Score Predictive of Short-Term Postoperative Morbidity and Mortality. *J Am Coll Surg.* 2015;220(5):904-11.e1. doi:10.1016/j.jamcollsurg.2015.01.053.

7 Suskind AM, Walter LC, Jin C, et al. Impact of frailty on complications in patients undergoing common urological procedures: a study from the American College of Surgeons National Surgical Quality Improvement database. *BJU Int.* 2016;117(5):836-42. doi:10.1111/bju.13399.

8 Subramaniam S, Aalberg JJ, Soriano RP, et al. New 5-Factor Modified Frailty Index Using American College of Surgeons NSQIP Data. *J Am Coll Surg.* 2018;226(2):173-181.e8. doi:10.1016/j.jamcollsurg.2017.11.005.

9 Tracy BM, Wilson JM, Smith RN, et al. The 5-Item Modified Frailty Index Predicts Adverse Outcomes in Trauma. *J Surg Res.* 2020;253:167-172. doi:10.1016/j.jss.2020.03.052.

10 Weaver DJ, Malik AT, Jain N, et al. The Modified 5-Item Frailty Index: A Concise and Useful Tool for Assessing the Impact of Frailty on Postoperative Morbidity Following Elective Posterior Lumbar Fusions. *World Neurosurg.* 2019;124:e626-e632. doi:10.1016/j.wneu.2018.12.168.

11 Yagi M, Michikawa T, Hosogane N, et al. The 5-Item Modified Frailty Index Is Predictive of Severe Adverse Events in Patients Undergoing Surgery for Adult Spinal Deformity. Spine (Phila Pa 1976). 2019;44(18):E1083-E1091. doi:10.1097/BRS.0000000000003063.

12 Wilson JM, Holzgrefe RE, Staley CA, et al. Use of a 5-Item Modified Frailty Index for Risk Stratification in Patients Undergoing Surgical Management of Distal Radius Fractures. *J Hand Surg Am.* 2018;43(8):701-709. doi:10.1016/j.jhsa.2018.05.029.

13 Daels FP, Gaizauskas A, Rioja J, et al. Age-related prevalence of diabetes mellitus, cardiovascular disease and anticoagulation therapy use in a urolithiasis population and their effect on outcomes: the Clinical Research Office of the Endourological Society Ureteroscopy Global Study. *World J Urol.* 2015;33(6):859-64. doi:10.1007/s00345-014-1382-6.

14 Sun J, Xu J, OuYang J. Risk Factors of Infectious Complications following Ureteroscopy: A Systematic Review and Meta-Analysis. Urol Int. 2020;104(1-2):113-124. doi:10.1159/000504326.

15 Reeves T, Pietropaolo A, Gadzhiev N, et al. Role of Endourological Procedures (PCNL and URS) on Renal Function: a Systematic Review. *Curr Urol Rep.* 2020;21(5):21. doi:10.1007/s11934-020-00973-4.

16 Xu P, Wang J. Number of Metabolic Syndrome Components Is the Central Predictor of the Impact of Metabolic Syndrome on Outcome of Percutaneous Nephrolithotomy in Staghorn Nephrolithiasis. *J Endourol.* 2019;33(11):946-953. doi:10.1089/end.2019.0404.

17 Wei W, Leng J, Shao H, et al. Diabetes, a risk factor for both infectious and major complications after percutaneous nephrolithotomy. *Int J Clin Exp Med.* 2015;8(9):16620-6.

18 Srisubat A, Potisat S, Lojanapiwat B, et al. Extracorporeal shock wave lithotripsy (ESWL) versus percutaneous nephrolithotomy (PCNL) or retrograde intrarenal surgery (RIRS) for kidney stones. Cochrane Database Syst Rev. 2014;(11):CD007044. doi:10.1002/14651858.CD007044.pub3.

19 Akman T, Binbay M, Ugurlu M, et al. Outcomes of retrograde intrarenal surgery compared with percutaneous nephrolithotomy in elderly patients with moderate-size kidney stones: a matched-pair analysis. *J Endourol.* 2012;26(6):625-9. doi:10.1089/end.2011.0526.

20 Ibrahim A, Elhilali MM, Fahmy N, et al. Double-Blinded Prospective Randomized Clinical Trial Comparing Regular and Moses Modes of Holmium Laser Lithotripsy. *J Endourol.* 2020;34(5):624-628. doi:10.1089/end.2019.0695.

21 Scales CD Jr, Saigal CS, Hanley JM, et al. NIDDK Urologic Diseases in America Project. The impact of unplanned postprocedure visits in the management of patients with urinary stones. *Surgery.* 2014;155(5):769-75. doi:10.1016/j.surg.2013.12.013.