The effect of travel distance on health-related quality of life for patients with nephrolithiasis

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Abstract

Introduction: Urolithiasis causes a significant impact on health-related quality of life (HRQOL). Patients with kidney stones have high levels of stress and anxiety. Symptom resolution often requires treatment. Travel distance is a barrier to care but little is known about its effects on HRQOL. We hypothesize that increased distance to treatment site is associated with decreased HRQOL.

Methods: Patients with a history of stones were enrolled at 11 tertiary centers as part of the QOL Stone Consortium of North America. HRQOL data were obtained using the Wisconsin Stone Quality of Life questionnaire (WISQOL). We calculated distance between patient and treatment site using national ZIP codes. We used linear models to evaluate the effect of distance on HRQOL, while also considering demographics data, stones/symptom status, and distance.

Results: Of the 1676 enrolled patients, 52% were male, 86% non-Latino White, and the mean age was 53 years. Mean distance to treatment site was 63.3 km (range 0–3774), with 74% reporting current stones and 45% current symptoms. WISQOL score and distance were negatively correlated for patients reporting current stones and symptoms (p=0.0010). Linear modelling revealed decreased WISQOL scores for patients with symptoms as distance increased from treatment site (p=0.0001), with a 4.7-point decrease for every 100 km traveled.

Conclusions: Stone disease imposes significant burden on patients' HRQOL due to a variety of factors. Patients with active stone symptoms report worse HRQOL with increased distance to their treatment site. Possible etiologies include travel burden, increased disease burden, decreased healthcare use, and delays in care.

Introduction

The impact of urolithiasis on health-related quality of life (HRQOL) is well known and significant.[1,2] Patients suffering from urolithiasis have elevated levels of stress and higher rates of depression compared to national averages.[3,4] Multiple studies evaluating HRQOL in stone disease have shown detriments in emotional, physical, and general health subscores.[5,6] Urolithiasis not only causes personal suffering but affects work and family life, along with producing significant financial burden.[7,8] The interplay between urolithiasis and HRQOL is complex, with a wide variety of environmental and patient-specific factors at play.

One such factor, distance to treatment site, has become an increasingly important consideration given trends toward regionalization in care. Regionalization has occurred in oncological care, with high-volume hospitals treating a larger proportion of prostate, bladder, and renal cancer than in the past.[9,10] Complex stone care has similarly followed, with percutaneous nephrolithotomy being performed more frequently in teaching hospitals and high-volume centers.[11] With regionalization, distance to treatment site increases for some and may represent a barrier to care.[12-15] The effects of distance on HRQOL, specifically in stone disease, have not been investigated.

There are limited studies evaluating the relationship between distance to care and HRQOL in urological patients suffering from stone disease. The objective of our study was to investigate the relationship between distance to treatment site and HRQOL in patients with urolithiasis with data from a large multi-institutional cohort of stone patients.

Methods

Study design, sites, and recruitment

Our study is a cross-sectional analysis from a large multi-institutional study. Participants were recruited from 11 tertiary care centers across the U.S. and Canada between January 2016 and June 2017. The institutional review board at each site approved the study. Patients were eligible for enrollment if they were over the age of 18, had a history of urolithiasis, and were English-speaking. Initial enrollment occurred at outpatient urology or multidisciplinary clinic appointments.

Data collection

All data were obtained at patient enrollment. The Wisconsin Stone Quality of Life questionnaire (WISQOL) was administered to and completed by participants at outpatient clinic appointments. The WISQOL questionnaire is a 28-item, disease-specific HRQOL measure that evaluates four specific domains related to quality of life: social, emotional, stone-related symptoms impact, and vitality. Maximum total score is 140 points. The development and validation of the WISQOL questionnaire were discussed previously.[16,17] Demographic information, including age, gender, body mass index (BMI), race/ethnicity, duration of stone disease, number of previous stone events, and number of associated comorbidities, were obtained directly from the patient. Additionally, patients reported whether they were currently experiencing stones and/or stone-related symptoms as "Yes," "Not sure," or "No." Patients also provided their zip code of residence.

Statistical analysis

Geodetic distance between patient and treatment site was calculated using national zip code data for U.S. sites and supplied for Canadian sites. In order to mitigate the influence of outliers, distance was censored at 500 km, with distance greater than 500 km constituting the farthest 1%. Given that current stone burden and symptoms were patient-reported and not radiographically confirmed, for all statistical analyses, patients reporting "Not sure" to their stone or symptom status were considered to have positive status and recategorized as "Yes."

First, Spearman rank correlations (r_s) were calculated between WISQOL score and distance, stratified by the presence of stones and/or symptoms. Next, linear models were fit to assess the effect of distance on WISQOL score while accounting for demographic and stone-related factors. Factors considered for the model included: site, age, gender, BMI classification, race/ethnicity, duration of stone disease, previous stone events, associated comorbidities, presence of stones and/or symptoms, distance to treatment site, and the presence of stone/symptoms × distance interaction. Backward model selection was used to include only explanatory variables with p values deemed marginally predictive ($p<0.20$). Spearman rank correlations were also calculated between distance and duration of stone disease, previous stone events, and age of onset, as these were viewed as possible surrogates for disease burden. For all analyses, statistical significance was concluded for p values less than the type I error $\alpha=0.05$. All statistical analyses were performed with SAS software Version 9.4 (Cary, NC).

Results

Patient characteristics

Summaries of demographic data are presented in Table 1 for patients dichotomized to "Remote" or "Not remote" and for the entire cohort. Remote was defined as having a distance in the third tertile, i.e., residing more than 45 km from treatment center. A total of 1676 participants were enrolled; however, distance data were unavailable for 11 participants, therefore, 1665 were included in the final analysis. This included 867 males and 798 females with a mean ± standard deviation age of 52.8±14.3 years; 73.6% of participants reported "Yes" or "Not sure" to currently having stones and 44.9% reported "Yes" or "Not sure" to currently experiencing symptoms attributed to stones.

Distance traveled to treatment site ranged from 0–3774.4 km, with a mean distance of 55.4±81.91 km after censoring at 500 km. Participants had a mean BMI of 30.3±7.5 kg/m^2, with 76.2% having a BMI of at least 25.0 kg/m^2. The majority of subjects, 85.5%, identified themselves as non-Latino White, and 3.5% identified as Black or African American. The mean age at onset of urolithiasis was 41.0±16.1 years, with a mean stone disease duration of 11.8±12.4 years. Subjects had a median of three prior stone events and one associated medical comorbidity. Mean WISQOL score and mean distance to treatment site are shown in Table 2 for each cross-classification of stone and symptom status.

Spearman rank correlation

Table 2 displays Spearman rank correlations for patients' QOL and distance to treatment sites, stratified by stone and symptom status. For the entire sample, there is a statistically significant negative correlation between WISQOL score and distancer $r_s=-0.110$ ($p<0.0001$). Furthermore, when considering the four mutually exclusive stone/symptom groups, No/No, No/Yes, Yes/No, and Yes/Yes, the negative correlation in the overall sample is driven by patients with both stones and symptoms (Yes/Yes) and symptoms but no stones (No/

Table 1. Sample demographics, distance to treatment site, health-related quality of life, and disease characteristics for patients with urolithiasis, categorized by remoteness

Variable		Not remote	Remote	Overall
Distance*		1113, 17.9±12.37	552, 154.7±277.65	1665, 63.3±172.55
Distance (censored)*		1113, 17.9±12.37	552, 130.9±106.85	1665, 55.4±81.91
Total WISQOL score*		1113, 109.8±27.90	552, 102.5±31.08	1665, 107.4±29.19
Current stones	Yes	585 (53.0)	300 (55.1)	885 (53.7)
	Not sure	218 (19.8)	110 (20.2)	328 (19.9)
	No	300 (27.2)	134 (24.6)	434 (26.4)
Current symptoms	Yes	371 (33.7)	240 (44.3)	611 (37.2)
	Not sure	91 (8.3)	35 (6.5)	126 (7.7)
	No	640 (58.1)	267 (49.3)	907 (55.2)
Gender	Female	529 (47.5)	269 (48.7)	798 (47.9)
	Male	584 (52.5)	283 (51.3)	867 (52.1)
Age (years)*		1113, 52.9±14.11	552, 52.6±14.59	1665, 52.8±14.27
BMI (kg/m^2)*		1098, 29.7±6.93	544, 31.3±8.36	1642, 30.3±7.47
BMI class	Underweight	14 (1.3)	10 (1.8)	24 (1.5)
	Normal	262 (23.9)	105 (19.3)	367 (22.4)
	Overweight	368 (33.5)	156 (28.7)	524 (31.9)
	Obese class I	252 (23.0)	120 (22.1)	372 (22.7)
	Obese class II	119 (10.8)	80 (14.7)	199 (12.1)
	Obese class III	83 (7.6)	73 (13.4)	156 (9.5)
Race - ethnicity	Asian	70 (6.8)	4 (0.8)	74 (4.7)
	Black/African American	43 (4.2)	11 (2.1)	54 (3.5)
	White - Latino	47 (4.6)	22 (4.1)	69 (4.4)
	White - non-Latino	851 (82.5)	485 (91.3)	1336 (85.5)
	Other	21 (2.0)	9 (1.7)	30 (1.9)
Age at onset (years)*		1040, 42.2±15.93	518, 38.7±16.16	1558, 41.0±16.08
Duration of stones (years)*		1039, 10.7±12.04	518, 14.0±12.90	1557, 11.8±12.43
Previous stone events†		968, 2.3 (4)	483, 4.0 (8)	1451, 3.0 (5)
Associated comorbidities†		1113, 1.0 (3)	552, 2.0 (2)	1665, 1.0 (2)

"Remote" is defined universally at the overall 67th percentile of 45 km. Continuous variables (denoted *) are presented as n, mean ± standard deviation; count variables (denoted †) are n, median (interquartile range); and discrete variables are n (%). BMI: body mass index; WISQOL: Wisconsin Stone Quality of Life questionnaire.

Yes). This can be seen through these groups having the most negative correlations (r_s=-0.128 and -0.175, respectively) and the Yes/Yes group with p=0.0010. This trend is especially apparent when contrasted with the No/No and Yes/No groups (p=0.5809 and 0.4607, respectively. Thus, from the Spearman rank correlations, it can be seen that as distance increases, WISQOL score tends to decrease for those patients currently experiencing stone-related symptoms but not for those with current stones and no symptoms or for those with neither stones nor symptoms.

Spearman rank correlations were also calculated between distance and three surrogate variables to evaluate the rela-

Table 2. Spearman rank correlation between WISQOL score and distance to stone treatment centers by the presence of stones and/or symptoms

Stones	Symptoms	n	Correlation	p	Mean WISQOL score	Mean distance (km)
–	–	1665	-0.110	<0.0001	107.4	55.4
–	No	907	-0.008	0.8134	122.4	49.5
–	Yes	737	-0.136	0.0002	89.3	61.5
No	–	434	-0.011	0.8130	122.1	52.4
Yes	–	1213	-0.129	<0.0001	102.3	55.9
No	No	362	0.029	0.5809	125.1	50.1
Yes	No	544	-0.032	0.4607	120.7	49.2
No	Yes	72	-0.175	0.1420	107.0	63.8
Yes	Yes	665	-0.128	0.0010	87.4	61.3

"Not sure" is classified as "Yes" and distance is censored at 500 km. WISQOL: Wisconsin Stone Quality of Life questionnaire.

tionship between distance to treatment site and disease burden. There was a positive correlation between distance and duration of stone disease (r_s=0.166, p<0.00001), as well as prior stone events (r_s=0.174, p<0.0001). There was a negative correlation between distance and age of disease onset (rs=-0.090, 0.0004). These findings suggest that patients living farther from their treatment site tend to have a longer duration of stone disease, more prior stone events, and be younger at disease onset — potentially signaling increased disease burden.

Linear modelling

Based on the results from the Spearman correlations, a linear model was fit to assess the effects of demographic factors, stone disease factors, current stone status, and distance on WISQOL score in patients who reported experiencing symptoms. Through backward selection, duration of stone disease, gender, and the interaction of distance × current stone status (which assessed if the effect on WISQOL score of having stones changed as a function of distance) were excluded from the model, with all p values being >0.20. The estimated differences in WISQOL score for each factor, along with associated p-values, are shown in Table 3. Site, age, BMI classification, number of previous stone events, number of comorbidities, presence of current stones, and distance were all found to be statistically significant. Notably, the presence of current stones resulted in a very negative and significant effect on WISQOL score, with the presence of stones for those experiencing symptoms leading to an estimated 17-point drop in WISQOL score (p<0.0001). Furthermore, the estimated effect of distance on WISQOL score for those subjects experiencing symptoms is -0.047 (p=0.0001). Thus, for every additional 100 km a patient with symptoms must travel, their total WISQOL score is expected to decrease by 4.7 points. Since the interaction between current stone status and distance was found to be not significant, having stones does not further compound the negative effect of distance on WISQOL score, i.e., for patients who are experiencing symptoms, the effect of having stones does not change as distance increases.

In our analysis, patients reporting "Not sure" in regard to their stone or symptom status were assumed to have positive status and recategorized as yes. In order to ensure that this did not unduly influence our results, we conducted sensitivity analyses by considering patients reporting "Not sure" as "No" and by excluding them, seen in Supplemental Tables 1–4 (available at *cuaj.ca*). Conclusions based on these sensitivity analyses, for both the Spearman correlations and the linear model, agree with the conclusions from the initial analysis considering patients reporting "Not sure" as "Yes." This supports the robustness of our initial results and analysis.

Table 3. Estimated changes in WISQOL score for subjects currently experiencing symptoms based on demographic information, stone disease factors, and distance

Variable		Estimate	p
Intercept		98.560	
Site			<0.0001
Age (years)		0.362	<0.0001
BMI class			0.0249
	Underweight	-2.235	
	Normal	ref	
	Overweight	0.619	
	Obese class I	1.174	
	Obese class II	-1.772	
	Obese class III	-11.026	
Race - ethnicity			0.0571
	Asian	8.051	
	Black/African American	-6.091	
	White - Latino	-5.760	
	White - non-Latino	ref	
	Other	-16.035	
Previous stone Events		-0.126	0.0322
Comorbidities		-2.817	0.0002
Presence of stones		-17.327	<0.0001
Distance (km)		-0.047	0.0001

Note: Distance has been censored at 500 km. BMI: body mass index; WISQOL: Wisconsin Stone Quality of Life questionnaire.

Discussion

Stone disease produces significant symptoms and stress, resulting in higher rates of depression and anxiety.[3,4] Symptoms from stones affect HRQOL at multiple points along the disease course.[1,18,19] As a result, a push to better understand the HRQOL of patients with stone disease has been undertaken. This is clearly illustrated by the development of the WISQOL questionnaire, a stone-specific, patient-reported outcome measure that can evaluate changes in patient HRQOL from a variety of factors.[20,21] One patient-specific factor that has not been well-studied is distance to treatment site.

Ours is the first study evaluating the relationship between distance to treatment site and quality of life in the context of stone disease. We found that for those patients currently experiencing stone-related symptoms, there is a significant negative correlation between patients' WISQOL score and distance to treatment site. This relationship was not apparent in patients without symptoms, regardless of whether or not they reported having stones. Therefore, we infer that as patients experiencing stone-related symptoms have to travel farther for stone treatment, their HRQOL decreases. Even after taking demographic and stone disease factors into account, distance to treatment site had a significant effect on WISQOL score in patients experiencing symptoms, with an

estimated decrease of 4.7 points for every 100 km traveled. Additionally, patients who currently report having stones in addition to symptoms scored an estimated 17 points lower on WISQOL, although this differential did not change with distance. To provide context, a 17-point decrease represents a 12% reduction in WISQOL score. For patients with stone-related symptoms, they experience an estimated 3% reduction in quality of life for every 100 km traveled.

Prior studies have shown negative relationships between distance to treatment site and factors related to stone care, such as followup compliance after ureteroscopy, but no study has evaluated this relationship in the context of quality of life.[22] Although a wide variety of etiologies are at play, increased burden of travel, increased disease burden, decreased healthcare utilization, and delays in timely care are likely the largest contributing factors.

The burden that increased travel distance places on quality of life cannot be understated. Modern healthcare costs put significant strain on patients financially. When these factors are compounded, increased travel distance can exacerbate the burden of healthcare costs given the added cost of transportation and loss of patient and partner income while obtaining care. Furthermore, increased disease burden is likely playing a role. Our data suggest increased disease burden as patients travel farther for treatment; specifically, we noted longer duration of stone disease, more prior stone events, and a younger age at disease onset. Increased disease burden is likely a product and consequence of longer distance to treatment site. Ultimately, increased disease burden can impact patients' quality of life even before they begin to seek care.

Similarly, burden can arise from delays in obtaining timely care, which can result in underuse. Patients living farther away from their treatment sites are known to use healthcare less frequently.[23] Studies have demonstrated this point in rural populations and even found that patients may forego free medical care at distances as close as 20 miles, or 32 km.[24] This propensity for decreased use may be due to lack of local care, socioeconomic factors, or a wide variety of other variables. Regardless, decreased use may be responsible for delays in obtaining care, which result in progression of disease, increased disease severity, persistent symptoms, and ultimately, worsening quality of life. Overall, elevated cost, increased disease burden, delays in obtaining care, and the propensity for decreased healthcare use are important sequalae of increased distance and produce significant effects on QOL.

Some of the limitations of our study include its retrospective, observational nature, which leaves it vulnerable to selection bias. Also, stone status was obtained by self-report, as opposed to radiographic data, thus potentially introducing response and/or measurement bias. All centers are tertiary care centers in North America, which predominantly face a greater burden of caring for patients with lower socioeconomic means and those without health insurance.[25,26] This may affect HRQOL assessments, as this sample may not be completely representative of the population of all patients with stone disease; although it can be argued that a similar patient population likely exists within the local area for direct comparison. We do recognize that our study population has a large proportion of Caucasian patients. This may represent an imbalance in our sample population or suggest a racial disparity in patients treated at centers of excellence, the latter of which is outside the scope of this study. Further, although we are able to point to differences in HRQOL based on stone and symptoms status and distance, we have yet to be able to evaluate their clinical significance. A minimally important difference for the WISQOL questionnaire has not been determined, although this is being investigated. Additionally, disease burden is assessed with the help of three surrogate variables. Though these provide a glimpse into the severity of disease, they may not be the best indicator. Currently, we are not able to speak specifically to stone burden, but future work will look to accurately assess stone burden to provide a more objective measure of disease burden. Further studies will evaluate which treatment modalities offer the best HRQOL. These center included in our study are based across North America; therefore, their applicability to the global landscape will remain to be seen, depending on the particular model of healthcare in each region. Finally, since this is a cross-sectional analysis of HRQOL, changes in HRQOL over time are beyond the scope of this particular study.

There is no simple solution on how best to treat patients who must travel far for stone care. With a declining urological workforce and aging population, disparities in the delivery of care are likely to increase in the future.[27] The answer to this problem is likely to come from multiple avenues, including, but not limited to, leveraging new technologies and aggressive symptom control. Telemedicine provides a way to bridge the gap between patient and provider. Video visits are suitable alternatives to initial outpatient visits – saving patients from long travel distances and taking time off work.[28] This could help providers stratify those patients who are farthest and have the highest symptom burden, thereby expediting further care.

Recent studies have brought attention to the effect stone symptoms have on HRQOL, independent of stone size or location, and our study supports these findings.[29] Aggressive symptom control may help to limit declines in HRQOL until treatment can be performed. Local providers may be hesitant to aggressively treat stone symptoms, especially in the climate of the opioid crisis, and this is a valid concern. Educating them on the variety of multimodal techniques available may encourage more appropriate symptom control. One limitation is that we do not know whether the reason for travel for treatment is related to a specific physician's

referral pattern or if a higher level of care is required due to patient or stone complexity. It is not possible to determine if centers closer to a patient with adequate capabilities to treat the stone are being bypassed.

Our study has shed light on the relationship between HRQOL and distance for individuals suffering from stone disease. This initial analysis is fundamental but raises important questions that require further investigation. Understanding the availability of local urological care, and specifically endourological care, may elucidate why patients travel for care. Ultimately, a better understanding of whether it is a global lack of urological care or specialty urological care will help tailor future interventions and potential distribution of healthcare. Further studies with additional data will be able to help determine the causes, in addition to distance, that impact a patient's HRQOL based upon their geographic location and distance to accessible healthcare.

Conclusions

Stone disease imposes significant burden on patients' HRQOL due to a variety of factors, spanning psychological, physiological, and economic components. A variety of patient-specific and environmental factors can influence this burden; our study has found distance to be an important exacerbating factor. Patients with active stone symptoms report worse HRQOL with increased distance to their treatment site; possible etiologies include increased burden of travel, increased disease burden, decreased healthcare use, and delays in timely care. Continued work to better understand the relationship between distance to care and HRQOL among patients with active stone disease will help to develop future interventions.

Competing interests: Dr. Sivalingam has been involved in product development consulting and educational programs for Bard Medical, Boston Scientific, and Cook Medical. Dr. Chew has ben a consultant for Auris Robotics, Bard Medical, and Olympus; a lecturer for Boston Scientific, Coloplast, Cook Medical, and Olympus; a scientific study consultant for Boston Scientific, Cook Medical, and Olympus; received honoraria from Boston Scientific and Cook Medical; and participated in clinical trails supported by Boston Scientific and Cook Medical. Dr. Chi has been an advisory board member for Boston Scientific; received research grants from Boston Scientific and Bard Medical; and received honoraria from Auris Robotics. The remaining authors report no competing personal or financial interests related to this work.

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References

1. Penniston KL, Nakada SY. Treatment expectations and health-related quality of life in stone formers. *Curr Opin Urol* 2016;26:50-5. https://doi.org/10.1097/MOU.0000000000000236
2. New F, Somani BK. A complete world literature review of quality of life (QOL) in patients with kidney stone disease (KSD). *Curr Urol Rep* 2016;17:1-6. https://doi.org/10.1007/s11934-016-0647-6
3. Angell J, Bryant M, Tu H, et al. Association of depression and urolithiasis. *Urology* 2012;79:518-25. https://doi.org/10.1016/j.urology.2011.10.007
4. Miyaoka R, Ortiz-Alvarado O, Kriedberg C, et al. Correlation between stress and kidney stone disease. *J Endourol* 2012;26:551-5. https://doi.org/10.1089/end.2010.0536
5. Diniz DHMP, Blay SL, Schor N. Quality of life of patients with nephrolithiasis and recurrent painful renal colic. *Nephron Clin Pract* 2007;106:91-7. https://doi.org/10.1159/000102995
6. Penniston KL, Sninsky BC, Nakada SY. Preliminary evidence of decreased disease-specific health-related quality of life in asymptomatic stone patients. *J Endourol* 2016;30Suppl1:S42-5. https://doi.org/10.1089/end.2016.0074
7. Saigal CS, Joyce G, Timilsina AR. Direct and indirect costs of nephrolithiasis in an employed population: Opportunity for disease management? *Kidney Int* 2005;68:1808-14. https://doi.org/10.1111/j.1523-1755.2005.00599.x
8. Hyams ES, Matlaga BR. Economic impact of urinary stones. *Transl Androl Urol* 2014;3:278-83.
9. Cooperberg MR, Modak S, Konety BR. Trends in regionalization of inpatient care for urological malignancies, 1988 to 2002. *J Urol* 2007;178:2103-8. https://doi.org/10.1016/j.juro.2007.07.040
10. Anderson CB, Gennarelli R, Herr HW, et al. Regionalization of radical cystectomy in the United States. *Urol Oncol Semin Orig Investig* 2017;35:528.e7-13. https://doi.org/10.1016/j.urolonc.2017.03.026
11. Morris DS, Taub DA, Wei JT, et al. Regionalization of percutaneous nephrolithotomy: Evidence for the increasing burden of care on tertiary centers. *J Urol* 2006;176:242-6. https://doi.org/10.1016/S0022-5347(06)00512-X
12. Nemet GF, Bailey AJ. Distance and health care utilization among the rural elderly. *Soc Sci Med* 2000;50:1197-1208. https://doi.org/10.1016/S0277-9536(99)00365-2
13. Goodman DC, Fisher E, Slukel TA, et al. The distance to community medical care and the likelihood of hospitalization: Is closer always better? *Am J Public Health* 1997;87:1144-50. https://doi.org/10.2105/AJPH.87.7.1144
14. Birklneyer JD, Siewers AE, Marth NJ, et al. Regionalization of high-risk surgery and implications for patient travel times. *J Am Med Assoc* 2003;290:2703-8. https://doi.org/10.1001/jama.290.20.2703
15. McGuirk MA, Porell FW. Spatial patterns of hospital utilization: The impact of distance and time. *Inquiry* 1984;21:84-95.
16. Penniston KL, Nakada SY. Development of an instrument to assess the health-related quality of life of kidney stone formers. *J Urol* 2013;189:921-30. https://doi.org/10.1016/j.juro.2012.08.247
17. Penniston KL, Antonelli JA, Viprakasit DP, et al. Validation and reliability of the Wisconsin Stone quality of life questionnaire. *J Urol* 2017;197:1280-8. https://doi.org/10.1016/j.juro.2016.11.097
18. Donnally CJ, Gupta A, Bensalah K, et al. Longitudinal evaluation of the SF-36 quality of life questionnaire in patients with kidney stones. *Urol Res* 2011;39:141-6. https://doi.org/10.1007/s00240-010-0313-2
19. Bryant M, Angell J, Tu H, et al. Health-related quality of life for stone formers. *J Urol* 2012;188:436-40. https://doi.org/10.1016/j.juro.2012.04.015
20. Streeper NM, Wertheim ML, Nakada SY, et al. Cystine stone formers have impaired health-related quality of life compared with non-cystine stone formers: A case-referent study piloting the Wisconsin Stone quality of life questionnaire among patients with cystine stones. *J Endourol* 2017;31:S48-53. https://doi.org/10.1089/end.2016.0564
21. Jiang H, Huang D, Yao S, et al. Improving drainage after percutaneous nephrolithotomy based on health-related quality of life: A prospective, randomized study. *J Endourol* 2017;31:1131-8. https://doi.org/10.1089/end.2017.0444
22. Brooks NA, Paul CJ, Ghareeb GM, et al. Pushing stones uphill: Why patients are lost to followup after uncomplicated ureteroscopy. *J Endourol* 2017;31:135-40. https://doi.org/10.1089/end.2016.0675
23. Chan L, Hart LG, Goodman DC. Geographic access to healthcare for rural Medicare beneficiaries. *J Rural Heal* 2006;22:140-6. https://doi.org/10.1111/j.1748-0361.2006.00022.x
24. Brustrom JE, Hunter DC. Going the distance: How far will women travel to undergo free mammography? *Mil Med* 2001;166:347-9. https://doi.org/10.1093/milmed/166.4.347
25. Calfee RP, Shah CM, Canham CD, et al. The influence of insurance status on access to and utilization of a tertiary hand surgery referral center. *J Bone Jt Surg Ser A* 2012;94:2177-84. https://doi.org/10.2106/JBJS.J.01966
26. Weiner BK, Black KP, Gish J. Access to spine care for the poor and near poor. *Spine J* 2009;9:221-4. https://doi.org/10.1016/S0513-5117(09)79098-2
27. McKibben MJ, Kirby EW, Langston J, et al. Projecting the urology workforce over the next 20 years. *Urology* 2016;98:21-6. https://doi.org/10.1016/j.urology.2016.07.028
28. Modi PK, Portney D, Hollenbeck BK, et al. Engaging telehealth to drive value-based urology. *Curr Opin Urol* 2018;28:342-7. https://doi.org/10.1097/MOU.0000000000000508
29. Portis JL, Neises SM, Portis AJ. Pain is independent of stone burden and predicts surgical intervention in patients with ureteral stones. *J Urol* 2018;200:597-603. https://doi.org/10.1016/j.juro.2018.04.075

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