ORIGINAL ARTICLE

Socioeconomic evaluation of the treatment of ureteral lithiasis

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Abstract

Background and aim: This study attempts to estimate the socioeconomic differences between three major alternatives for the management of upper and lower ureteral lithiasis.

Material and methods: Two hundred and forty patients with upper and lower ureteral lithiasis, have been studied retrospectively, divided in six equal groups of forty. These patients have been treated either by extracorporeal shockwave lithotripsy (SWL), or with ureteroscopy with semirigid ureteroscope and the use of pneumatic lithoclast, or with ureteroscopy with flexible ureteroscope and the use of Holmium YAG Laser. For cost calculation, the reimbursement fee paid by insurance to the hospital was taken into account. For the estimation of the social burden, the length of hospital stay and the number of outpatient visits have been included as countable parameters.

Results: The percentage of effective stone removal for upper ureter was 81.0% for SWL, 62.5% for ureteroscopy with semirigid ureteroscope and the use of pneumatic lithoclast and, 82.5% for ureteroscopy with flexible ureteroscope and the use of Holmium YAG Laser. The same percentages for lower ureter were 82.5%, 92.5% and 97.5% respectively. The cost of stone removal for both the upper and lower ureter using extracorporeal lithotripsy was significantly higher compared to the other two procedures (median cost for upper ureter 828 € vs 474.50 € and 396 € respectively, and for lower ureter 826 € vs 396 € and 271 €, $p<0.001$). Regarding the social aspect, SWL is mainly an outpatient procedure, requiring a short hospital stay (for upper ureter 1.63 vs 2.48 and 2.45 respectively and for lower ureter 1.35 vs 2.43 and 2.13days), but needing more and prevailing clinic visits (for upper ureter 1.43 vs 1.45 and 1 respectively and for lower ureter 1.45 vs 1.15 and 0.55 visitsgive numbers, compare), both in outpatient and in accident and emergency (A&E) department.

Conclusion: The increase in the expenses with regard to health management indicates the necessity of cost accounting the health programs including the medical procedures as a means to improve the relation between cost and benefit.
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Key Words: ureteral lithiasis, ureteroscopy, extracorporeal shockwave lithotripsy, cost analysis

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Urolithiasis is a common problem that affects 1-5% of the population in the developed countries and it is considered to be the third most common disease of the urinary tract after urinary tract infections and prostate diseases. The percentage of recurrence for calcium oxalate stones (one of the most common forms) is estimated to reach 10% in 1 year, 35% in 5 years and 50% in 10 years. According to global statistics 25% of patients with urolithiasis consult their urologist once per year for problems regarding urolithiasis. Despite the fact that the implications of urolithiasis are not life threatening, this disease can be a serious cause of morbidity[1]. Medical care has reached a crisis point as the cost of health care consumes increasing portions of national product. The aging population and increasing life expectancies have further taxed the system and directed attention to medical specialties such as urology, which treat the elderly and utilize increasing proportions of the health care. The rational use of the resources offered during a medical act, the selection of the most appropriate and economically convenient one, results to a decrease of the cost and the preserving of valuable economical profits[2]. To achieve this purpose every medical act performed in a hospital should be defined, studied and cost evaluated[3]. The conclusions of these studies could be utilized from the hospital management and the medical staff[4].

Material and methods

The upper ureter was defined as the part of the ureter between the ureteropelvic junction and the upper border of the sacroiliac joint while the remaining part was defined as the lower ureter. In each part there were 3 groups of patients, according to the initial type of treatment that had been selected. The types of treatment were extracorporeal shockwave lithotripsy (SWL), ureteroscopy with semirigid ureteroscope and the use of pneumatic lithotripter and ureteroscopy with a flexible ureteroscope and the use of Holmium YAG Laser.

SWL was performed in the Lithotripsy Unit in the Department of Urology of Hippokratio General Hospital in Thessaloniki, with the lithotripter Siemens Lithostar Plus with 4000 pulses, maximum tension 16.4 kV and a frequency of 90 shocks/minute and in the Lithotripsy

Unit in the Department of Urology of Medical School of Democritus University of Thrace in the University Hospital of Alexandroupolis, with the lithotripter Dornier Doli S II with 4500 pulses, maximum tension 18 kV and frequency 80 shocks/minute. Intravenous analgesia was administered to all patients.

For ureteroscopy with a semirigid ureteroscope and pneumatic lithotripter in the Department of Urology of Democritus University of Thrace, a semirigid ureteroscope Olympus 9-11 Fr and a pneumatic lithotripter Swiss Lithoclast were used. In the Department of Urology of Hippokratio General Hospital in Thessaloniki a semirigid ureteroscope Storz 9-11 Fr and a pneumatic lithotripter Swiss Lithoclast. At the end of the procedure a Double J ureteral stent was used if it was considered to be necessary. The procedure took place under general or spinal anaesthesia and always a perioperative antimicrobial prophylaxis (aminoglycoside, cephalosporin or quinolone) was administered.

For ureteroscopy with a flexible ureteroscope and Holmium YAG Laser which took place in the Department of Urology of Democritus University of Thrace, a flexible ureteroscope Storz 7.5 Fr and a lithotripter Dornier Holmium-YAG laser, with a wavelength in 2080 nm, pulse rate 250 μs and maximum power of 15W (1.5 J in 10Hz and 1.8J in 8 Hz) were used. Initially, the power adjustment started at a lower rate of 0.5J and increased according to the case. The laser fibre was a 365 flexible quartz fibre of Dornier with the capability of multiple uses. At the end of the procedure a Double J ureteral stent was used if it was considered to be necessary. The procedure took place under general or spinal anesthesia and always a perioperative antimicrobial prophylaxis was administered (aminoglycoside, cephalosporin or quinolone).

All groups were equal in number consisting of 40 patients each. There were no differences in sex (p=0.542) and age of the patients (p=0.366) and the size of the stone (p=0.914). The epidemiological characteristics are presented in Table 1. Group A1, A2 and A3 consisted of 40 patients each, with an upper ureteral stone, which initially were treated with SWL, semirigid ureteroscopy with pneumatic lithotripter and flexible ureteroscopy with Holmium YAG Laser, respectively. For lower ureteral lithiasis, Group B1, B2 and B3 consisted of 40 patients each, which initially were treated with SWL, semirigid ureteroscopy with pneumatic lithotripter and flexible ureteroscopy with Holmium YAG Laser, respectively.

The cost evaluation for each therapeutic procedure was based on the reimbursement fees paid by medical insurances to the hospital. Upon these charges, for each one of the 240 patients in both hospitals, the total cost that has been charged to each patient's medical insurance was calculated, until the patient was rendered stone free.

Statistical analysis

The statistical analysis of the data was performed with the use of "Statistical Package for the Social Sciences" (SPSS), version 11.0 (SPSS, Inc., Chicago, IL, USA). The control of normality of distribution of quantitative variables became with the use of Kolmogorov-Smirnov control. The quantitative variables (age, stone and size) that followed the normal distribution expressed as median values ± 1 standard deviation (SD). Verification of equality of values of these variables among the six different groups with upper or lower ureteral lithiasis was performed with the use of a simple analysis of variance (ANOVA). The cost of therapy that deviates considerably from the normal distribution because of a large proportion of patients near to minimal cost, it was expressed also as median value and range. Statistical evaluation of the difference of treatment cost between two independent samples of patients was performed with the use of the non-parametric Mann-Whitney test, while testing equality of population medians among 2 or more independent groups was performed with the use of the non-parametric Kruskal-Wallis one-way analysis of variance. Afterwards, Mann-Whitney test with the Bonferroni correction was used to address the problem of multiple comparisons (α=0.017). Qualitative variables (sex and treatment outcome) were expressed as absolute and relative frequencies and were statistically evaluated with χ^2 test. To estimate the probability of successful treatment outcome we have calculated the Odds ratio (OR) and the relative 95% confidence intervals (C.I.) using simple logistic regression models. All statistical tests were double-sided and results were considered statistically significant for values $p < 0.05$.

Results

The success rate of stone removal for the upper ureter was 81.0% (32 pts) for SWL, 62.5% (25 pts) for semirigid ureteroscopy and pneumatic lithotripter and 82.5% (33 pts) for flexible ureteroscopy with Holmium YAG Laser. The comparison of the success rates of the three procedures with the x^2 test tended to show higher success rate for the SWL and ureteroscopy with Holmium YAG Laser than the semirigid ureteroscopy with pneumatic lithotripter (p=0.079). In particular, the likelihood of success

Table 1: Groups of patients

	A1	A2	A3	B1	B2	B3
Number of patients	40	40	40	40	40	40
Male/ Female	18/22	23/17	19/21	19/21	20/20	24/16
Age	56.30 ±12.32	50.63 ±16.10	55.75 ±13.16	56.25 ±12.27	54.98 ±12.70	56.08 ±12.75
Stone size	10.32 ±3.67	10.33 ±3.40	10.475 ±3.92	11.23 ±6.97	10.83 ±2.89	10.33 ±3.68

was 2.4 times (95% C.I.=0.9 – 6.6, p=0.087) higher with SWL and 2.8 times (95% C.I.=1.0 – 8.0, p=0.049) higher for flexible ureteroscopy and Holmium YAG Laser than the semirigid ureteroscopy and pneumatic lithotripter.

The success rate of stone removal for the lower ureter was 82.5% (33 pts) for SWL, 92.5% (37 pts) for semirigid ureteroscopy and pneumatic lithotripter and 97.5% (39 pts) for flexible ureteroscopy and Holmium YAG Laser. The comparison of the success rates of the three procedures with the x^2 test tended to show higher success rate for semirigid ureteroscopy and pneumatic lithotripter and flexible ureteroscopy and Holmium YAG Laser than SWL (p=0.061). In particular, the likelihood of success was 2.6 times (95% C.I.=0.9 – 10.9, p=0.188) higher for semirigid ureteroscopy and pneumatic lithotripter and 8,3 times (95% C.I.=1.0 – 70.7, p=0.053) higher for flexible ureteroscopy and Holmium YAG Laser than the SWL.

The comparison of success rate for stone removal among the three procedures both for the upper and the lower ureter showed that the success rate of the SWL was independent of the location for the stone (p=0.775). On the other hand, semirigid ureteroscopy and pneumatic lithotripter and flexible ureteroscopy and Holmium YAG Laser had a significantly higher rate, when the stone was located in the lower ureter (p=0.001 and p=0.025, respectively), with 7.4 times (95% C.I.=1.9 – 28.2, p=0.003) and 8.4 times (95% C.I.=1.0 – 70.7, p=0.053) higher possibility of complete stone removal for the lower than the upper ureter.

Cost of therapy for the upper ureteral stones

For the upper ureteral stones the final cost ranged from: a)820 to 2533 €, with median cost 828 € (mean cost 1020.95 ± 433.80 €) for the patients who initially underwent SWL, b) from 231 to 1894 €, with median cost 474.50 € (mean cost 705.93 ± 424.50 Euros) for the patients who initially underwent semirigid ureteroscopy and pneumatic lithotripter and c) from 231 to 1256 €, with median cost 396 € (mean cost 508.60 ± 326.65 €) for the patients who initially underwent flexible ureteroscopy and Holmium YAG Laser. The non-parametric Kruskal-Wallis one-way analysis of variance showed that, the effect of the initial procedure in the management of the upper ureteral stones in the total cost of the therapy was statistically significant (p<0.001). Checking multiple comparisons using Mann-Whitney test with significance level adjusted to α=0.017 for the number of comparisons, showed that the cost for stone removal from the upper ureter with the use of SWL was significantly higher from the cost of semirigid ureteroscopy and pneumatic lithotripter (p<0.001) and that of flexible ureteroscopy and Holmium YAG Laser (p<0.001).

Also, the cost for stone removal from the upper ureter with semirigid ureteroscopy and pneumatic lithotripter was significantly higher than the cost of flexible ureteroscope and Holmium YAG Laser (p<0.001) (Table 2).

Cost of therapy for the lower ureteral stones

For the lower ureteral stones the final cost ranged from: a) 820 to 2113 Euros, with median cost 826 € (mean cost 958.63 ± 319.52 €) for the patients who initially underwent SWL, b) from 231 to 1239 €, with median cost 396 € (mean cost 411.32 ± 206.26 €) for the patients who initially underwent semirigid ureteroscopy and pneumatic lithotripter and c) from 231 to 781 €, with median cost 271 € (mean cost 331.58 ± 121.64 €) for the patients who initially underwent flexible ureteroscope and Holmium YAG Laser .

Table 2: Treatment cost for upper ureteral stones (Euros)

	Treatment cost for upper ureteral stones (Euros)	
	Median cost (range)	Mean cost (standard deviation)
Group A1	828.00 (820 – 2533)	1020.95 (433.81)
Group A2	474.50 (231 – 1894)	705.93 (424.75)
Group A3	396.00 (231 – 1256)	508.60 (326.65)
Total	799.00 (231 – 2533)	745.16 (447.96)

The effect of the initial procedure in the management of the lower ureteral stones in the total cost of the therapy was statistically significant (p<0.001). Checking multiple comparisons showed that the cost for stone removal from the lower ureter with the use of SWL was significantly higher from the cost of semirigid ureteroscopy and pneumatic lithotripter (p<0.001) and that of flexible ureteroscope and Holmium YAG Laser (p<0.001).

Also, the cost for stone removal from the lower ureter with semirigid ureteroscopy and pneumatic lithotripter was significantly higher than the cost of flexible ureteroscope and Holmium YAG Laser (p=0.023, Table 3).

Comparison of treatment cost between the upper and the lower ureter

The comparison of the cost of each procedure for stone removal of the upper and the lower ureter showed that the cost of SWL was independent of the position of the stone (p=0.759). On the other hand, both semirigid ureteroscopy and pneumatic lithotripter and flexible ureteroscope and Holmium YAG Laser had a significantly higher cost, when the stone was located in the upper ureter (p<0.001 and p=0.005 respectively). Totally the cost of therapy for the upper ureter was statistically higher than that of the lower ureter (p<0.001).

Table 3: Treatment cost for upper ureteral stones (€)

	Treatment cost for lower ureteral stones (Euros)	
	Median cost (range)	Mean cost (standard deviation)
GroupB1	826.00 (820 – 2113)	958.63 (319.52)
Group B2	396.00 (231 – 1239)	411.32 (206.26)
Group B3	271.00 (231 – 781)	331.58 (121.64)
Total	436.00 (231 – 2113)	567.17 (361.36)

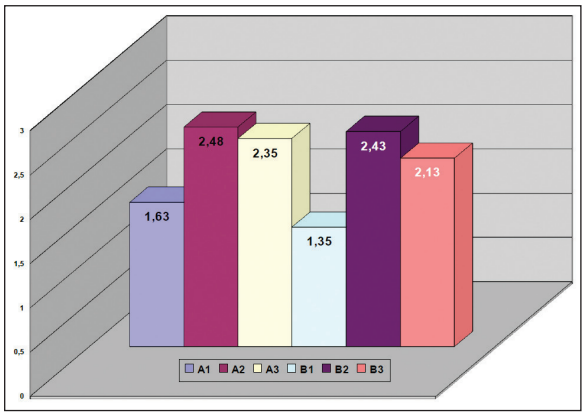

Figure 1: Mean days of hospitalization

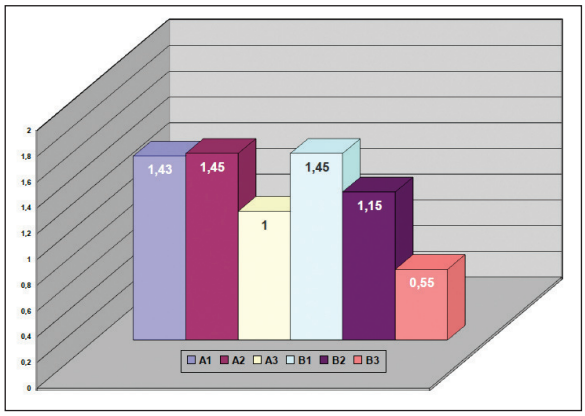

Figure 2: Mean days of visits as outpatients

Figures 1 and 2 show the mean number of days of hospitalization and the mean number of outpatient visits for each group of patient. SWL requires fewer days of hospitalization, being a procedure that is performed in an outpatient basis. On the other hand, it requires more outpatient visits, contrary to the flexible ureteroscope and Holmium YAG Laser. This is due to the fact that, the method is more effective and the necessity of placing a double J stent is lower.

Discussion

The always rising incidence of urolithiasis and the morbidity related to it requires an evaluation of the economical part of the disease. Its management depends on the size of the stone, its location in the urinary tract but also on the choice of therapeutic procedure like SWL, ureteroscopy, percutaneous nephrolithotripsy or open surgery. These procedures require hospitalization, outpatient visits and also a postoperative treatment.[5] The selection of the therapeutic procedure depends on many factors that include characteristics of the stone (size, location, texture), anatomy of the kidney and the ureter, the patient's desire, the equipment provided. The calculation of the total cost of therapy, besides the initial cost of the selected procedure, should include the efficacy of the procedure, the cost of re-intervention when required, the cost of additional procedures and the necessity of hospitalization[6].

Regarding the ureteral lithiasis a few studies have been published that investigate the economical consequence of the various treatment procedures. Most studies give an advance to ureteroscopy against SWL mainly because the complete stone removal rates are higher than those of SWL which usually requires multiple sessions.

Ureteroscopic lithotripsy seems to excel against SWL according to Parker et al[7] in a study of 220 patients regarding the upper ureter. One hundred and eleven patients were initially treated with SWL and 109 patients were treated with a semirigid or flexible ureteroscope and Holmium YAG Laser. After ureteroscopy, in most patients a double J stent was placed. 55% of the patients from the first group were stone-free after 1 session of SWL and 90.8% after ureteroscopic lithotripsy. 45% patients of the first group needed secondary treatment while in the second group the percentage was 9%. Calculating the cost of the initial procedure, the results showed that SWL was 20.3% (2200$) more expensive than ureteroscopy, notwithstanding the placement of a double J stent. If secondary treatments are added to that cost, then it rises to 39.9% (6900$)[7].

In a multicenter, perspective, randomized study from the United States 64 patients with lower ureteral stone less than 1cm in diameter were treated. 32 patients underwent ureteroscopy with a semirigid ureteroscope and the use of either Holmium YAG or pulsed dye Laser. From the group of SWL 94% were released from the hospital the same day, in comparison to the 75% of the ureteroscopy group. The estimated cost and charge for each procedure were calculated based on cumulative costs and charges at 1 of the participating hospitals. Operating room cost was based on mean procedural time for each group. Supply costs and charges assumed from the use of routine disposable items. Anaesthesia charges were based on general anaesthesia in the ureteroscopy group and intravenous sedation in the SWL group, reflecting the type of anaesthesia used in the majority of patients and the mean length of anaesthesia time in the group. The cost of stent removal was added to the cost of ureteroscopy since the majority of patients underwent stent placement at the conclusion of the procedure. Professional fees were based on anaesthesiologist and urologist fees at the operating hospital. Cost analysis revealed that SWL was more costly than ureteroscopy by $1255 (cost) and $1792 (charge) if outpatient treatment for both modalities and stent removal for ureteroscopy cases were assumed. Office stent removal in patients who had undergone ureteroscopy (greater than 90%) contributed $651 (cost) and $720 (charge) to the treatment cost. However, overnight observation, as was the case in 25% of the ureteroscopy group, would have added an additional $435 to the hospital charges, which was not assumed for these calculations, and would reduce the charge difference by 37%[8].

In a large study from Taiwan, 964 patients with lower ureteral stone were included. Five hundred and twenty

four underwent SWL, under intravenous sedation and 430 underwent ureteroscopic lithotripsy with a semirigid ureteroscope and the use of Swiss Lithoclast. In the 10.2% a double J stent was placed after the procedure and there was a 3 day hospitalization. Eighty seven of the patients of the SWL group were stone free and 96% of patients of the ureteroscopy group. The mean costs for SWL and ureteroscopy therapy was $1030 and $956, respectively. However, if the procedure went smoothly (no retreatment, auxiliary procedures, and complications), the mean costs for SWL and ureteroscopy were $927 and $784, respectively[9].

Due to the various ways of cost accounting in different parts of the world the cost-efficacy rate differs. In a Greek study, Pardalidis et al present their 10 year experience in the treatment of patients with a lower ureteral stone. Three hundred ninety five patients underwent SWL and 228 underwent ureteroscopy with a semirigid ureteroscope and an ultrasound lithotripter. The cost in these two procedures was similar while ureteroscopy required hospitalization of the patients for a mean period of 2.5 days and on the other hand the SWL was performed on an outpatient basis[10].

Finally, in a recent prospective randomized study from China, 42 patients with an upper ureteral stone less that 15mm are included. Twenty two patients underwent SWL under intravenous analgesia and 20 patients underwent ureteroscopy under general anesthesia. The method of lithotripsy was selected by the surgeon. In 55% of the patients a Double J stent was placed after the procedure. The efficiency quotient was found to be comparable for SWL and ureteroscopy, 61.3% and 63%, respectively. Although ureteroscopy is minimal invasive, it requires hospitalization and the patients have postoperative pain. The total cost for the two methods was counted to 1637$ for the SWL and 2154$ for ureteroscopic lithotripsy. The cost-effectiveness index, treatment time, pain score, and hospital stay were greater in the URSL group. However, the degree of hydronephrosis significantly influenced the success rate of SWL. All patients with severe hydronephrosis in the SWL group needed auxiliary surgical procedures to become stone free. Understanding the cost-effectiveness, success rate, pain score, and patient satisfaction score for the two different approaches constitutes the indispensable requisites for choosing the optimal first-line therapeutic strategy [11].

Wolf et al in 1995 created a decision tree modeling to compare the cost of stone therapy in the lower ureter. They used as endpoints both cost and patient preferences. They performed a meta-analysis of published studies between 1988 and 1994. Ureteroscopic lithotripsy (URS) appeared to be more effective than one or more sessions of SWL (92.1% against 74.3%, against 84.5%) and had a lower retreatment/complication rate. Although initially SWL was slightly more expensive than ureteroscopy, 4420$ against 4337$, the difference increased when the additional costs of complications and retreatment were calculated (6745$ against 4337$). Using values for an "average" patient, SWL was preferred to URS in terms of patient satisfaction. The most important factors distinguishing between URS and SWL were the success of treatment, the cost of initial therapy, and patient attitudes toward unplanned ancillary procedures and retreatment. Although no alteration of success rates and cost figures within reasonable ranges made URS less cost-effective than SWL, individual differences in patients' aversion for complications allowed URS to be preferred to SWL in some situations. Therefore, SWL is less cost-effective than URS and is not necessarily preferred by patients[12].

Finally, in 2002 Lotan et al suggested a model of decision making analysis, to determine the most cost effective treatment procedure for upper, mid and lower ureteral stones, calculating the costs and the success rates. The estimated cost of each procedure was based on the cumulative sum of various cost included operating room, operating room supplies, day surgery, recovery room, laboratory costs, professional fees and anaesthesia costs based on general anaesthesia for ureteroscopy and intravenous sedation for shock wave lithotripsy. The cost of office cystoscopy and stent removal was added to the cost of ureteroscopy. The cost of initial diagnosis and follow-up was excluded from calculation, since it was presumed to be identical in the various treatment groups. Complications were not included in cost analysis due to the infrequent need for post-treatment intervention. Even major complications requiring surgical interventions, such as ureteral stricture, have little impact on cost due to the rarity of the event. The total cost for SWL was 4225$, for ureteroscopic lithotripsy was 2645$ and for open surgery 8000$. The cost for the upper ureter was 1440$, for the mid ureter 1670$ and for the lower ureter 1750$. Ureteroscopy was more cost-effective than SWL for all ureteral stones after observation fails, largely as a result of the high cost of purchasing and maintaining a lithotripter[13].

Conclusions

The economical impact of the urological treatment procedures are evaluated differently from urologists, hospital managers, insurance services, patients and politicians. The raising cost and debit of the health system obligates politicians, employers and citizens to examine and determine the economical resources, in order to be able to maintain "health". The constant raise of the middle aged population, the planning of the human resources in the health section, preventive medicine, the technological development and the efficacy improvement are studied separately considering the economical aspects.

In our study, SWL, although is the less invasive method, has the higher cost and needs more hospital visits. However, we cannot determine which method is the best, if there is one, as various factors influence the final decision. Our purpose is, to demonstrate that, social and economical impacts are also two important issues, among all the others, which guide the final therapeutic decision.

As the initiation of new technologies is an important factor on the total health system expenses, governments

should evaluate this cost and help the introduction of new therapeutic methods. The economical evaluation of various procedures regarding the ureteral lithiasis, as in our study, is an example of how urologists could select their treatment methods for the best results regarding the patients' treatment.

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