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Preoperative Urinalysis as a Predictor of Postoperative Infection in Retrograde Intrarenal Surgery for Patients with Sterile Urine Cultures

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doi: [10.33472/AFJBS.6.15.2024.3233-3242](https://doi.org/10.33472/AFJBS.6.15.2024.3233-3242)**ABSTRACT:**

Objective: Infection of the urinary tract following surgery is the most frequent side effect of retrograde intrarenal operations, although the precise causes are yet unknown. The objective was to assess the potential contributing factors, particularly preoperative urinalysis, to postoperative urinary tract infection following retrograde intrarenal surgery. **Material and Methods:** A comparative cross-sectional study was done in 2021 to 2022. Patients with paediatric diagnoses and stones larger than 2 cm were not included in the research. In the early postoperative phase, the patients were split into two groups: those having and those lacking urinary tract infections. The parameters of the urine analysis as well as the sterile urine cultures that had been collected prior to the treatment were examined independently. **Results:** The study comprised 280 patients in all who met the predetermined criteria. Regarding demographics, there was statistically no distinction between the two categories. Those who experienced postoperative early urinary tract infections had a substantially greater number of sufferers with a history of prior urinary tract infection (55% vs. 20.5%) and a longer operating time (62.50 ± 16.6 minutes vs. 60 ± 19.40 minutes). In patients with postoperative early urinary tract infection, there was a substantial increase in the presence of pyuria, leukocyte count, leukocyte esterase positivity, and nitrite positivity among urine results. Urinary tract infection history, length of operation, and nitrite positive were determined to be independent predictors of postoperative early urinary tract infection in multivariate analysis. **Conclusion:** The three characteristics that were found to be independent risk indicators for postoperative infection of the urinary tract in kidney stones measuring between 1 and 2 cm were prior history of infection in the urinary tract, length of operation, and nitrite positive in urinalysis.

Keywords: Leukocyte esterase, nitrite, pyuria, retrograde intrarenal surgery, urolithiasis

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1. Introduction

The most popular forms of medical care for kidney stones that range in size from 01 to 02 cm include endourological procedures like shock wave lithotripsy, interventional nephrolithotomy, and retrograde intrarenal surgery (RIRS). These methods of therapy are also recommended by the standards of the Endourological Society, the American Urological Association (AUA), and the European Association of Urology (1,2). Miniaturised flexible ureteroscopes enable successful retrograde intrarenal resection as a minimally invasive treatment with few consequences. The complication rate following retrograde intrarenal surgery ranges from 9% to 25% (2,3). After RIRS, urinary tract infections (UTIs) are the most common (4,5). De la Rosette et al. (6) examined 11 885 patients for the kinds of ureteroscopic lithotripsy problems, and they found that postoperative fever (1.8%) and hematuria requiring blood transfusion (0.2%) were the most common issues. Most of the issues were Clavien grades 1 or 2.

Prophylactic empirical antibiotic treatment has been ubiquitous and is currently employed as the norm to avoid postoperative UTI as complications following surgery is the most common consequence. Prophylactic empirical antibiotics have been shown by Lo et al. (7) to lower the rate of bacteriuria without affecting clinical outcomes. The risk of postoperative UTI is still significant, and serious outcomes like urosepsis are seen in everyday practice due to the empirical administration of antibiotics, rising antimicrobial obstruction, and unexpected patient variables.

The predicted factors of postoperative UTI were revealed by multiple research. Several variables are commonly associated with postoperative urinary tract infections (UTIs), including antimicrobial resistance, prolonged duration of surgery, preoperative pyuria, the stone itself, diabetes mellitus (DM), obesity, and urine catheter use (8,9). Regarding the variables and methods of preventing postoperative infection, there is disagreement, nonetheless.

In an effort to lower the incidence of complications associated to the surgery, our study looked into the factors that lead to urinary tract infections following RIRS. Particular attention is paid to preoperative basic urine characteristics, along with aspects linked to the patient and operation.

2. Material And Methods

A comparative cross-sectional study was done at Qaid-e-Azam Medical College/ Bahawal Victoria Hospital Bahawalpur in 2021 to 2022 on individuals who received RIRS for kidney or proximal ureteral stones. The study comprised 280 individuals who had a total stone size of between 1 and 2 cm. In order to establish a uniform study population with respect to treatment indications based on guidelines and potential consequences, only upper ureter stones and renal stones with sizes ranging from 10 to 20 mm were selected. A total of 215 people with urinary stones greater than 20 mm, 123 individuals with stones less than 10 mm, and 17 individuals who were undergoing clean intermittent catheterization or had an implanted urinary catheter were removed.

Two groups of patients were created: those who had a postoperative UTI and those who did not. The patients' age, sex, body mass index (BMI), supplementary diabetes mellitus (DM), hypertension (HT), Charlson Comorbidity Index (CCI), stone size, and the site of the stone were among the demographic data that were subsequently analyzed. Other perioperative attributes included preoperative hydronephrosis, UTI history (defined as any symptomatic UTI with positive urine culture), and preoperative Double-J stent. Finally, operative

characteristics included the use of incision sheaths, operation time, and remaining fragments (shards bigger than 2 mm).

Fever more than 38.3°C and positive blood or urinary bacterial culture results within one month following ureteroscopy were considered postoperative UTIs. Throughout the 30 day period before to surgery, sterile urine samples were taken from each patient. Prior to surgery, a urine culture and urinalysis were taken simultaneously from every patient. Values from urinalysis, including leukocyte esterase count, nitrite positive, and the existence of pyuria, were analysed. A urinalysis with ≥ 5 white blood cells/mm³ was used to define pyuria. Each patient received a different set of prophylactic antibiotics based on the frequency of previous positive urine cultures; if there was no prior positive urine culture, cefuroxime 1500 mg was selected as a preventive measure. This study did not include individuals receiving antibiotic therapy. For flexible ureterorenoscopes (URS), 7.5 F Storz Flex-X2 was utilized; a hydrophilic-coated ureteral accessing sheath (9.5/11.5F or 12/14F) was recommended.

The Statistical Package for the Social Sciences Statistics version 22 (IBM SPSS Corp.; Armonk, NY, USA) was used to conduct the statistical analyses. The t-test for various samples was employed to compare the means. The Mann-Whitney U test was recommended in cases when the factors separating the groups had a non-normal distribution. For categorical variables, the chi-square test or Fisher's exact test were employed. For multivariate analysis, logistic regression was used, and a P value of less than .05 was regarded as a significant result.

3. Results

Twenty (7.14%) of the 280 patients with RIRS suffering from 1-2 cm renal and/or proximate ureteral stones also had postoperative UTI. Group 1 consisted of twenty patients who had a postoperative UTI, while Group 2 consisted of 260 patients who had no postoperative UTI. In contrast to the non-UTI patients, who had a greater percentage of male patients (55% vs. 39.8%, $P = .181$), the majority of patients who acquired post-operative UTIs were female. There were similarities in age, BMI, HT, CCI, and concomitant DM scores between the two groups. The two groups' median stone sizes (median 13.5 mm vs. 15 mm, $P = .285$) were comparable. The percentage of UTI history was higher in patients with postoperative UTI (55% vs. 20.5%, $P = 0.000$), and their operative times were longer (median 62.5 ± 16.6 minutes vs. 60 ± 19.4 minutes, $P = .008$). Neither of the two groups was impacted by residual parts, access sheath utilisation, or preoperative hydronephrosis. Preoperative Double-J stent rates were greater among people with postoperative UTI, although this difference was not considered significant (40% vs. 23.4%, $P = .097$) (Table 1).

The characteristics of urinalysis that were acquired concurrently with sterile specimens of urine were examined in order to forecast the postoperative UTI. Urinary leukocyte counts in postoperative individuals with UTI were greater (median 22.50 vs. 7.0, $P = .009$), and pyuria was more prevalent (85% vs. 59.80%, $P = .026$). Individuals with postoperative UTI had a greater proportion of nitrite positivity (35% vs. 8.6%, $P = .000$) and leukocyte esterase positivity (90% vs. 63.6%, $P = .017$) (Table 2). In addition to sensitiveness, specificity positive predictive value, and negative predictive value, each urine test parameter and its permutations were examined for the diagnostic odds ratios (DOR) [$\text{sensitivity}/(1 - \text{sensitivity})/(1 - \text{specificity})/\text{specificity}$]. The largest DOR is found when nitrite and leukocyte esterase are combined; nitrite only has the lowest DOR. The sensitivity of pyuria and leukocyte esterase is good (85% and 90%), while the specificity rates are considerably lower (40.1% and 36.4%). Table 3 shows that nitrite has a larger positive predictive value (23.3% vs. 9.5%) than both pyuria and leukocyte esterase, despite having low sensitivity (35%) and elevated specificity (91.4%).

The results of multivariate analysis, which took into account covariates identified by univariate analysis, including leukocyte count in urinalysis, the existence of pyuria, leukocyte esterase, and nitrite positivity, showed that in RIRS individuals who had stones between 1 and 2 cm, postoperative UTI was independently associated with UTI history, stretched operative time, and nitrite positivity in preoperative urinalysis (Table 4).

Not every patient could have a stone analysis done. Eight patients (40%) in category 1 underwent stone analysis. In this group, calcium oxalate stones (including those mixed with calcium phosphate) constituted the most common, occurring in 4 patients (50%), uric acid stones in 1 patient (5%), struvite stones in two individuals (%) 10, and cystine stones in 1 patient (%) 5. The second group contained 82 participants (30.5%) who underwent stone analysis. Of them, 63 individuals (76.8%) had calcium oxalate stones (including mixtures with calcium phosphate), 12 patients (14.6%) had uric acid stones, and 7 people (8.6%) had cystine stones.

Table1. Perioperative and Demographic Features			
	Postoperative UTI		P
	Yes (n=20)	No (n=260)	
Age (years)Ave $\pm$ SD	47.8 $\pm$ 12.6	47.9 $\pm$ 14.7	.988 [‡]
Sex			
Male	9 (45%)	162 (62.3%)	
Female	11 (55%)	97 (37.4%)	.181 [†]
BMI Med $\pm$ SD	26.3 $\pm$ 3.2	27.4 $\pm$ 4.7	.436 [§]
DM			
Yes	3 (15%)	55 (21.1%)	
No	17 (85%)	205 (78.9%)	.510 [†]
HT			
Yes	4 (20%)	66 (25.6%)	
No	16 (80%)	194 (74.4%)	.575 [†]
Charlson comorbidity index			
0-1	14 (70%)	203 (77.9%)	
≥ 2	6 (30%)	57 (22.1%)	.410 [†]
Stone diameter (mm)Med $\pm$ SD	13.5 $\pm$ 4.1	15 $\pm$ 3.6	.285 [§]
Stone localization			
Upper calyx	3 (15%)	9 (3.3%)	
Middle calyx	2 (10%)	28 (10.8%)	
Lowercalyx	4 (20%)	87 (33.4%)	
Renal pelvis	8 (40%)	68 (26.8%)	
Proximal ureter	0 (0%)	12 (4.5%)	
Multiple	3 (15%)	65 (24.9%)	.090 [†]
Preoperative hydronephrosis			
Yes	8 (40%)	135 (52.1%)	
No	12 (60%)	124 (47.9%)	.550 [†]
UTI history			
Yes	11 (55%)	53 (20.5%)	.001
No	9 (45%)	206 (79.5%)	.000 ^{**}

Preoperative Double-jstent			
Yes	8 (40%)	61 (23.4%)	
No	12 (60%)	199 (76.6%)	.097 [†]
Access sheath use			
Yes	10 (50%)	151 (58.4%)	
No	10 (50%)	109 (41.6%)	.465 [†]
Operation time (min)Med ± SD	62.5±16.6	60±19.4	.008**
Residual fragment			
Yes	3 (30%)	90 (34.6%)	
No	17 (70%)	170 (65.4%)	.073 [†]
UTI, urinary tract infection; Ave, average; Med, median; BMI, body mass index; DM, diabetes mellitus; HT, hypertension, SD Standard Deviation. [†] Chi-square test, [§] Mann–Whitney <i>U</i> test, [‡] independent samples <i>t</i> -test. *: $p < .05$, **: $p < .01$.			

Table 2. Relationship Between Preoperative Urine Analysis and Postoperative UTI			
Preoperative Urine Analysis	Postoperative UTI		P
	Yes	No	
WBC Med± SD	22.5±196.2	7.0 ± 86.9	.009**
Pyuria			
No	3 (15%)	108 (40.2%)	
Yes	17 (85%)	161 (59.8%)	.026*
Leukocyte esterase			
–	2 (10%)	98 (36.4%)	
+	18 (90%)	171 (63.6%)	.017*
Nitrite			
–	13 (65%)	246 (91.4%)	.001
+	7 (35%)	23 (8.6%)	.000**
UTI, urinary tract infection; Med, median; WBC, white blood cells; Pyuria, ≥ 5 WBC/mm ³ in urinalysis. SD Standard deviation. [†] Chi-square test, [§] Mann–Whitney <i>U</i> test. *: $p < .05$, **: $p < .01$.			

Table 3. Urine Analysis as a Predictor of Postoperative UTI							
Preoperative Urine Analysis for Prediction of Postoperative UTI							
	WBC+	LE +	N+	WBC+LE+	WBC+N+	LE+N+	WBC+LE+N+
Sensitivity	85%	90%	35%	85%	30%	35%	30%
Specificity	40.1%	36.4%	91.4%	47.6%	92.6%	91.4%	92.6%
PPV	9.5%	9.5%	23.3%	10.8%	23%	23.3%	23%
NPV	97.3%	98%	94.9%	97.7%	94.7%	94.9%	94.7%
The diagnostic odds ratio (DOR)	3.80	5.16	5.76	5.0	5.33	5.76	5.33

WBC, white blood cells in urine analysis; pyuria: ≥ 5 WBC/mm³ in urinalysis; LE, leukocyte esterase; N, nitrite; UTI, urinary tract infection ; PPV, positive predictive value; NPV, negative predictive value.

Table 4. Factors Associated with Postoperative UTI-Univariate Versus Multivariate Analysis

Univariate Analysis Multivariate Analysis						
	OR	95%CI	P	OR	95%CI	P
Preoperative Double-j stent	2.18	0.85-5.57	.103			
UTI history	4.76	1.87-12.04	.001**	5.03	1.86-13.59	.001**
Preoperative hydronephrosis	0.60	0.24-1.51	.280			
Access sheath use	0.71	0.28-1.77	.467			
Operation time	1.03	1.01-1.05	.025*	1.04	1.01-1.06	.006**
Residual fragment	0.34	0.09-1.17	.086			
WBC in urinalysis	1.004	1.001-1.007	.002**			
Pyuria	3.80	1.08-13.29	.036			
Leukocyte esterase positivity	5.16	1.17-22.70	.030*			
Nitrite positivity	5.76	2.09-15.86	.001**	8.31	2.61-26.5	.000**
Cox regression analysis.						
UTI, urinary tract infection; pyuria: ≥ 5 WBC/mm ³ in urinalysis; OR, odds ratio. Significant values of univariate analysis should be also bold.						

4. Discussion

RIRS is the most widely used treatment procedure for kidney stones between 1 and 2 cm in size and the proximal ureter because to technological advancements and instrument miniaturisation. Despite having significant complications—postoperative urinary tract infections being the most frequent in daily practice—the minimally invasive nature of this procedure makes it a frequently selected treatment. After ureteroscopy, De Coninck et al. (10) conducted a systematic study focusing on the frequency of postoperative UTI, which ranged from 0.2% to 15%. The prevalence of postoperative UTI was reported in 14 recent researches. The variable rates may be due to diverse postoperative UTI characterizations, preoperative reservations, and prophylactic measures.

Following RIRS, 20 (6.9%) out of 289 participants in our research experienced postoperative UTI. We may have acquired a lesser postoperative infection rate than some studies by getting a sterile urine culture from every patient and adhering to a patient-based, routine antibiotic prophylactic regimen in the operation preparatory period. We are a stone disease referral centre with a large number of difficult patients and some unpredictability which could account for the fact that it appears to be at a higher incidence than that in some studies. Many earlier studies have routinely looked into which patients might get postoperative UTIs. A number of variables have been shown to be primarily predictive of postoperative infection, including female gender, diabetes mellitus, hydronephrosis, stone size, inclusion of a urethral catheter, ureteral stent, and percutaneous nephrostomy (11, 12, 9). After ureteroscopy, extended operating duration is a recognized predictor of postoperative UTI. While there is no universal agreement on the ideal duration of operation or whether to set one, the general view is that the duration of operation should be as brief as feasible to avoid prolonged elevation of intrarenal pressure. Following 3298 URS surgeries, Southern et al. (13) examined the risk variables influencing postoperative fever and a systemic inflammation syndrome. The rate of complications associated with infection following surgery was 6.9%, and the factors that independently predicted the percentage were female gender, surgical time, CCI, and positive

preoperative urine culture. The average operating time was greater for patients with postoperative infection problems (57 vs. 49 minutes). Moses et al. (2014) identified three factors pre-stenting, non-compliance with AUA antibiotic prophylaxis guidelines, and an operation lasting more than two hours as determinants of postoperative UTI following URS. According to Kim et al. (82.8 vs. 64.5 minutes), operation time was the sole independent predictor for postoperative UTI following URS. They also established an acceptable threshold of 70 minutes for operative time, with an associated sensitivity of 58.1% and precision of 61.7%. A prolonged operation duration was also found to be a separate risk indicator in our investigation for postoperative UTI following RIRS in ureteral/renal stones measuring 1-2 cm (median 62.5 ± 16.6 vs. 60 ± 19.4 mm; $P = .006$). Our study is unique from others, though, in that we had comparable stone loads and collected sterile preoperative urine cultures prior to the procedure. As was already mentioned, a lengthy surgical procedure increases the pressure inside the renal pelvis, which causes a large irrigation volume to be absorbed systemically. One established hazards for reinfection is previous exposure of urinary tract infections. Such a preoperative background can also be useful in anticipating the possibility of a postoperative urinary tract infection. Preoperative severe pyelonephritis was identified by Mitsuzuka et al. (2015) as an independent predictor of postoperative UTI following URS. According to their research, patients who had antibiotic treatment before to surgery had greater incidence of postoperative complications. On the other hand, the recipients were not included in this research, and within a month all of the patients had a sterile urine culture taken in order to prepare them for surgery. Preoperative sepsis raises the risk of postoperative UTI and sepsis following URS, as shown by Youssef et al. (2016). We described the history of UTI in the research as any symptomatic UTI within the previous year that was confirmed by positive urine culture results. It was found that the individual in the category with a history of UTI experienced postoperative infection considerably more commonly than the patient category with no history (55% vs. 20.5%, $P = .000$).

It is important to note that all of the patients in our research had their operations conducted following a sterile urine culture obtained during the preoperative phase. Getting a sterile urine culture is crucial, particularly in light of the fact that these procedures raise intrarenal pressure. Remarkably, investigations on the microbiome additionally show that the genitourinary system, which is considered sterile, is not genuinely sterile. Numerous species colonise the urinary tract, as evidenced by advancements in 16S rRNA sequencing and sophisticated polymerase chain response methodologies (17).

Getting a clean urine culture is crucial, especially for stone sufferers, but it's not always accurate. Although it is utilised on a daily basis, a basic urine analysis is often disregarded in favour of the urine culture. Our research has shown that a urine analysis performed concurrently with a sterile urine culture can offer valuable information on the course of infection during the recovery phase. The simplicity of the urine analysis procedure is its biggest benefit. Preoperative pyuria was linked to postoperative UTI, according to Mitsuzuka et al.'s observations, and postoperative UTI got worse as pyuria levels rose. Asymptomatic pyuria has been shown to be related to postoperative UTI by Kohada et al. (2018), who examined the risk variables for postoperative UTI following transurethral excision of bladder tumors. The postoperative UTI predictors after percutaneous nephrolithotomy were reported by Chen et al. (19). They identified several indicators of postoperative UTI and urosepsis, including pyuria, nitrite positivity, positive urine culture, and positive stone culture. The best criterion to identify post-operative disease was determined to be the presence of pyuria and nitrite positivity, with a 90% association identified with culture positivity. The risk variables for postoperative uroseptic shock after percutaneous nephrolithotomy were determined by Fan et al (20). The three independent hazard factors comprised postoperative blood leukopenia, stone size, and preoperative urine nitrite. In contrast to our investigation, none of

the four studies that looked into preoperative urine analysis acquired preoperative sterile urine cultures. All urine analysis parameters are involved in univariate analysis for postoperative UTI prediction, according to our research, with nitrite positivity serving as the sole independent predictor of postoperative UTI following RIRS (OR: 8.31, $P = .000$). Nitrate has the best a negative probability and specificity among the urinalysis parameters. Among the 259 patients (94.9%) with negative nitrite results, we demonstrated that 246 did not have a postoperative UTI. After RIRS, nitrite had the greatest DOR (5.76) for postoperative UTI prediction; however, nitrite in combination of additional urine analytical parameters could not improve postoperative UTI prediction.

Our study's primary contribution is the identification of urine analytical factors that, in spite of sterile urine culture, may aid in the prediction of postoperative infection. It is evident that the requirement of sterile urine samples was not sought in other investigations. This is the first study that addresses this issue. Getting a preoperative sterile urine culture is specifically crucial, particularly for patients with ureteral or renal stones, but it does not ensure that there won't be an infection during the recovery phase. Our goal in our investigation was to observe these variables.

Retrospective modality, restricted stone testing in every individual, and infectious stone incidence are some of the major limitations of our study. One drawback of our clinic's relevance to the general public is that it treats complicated instances of stone disorders. One could argue that a restriction is the small number of patients, particularly in the postoperative infection group. One month may be a long time, even if there isn't agreement in the current standards regarding the amount of time that should pass between the preoperative sterile urine culture and the procedure. While majority of individuals in the trial had this phase lasting less than two weeks, and there was a comparable amount of time between the two categories, this period need to be as brief as feasible.

In conclusion, the independent risk variables that can forecast the complications that result in RIRS for ureteral/renal stones between 1 cm and 2 cm in size are nitrite positivity in the preoperative urinalysis, history of UTI, and longer operation time. A basic urine assay, particularly for nitrite positive, should be taken into consideration even if preoperative sterile testing of urine is crucial and ought to be obtained. It is advised to use a patient-based strategy that takes risk factors into account.

5. References

1. Türk C (Chair), Skolarikos A (Vice-chair), Neisius A, Petřík C, Seitz KT. Urolithiasis. Netherlands: EAU Guidel Off Arnhem; 2019.
2. Assimos D, Krambeck A, Miller NL, et al. Surgical management of stones: American Urological Association/Endourological Society Guideline, PART I. *J Urol.* 2016;196(4):1153-1160.
3. Perez Castro E, Osther PJS, Jinga V, et al. Differences in ureteroscopic stone treatment and outcomes for distal, mid-, proximal, or multiple ureteral locations: the Clinical Research Office of the Endourological society ureteroscopy global study. *Eur Urol.* 2014;66(1):102-109.
4. Geavlete P, Georgescu D, Niță G, Mirciulescu V, Cauni V. Complications of 2735 retrograde semirigid ureteroscopy procedures: a single-center experience. *J Endourol.* 2006;20(3):179-185.
5. Breda A, Ogunyemi O, Leppert JT, Schulam PG. Flexible ureteroscopy and laser lithotripsy for multiple unilateral intrarenal stones. *Eur Urol.* 2009;55(5):1190-1196.

6. de la Rosette J, Denstedt J, Geavlete P, et al. The Clinical Research Office of the Endourological society ureteroscopy global study: indications, complications, and outcomes in 11,885 patients. *J Endourol.* 2014;28(2):131-139.
7. Lo CW, Yang SS-D, Hsieh CH, Chang SJ. Effectiveness of prophylactic antibiotics against post-ureteroscopic lithotripsy infections: systematic review and meta-analysis. *Surg Infect (Larchmt).* 2015;16(4):415-420.
8. Kim JW, Lee YJ, Chung JW, et al. Clinical characteristics of post- operative febrile urinary tract infections after ureteroscopic lithotripsy. *Investig Clin Urol.* 2018;59(5):335-341.
9. Senocak C, Ozcan C, Sahin T, et al. Risk factors of infectious complications after flexible uretero-rensoscopy with laser litho- tripsy. *Urol J.* 2018;15(4):158-163.
10. De Coninck V, Keller EX, Somani B, et al. Complications of ure- teroscopy: a complete overview. *World J Urol.* 2020;38(9):2147- 2166.
11. Sohn DW, Kim SW, Hong CG, Yoon BIl, Ha US, Cho YH. Risk factors of infectious complication after ureteroscopic procedures of the upper urinary tract. *J Infect Chemother.* 2013;19(6):1102- 1108.
12. Martov A, Gravas S, Etemadian M, et al. Postoperative infection rates in patients with a negative baseline urine culture undergoing ureteroscopic stone removal: a matched case-control analysis on antibiotic prophylaxis from the CROES URS global study. *J Endourol.* 2015;29(2):171-180.
13. Southern JB, Higgins AM, Young AJ, et al. Risk factors for post- operative fever and systemic inflammatory response syndrome after ureteroscopy for stone disease. *J Endourol.* 2019;33(7):516-522.
14. Moses RA, Ghali FM, Pais VM, Hyams ES. Unplanned hospital return for infection following ureteroscopy can we identify modifiable risk factors? *J Urol.* 2016;195(4 Pt 1):931-936.
15. Mitsuzuka K, Nakano O, Takahashi N, Satoh M. Identification of factors associated with postoperative febrile urinary tract infection after ureteroscopy for urinary stones. *Urolithiasis.* 2016;44(3):257-262.
16. Youssef RF, Neisius A, Goldsmith ZG, et al. Clinical outcomes After ureteroscopic lithotripsy in patients who initially presented with urosepsis: matched pair comparison with elective ureteros- copy. *J Endourol.* 2014;28(12):1439-1443.
17. Whiteside SA, Razvi H, Dave S, Reid G, Burton JP. The microbiome of the urinary tract - A role beyond infection. *Nat Rev Urol.* 2015;12(2):81-90.
18. Kohada Y, Goriki A, Yukihiro K, Ohara S, Kajiwara M. The risk factors of urinary tract infection after transurethral resection of bladder tumors. *World J Urol.* 2019;37(12):2715-2719.
19. Chen D, Jiang C, Liang X, et al. Early and rapid prediction of postoperative infections following percutaneous nephrolithotomy in patients with complex kidney stones. *BJU Int.* 2019;123(6):1041- 1047.
20. Fan J, Wan S, Liu L, et al. Predictors for uroseptic shock in patients who undergo minimally invasive percutaneous nephrolithotomy. *Urolithiasis.* 2017;45(6):573-578.