Prognosis of urinary tract infections: predictive factors and role of Ramadan fasting

Pronostic des infections des voies urinaires : facteurs prédictifs et rôle du jeûne du Ramadan

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RÉSUMÉ

Contexte : Le rôle du jeûne du Ramadan (JR) comme facteur prédictif de récurrence de l'infection urinaire (IU) est un véritable sujet de controverse.
Objectif : La présente étude avait comme objectif d'identifier les facteurs pronostiques des IUs récurrentes.
Méthodes : Il s'agissait d'une étude rétrospective ayant inclus tous les patients diagnostiqués pour IU à la consultation externe et au service des maladies infectieuses du centre hospital-universitaire Hedi Chaker,Sfax,Tunisie, entre 2010 et 2017. La méthode de Kaplan-Meier a été utilisée pour calculer les médianes de survie sans récurrence (SSR) et estimer les courbes de survie. Le test log-Rank a été utilisé pour comparer ces courbes. Les analyses univariée et multivariée ont été effectuées par un modèle proportionnel de Cox afin d'identifier les facteurs de récurrence de l'IU (sexe, âge, groupe d'âge, saisons, comorbidités, première IU diagnostiquée durant le Ramadan, hospitalisation pour IU récurrente, durée du séjour à l'hôpital, type de présentation clinique de l'IU).
Résultats : Au cours du suivi, parmi les 867 patients ayant une IU, 105 (12,1%) ont développé une IU récurrente. La médiane [intervalle de confiance 95%] de la SSR était de 60 [40 à 82] jours. Les patients ayant une IU diagnostiquée pendant le Ramadan avaient une SSR plus courte par rapport à ceux diagnostiqués en dehors du Ramadan (respectivement, 32 contre 60 jours, p=0,002). Le JR (Odds ratio = 2,96 ; p=0,033) et le diabète sucré (Odds ratio = 1,6 ; p=0,033) étaient les facteurs pronostiques indépendants de récurrence dans l'analyse de régression multivariée de Cox.
Conclusion : Le diabète sucré et le JR étaient les facteurs pronostiques de SSR retrouvés chez les patients diagnostiqués pour IU.

Mots-clés
Religion, Alimentation, Hydratation, Fonction rénale, Septicité

SUMMARY

Background: The role of Ramadan fasting (RF) as a predictive factor of urinary tract infection (UTI) recurrence was controversially discussed in the literature.
Aim: The present study aimed to identify the prognosis factors of recurrent UTIs.
Methods: Data were retrospectively collected from patients with UTI diagnosed at the infectious diseases department and its affiliated outpatient department in Hedi Chaker University Hospital, Sfax, Tunisia, between 2010 and 2017. Kaplan-Meier method was used to generate recurrence-free survival (RFS) curves for first episode of UTI diagnosed in two groups: during and outside Ramadan, which were compared using Log-rank test for statistical inference. Univariate and multivariate Cox proportional hazards regression models were used to identify UTI recurrence factors (sex, age, age group, season, comorbidities, first UTI episode diagnosed during Ramadan, UTI requiring hospitalization, length of hospital stay, nosocomial UTI, clinical presentation).
Results: During the follow up, among the 867 patients with UTI, 105 (12.1%) developed a recurrent UTI one. The RFS median [95% confidence interval] was 60 [40 to 82] days. Survival curves showed that patients with UTI diagnosed during Ramadan had shorter RFS compared with those diagnosed outside of Ramadan (32 vs. 60 days, respectively, p=0.002). RF (hazard ratio = 2.96; p = 0.033) and diabetes mellitus (hazard ratio =1.6; p = 0.033) were independently associated with UTI recurrence in multivariate Cox regression analysis.
Conclusion: Recurrent UTI was a prevalent and challenging condition among patients with UTI. Diabetes mellitus and RF had a prognosis value for recurrence in UTI.

Key-words
Religion, Diet, Hydration, Kidney function, Septicity

INTRODUCTION

Urinary tract infection (UTI) remains a public health problem in both developed and developing countries (1). It is the third most common infection experienced by humans after respiratory and gastro-intestinal infections (2, 3). UTI was estimated to affect 150 million people per annum worldwide (4). In Central-Eastern Tunisia, UTIs represented 14.9% of all communicable diseases diagnosed between 2002 and 2013 (5). Bacterial infections of the urinary tract are very frequent in both community and hospital settings, occur in all age groups, and usually required urgent treatment (6). Moreover, UTIs constitute a serious economic cost to countries (7).

Although most UTIs could be effectively treated by antibiotics, UTI recurrence is a common problem and sometimes may be very troublesome (8). Recurrent UTIs, which include relapses and reinfection (8), are usually not life-threatening. However, their high incidence significantly increases health-care costs and has a negative impact on patients' life quality (9, 10). In recent years, research on UTI recurrence has attracted a wide attention (11). Current guidelines suggested that for better management and disease prognosis, it is mandatory to identify the risk factors rather than treating recurrent UTI with antibiotics alone (12). To identify prognosis factors of recurrent UTI, investigations should include a history review and a physical examination to rule out urogenital anatomical anomalies, immunodeficiency, voiding dysfunction, and health behavioral problems. One of the factors influencing the risk of recurrent UTI was fluid intake (11). Meanwhile Ramadan fasting (RF), which is a religious ritual of all healthy adult Muslims, decreases water intake. However, there is no clear agreement on the effects of RF on UTI recurrence. Several studies investigated the relationship between RF and urinary lithiasis, which was known as a risk factor of UTI (13). Some previous studies compared the prevalence of urinary lithiasis during Ramadan with other months of the lunar year and showed that RF did not seem a risk factor for urinary lithiasis (14, 15). On the contrary, another study demonstrated an association between RF and the incidence of renal colic admission (16).

In this perspective, this retrospective study aimed to identify prognosis factors predicting recurrence in patients with UTI with a special attention to the effects of RF.

METHODS

Study design

This was a retrospective cohort study including patients with UTI diagnosed at the infectious diseases department and its affiliated outpatient department in Hedi Chaker University Hospital (UH), Sfax, Tunisia, from January 1st, 2010 to December 31st, 2017. This UH is an 889-bed tertiary level teaching hospital with 15 hospital departments. It exerts a pull on the neighboring towns and manages a flow of patients coming from different governorates in Southern Tunisia.

Study population

All inpatients and outpatients diagnosed with UTI at the Infectious Diseases Department and aged 15 years and above were enrolled in the study cohort. The primary outcome was time to symptomatic UTI event that met criteria for clinical or culture confirmed UTI.

Study protocol

At enrollment, eligible patients with UTI were divided into two groups: first episode of UTI occurred during or outside Ramadan. Then they were followed-up during the study period in order to identify recurrent cases in each group.

Applied definitions

UTI was defined as the presence of urinary symptoms (dysuria, frequency, urgency, sensing of residual urine), and/or symptoms consistent with active clinical infection: fever (≥38 °C), or tenderness of costo-vertebral angle on physical exam as well as the isolation of uro-pathogen from urine (17). The clinical forms of UTI included acute pyelonephritis, cystitis, prostatitis and emphysematous pyelonephritis (17). Nosocomial UTI was defined as a one acquired in health institution, 48 hours after the hospitalization, and was not present or incubating at the time of the admission (18).

The outcome of interest was "recurrence of UTI" which was defined as a further infection by a new or the same micro-organism occurring within one year after the primary outcome (19, 20). A recurrence free-survival (RFS) was defined as the occurrence of recurrence from the date of the initially confirmed UTI to the study end point.

Data collection

Data were collected from both laboratory reports and medical records using a pre-established case record

form. These data included patient demographics such as sex and age, comorbidities, clinical presentation, the site and date of acquisition as well as the disease evolution (complication, recurrence...). The entire process of data retrieval and data entry was done by the investigators.

Statistical analysis

All statistical analysis was performed using SPSS.20. The results of continuous variables were presented as median and interquartile range (IQR), those of categorical variables as percentages. The Kaplan–Meier method was used for survival analysis by calculating the cumulative recurrence rate during the follow-up. Kaplan-Meier RFS curves were built for both groups (first episode of UTI diagnosed during / outside Ramadan) and then survival rates were compared using Log-rank test for statistical inference. Patients were censored at their last follow-up visit. Cox proportional hazards regression model (HR: Hazard Ratio; 95% CI; p-value) was used for univariate and multivariate analysis to identify UTI recurrence factors (sex, age, age group, season, comorbidities, first UTI episode diagnosed during Ramadan, UTI requiring hospitalization, length of hospital stay, nosocomial UTI, clinical presentation). All variables associated with survival that had $p<0.25$ in univariate analysis were entered into the multivariate analysis model. Statistical significance was set at a p- value less than 0.05.

RESULTS

Demographic and clinical characteristics of the study population

During a period of 8 years, 867 patients with UTI were included. Table 1 exposes their demographic and clinical characteristics. There was a predominance of female sex and of patients aged lower than 65 years. No season predominance was noted. Diabetes mellitus and urinary lithiasis dominated the comorbidities. Results showed that 9.5% of UTI were diagnosed during the 8 months of Ramadan. The UTI clinical presentation was dominated by acute pyelonephritis.

RFS in patients with UTI

During the follow-up 105 patients developed a recurrent UTI (12.1%). Figure 1 exposes the Kaplan–Meier RFS curves of UTI stratified by the time of occurrence of the first UTI infection episode. The median RFS [95%CI] was 60 [40 to 82] days. When stratified by diagnosis of first UTI episode during and outside Ramadan, survival curve analysis showed that patients with UTI diagnosed during Ramadan had shorter RFS compared with those diagnosed outside of Ramadan (32 [35 to 85] vs. 60 [35 to 85] days; p=0.002).

Prognostic factors associated with UTI recurrence: results of univariate and multivariate Cox analysis

Table 2 exposes the univariate and multivariate analysis of RFS of patients with UTI using the Cox proportional hazards model. The univariate analysis showed that the factors significantly associated with UTI recurrence were diabetes mellitus (HR=1.5; p=0.049), diagnosis during Ramadan (HR=3.86; p=0.005) and nosocomial UTI (HR=3.2; p=0.025). According to the multivariate Cox regression analysis for survival, only diagnosis during Ramadan and diabetes mellitus were found to be significantly associated with UTI recurrence.

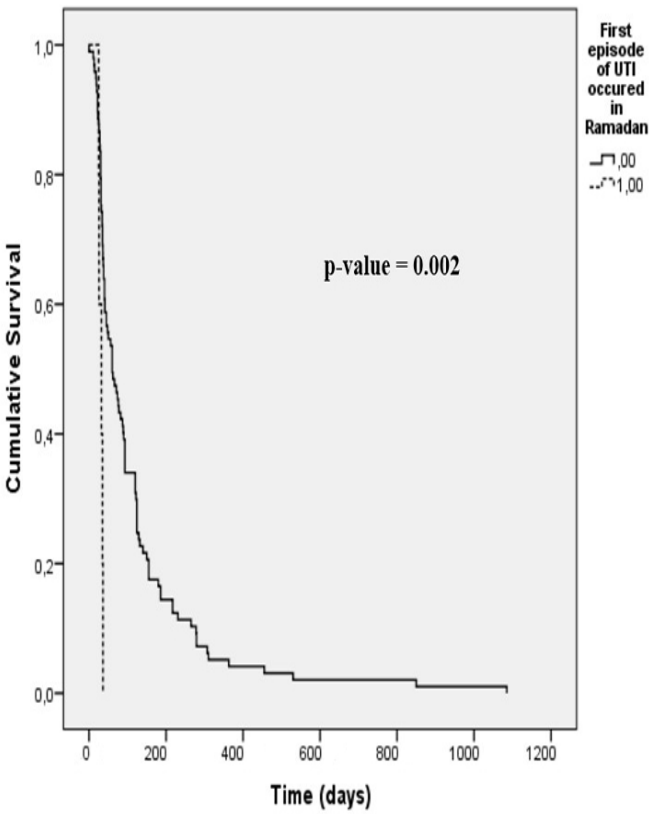

Figure 1: Kaplan–Meier recurrence-free survival curves of urinary tract infection (UTI) stratified by the time of occurrence of the first (UTI) episode

Table 1: Characteristics of patients with urinary tract infections (UTIs) (n=867)

Variables			
Sex			
Female		561	64.7
Age (years)		55	[34-73]
Age ≥65 years		330	38.1
Season			
Winter		200	23.1
Autumn		203	23.4
Spring		219	25.3
Summer		245	28,2
Comorbidities			
Diabetes mellitus		268	30.9
Urinary lithiasis		94	10.8
Urinary tract tuberculosis		4	0.5
Neurological bladder		46	5.3
Benign prostatic hyperplasia		50	5.8
Chronic kidney disease		40	4.6
Congenital urological malformation		15	1.7
Urological cancer		15	1.7
Immune suppression		19	2.2
First UTI episode diagnosed in Ramadan		82	9.5
UTI requiring hospitalisation		564	65.1
Length of hospital stay (days)		5	[3-7]
Nosocomial UTIs		43	5
Clinical presentation			
Cystitis	Acute	744	85.5
Prostatitis	pyelonephritis		
Urinary abcess		76	8.8
Epididymo-orchitis		28	3.2
		19	2.2
Emphysematous pyelonephritis		12	1.4
		3	0.3

Quantitative data were expressed as median (interquartile range) and qualitative data were presented as number (%).

DISCUSSION

This study illustrated the potential burden of recurrent UTI and the role of RF in predicting recurrence. Patients with first episode of UTI occuring during Ramadan had lower survival rates and then, poorer prognosis than the other recurrent UTI, which was also illustrated in the multivariate analysis.

Recurrent UTI is one of the most common reasons for counsultation in infectious diseases departments. It should be considered a different disease from the first infection as new evidence suggests a distinct pathogenesis in recurrent UTI (11). Therefore, patients with recurrent UTI should undergo a comprehensive investigation to identify the prognosis factors associated with recurrence and then to reduce the disease burden through targeted risk factors interventions. Several prognosis factors of recurrent UTI have been reported, such as immunodeficiency, diabetes mellitus, urinary tract abnormality, voiding dysfunction and behavioral factors (11).

Diabetes mellitus was the main associated comorbidity in the present study population and was found to be an independent prognostic factor significantly associated with UTI recurrence. UTIs were frequently encountered among diabetic patients in many recent studies (21, 22). In addition, diabetes mellitus has been previously identified as a possible risk factor for recurrent UTI (11, 23, 24). The higher risk of recurrent UTI in patients with diabetes mellitus might be due to the high incidence of persistent or recurrent asymptomatic bacteriuria, a risk factor for new episodes of UTI, if not properly managed (23). Meanwhile, diabetes mellitus may rapidly induce an immunosuppressed state (25), whereas it is well known that patients with immunodeficiency tend to have recurrent and severe UTIs (26).

Another interesting finding in the present study was that first UTI diagnosed during Ramadan was a predictive factor for recurrence. Indeed, Ramadan is the ninth month of the lunar year (Hijri), when Muslims abstain from eating and drinking from sunrise to sunset. Daily fasting period can last 15-16 hours in summer (27). Fluid and diet restrictions during this month could cause intermittent hypohydration and some changes in urinary metabolites that have different effects on calculus formation (28, 29). Being aware that calculi were well-known as causative factors in UTI (13), RF could increase the risk for developing recurrent UTI through fostering urinary calculus formation. Yet, the link between RF and UTI recurrence was controversial in literature: clinical studies showed variable and inconclusive results on the influence of RF on the risk of recurrent UTI (27, 30). Until now, other previous studies reported that lifestyle factors such as fluid intake and diet were not considered independent risk factors for recurrent UTI (11).

During the follow up, 12.1% of eligible patients developed a recurrent UTI and the median RFS was 60 days. In fact, the frequency of recurrent UTI varies by population (31). A previous study showed that the risk of recurrence within 30 days was 4.1%, while recurrence within one month to one year occurred in 8.1% (32). In a study, conducted in the United states, following 285 females with first UTI for six months, the risk of a second episode was 24% within

Table 2: Univariate and multivariate analysis of recurrence-free survival of patients with urinary tract infection (UTI) using the Cox proportional hazards model

Covariates		Univariate analysis		Multivariate analysis	
		Crude HR (95% CI)	p	Adjusted HR (95% CI)	p
Diagnosis during Ramadan	No	1	***0.005****	1	***0.033****
	Yes	3.86 [1.49-9.97]		2.96 [1.09-8.08]	
Sex	Male	1	0.55		
	Female	1.13 [0.75-1.71]			
Age ≥65 years	No	1	0.93		
	Yes	1.02 [0.68-1.52]			
Season	Autumn	1	0.73		
	Summer	1.03 [0.58-1.82]	0.92		
	Spring	1.24 [0.74-2.08]	0.41		
	Winter	0.92 [0.51-1.66]	0.79		
Comorbidities					
Diabetes mellitus	No	1	***0.049****	1	***0.033****
	Yes	1.50 [1.01-2.47]		1.59 [1.04-2.43]	
Urinary lithiasis	No	1	0.20		
	Yes	1.39 [0.83-2.33]			
Urinary tract tuberculosis	No	1	0.76		
	Yes	1.35 [0.18-9.83]			
Neurological bladder	No	1	0.84		
	Yes	0.94 [0.52-1.69]			
Benign prostatic hyperplasia	No	1	0.84		
	Yes	1.06 [0.57-1.95]			
Chronic kidney disease	No	1	0.45		
	Yes	1.37 [0.60-3.16]			

Congenital urological malformation	**No**	1	0.08		
	Yes	1.99 [0.91-4.35]			
Urological cancer	**No**	1	0.11		
	Yes	0.44 [0.16-1.22]			
Immune suppression	**No**	1	0.25		
	Yes	1.96 [0.61-6.27]			
Nosocomial UTIs	**No**	1	***0.025****	1	0.055
	Yes	3.22 [1.15-8.97]		2.98 [0.97-9.08]	
Clinical presentation					
Acute pyelonephritis	**No**	1	0.47		
	Yes	1.22 [0.71-2.09]			
Cystitis	**No**	1	0.69		
	Yes	1.15 [0.57-2.29]			
Prostatitis	**No**	1	0.39		
	Yes	1.41 [0.65-3.04]			
Urinary abscess	**No**	1	0.40		
	Yes	1.65 [0.52-5.21]			
Epididymo- orchitis	**No**	1	0.09		
	Yes	0.29 [0.07-1.21]			
Emphysematous pyelonephritis	**No**	1	0.77		
	Yes	1.22 [0.29-5.00]			

HR: Hazard Ratio; CI: Confidence Interval; *: Statistically significant difference

six months (33). Another South Korean study showed that the 12-month risk of recurrence was 9.2% for females and 5.7% for males (34). These discrepancies in recurrence delays could be related to the dissimilarity in the case definition, the methodology adopted and the diagnosis criteria between studies.

Previous studies have demonstrated that UTI were common among the female population (35-37), which was consistent with the present study. This could be explained by risk factors specific to females for UTIs including the shortness of the urethra and its close relationship to the anus (35).

Incidence of UTI was seasonal, peaking in summer with low rates in winter. This seasonality may be explained by changes in weather, specifically, temperature which may have an impact on hosts, urinary pathogens or both (38). In fact the hotter weather may reduce hydration levels, which, in turn, may lead to more concentrated urine, less frequent voiding and less clearance of potential urinary pathogens (39). Moreover, the hot weather may lead to a moisture perineum, which could facilitate bacterial transfer from the rectum to the urethra (40).

In this study, most of the eligible patients had a history of urinary lithiasis. The latter has been reported as a comorbidity frequently associated with UTIs and the development of infection could complicate the management of pre-existing lithiasis (13). Therefore, it should be treated at an early stage in order to avoid recurrence and severe forms of UTI.

This study demonstrated that recurrent UTI occurred more frequently when the previous episode was a nosocomial UTI. Indeed, hospital acquired infections are often caused by multidrug-resistant organisms (41). In line with this, an hypothesis holds that some same-strain episodes of recurrent UTI may originate from uropathogens lying dormant in the bladder following a previous UTI (42). Taking into account all these considerations, it was concluded that the acquisition of the first episode of UTI during hospital admission could be a predisposing factor to treatment failure to eradicate the uropathogen from the organism, resulting in the return of this infection. In fact, preventive measures to avoid transmission of multidrug-resistant uropathogen during hospital stay and then reducing the risk of nosocomial UTI have been proved to be efficacious and are mandatory to attempt to decrease the incidence of recurrent UTI (43).

The present study enlightened association between UTI diagnosis during Ramadan and its recurrence. Nevertheless, it had some limitations: The retrospective design and the seasonal variation of Ramadan month should be taken into consideration before making conclusions. Moreover, RF for patients with UTI occurring in Ramadan could not be affirmed, in order to preserve the patients' intimacy. Therefore, this finding should be interpreted according to sociocultural habits, rituals and religious beliefs of populations. Another limitation of this study was the small number of patients with recurrent UTI, which could interfere in the statistical performance of the comparative tests. Further large scale, multicenter and prospective studies are mandatory in order to better elucidate this relationship.

CONCLUSION

Recurrent UTI was a substantial burden among patients with UTI diagnosed in Southern Tunisia. Despite the availability of effective and easy to administer antibiotics in UTI treatment, preventing UTI recurrence sometimes might be challenging for both patients and doctors. Nowadays, recurrent UTI may be considered a distinct disease and patients with recurrent UTI should be managed aggressively. The present study revealed that occurrence of the UTI first episode in Ramadan was a predictive factor of UTI recurrence. Larger investigations are needed to better explain details in the pathogenesis of recurrent UTI in order to identify high-risk patients who require specific care.

REFERENCES

1. Vasquez Y, Hand WL. Antibiotic susceptibility patterns of community-acquired urinary tract infection isolates from female patients on the US (texas)-mexico border. J Appl Res. 2004;4(2).
2. Najar M, Saldanha C, Banday K. Approach to urinary tract infections. Indian J Nephrol. 2009;19(4):129.
3. Nickel JC. Management of urinary tract infections: historical perspective and current strategies: part 1—before antibiotics. J Urol. 2005;173(1):21-6.
4. Flores-Mireles AL, Walker JN, Caparon M, Hultgren SJ. Urinary tract infections: epidemiology, mechanisms of infection and treatment options. Nat Rev Microbiol. 2015;13(5):269.
5. Fredj MB, Belguith AS, Abroug H, et al. Hospitalizations for communicable diseases in a developing country: prevalence and trends— Monastir, Tunisia, 2002–2013. Int J Infect Dis. 2017;55:102-8.
6. Tandogdu Z, Wagenlehner FM. Global epidemiology of urinary tract infections. Curr Opin Infect Dis. 2016;29(1):73-9.
7. Shiralizadeh S, Taghizadeh S, Asgharzadeh M, et al. Urinary tract infections: raising problem in developing countries. Rev Med Microbiol. 2018;29(4):159-65.

8. Epp A, Larochelle A. Recurrent urinary tract infection. J Obstet Gynaecol Can. 2010;32(11):1082-90.
9. Renard J, Ballarini S, Mascarenhas T, et al. Recurrent lower urinary tract infections have a detrimental effect on patient quality of life: a prospective, observational study. Infect Dis Ther. 2015; 4(1): 125–35.
10. Ciani O, Grassi D, Tarricone R. An economic perspective on urinary tract infection: the "costs of resignation". Clin Drug Investig. 2013;33(4):255-61.
11. Jhang J-F, Kuo H-C. Recent advances in recurrent urinary tract infection from pathogenesis and biomarkers to prevention. Ci Ji Yi Xue Za Zhi. 2017;29(3):131.
12. Grabe M BR, Johansen TE, Cai T, et al. Guidelines on urological infections EAU Guideline . 2015. Available : https://uroweb.org/wp-content/uploads/19-Urological-infections_LR2.pdf
13. Thomas B, Tolley D. Concurrent urinary tract infection and stone disease: pathogenesis, diagnosis and management. Nat Clin Pract Urol. 2008;5(12):668-75.
14. Basiri A, Moghaddam SM, Khoddam R, Nejad ST, Hakimi A. Monthly variations of urinary stone colic in Iran and its relationship to the fasting month of Ramadan. J Pak Med Assoc. 2004;54(1):6-8.
15. Al Mahayni AO, Alkhateeb SS, Abusaq IH, Al Mufarrih AA, Jaafari MI, Bawazir AA. Does fasting in Ramadan increase the risk of developing urinary stones? Saudi Med J. 2018;39(5):481-6.
16. Abdolreza N, Omalbanin A, Mahdieh TS, et al. Comparison of the number of patients admitted with renal colic during various stages of peri-Ramadan month. Saudi J Kidney Dis Transpl. 2011;22(6):1199-202.
17. Ben Ayed H, Koubaa M, Hammami F, et al., editors. Performance of an easy and simple new scoring model in predicting multi-drug resistant Enterobacteriaceae in community-acquired urinary tract infections. Open Forum Infect Dis. 2019.
18. Allegranzi B, Nejad SB, Combescure C, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. Lancet. 2011;377(9761):228-41.
19. Stapleton AE, Dziura J, Hooton TM, et al., editors. Recurrent urinary tract infection and urinary Escherichia coli in women ingesting cranberry juice daily: a randomized controlled trial. Mayo Clin Proc. 2012; 87(2):143-50.
20. Hooton TM. Recurrent urinary tract infection in women. Int J Antimicrob Agents.2001;17(4):259-68.
21. Sharma S, Govind B, Naidu SK, Kinjarapu S, Rasool M. Clinical and laboratory profile of urinary tract infections in type 2 diabetics aged over 60 years. J Clin Diagn Res. 2017;11(4):OC25-OC8.
22. Nitzan O, Elias M, Chazan B, Saliba W. Urinary tract infections in patients with type 2 diabetes mellitus: review of prevalence, diagnosis, and management. Diabetes Metab Syndr Obes. 2015;8:129-36.
23. Rutten GE, Zuithoff NP, Gorter KJ, Hak E, Hoepelman AI. Risk of recurrent acute lower urinary tract infections and prescription pattern of antibiotics in women with and without diabetes in primary care. Fam Pract. 2010;27(4):379-85.
24. Geerlings SE, Stolk RP, Camps MJ, et al. Asymptomatic bacteriuria may be considered a complication in women with diabetes. Diabetes Mellitus Women Asymptomatic Bacteriuria Utrecht Study Group. Diabetes Care. 2000;23(6):744-9.
25. Luo B, Chan W, Lord S, et al. Diabetes induces rapid suppression of adaptive immunity followed by homeostatic T cell proliferation. Scand J Immunol.;65(1):22-31.
26. Chapel H, Cunningham Rundles C. Update in understanding common variable immunodeficiency disorders (CVIDs) and the management of patients with these conditions. Br J Haematol. 2009;145(6):709-27.
27. Cevik Y, Corbacioglu SK, Cikrikci G, Oncul V, Emektar E. The effects of Ramadan fasting on the number of renal colic visits to the emergency department. Pak J Med Sci. 2016;32(1):18.
28. Miladipour AH, Shakhssalim N, Parvin M, Azadvari M. Effect of Ramadan fasting on urinary risk factors for calculus formation. Iran J Kidney Dis. 2012;6(1):33.
29. Al Mahayni AO, Alkhateeb SS, Abusaq IH, Al Mufarrih AA, Jaafari MI, Bawazir AA. Does fasting in Ramadan increase the risk of developing urinary stones? Saudi Med J. 2018;39(5):481.
30. Beetz R. Mild dehydration: a risk factor of urinary tract infection? Eur J Clin Nutr. 2003;57 Suppl 2:S52-8.
31. Foxman B. Urinary tract infection syndromes: occurrence, recurrence, bacteriology, risk factors, and disease burden. Infect Dis Clin North Am.2014;28(1):1-13.
32. Drekonja DM, Rector TS, Cutting A, Johnson JR. Urinary tract infection in male veterans: treatment patterns and outcomes. JAMA Intern Med.2013;173(1):62-8.
33. Foxman B, Gillespie B, Koopman J, et al. Risk factors for second urinary tract infection among college women. Am J Epidemiol.2000;151(12):1194-205.
34. Ki M, Park T, Choi B, Foxman B. The epidemiology of acute pyelonephritis in South Korea, 1997–1999. Am J Epidemiol.2004;160(10):985-93.
35. Minardi D, d'Anzeo G, Cantoro D, Conti A, Muzzonigro G. Urinary tract infections in women: etiology and treatment options. Int J Gen Med. 2011;4:333.
36. Tan CW, Chlebicki MP. Urinary tract infections in adults. Singapore Med J. 2016;57(9):485.
37. Geerlings SE. Clinical presentations and epidemiology of urinary tract infections. Microbiol Spectr. 2016;4(5).
38. Simmering J, Cavanaugh J, Polgreen L, Polgreen P. Warmer weather as a risk factor for hospitalisations due to urinary tract infections. Epidemiol Infect. 2018;146(3):386-93.
39. Beetz R. Mild dehydration: a risk factor of urinary tract infection? Eur J Clin Nutr. 2003;57(S2):S52.
40. Anderson JE. Seasonality of symptomatic bacterial urinary infections in women. J Epidemiol Community Health. 1983;37(4):286-90.
41. Irek EO, Amupitan AA, Obadare TO, Aboderin AO. A systematic review of healthcare-associated infections in Africa: An antimicrobial resistance perspective. Afr J Lab Med. 2018;7(2):1-9.
42. Nickel JC. Urinary tract infections and resistant bacteria: highlights of a symposium at the combined meeting of the 25th international congress of chemotherapy (icc) and the 17th European congress of clinical microbiology and infectious diseases (eccmid), March 31–April 3, 2007, Munich, Germany. Rev Urol. 2007;9(2):78.
43. Bodro M, Sanclemente G, Lipperheide I, et al. Impact of antibiotic resistance on the development of recurrent and relapsing symptomatic urinary tract infection in kidney recipients. Am J Transplant.2015;15(4):1021-7.