Prevalence of urinary tract infection in diabetic patients and identification of the causal microorganisms

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Abstract

Background and objective: Urinary tract infection (UTI) is a condition in which the urinary tract is infected with a pathogen causing inflammation. One of the predisposing factors for UTIs is diabetes mellitus (DM), spillage of glucose into the urine provide a good culture medium for bacteria. The objectives of this study were to evaluate the distribution of UTIs among diabetic patients of both genders with studying the effect of some relative factors, and identifying types of the causal microorganisms.

Methods: Diabetic patients (type1 and 2), from both genders were included in this study. All patients were interviewed. Uncontaminated urine samples were collected for microscopic and macroscopic analysis. Isolations and identifications of bacteria were done by standard methods.

Results: Out of 150 diabetic patients, 53 (35.33%) have UTI. Gender, middle age and high level of proteinuria were risk factors, while type and duration of DM with its type of treatment, body mass index (BMI), and hypertension were non significant. The isolated types of pathogens were Escherichia coli (45.3%), Klebsiella pneumoniae (15.1%), Staphylococcus saprophyticus (15.1%), Citrobacter diversus (11.3%), Candida albicans (7.5%) and Staphylococcus aureus (5.7%).

Conclusion: This study revealed that diabetic females were most susceptible to get UTIs than diabetic males. In both genders the most reliable age for UTI were between 31-40 years. The results showed that the level of proteinuria was higher in patients suffering from UTIs associated with DM, which considered as a risk factor. Certain types of microorganisms were isolated; the most common types were Escherichia coli, Klebsiella pneumoniae and Staphylococcus saprophyticus.

Keywords: Diabetes mellitus; Urinary tract infections; Bacteria.

Introduction

One of the most well known bacterial infections is the UTI [1]. Both men and women are subjected to UTIs. About 50% of women report indicates having at least one UTI in their lifetime [2]. Urinary tract infections are either complicated which are difficult to treat, or uncomplicated, easy to be treated and occur mostly in adult young women. Many conditions are enhanced susceptibility for the development of a UTI with complicated. Amongst these conditions are age and DM [3]. It was reported that DM increases the risk of UTI 20- to 30- folds under the age of 44 [4], and between 10-30 years old in females and over 51 years old in males [5]. Most investigators report that the prevalence of asymptomatic bacteriuria (ASB) in women with DM is three to four times higher than in women without DM [6]. This was differing in the case of males in which the results were more consistent; a frequency between 1 and 2% has been found, with no difference between diabetic and nondiabetic men [7]. Also, the frequency of symptomatic infections in women with DM is also increased [8]. On other side, proteinuria is a sign of chronic kidney disease (CKD), which can result from diabetes, high blood pressure, and diseases that

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cause inflammation in the kidneys. For this reason, testing for albumin in the urine is part of a routine medical assessment for everyone. Kidney disease is sometimes called renal disease. If CKD progresses, it can lead to end-stage renal disease (ESRD), when the kidneys fail completely. A person with ESRD must receive a kidney transplant or regular blood-cleansing treatments called dialysis. In the United States, diabetes is the leading cause of ESRD. In both type 1 and type 2 diabetes, albumin in the urine is one of the first signs of deteriorating kidney function. As kidney function declines, the amount of albumin in the urine increases [9]. UTIs are commonly said to be associated with positive results in reagent-strip urinalysis for proteinuria. Some reviews suggesting between 63 cases of culture-confirmed UTI, (83%) having reagent-strip positive tests for protein [10]. Symptomatic UTIs account for 2–3% of all consultations in general practice and around 6% in the case of women. Asymptomatic UTI is found in approximately 4–7% of pregnant women, 10% of elderly men and 20% of elderly women [11, 12]. Concerning of the relation between hypertension and UTI, a study was carried out on a group of 333 patients admitted/ in the University of Medicine and Pharmacy "Victor Babes" in Timisoara. The patients were diagnosed with one of the clinical forms of UTI. The patients were aged between 65 and 92 years. 16% of them were men and 84% were women. The results showed that of all patients 65.8% had no hypertension at admission and also had no history of hypertension, 24.9% had a history of hypertension longer than the history of UTI, and just 9.3% of the patients with UTI had no history of hypertension but had hypertension at admission. It was observed that hypertension was present just in patients with chronic obstructive or non-obstructive pyelonephritis. In conclusions: It is very difficult, to establish in elderly, the amount of patients who develop hypertension due to chronic pyelonephritis, because in this age atherosclerosis is also incriminated in the

ethiopathogeny of hypertension [13]. Other risk factors for ASB in type 2 diabetic patients were macroalbuminuria, a lower BMI, and a UTI during the previous year. Except for the lower BMI, these risk factors have been reported previously in type 2 diabetic patients. Previous UTI as a risk factor for ASB indicates that bacteriuria can be present with or without symptoms in the same patient. The significant positive correlation of a lower (but still very high) BMI with ASB in women with type 2 diabetes is difficult to explain. The correlation is probably a coincidence because BMI disappeared as a risk factor [14]. Although *Eschichia coli* is the most common uropathogen and causes the majority of infection, other Gram-negative uropathogens are virulence factors of UTIs such as *Klebsiella* [6]. The adherence of *E.coli* (type1-fimbriated) to uroepithelial cells of women with DM is increased, compared with the adherence to uroepithelial cells of women without DM [14]. However, the bacteria isolated from diabetic patients with UTI are similar to those found in nondiabetic patients with complicated UTI [7]. It has been reported that *E.coli* to be a causative uropathogen in 47% of the UTI in diabetic patients and in 68% of the UTIs in nondiabetic patients[8]. Uropathogens other than *E.coli* found in patients with DM, included *Klebsiella* spp, *Enterobacter spp*, *Proteus spp*, group *B Streptococci* and *Enterococcus faecalis* [3, 4, 15].

Methods

One hundred fifty diabetic patients (type 1 and type 2), 92 females and 58 males were participated in this prospective study. Their ages were ranged between (17-80) years. Diabetic patients were selected randomly in Layla Qasm center for diabetic patients in Erbil city. All of those patients were seen and interviewed to extract data such as the following factors that may promote UTI in diabetic patients:
1- Gender, 92 females & 58 males were investigated to find out the number of patients who have UTI. 2- Age, different range of age groups in years, were

Investigated as following: (17-30, 31-40, 41 -50, 51-60, and ≥61). 3- Measurement of proteinuria: proteinuria was analyzed macroscopically for all patients from the urine samples. 4-Hypertension, blood pressure measured by a mercury sphygmomanometer for all diabetic patients. 5-Duration of DM: the duration was divided into two time intervals. The first one was for less than 5 years, whereas the second was for equal to or more than 5 years. 6- Type of DM, BMI, type of treatment and smoking habits were recorded for all the diabetic patients. 7-A mid-stream morning urine samples were obtained into sterile containers from all of the patients (patients on antibiotic treatment and pregnant women were excluded), and then urine analysis (macroscopic and microscopic) examinations were investigated. All isolates of significant bacteriuria were identified by standard methods and confirmed by using API 20E system (bioMerieux France Co.).

Results

The results obtained for the selected factors that may interfere with UTIs in diabetic patients as mentioned in methods were statistically analyzed by Chi square test:
1-Gender: out of 150 diabetic patients, 53 (35.33%) of them get UTIs by investigating significant bacteriuria of both genders. Amongst 92 females and 58 males, the percentage of UTIs among females (46.74%) in which was higher than that of the males (17.24%) and it is statistically significant (P< 0.01) Table 1. 2-Age: Table 2 represents distribution of UTI among different age groups in both genders, the percentage of UTI among patients of age (31-40) was (46.15%) higher than the other rest group of ages, but statistically not significant. 3-Measuring of proteinuria level in diabetic patients: Table 3 represents the levels of proteinuria in diabetic patients with UTI. In both genders, results showed that about 50% of UTIs associated with positive proteinuria level, and 28% of UTI diabetic patients were not associated with the level of proteinuria. Statistical analysis (P<0.01)

revealed that the level of proteinuria was a risk factor. 4-Hypertension and UTI in diabetic patients: Chi square analysis showed an amount which is very close to be significant between males who are hypertensive with UTI (28.57%) and males who are not hypertensive (10.81%) Table 4, while in females there were no significant differences. 5-Duration of diabetes mellitus with UTI: no significant difference was found. For duration less than 5 years was (58.49%), but for equal to or more than 5 years it was (41.51%). 6- Measuring of the effect of type of DM, type of treatment, BMI and smoking on UTI: results analysis showed no significant differences. 7- Numbers and percentages of the causal microorganisms: The most frequently isolated bacteria were *Escherichia coli* (45.28%), then *Klebsiella pneumoniae* (15.1%), *Staphylococcus saprophyticus* (15.1%), then *Citrobacter diversus* (11.32%) Table 5. 8- Table 6 shows the effect of duration of diabetes mellitus on the type of the causal microorganisms: no significant difference was recorded but as we see in Table 6 the value is very near to be significant .The percentage for those patients whom their duration were less than 5 years were (60.38%) while for equal to or more than 5 years duration were (39.62%).

Table 1: Distribution of UTIs among diabetic patients (males and females).

Diabetic Patients	Male No. (%)	Female No. (%)	Male and Female No. (%)
Positive UTI (Significant bacteriuria)	10 (17.24)	43 (46.74)	53 (35.33)
Negative UTI (Non-significant bacteriuria)	48 (82.76)	49 (53.26)	97 (64.67)
Total	58	92	150

Significant difference between males and females, (P<0.01), X^2 =13.55, p-Value =0.002

Table 2: Distribution of age among UTI diabetic patients (males and females)

Diabetic Patients	Age groups (years) 17-30		31-40		41-50		51-60		≥61		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Positive UTI	4	36.36	6	46.15	22	41.50	14	32.56	7	23.33	53	35.33
Negative UTI	7	63.64	7	53.85	31	58.50	29	67.44	23	76.67	97	64.77
Total	11		13		53		43		30		150	

No significant difference between different age groups, X^2 =3.59, p-value=0.46

Table 3: Relation between level of proteinuria and UTI among diabetic patients

Diabetic Patients	+ve proteinuria		-ve proteinuria		Total	
	No.	%	No.	%	No.	%
Positive UTI	25	50	28	28	53	35.33
Negative UTI	25	50	72	72	97	64.67
Total	50		100		150	

Significant difference (P<0.01) between positive and negative proteinuria levels in diabetic patients, X^2 =7.06, p-value=0.007

Table 4: Hypertension with UTI among male diabetic patients.

Diabetic Patients	Hypertensive		Non-Hypertensive		Total	
	No.	%	No.	%	No.	%
Positive UTI	6	28.57	4	10.81	10	17.24
Negative UTI	15	71.43	33	89.19	48	82.76
Total	21		37		58	

No significant difference between hypertensive and non- hypertensive males, X^2 =2.96, p-value=0.08

Table 5: Numbers and percentages of the type of microorganisms cause UTI in diabetic patients**.**

Etiology of UTI	No.	%
Escherichia coli	24	45.28
Klebsiella pneumoniae	8	15.10
Staphylococcus saprophyticus	8	15.10
Citrobacter diversus	6	11.32
Candida albicans	4	7.54
Staphylococcus aureus	3	5.66
Total	53	100

Table 6: Duration of diabetes mellitus with type of microorganisms in males and females

Etiology of UTI in diabetic patients	Duration of diabetes mellitus (years)					
	<5 years		≥5 years		Total	
	No.	%	No.	%	No.	%
Escherichia coli	13	40.62	11	52.38	24	45.28
Klebsiella pneumoniae	8	25.00	0	0	8	15.10
Staphylococus saprophyticus	3	9.38	5	23.81	8	15.10
Citrobacter diversus	3	9.38	3	14.29	6	11.32
	2	6.25	2	9.52	4	7.54
Candida albicans	3	9.38	0	0	3	5.66
Staphylococcus aureus	32	60.38	21	39.62	53	100
Total						

No significant difference between the duration and type of microorganisms, X^2 =9.80, p-value=0.08

Discussion

Several different factors accompanied with UTIs are thought to be linked with diabetic patients. The results of this study showed that among these factors; gender, age, proteinuria and hypertension are likely to be the most effective factors. These factors are totally varies in their occurrences comparing with people who are non-diabetic. Therefore, it is necessary to shed a light upon each single factor in order to estimate, in details, the correlation between three parameters which are forming a "triangle of events" factor, UTIs and DM. As mentioned in many studies, women are more prone to UTI compared with men [5]. Different groups of diabetic and non-diabetic participants showed that UTIs women are forming higher ratio, whereas the lowest was for men. Women infected with UTI via different ways including anatomical and behavioral, Table1. In previous works [4], the most convenient susceptible age of UTI in diabetic patients was below 44 years old. Yass *et al* [5], have found that the susceptible age for UT infection was between 10-30 in males and over 51 in females (both were non-diabetics). Other signs indicate to other condition such as age over 65 years old. A matter indicates that age is not exerting a dramatic influence neither in UTI nor in DM, Table2. Another factor which has been proposed as constitutes an enhanced risk of UTI in diabetics includes proteinuria. Proteinuria is a sign for chronic kidney disease (CKD). Therefore, the relation between proteinuria level and UTI may help diagnosis. It may lead to CKD or as a preliminary stage of its occurrence. Based on data obtained in this work, proteinuria was significantly high in diabetic patients with UTI. This indicates that those patients might be considered to be within their way to have CKD. That means they are moving toward further development of getting kidney failure. In this case, diabetics are required to be under regular control of their proteinuria and follow a proper method of treatment and

Precaution, Table3. On other side, the present work indicated that diabetic men with UTI were showed different rates of hypertension, compared with non-hypertension (28.57% and 10.81%, respectively). A matter reflexes the fact that conjugated influences of both UTI and DM together are in tendency of creating hypertension. Although the result was not significant, but it was very close to the significance (P = 0.08), Table 4. The non-significance occurrence may be related to certain factors such as the different duration time of infection or whether those participants were under medical treatment or other factor which needs further study. This was totally different with data obtained for women which showed insignificant result. Many works indicate that *Escherichia coli* are the most common uropathogen [5]. Bacteria colonizing the perineum and vagina can enter the bladder and further ascend to the kidney. The essential step in the pathogenesis of UTIs is the adherence of uropathogens to the bladder mucosa. Adhesins are therefore important virulence factors. Although virulence factors have been characterized best in *E. coli* (the most common uropathogen), but many of the same principles may be applicable to other uropathogens; for example *Klebsiellae*[16]. The present study showed different uropathogens with different percentages, Table 5. Ineffectual influence is also may depends upon the physiological state of the patient. In other parameters, measuring the influence of the duration of DM, the effect of the type of DM with UTIs, No significant results obtained, which indicate no effect being noticed. But it is worth to mention that the results obtained from the relation between duration of DM with the type of causal microorganisms were close to be significant (P = 0.08), 60.38% for patients whom their duration was less than 5 years and 39.62% for those whom their duration was equal or more than 5 years, Table 6. Therefore, we can realize an expected effect due to a possible circumstance such as the physiological state of the patients.

Recommendation

Since diabetic patients were more susceptible to get UTIs (specially in women), they should be advised for controlling their level of blood glucose and make regular attendance to the specialized health center, and be aware of healthy habits.

References

1. Hooton TM, Stamm WE. Diagnosis and treatment of uncomplicated urinary tract infection. Infect Dis Clin North AM 1997: 11(3):551-81.
2. Barnett BJ, Stephens DS. Urinary tract infection: an overview. Am J Med Sci 1997; 314(4):245-9.
3. Johnson JR, Roberts PL, Stamm WE. P fimbriae and other virulence factors in *Escherichia coli* urosepsis: association with patients' characteristics. J Infect Dis 1987; 156(1):225-9.
4. Nicolle LE, Fries D, Harding GK, Roos LL. Hospitalization for acute pyelonephritis in Manitoba, Canada, during the period from 1989 to 1992, impact of diabetes, pregnancy, and aboriginal origin. Clin Infect Dis 1996; 22(6):1051-6.
5. Yass MA, Ali SS, Ahmed AA. ABO-Rh blood groups and type of food are amongst urinary tract infection causatives. Zanco J Med Sci 2012: 16 (1):71-77.
6. Zhanel GG, Harding GK, Nicolle LE. Asymptomatic bacteriuria in patients with diabetes mellitus. Rev Infect Dis 1991; 13(1):150-4.
7. Forland M, Thomas V, Shelokov A. Urinary tract infections in patients with diabetes mellitus. Studies on antibody coating of bacteria. JAMA 1977; 238 (18): 1924- 6.
8. Paterson JE, Andrriole VT. Bacterial urinary tract infection in diabetes. Infect Dis Clin North Am 1997; 11(3):735-50.
9. United States Renal Data System. USRDS 2007 Annual Data Report. Bethesda, MD: National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, U.S. Department of Health and Human Services; 2007.
10. Simerville JA, Maxted WC, Pahira JJ. Urinalysis: a comprehensive review. Am Fam Physician 2005; 71:1153-62.
11. Stamm WE, Hooton TM. Management of urinary tract infections in adults. N Engl J Med 1993; 329:1328-34.
12. Tomson C. Urinary tract infection. In: Warrell DA, Cox TM, Firth JD, Benz EJ Jr, editors. Oxford Textbook of Medicine. 4th ed. Oxford, UK: Oxford University Press; 2003:420-33.
13. Pacurari A, Serban C, Narita A, Romosan I. Is urinary tract infection a risk factor for hypertension in elderly? J Hypertens, 2010; 28: P e512.
14. Geerlings SE, Stolk RP, Camps MJL, et al. Asymptomatic bacteriuria may be considered a complication in women with diabetes. Diabetes Care, 2000; 23(6): 744-9.
15. Wheat LG. Infection and diabetes mellitus. Diabetes Care.1980; 3(1):187-97.
16. Hoepelman IM, Meiland R, Geerling SE. Pathogenesis and management of bacterial urinary tract infections in adult patients with diabetes mellitus. Int J Antmicrob Agents, 2003; 22: S35-S43.