Bacterial and Fungal Infections Among Diabetics

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ABSTRACT. One hundred and fifty specimens were collected from diabetic patients suffering from infections over a period of 9 months. Urine was the most frequently collected specimen from diabetic patients (50%) followed by foot swabs (24%), tracheal aspiration and sputum (12.7%), blood (6.7%), vaginal swabs (3.3%), and eye swabs and each stool represented 1.3%. A wide variety of gram-negative bacteria representing 12 different species were identified as the etiologic agents of infections in these specimens. Clearly, *E. coli* dominated over all the other species. Among the 150 microbes causing infections in diabetic patients, a total of 40 (26.7%) were identified as *E. coli*. *Pseudomonas aeruginosa* were the second bacterial species causing infections. They were isolated from 20%, followed by *Klebsiella pneumoniae* (9.3%), and *Proteus mirabilis* (4.7%). *Salmonella, Enterobacter, Acinetobacter*, and *Citrobacter* were found in 2% of the cases. *Morganella* (1.3%) and *Serratia* were detected in less than 1%. Among gram-positive bacteria, S*taphylococci* were the most frequent organisms and were isolated from 20 (13.3%) specimens. Other gram-positive bacteria were *Streptococcus* (4%), *Enterococcus faecalis* (2%), *Micrococcus 2* (1.3%), and *Diphtheroids* were detected in less than 1%. *Candida albicans* and *Candida spp.* were isolated from 12 diabetic patients.

Keywords: Bacteria, Fungi, Diabetic patients.

Introduction

Diabetic patients are more susceptible to bacterial and fungal infections and urinary

tract infections (UTI) have long been recognized as a significant problem in patients with *Diabetes mellitus*. Studies documented a two-to-threefold increase in this problem in diabetic women[1]. Kass[2] documented a 16-19% rate of bacteriuria in diabetic women compared to 5-8% in non-diabetic women.

Diabetics also have an increased propensity to develop soft tissue infections. In patients with *Diabetes mellitus*, soft tissue and bone infection of the lower limbs is the most common cause for hospital admission[3]. The rate of lower extremity amputation among diabetics is more than 40 times that of non-diabetics[4].

Lower respiratory tract infections were common in diabetic patients and diabetes is often identified as an independent risk factor for developing these infections[5]. Although the mortality from infection has decreased with the advent of insulin therapy and broad spectrum antimicrobial agents, pneumonia remains a significant cause of morbidity in the diabetic patient[6]. The purpose of this study was to identify the most common organisms causing superficial and deep infections in Saudi diabetics.

Materials and Methods

One hundred and fifty different specimens were collected from diabetic patients (61 males and 89 females) from the King Khalid National Guard Hospital in Jeddah, Saudi Arabia, over a period of 9 months. The specimens were transported to the bacteriology laboratory in the Microbiology Department, Faculty of Medicine & Allied Sciences, King Abdulaziz University, Jeddah, Saudi Arabia, and were processed without delay.

Specimens except urine and stools were cultured in the following agar media: sheep blood, chocolate, and MacConkey & Sabouraud's dextrose agar.

Urine specimens were cultured in cystine lactose electrolyte deficient media (CLED) and MacConkey agar. Stool specimens were cultured in deoxycholate citrate agar (DCA), xylose lysine desoxycholate agar (XLD), and MacConkey.

The culture plates were incubated aerobically at 37°C (under 5% CO_2, chocolate blood agar) and examined at 24 and 48h. For anaerobic cultures, the specimens were inoculated onto blood agar containing kanamycin and vancomycin (75 µg/ml and 7.5 µg/ml, respectively). This media was incubated in Gas Pak (BBL) jars at 37°C and examined after 48 and 96h of incubation. Aerobic bacteria were identified according to standard methods[7]. Anaerobic bacteria were identified by techniques described previously[8].

Results

Distribution of Infections: In this study 150 specimens were collected from diabetic patients (61 males and 89 females) suffering from infections over a period of 9 months. Urine was the most frequently collected specimen from diabetic patients (50%) followed by foot swabs (24%), tracheal aspiration and sputum (12.7%), blood

(6.7%), vaginal swabs (3.3%), and eye swabs and each stool represented 1.3% (Table 1, Fig. 1).

TABLE 1. Distribution of organisms according to types of specimens among 150 diabetic patients.

Organism	Urine	Wound (Foot) Swab	Sputum	Blood	Eye Swab	Tracheal Aspiration	High Vaginal Swab	Stool	Total
E. coli	35	2	1	2	--	--	--	--	40
Staph. aureus	3	9	4	1	1	1	1	--	20
Pseudomonas	6	18	3	--	1	2	--	--	30
Klebsiella p.	9	--	4	--	--	1	--	--	14
Streptococcus	2	3	--	1	--	--	--	--	6
Acinetobacter	--	--	--	1	--	2	--	--	3
Enterobacter	1	2	--	--	--	--	--	--	3
Enterococcus	2	1	--	--	--	--	--	--	3
Morganella	1	--	--	1	--	--	--	--	2
Salmonella	1	--	--	--	--	--	--	2	3
Micrococcus	--	--	--	2	--	--	--	--	2
Diphtheroid	--	--	--	1	--	--	--	--	1
Serratia	1	--	--	--	--	--	--	--	1
Staph. waneri	--	--	--	1	--	--	--	--	1
Citrobacter	--	--	--	--	--	2	--	--	3
Proteus	6	1	--	--	--	--	--	--	7
Candida	8	--	--	--	--	--	4	--	12
Total Specimens	75	36	12	10	2	8	5	2	150

Bacterial Infections: The distribution of gram-negative bacterial species causing infections in diabetic patients is shown in Table 2. A wide variety of gram-negative bacteria representing 12 different species were identified as the etiologic agents of infections. Clearly, *E. coli* was predominant over all other species. Among the 150 microbes causing infections in diabetic patients, a total of 40 (26.7%) were identified as *E. coli*. The second bacterial species causing infections in diabetic patients was *Pseudomonas aeruginosa* isolated from 20% followed by *Klebsiella pneumoniae* (9.3%), and *Proteus mirabilis* (4.7%). *Salmonella, Enterobacter, Acinetobacter, Citrobacter* were found in two of the cases, *Morganella* (1.3%), and *Merratia* (<1%).

Among gram-positive bacteria, S*taphylococci* were the most frequent organisms encountered and were isolated from 20 (13.3%) of the specimens. Other gram-positive bacteria detected were: *Streptococci* (4%), *Enterococcus faecalis* (2%), *Micrococci* (1.3%), and *Diphtheroid* (<1%) (Table 2).

TABLE 2. Distribution of bacterial and fungal species isolated from different sites from 150 diabetic
patients.

Organism	Number of Strains (%)
E. coli	40 (26.7)
Pseudomonas aeruginosa	30 (20)
Staphylococcus aureus	20 (13.3)
Klebsiella pneumoniae	14 (9.3)
Proteus mirabilis	7 (4.7)
Streptococcus agalactica (beta haemolytic) group B	1 (0.7)
Streptococcus pyogenes (beta haemolytic) group A	4 (2.7)
Streptococcus (beta haemolytic) group G	1 (0.7)
Enterococcus faecalis	3 (2)
Enterobacter cloacae	2 (1.3)
Enterobacter sakazakii	1 (0.7)
Salmonella species	3 (2)
Micrococcus	2 (1.3)
Morganella morganii	2 (1.3)
Diphtheroids	1 (0.7)
Serratia marcescense	1 (0.7)
Staphylococcus waneri	1 (0.7)
Acinetobacter cloacae	3 (2)
Citrobacter diversus	1 (0.7)
Citrobacter freundii	1 (0.7)
Candida albicans	4 (2.7)
Candida tropicalis	2 (1.3)
Candida famata	2 (1.3)
Candida glabrata	2 (1.3)
Candida colliculosa	1 (0.7)
Candida parapsilosis	1 (0.7)
Total Specimens	150 (100%)

Fungal Infections: *Candida* were isolated from 12 (8%) diabetic patients. They
were identified as *Candida albicans* (2.7%), *Candida tropicalis* (1.3%), *Candida fam-
ata* (1.3%), *Candida glabrata* (1.3%), and *Candida colliculosa* and *Candida parapsilo-
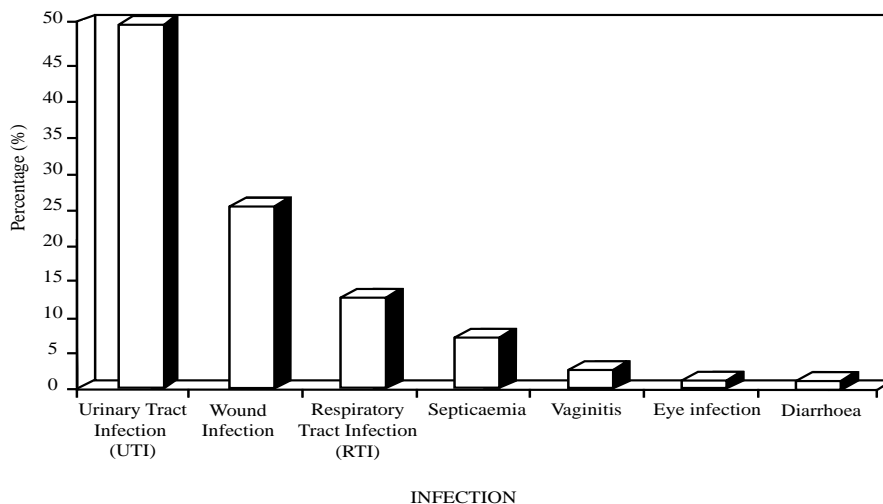sis* each were found in one of the cases (0.7%) (Table 2).

Fig. 1. Distribution of infections among 150 diabetic patients.

Discussion

Urinary tract infection (UTI) has long been recognized as a significant problem in patients with *Diabetes mellitus*. Variable rates of uncomplicated UTI in diabetics have been reported in studies performed since the advent of quantitative microbiology. Some early studies showed no difference between the frequency of UTI in diabetics compared to controls[9]. But more recent studies documented a two-to-threefold increase of this problem in diabetic women[10]. Kass[2] documented a 16-19% rate of bacteriuria in diabetic women compared to 5-8% in nondiabetic women.

In the present study we found that UTI were common in diabetic patients. UTI accounts for 50% of the infections (20% in males and 30% in females). Gram-negative bacteria was the most common bacterial pathogens isolated from diabetic patients with UTI (82%) (Table 2). *E. coli* caused the majority of UTI (46.7% followed in descending frequency with *Klebsiella pneumoniae* (12%); *Pseudomonas* and *Proteus* each accounting for 8%; and *Enterobacter, Salmonella, Serratia,* and *Morganella* each 1.35%. Previous studies have shown that *E. coli* is the most common bacterial cause of UTI in diabetics; other *Coli* forms such as *Klebsiella pneumoniae* and *Proteus mirabilis* also are common. Infections due to *Enterobacter spp., Enterococcus spp.,* and *Pseudomonas aeruginosa* should be considered in diabetics who are hospitalized or have had recent urologic procedures. *Enterobacter spp* infection has been observed to be mainly community acquired[11,12] and *Enterococcus spp* and *Pseudomonas aeruginosa* should be considered in patients in the community who have recently received antimicrobial agents. Diabetic patients were also prone to get urinary tract *Candidiasis*. These results showed that *Candidiasis* represented 10.7% of UTI.

Surveillance programs and several authors suggest an increase in *Candida* species as a cause of UTI[12,13]. Fisher *et al*[14] demonstrated that concomitant antibiotic administration, urinary tract instrumentation, and previous bacteriuria were significant risk factors for *Candiduria* in both catheterized and uncatheterized patients including diabetic patients.

Our data showed that foot infections among diabetic patients accounted for 24% of infection and came second to urinary tract infection. Studies showed that in patients with *Diabetes mellitus*, soft tissue and bone infection of the lower limbs is the most common indication for hospital admission[3]. Diaz-Colodrero *et al*[15] in Spain evaluated 31 diabetic patients hospitalized for severe foot infection and found that 56% of the cases were caused by gram-positive cocci (predominantly *Staphylococcus aureus* and *Enterococcus*) and 43% of the cases were caused by gram-negative *Bacilli*. Comparing this study, our result showed that *Staphylococci* and *Streptococci* account for 36.1% of the foot infections but gram-negative bacteria, in particular *Pseudomonas aeruginosa*, occur in 63.9% of the cases. However, the 63.9% of the gram-negative *Bacilli* isolated in our study was higher than that reported elsewhere (50%)[16,17,18].

Our study clearly showed that lower respiratory tract infections came after urinary tract and foot infections in rank and account for 8.7% as a common cause of infections.

Pneumonia remains a significant cause of morbidity in the diabetic patient. Gram-negative aerobes cause approximately 10-20% of all community-acquired *Pneumonia* and 60-80% of all nosocomial pneumonias[19]. The majority of *Pneumonias* caused by gram-negative aerobes in diabetic hosts are members of the *Enterobacteriaceae* family which include *E. coli, Enterobacter, Klebsiella spp.,* and *Serratia*, as well as, the pseudomonal species such as *Pseudomonas aeruginosa*[19]. This is in line with our finding that the majority of *Pneumonia* caused by gram-negative aerobes in diabetic patients were members of the *Enterobacteriaceae* family.

It is hoped that this data will give some guidance to physicians in the community who frequently have to deal with infections in diabetics. Thus, the micro-organisms isolated in this study should be targeted in any study in the future.

References

[1] **Forland M, Thomas V, Shelokov A.** Urinary tract infections in patients with *Diabetes mellitus*: Studies on antibody coating of bacteria. *JAMA* 1977; **238(18):** 1924-1926.

[2] **Kass EH.** Asymptomatic infections of the urinary tract. *Trans Assoc Am Physicians* 1956; **69:** 56-60.

[3] **Gibbons GW, Eliopoulos GM.** Infection of the diabetic foot. In: Kozak GO, Hoar CS, Rowbotham JL *et al*, eds. *Management of diabetic foot problems.* Philadelphia: W.H. Saunders, 1984: 97.

[4]   **Centers for Disease Control.** Lower extremity amputations among persons with *Diabetes mellitus--* Washington. *MMWR* 1991; **40:** 737-739.

[5]   **MacKowiak PA, Martin RU, Smith JW.** The role of bacterial interference in the increased prevalence of oropharyngeal gram-negative bacilli among alcoholics and diabetics. *Am Rev Respir Dis* 1979; **120(3):** 589-593.

[6]   **Younger D, Hadley WB.** Infection and diabetes. In: Marbie A, Whilte P, Bradley RF *et al*, eds. *Joslin's Diabetes mellitus, 11th edn.,* Philadelphia: Lea & Febiger, 1971; 621.

[7]   **Hawkey PM, Lewis DA (Editors).** *Medical bacteriology: a practical approach.* Oxford: IRL Press, 1989.

[8]   **Holdeman LU, Cato EP, Moore WEC (Editors).** *Anaerobe Laboratory Manual, 4th edition.* Virginia Polytechnic Institute and State University, Blacksburg, 1977.

[9]   **O'Sullivan DJ, Fitzgerald MG, Meynell MJ.** Urinary tract infection: a comparative study in the diabetic and general populations. *Br Med J* 1961; **1:** 786-792.

[10]   **Ooi BS, Chen BTM, Yu M.** Prevalence and site of *Bacteriuria* in *Diabetes mellitus. Post Grad Med J* 1974; **50(586):** 497-499.

[11]   **Mani S, Edberg SC, Patterson JE.** Community-acquired *bacteremia* due to multiresistent *Enterobacter bacteremia* in a patient with urosepsis. *Clin Inf Dis* 1992; **15(3):** 565-566.

[12]   **Frangos DM, Nyberg LM Jr.** Genito urinary fungal infections. *South Med J* 1986; **7(4):** 455-459.

[13]   **Stamm WE.** Catheter-associated urinary tract infections: epidemiology, pathogenesis and prevention. *Am J Med* 1991; **91(3B):** 655-751.

[14]   **Fisher JF, Chew WH, Shadomy S, Duma RJ, Mayhall CG, House WC.** Urinary tract infections due to *Candida albicans*. *Rev Infect Dis* 1982; **4(6):** 1107-1118.

[15]   **Diaz Colodrero G, Altclas J, Jasovich A, Mikaelian G, Fiks G, Caro E.** Microbiology and conservative surgery of serious infections of the diabetic foot. *Enterm Infecc Microbiol Clin* 1992; **10(8):** 451-455.

[16]   **Grayson ML, Gibbons GW, Habershaw GM, Freeman DV, Pomposelli FB, Rosenblum BI, Levine E, Karchmer AW.** Use of ampicillin/sulbactam versus imipenem/cilastatin in the treatment of limb-threatening foot infections in diabetic patients. *Clin Infect Dis* 1994; **18(5):** 683-693.

[17]   **Lipsky BA, Pecoraro RF, Larson SA, Hanley ME, Ahroni JH.** Out-patient management of uncomplicated lower-extremity infections in diabetic patients. *Arch Intern Med* 1990; **150(4):** 790-797.

[18]   **Peterson LR, Lissack LM, Canter K, Fasching CE, Clabot SC, Gerding DN.** Therapy of lower extremity infections with ciprofloxacin in patients with *Diabetes mellitus*, *Peripheral vascular disease*, or both. *Am J Med* 1989; **86(6Pt2):** 801-808.

[19]   **Scheld WM, Mandell GL.** *Nosocomial pneumonia*: pathogenesis and recent advances in diagnosis and therapy. *Rev Infect Dis* 1991; **13(Suppl 9):** S743-751.

البكتريا والفطريات المسببة للالتهابات في مرضى السكري

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المستخلص.   لقد تم جـمع ١٥٠ عينة من مرضى السكر خـلال مدة
الدراسـة (٦١ ذكر و٨٩ أنثى). وكانت عينات البـول هي أكثـر العينات
التي جُمعت خلال هذا البحث بنسبة (٥٠٪) تلتها المسحات المأخوذة من
الجهاز التنفسي (١٢٫٧٪) ثم عينات الدم (٦٫٧٪) ثم المسحات المهبلية
(٣٫٣٪) وأخيراً البراز والمسـحات المأخوذة من العين وكـلاهمـا بنسبة
(١٫٣٪). لقد تم عزل ١٢ نوعاً من البكتريا سالبة الجرام والتي تمثل نسبة
(٦٩٫٣٪) وكانت بكتريا شرشيات القولون آكثر الجراثيم المعزولة شيوعاً
(٢٦٫٧٪) تليها العصيات الكاذبة (٢٠٪) ثم بقية البكتريا سالبة الجرام
بترتيب تنازلي كـالتالي: الكلبسيات الرئوية (٩٫٣٪) والمتقلبات (٤٫٧٪)
ثم كـلاً من السـالمونيلا والأمعائيات وأسيتنو باكتر ،والبكتيريا المستترة
(٢٪) ثم المرجينييلات والمنشاريات بنسبة أقل من (١٪). آمـا بالنسبة
للبكتيريا الموجبة الجـرام (٢٢٫٧٪) فقد كـانت المكورات العنقـودية
البرتقالية أكثر الجراثيم المعزولة شيوعاً (٢٢٫٣٪) تليها المكورات السبحية
(٤٪) ثم بقية البكتريا موجبة الجرام بترتيب تنازلي كـالتالي: المكورات
العنقودية الأمعائية ثم المكورات الدقيقة (١٫٣٪) وأخيراً شبه عصيات
الدفتيريا في أقل من (١٪). آما بالنسبة للفطريات المسببة للإلتهابات في
مرضى السكر فقد وجد أن المسبب الأساسي لها هي المبيضات.