

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, *Staphylococci* 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

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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% CO₂, 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
<i>E. coli</i>	35	2	1	2	--	--	--	--	40
<i>Staph. aureus</i>	3	9	4	1	1	1	1	--	20
<i>Pseudomonas</i>	6	18	3	--	1	2	--	--	30
<i>Klebsiella p.</i>	9	--	4	--	--	1	--	--	14
<i>Streptococcus</i>	2	3	--	1	--	--	--	--	6
<i>Acinetobacter</i>	--	--	--	1	--	2	--	--	3
<i>Enterobacter</i>	1	2	--	--	--	--	--	--	3
<i>Enterococcus</i>	2	1	--	--	--	--	--	--	3
<i>Morganella</i>	1	--	--	1	--	--	--	--	2
<i>Salmonella</i>	1	--	--	--	--	--	--	2	3
<i>Micrococcus</i>	--	--	--	2	--	--	--	--	2
<i>Diphtheroid</i>	--	--	--	1	--	--	--	--	1
<i>Serratia</i>	1	--	--	--	--	--	--	--	1
<i>Staph. waneri</i>	--	--	--	1	--	--	--	--	1
<i>Citrobacter</i>	--	--	--	--	--	2	--	--	3
<i>Proteus</i>	6	1	--	--	--	--	--	--	7
<i>Candida</i>	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, *Staphylococci* 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 (%)
<i>E. coli</i>	40 (26.7)
<i>Pseudomonas aeruginosa</i>	30 (20)
<i>Staphylococcus aureus</i>	20 (13.3)
<i>Klebsiella pneumoniae</i>	14 (9.3)
<i>Proteus mirabilis</i>	7 (4.7)
<i>Streptococcus agalactica</i> (beta haemolytic) group B	1 (0.7)
<i>Streptococcus pyogenes</i> (beta haemolytic) group A	4 (2.7)
<i>Streptococcus</i> (beta haemolytic) group G	1 (0.7)
<i>Enterococcus faecalis</i>	3 (2)
<i>Enterobacter cloacae</i>	2 (1.3)
<i>Enterobacter sakazakii</i>	1 (0.7)
<i>Salmonella</i> species	3 (2)
<i>Micrococcus</i>	2 (1.3)
<i>Morganella morganii</i>	2 (1.3)
<i>Diphtheroids</i>	1 (0.7)
<i>Serratia marcescense</i>	1 (0.7)
<i>Staphylococcus wani</i>	1 (0.7)
<i>Acinetobacter cloacae</i>	3 (2)
<i>Citrobacter diversus</i>	1 (0.7)
<i>Citrobacter freundii</i>	1 (0.7)
<i>Candida albicans</i>	4 (2.7)
<i>Candida tropicalis</i>	2 (1.3)
<i>Candida famata</i>	2 (1.3)
<i>Candida glabrata</i>	2 (1.3)
<i>Candida colliculosa</i>	1 (0.7)
<i>Candida parapsilosis</i>	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 famata* (1.3%), *Candida glabrata* (1.3%), and *Candida colliculosa* and *Candida parapsilosis* each were found in one of the cases (0.7%) (Table 2).

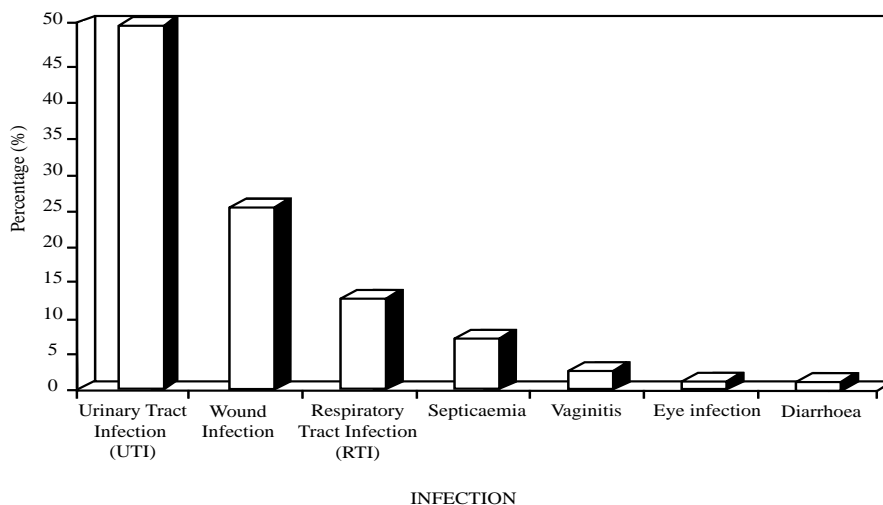


Fig. 1. Distribution of infections among 150 diabetic patients.

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.

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البكتريا والفطريات المسببة للالتهابات في مرضى السكري

سليمان الشيخ و أيمن جوهرجي

قسم الكائنات الدقيقة ، كلية الطب والعلوم الطبية ، جامعة الملك عبدالعزيز ، جدة ،
وقسم الكائنات الدقيقة ، جامعة أم القرى ، مكة المكرمة ، المملكة العربية السعودية

المستخلص. لقد تم جمع ١٥٠ عينة من مرضى السكر خلال مدة الدراسة (٦١ ذكر و٨٩ أنثى). وكانت عينات البول هي أكثر العينات التي جمعت خلال هذا البحث بنسبة (٥٠٪) تلتها المسحات المأخوذة من الجهاز التنفسي (٧، ١٢٪) ثم عينات الدم (٧، ٦٪) ثم المسحات المهبلية (٣، ٣٪) وأخيراً البراز والمسحات المأخوذة من العين وكلاهما بنسبة (٣، ١٪). لقد تم عزل ١٢ نوعاً من البكتريا سالبة الجرام والتي تمثل نسبة (٣، ٦٩٪) وكانت بكتريا شرشيات القولون أكثر الجراثيم المعزولة شيوياً (٧، ٢٦٪) تليها العصيات الكاذبة (٢٠٪) ثم بقية البكتريا سالبة الجرام بترتيب تنازلي كالتالي: الكلبيات الرئوية (٣، ٩٪) والمتقلبات (٧، ٤٪) ثم كلاً من السالمونيلا والأمعائيات وأسيتنوباكتريا، والبكتيريا المستترة (٢٪) ثم المرجينييلات والمنشاريات بنسبة أقل من (١٪). أما بالنسبة للبكتيريا الموجبة الجرام (٧، ٢٢٪) فقد كانت المكورات العنقودية البرتقالية أكثر الجراثيم المعزولة شيوياً (٣، ٢٢٪) تليها المكورات السبحية (٤٪) ثم بقية البكتريا موجبة الجرام بترتيب تنازلي كالتالي: المكورات العنقودية الأمعائية ثم المكورات الدقيقة (٣، ١٪) وأخيراً شبه عصيات الدفتيريا في أقل من (١٪). أما بالنسبة للفطريات المسببة للالتهابات في مرضى السكر فقد وجد أن المسبب الأساسي لها هي المبيضات.