Original Article

Incidence of bacterial and fungal infections among infected diabetic patients

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العدوى البكتيرية والفطرية في مرضى السكري
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أستاذ مساعد الكائنات الدقيقة الطبية الجزيئية, قسم الكائنات الدقيقة الطبية بكلية الطب بجامعة أم القرى.

الملخص العربي

الخلفية العلمية: المرضى المصابين بداء السكري أكثر عرضة للإصابة بمختلف الأمراض البكتيرية والفطرية من غير المرضى بداء السكري. و يعزى ذلك إلى العديد من عوامل الخطر الناجمة عن السكري مثل تشوهات الأوعية الدموية والأعصاب و اعتلال الكلية وتأخر التئام الجروح ونقص المناعة.
الهدف من البحث: يهدف هذا البحث إلى معرفة أكثر الأمراض البكتيرية والفطرية التي تصيب مرضى السكري بالعدوى.
الطرق: تم تجميع مائة وتسعة وثلاثون عينة في هذا البحث من مرضى السكري خلال عام كامل من مستشفيات مختلفة من مدينتي مكة وجدة بالمملكة العربية السعودية وتم فحص هذه العينات مخبريا باستخدام الطرق القياسية المستخدمة في الإحياء الدقيقة الطبية.
النتائج: من المائة وتسعة وثلاثون عينة التي تم جمعها من مرضى السكري المصابين بالعدوى في هذه الدراسة كانت الإصابات أكثر شيوعا في الإناث (53.2 ٪) من الذكور (46.8 ٪)، وفي الفترة العمرية 51-70 سنة (45.3 ٪) وكانت الإصابة بالعدوى البكتيرية أكثر شيوعا (92.8 ٪) من العدوى الفطرية (7.2 ٪) وشملت الإصابات: التهابات القدم السكري (40.3 ٪)، والتهابات المسالك البولية (20.1 ٪)، والتهابات الجهاز التنفسي (16.5 ٪)، والتهابات الجلد (10.8 ٪) ، وتسمم الدم (10.1 ٪)، والتهابات الجهاز التناسلي (1.4 ٪) والتهابات العين (0.7 ٪). وكانت أكثر الجراثيم المعزولة من مرضى السكري المصابين بالعدوى هي بكتريا اي كولاي (19.4 ٪) ، والمكورات العنقودية الذهبية (18.7 ٪). ا كما أظهرت الدراسة أن المبيضات كانت هي الأكثر شيوعا من بين الفطريات المعزولة في مرضى السكري المصابين.بالعدوى في هذه الدراسة.

الاستنتاجات : أظهرت هذه الدراسة أن العدوى بين مرضى السكري كانت أكثر شيوعا في الإناث من الذكور و في الفترة العمرية 51-70 سنة. بالإضافة إلى ذلك ، كان مرضى السكري أكثر عرضة للإصابة بالعدوى البكتيرية من العدوى الفطرية.

ABSTRACT

Background: Patients with diabetes are more vulnerable to various bacterial and fungal infections than non-diabetic patients. This may be attributable to many risk factors resulting from diabetes such as; vascular abnormalities, neuropathy, nephropathy, delayed wound healing and immune depression.

Aim: the aim of the current study was to determine the most common bacterial and fungal infections among infected diabetic patients.

Methods: One hundred and thirty nine different specimens were collected over a period of one year from diabetic patients from different hospitals in Makkah and Jeddah cities of Saudi Arabia. The collected specimens were cultured and identified using standards microbiological methods.

Results: Out of the 139 specimens collected from infected diabetic patients in the present study the infections were more common in female (53.2%) than male (46.8%), and in the age period 51-70 years (45.3%). The detected infections among infected diabetic patients were (92.8%) bacterial infections and (7.2%) fungal infections and included diabetic foot infections (40.3%), urinary tract infections (20.1%), respiratory tract infections (16.5%), skin infections (10.8%), septicaemia (10.1%), genital tract infections (1.4%) and eye infection (0.7%). The isolated organisms from those infected diabetic patients were commonly *Escherichia coli* (19.4%) and *Staphylococcus aureus* (18.7%). This study also showed that *Candida species* were the most common fungi among infected diabetic patients.

Conclusions: This study showed that the infections among diabetic patients were more common in female than male and in the age period 51-70 years. In addition, infected diabetic patients were more susceptible to bacterial infections than fungal infections.

*Keywords***:** *Diabetes, Infections, Bacteria, Fungi*

INTRODUCTION

D iabetic patients are more susceptible to infections than normal individual[1]. This may be attributable to many factors which resulting from diabetes especially in conditions of poor glycaemic control and long duration of diabetes.

Infections contributed factors are such as; vascular abnormalities, neuropathy, nephropathy and delayed wound healing[2,3]. The vascular abnormalities especially microvascular may lead to organ dysfunction[4].

In addition, the immune depression has essential role in increasing the susceptibility of infections among diabetic patients. This depression in immunity can be showed by impaired leukocyte function, decrease T cell–mediated immune response, reduced chemotaxis releasing and failure of neutrophils and macrophages migration to the affected area.
All of these risk factors can be accelerated with increasing of metabolic abnormalities of diabetes[5].

Furthermore, there are other factors at the cellular level, which might increase the risk of infections, these include; increase in the number of acute inflammatory cells, absence of cellular growth and some cellular changes[3].

Treatment of any infection in diabetic patients is more difficult than non-diabetic ones especially when there is poor glycaemic control[4].

Although various infections can affect diabetic patients, the following infections are more commonly seen in diabetic patients and include; skin and wound infections[3] (like foot infection[6], cellulites[7], erysipelas[8], gas gangrene[9], and necrotizing fasciitis[10]), urinary tract infections[11], respiratory tract infections[12], genital tract infections[13] and septicaemia.[14]

In this study, we have evaluated the most common bacterial and fungal infections among infected diabetic patients.

MATERIAL AND METHODS

Specimens collection
One hundred and thirty nine different specimens were collected over a period of one year from diabetic patients (74 males and 65 females) (106 Saudi and 33 non-Saudi) from different hospitals in Makkah city of Saudi Arabia (81 samples in total) including: King Abdulaziz Hospital (35 samples), King Faisal Hospital (30 samples), Ajyad General Hospital (6 samples), Hera General Hospital (6 samples), and Al-Noor Specialised Hospital (4 samples) and Jeddah city of Saudi Arabia (58 samples in total) cities including; King Fahad General Hospital (43 samples) and King Abdulaziz Medical City (15 samples).

Specimens handling
All specimens were delivered to the Microbiology laboratory of the Faculty of Medicine at Umm Al-Qura University and tested without delay.

Culture of the Specimens
Specimens except urine and stool were cultured in the following media: columbia blood agar, macConkey agar, chocolate agar and sabouraud dextrose agar.

Urine specimens were cultured in cystine electrolyte deficient media (CLED) and in a biplate; half containing MacConkey agar and the other half blood agar.

Stool specimens were cultured in deoxycholate citrate agar (DCA), xylose lysine desoxycholate agar (XLD), MacConkey media and *campylobacter* selective media (skirrows). The culture plates were incubated aerobically at 37ºC (under 5% CO_2, chocolate blood agar) (42ºC for *Campylobacter* selective media) and examined at 24 and 48 hour. For anaerobic cultures, the specimens were inoculated onto blood agar containing kanamycin and vancomycin (75 µg/ml and 7.5µg/ml, respectively). This media was incubated in Gas Pak (BBL) jars at 37ºC and examined after 48 and 96 hour of incubation. While, for fungal culture, the sabouraud dextrose plate were incubated for 1-2 weeks at 25º C.

Identification of culture
Bacterial and fungal growth in culture media were identified according to growth characteristics, colonial morphology, gram stain and proper biochemical tests. Aerobic bacteria and fungi were identified according to standard methods[15]. Anaerobic bacteria were identified by techniques described previously[16]. In addition, all positive cultures identifications were confirmed using VITEK II machine according to manufacturer's instructions.

Data analysis
Results were statistically analysed by calculating the mean, median, standard deviation, range and p value, using a Fisher test (Graph Pad Instat programme statistical software). P-values of less than 0.5 were considered significant.

RESULTS

Study samples description
One hundred thirty nine positive samples were identified in this study from infected diabetic patients, age range = 15-100 years, mean age = 61 years, median age = 61 years, mode age = 60 years and standard deviation of age = 15.6 years.
Most of the infected diabetic patients in our study were more than fifty years old (74.8%) and 25.2% of them were less than fifty years old and this difference was statistically extremely significant (p-value is <0.0001). (Table 1).

Table 1 Distribution of positive samples from infected diabetic patients according to age differences

Age period (per years)	<30	30-40	41-50	51-60	61-70	71-80	81-90	>90
Number of positive samples	4 (2.9%)	10 (7.2%)	21 (15.1%)	33 (23.7%)	30 (21.6%)	26 (18.7%)	13 (9.4%)	2 (1.4%)

Distribution of infections among infected diabetic patients
Out of 139 positive samples collected in this study from infected diabetic patients, 129 (92.8%) were positive for bacterial growth and only 10 (7.2%) were positive for fungal growth. This difference was statistically extremely significant (p-value is <0.0001).
The most common infections found in diabetic patients in this study were diabetic foot infection 56 (40.3%) followed by urinary tract infection 28 (20.1%), respiratory tract infection 23 (16.5%), skin infection 15 (10.8%), septicaemia 14 (10.1%), genital tract infection 2 (1.4%) and eye infection 1 (0.7%) (Table 2).

Table 2 Distribution of infections among infected diabetic patients

Type of infections	Male	Female	Saudi	Non-Saudi	Total (%)
Diabetic foot infection	33 (58.9%)	23 (40.1%)	44 (78.6%)	12 (21.4%)	56 (40.3%)
Urinary tract infection	7 (25%)	21 (75%)	22 (78.6%)	6 (21.4%)	28 (20.1%)
Respiratory tract infection	12 (52.2%)	11 (47.8%)	18 (78.3%)	5 (21.7%)	23 (16.5%)
Skin infection	8 (53.3%)	7 (46.7%)	10 (66.7%)	5 (33.3%)	15 (10.8%)
Septicaemia	4 (28.6%)	10 (71.4%)	10 (71.4%)	4 (28.6%)	14 (10.1%)
Genital tract infection	0	2 (100%)	1 (50%)	1 (50%)	2 (1.4%)
Eye infection	1 (100%)	0	1 (100%)	0	1 (0.7%)
Total (%)	65 (46.8%)	74 (53.2%)	106 (76.3%)	33 (23.7%)	139 (100%)

Distribution of bacterial infections among infected diabetic patients
In this study, out of 129 (92.8%) bacterial positive samples identified from diabetic patients, 87 (67.4%) were positive for gram-negative bacteria and 42 (32.6%) were positive for gram-positive bacteria. This difference was statistically extremely significant (p-value is <0.0001). The most common isolated bacteria from diabetic patients in our study were *E. coli* (19.4 %) and *S. aureus* (18.7%). Other bacteria isolated from infected diabetic patients in this study are shown in (Table 3).

Table 3 Distribution of isolated bacteria from infected diabetic patients according to infection type

Bacteria	Diabetic foot infection	Urinary tract infection	Respiratory tract infection	Skin infection	Septicaemia	Genital tract infection	Eye infection	Total %)
Escherichia coli	14 (25.5%)	9 (40.9%)	0	1 (6.7%)	3 (21.4%)	0	0	27 (20.9%)
Staphylococcus aureus	13 (23.6%)	0	5 (23.8%)	5 (33.3%)	2 (14.3%)	0	1 (100%)	26 (20.2%)
Pseudomonas aeruginosa	8 (14.5%)	1 (4.5%)	3 (14.3%)	1 (6.7%)	2 (14.3%)	0	0	15 (11.6 %)
Klebsiella pneumoniae	3 (5.5%)	4 (18.2%)	3 (14.3%)	1 (6.7%)	2 (14.3%)	0	0	13 (10.1%)
Acinetobacter species	3 (5.5%)	1 (4.5%)	5 (23.8%)	2 (13.3%)	1 (7.1%)	1 (100%)	0	13 (10.1%)
Proteus mirabilis	3 (5.5%)	2 (9.1%)	2 (9.5%)	2 (13.3%)	0	0	0	9 (7%)
Enterococcus fecalis	2 (3.6%)	4 (18.2%)	1 (4.8%)	1 (6.7%)	0	0	0	8 (6.2%)
Staphylococcus epidermidis	0	0	1 (4.8%)	0	3 (21.4%)	0	0	4 (3.1%)
Morganella morganii	3 (5.5%)	0	0	0	0	0	0	3 (2.3 %)
Providencia stuartii	0	0	1 (4.8%)	1 (6.7%)	0	0	0	2 (1.6 %)
Streptococcus pyogenes	1 (1.8%)	0	0	0	0	0	0	1 (0.8%)
Proteus vulgaris	1 (1.8%)	0	0	0	0	0	0	1 (0.8%)
Staphylococcus hemolyticus	0	0	0	1 (6.7%)	0	0	0	1 (0.8%)
Klebsiella oxytoce	0	1 (4.5%)	0	0	0	0	0	1 (0.8%)
Enterococcus faecium	0	0	0	0	1 (7.1%)	0	0	1 (0.8%)
Enterobacter cloacae	1 (1.8%)	0	0	0	0	0	0	1 (0.8%)
Enterobacter aerogenes	1 (1.8%)	0	0	0	0	0	0	1 (0.8%)
Citrobacter koseri	1 (1.8%)	0	0	0	0	0	0	1 (0.8%)
Chromobacterium violaceum	1 (1.8%)	0	0	0	0	0	0	1 (0.8%)
Total (%)	55 (39.7%)	22 (15.8%)	21 (15.1%)	15 (10.8%)	14 (10.1%)	1 (0.7%)	1 (0.7%)	129 (92.8%)

Distribution of fungal infections among infected diabetic patients

Out of 10 (7.2%) fungal positive samples identified from diabetic patients in the current study, 5 (3.6%) were positive for *Candida species*, 4 (2.9%) were positive for *Candida albicans* and only 1 (0.7%) were positive for *Aspergillus species* (Table 4).

Table 4 Distribution of isolated fungi from infected diabetic patients according to infection type

Organism name	Diabetic foot infection	Urinary tract infection	Respiratory tract infection	Genital tract infection	Total (%)
Candida albicans	0	3 (50%)	0	1 (100%)	4 (40%)
Candida species	0	3 (50%)	2 (100%)	0	5 (50%)
Aspergillus species	1 (100%)	0	0	0	1 (10%)
Total (%)	1 (0.7%)	6 (4.3%)	2 (1.4%)	1 (0.7%)	10 (7.2%)

DISCUSSION

Diabetes is a worldwide disease that is not only considered as a chronic disease but also as a fatal disease. World health organisation estimated that diabetes affects more than 180 million people and leads to about 1.1 million deaths per year worldwide. In Saudi Arabia, the prevalence of diabetes is more than 24% of adult population[17]. Diabetes has long been suspected as a risk factor of infections so that diabetic patients are more susceptible to bacterial and fungal infections than normal individuals[1].

Bacterial infections are so far more prevalent than fungal infections to infect the normal people and diabetic patients worldwide. From those bacteria, *S. aureus*, *Enterococcus species*, and *Streptococci group B* are frequently the most isolated gram-positive bacteria while E. *coli*, *Pseudomonas aeruginosa* and *Proteus mirabilis* are frequently the most isolated gram-negative bacteria[18].

In agreement with Abdulrazak *et al*[18] findings, bacterial infections among infected diabetic patients were 13 times more prevalent than fungal infections in our study (92.8%) versus (7.2%). In addition, the most common isolated organisms from diabetic patients in this study were *E. coli* (19.4%) and *S. aureus* (18.7%).

In the current study, the most common infection found in diabetic patients was foot infection (40.3%). This was in accordance to Hirsch *et al*[3] findings whom reported that wound infection (in particular foot wound infection) considers the major infection in diabetic patients that

affecting 25% of them. In addition, Frykberg *et al*[19] reported that diabetic foot infection is the major source of morbidity and the leading cause of hospitalisation for diabetic patients.

Rathur and Boulton[20] stated that diabetic foot infection affects men more than women, which was in agreement with findings of this study, where 58.9% of diabetic foot infections were from male patients and 40.1% were from female patients.

In the current study, 98.2% of diabetic foot infections were of bacterial origin in which *E. coli* formed 25.5% of infection followed by *S. aureus* (23.6%) and *Pseudomonas aeruginosa* (14.5%). In contrast to the finding of this study, Hirsch *et al.*[3] found that the most common causative organism of diabetic foot infection is *S. aureus*. Abdulrazak *et al*[18] reported that *Pseudomonas aeruginosa* is one of the common bacterial causes of diabetic foot infection which is in agreement with our finding.

In the other hand, 1.8% of diabetic foot infections in this study were of fungal origin, and the only isolated fungi were *Aspergillus species*. This was in contrast to Abdulrazak *et al.*[18] whom reported that *Candida species* are the most common fungal causative agents of foot infection.

Skin infections other than diabetic foot infections are also common in diabetic patients such as; cellulitis, necrotizing fasciitis and others[8,9]. In the present study, skin infections other than foot infections constituted 10.8% of all infections among infected diabetic patients, and 33.3% were caused by *S. aureus*. This was in accordance to several studies[7-9] which reported that *S. aureus* is the main cause of skin infection among diabetic patients.

After diabetic foot infection, urinary tract infection (UTI) was the second most prevalent infection among infected diabetic patients in this study (20.1%). This was in accordance to Geerlings *et al.*[11] findings whom reported that UTIs are highly prevalent and more complicated among diabetic patients.

In addition, Geerlings *et al.*[11] found that UTIs are more common in female than male, which was in agreement with findings of this study, where 75% of diabetic patients with UTIs were female and 25% of diabetic patients with UTIs were males.

In the present study, 78.6% of UTIs among infected diabetic patients were of bacterial origin where *E. coli* constituted 40.9% of them followed by *Klebsiella pneumoniae* and *Enterococcus fecalis* (18.2%) for each. In accordance to findings of this study, several studies[11,21,22] found that the most common causative bacterial agents of UTIs among diabetic patients were *E. coli*, *Klebsiella pneumoniae* and *Enterococcus fecalis* .

For fungal UTI among diabetic patients, several studies[11,21,22] reported *Candida albicans* as a common causative fungus. This was in agreement with findings of this study where *Candida albicans* (50%) and *Candida species* (50%) were the causative fungal agents of UTIs among infected diabetic patients.

Respiratory tract infections (in particular lower respiratory tract infections) considered one of the common infections seen in diabetic patients[5].

In agreement to Muller *et al.*[5] findings, respiratory tract infections were found to be the third most common infection among infected diabetic patients in this study (16.5%). For these respiratory tract infections, 91.3% of them were of bacterial origins where *S. aureus* constituted the most common causative bacteria (23.8%) followed by *Pseudomonas aeruginosa* and *Klebsiella pneu*moniae (14.3%) for each. Worth noting that *Acinetobacter species* found to be more common among infected diabetic patients with respiratory tract

infections acquired from hospital through intensive care units (23.8% of respiratory tract infections in this study were due to *Acinetobacter species*) which was in agreement with Kuo *et al.*[23]

For fungal respiratory tract infections, 8.7% of respiratory tract infections among diabetic patients in this study were due to fungal infections and *Candida species* were the only fungi isolated in these cases.

Septicaemia is one of most common leading cause of death among diabetic patients. It is mostly caused by *S. aureus*, *E. coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*[4,14]. In accordance to the above-mentioned studies, septicaemia or specifically bacteraemia was the fourth most common infection among infected diabetic patients in this study (10.1%). Bacteraemia was mostly caused by *E. coli* (21.4%) and *S. epidermidis* (21.4%) followed by *S. aureus*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* (14.3%) for each.

In the current study, only two (1.4%) infections among infected diabetic patients were genital infections, caused by *Candida albicans* and *Acinetobacter* baumannii and both of them were in female patients. This was in agreement with several studies which reported that genital infections among diabetic patients are more commonly seen in female than in male and they mainly caused by *Candida*, *Chlamydia trachomatis*, *Neisseria gonorrhoea* and *Streptococci viridans*[13,24,25].

Other infection found in diabetic patients in the current study was eye infection, in which one Saudi diabetic male patient suffered from eye infection that caused by *S. aureus*.

CONCLUSIONS

In conclusion**,** this study showed that the infections among diabetic patients were more common in female than male and that diabetic patients were at high risk to infections in the age period 51-70 years. In addition, infected diabetic patients were more susceptible to bacterial infections than fungal infections and that the most common bacteria isolated from infected diabetic patients were *E. coli* and *S. aureus* while the most common fungi isolated from them was *Candida*. Furthermore, the most common types of infections found among infected diabetic patients were diabetic foot infections followed by UTI and respiratory tract infection .

It is hoped that the results obtained from this study will be of great benefits to physicians who frequently deal with diabetic patients in their proper identification and diagnosis of bacterial and fungal infections.

As a recommendation from this study, we recommend extending this project to cover different regions and cities of Saudi Arabia to give a broader picture about the situation of bacterial and fungal infections among diabetic patients. In addition, we may recommend adding viral and parasitic causes of such infections
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ACNOWLEGMENT

REFERENCES

1. Jackson, L. A. Evaluating diabetes mellitus as a risk factor for community-acquired infections. Clinical Infectious Diseases 2005; 41(3): 289-290.

2. Bonadio, M., Boldrini, E., Forotti, G., et al. Asymptomatic bacteriuria in women with diabetes: influence of metabolic control. Clinical Infectious Diseases 2004; 38(6): e41-e45,

3. Hirsch, T., Spielmann, M., Zuhaili, B., et al. Enhanced susceptibility to infections in a diabetic wound healing model. BMC Surgery 2008; 8(5): 1-8.

4. Moutzouri, A. G., Athanassiou, G. A., Dimitropoulou, D., Skoutelis, A. T. and Gogos, C. A. Severe sepsis and diabetes mellitus have additive effects on red blood cell deformability. Journal of Infection: 2008; 1-5.

5. Muller, L. M., Gorter, K. J., Hak, E., et al. Increased risk of common infections in patients with type 1 and type 2 diabetes mellitus. Clinical Infectious Diseases 2005; 41(3): 281-288,

6. Burke, A. Cunha. Diabetic Foot Infection. Retrieved 10 May 2011 from eMedicine; .

7. Eron, L. J. and J. A. Burns. Cellulitis and the Role of the Clinical Microbiology Laboratory. Clinical Microbiology Newsletter 2007; 29(20): 151-158

8. Pereira, D., Galacini, M., Yoshino, R., Marinelli, B., Foroni, C. Epidemiological data and co morbidities of 428 patients hospitalized with erysipelas. Angiology 2010;.;61(5):492-4,

9. Brook, I. Microbiology and management of soft tissue and muscle infections. International Journal of Surgery: 2007; 1-9

10. Shimizu, T. Tokuda Y. Necrotizing fasciitis. Intern Med. ; 2010;49(12):1051-7.

11. Geerlings, S. E. Urinary tract infections in patients with diabetes mellitus: epidemiology, pathogenesis and treatment. Int J Antimicrob Agents 2008; 31(1 Suppl):S54-S57.

12. Kornum, J. B., Thomsen, R. W., Riis, A., et al. Type 2 diabetes and pneumonia outcomes: a population-based cohort study. Diabetes Care 2007; 30(9): 2251-2257.

13. Haggerty, C. L., Hillier, S. L., Bass, D. C. and Ness, R. B. Bacterial vaginosis and anaerobic bacteria are associated with endometritis. Clinical Infectious Diseases2004; 39(7): 990-995

14. Gaidelyte, A., Vaara, M. and Bamford, D. H. Bacteria, phages and septicemia. PLoS ONE 2007;2(11): 1-5

15. Hawkey PM, Lewis DA (Editors). Medical bacteriology: a practical approach. Oxford: IRL Press,1989.

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

17. Alqurashi, K., Aljabri, K., Bokhari, S. Prevalence of diabetes mellitus in a Saudi community. Ann Saudi Med. 2011; 31(1):19-23

18. Abdulrazak, A., Bitar, Z. I., Al-Shamali, A. A. and Mobasher, L. A. Bacteriological study of diabetic foot infections. Journal of Diabetes and Its Complications 2005;19(3): 138-41,

19. Frykberg, R. G., Zgonis, T., Armstrong, D. G., et al. Diabetic foot disorders. A clinical practice guideline. Journal of Foot Ankle Surgery 2006; 45(5 Suppl): S1-S66.

20. Rathur, H. M. and Boulton, A. J. The diabetic foot. Clinical Dermatology 2007; 25(1): 109-120.

21. Chen, L, Jackson, L, Boyko, J. Diabetes mellitus and urinary tract infection: epidemiology, pathogenesis and proposed studies in animal models. J Urol.; 2009;182(6 Suppl):S51-6.

22. Sobel, J, Fisher, J, Kauffman, CA, Newman, A. Candida urinary tract infections-- epidemiology. Clin Infect Dis.;52 Suppl 2011; 6:S433-436.

23. Kuo, L. C., Yu, C. J., Kuo, M. L., et al. Antimicrobial resistance of bacterial isolates from respiratory care wards in Taiwan: a horizontal surveillance study.Int J Antimicrob Agents 2008;31(5): 420-426.

24. Miller, K. E. Diagnosis and treatment of Chlamydia trachomatis infection.   Am Fam Physician 2006; 73(8): 1411-1416.

25. Lattif A. Molecular typing and in vitro fluconazole susceptibility of Candida species isolated from diabetic and nondiabetic women with vulvovaginal candidiasis in India. J Microbiol Immunol Infect.; 2011; 44(3):166-71.