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Bacterial Isolates from Diabetic Foot Ulcer with Antibiotic Sensitivity Pattern

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Abstract

A cross-sectional, descriptive study was carried out in the Department of Surgery, Mymensingh Medical College Hospital, Mymensingh, Bangladesh, between October 2014 and September 2015, to determine the microbiological profile and antibiotic susceptibility patterns of organisms isolated from diabetic foot ulcer. A total of 130 patients of diabetic foot ulcer were included in the study according to inclusion and exclusion criteria. Samples of pus were collected from those patients and sent for culture and sensitivity tests. Out of 130 cases, the highest number of patients 55(42.4%) were in 50-59 years age group. The mean age was 60.1±9.8 years. Most of the patients (70%) were male. 90(69.2%) samples yielded growth, while 40(30.8%) did not show any bacterial growth. Out of those 90 samples with growths, 112 bacteria were isolated. Of them, 59(52.7%) organisms were gram-positive, while 28(25%) were gram-negative and 25(22.3%) organisms were both gram-positive and gram-negative. Out of 59 gram-positive isolates, 35(59.3%) were *S. aureus*, 18(30.5%) were *Enterococci*, and 6(10.2%) were *Streptococci.* In 28 gram-negative isolates, 15(53.7%) were *E. coli*, 6(21.4%) were *Pseudomonas*, 4(14.2%) were *klebsiella*, and 3(10.7%) were *proteus*. Regarding antibiotic sensitivity, all gram-positive bacteria (100%) were sensitive to vancomycin. *S. aureus* was 80% sensitive to ceftriaxone, 71.4% to flucloxacillin, 65.7% to clavulanic acid, 54.2% to ampicillin, 48.5% to amoxicillin, and 28.5% to cotrimoxazole. *Enterococci spp*. was 61.1% sensitive to ceftriaxone, 33.3% to clavulanic acid, (27.7%) to ampicillin, and 16.6% to both amoxicillin and cotrimoxazole. *Streptococcus spp*. showed 83.3% sensitivity to ceftriaxone, 66.6% to flucloxacillin, 33.3% to clavulanic acid, and 16.6% to cotrimoxazole. Among gram-negative bacteria, *E. coli* was found to be sensitive to imipenem (100%), ceftriaxone (86%), amikacin (100%), cefuroxime (73.3%), ampicillin (33.3%), ciprofloxacin (60%), and gentamycin (60%). *Pseudomonas* was found to be sensitive to imipenem (50%), ceftriaxone (66.6%), amikacin (83.3%), and cefuroxime (66.6%). *Klebsiella* was found to be sensitive to imipenem (100%), ceftriaxone (75%), amikacin (75%), cefuroxime (50%), and ciprofloxacin (25%). *Proteus* was found to be sensitive to imipenem (100%), ceftriaxone (66.6%), amikacin (66.6%), cefuroxime (33.3%), ciprofloxacin (66.6%), and gentamycin (66.6%).

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Introduction

Diabetes mellitus (DM) is an epidemic disease worldwide, making it one of the most challenging health problems in the 21st century. Diabetic foot is defined as the foot of diabetic patients with ulceration, infection and/ or destruction of the deep tissues associated with neurological abnormalities and various degrees of peripheral vascular disease in the lower limb.[1] Diabetic foot is the most common complication of diabetes mellitus, and is greater than retinopathy, nephropathy, heart attack and stroke combined. A patient with diabetic foot has major negative effects on quality of life due to loss of mobility, loss of work and reduction of social activities. Diabetic foot infection in type 2 diabetes has male predominance and most of the patients are

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overweight, hyperglycemic having DM for more than 10 years. Ulcer is the most common presentation of diabetic foot. Neuropathic ulcers occur in 78.4% patients and the rest of the 22.6% had neuroischemic ulcers.[2] Foot ulcers are common in diabetic patients with prevalence of 25%.[3] Peripheral neuropathy clearly renders the patient victim to unrecognized injury, which potentiates the risk of bacterial invasion and infection.[4]

Diabetic foot infections are often polymicrobial. *Staphylococcus aureus* and *Pseudomonas aeruginosa* are the most common organisms responsible for diabetic foot infections.[5] Anaerobic organisms are also common causes of diabetic foot infection, but the prevalence is less.[6] Proper antibiotics according to culture and sensitivity should be used to management protocol.[7] Ceftriaxone, flucloxacillin are the most effective antibiotics for gram positive organisms.[8] Imipenem, meropenem, and ceftriaxone are the most effective agents against gram negative organisms.[9] Proper management of diabetic foot should be by multidisciplinary team approach.

Diabetic foot infection can be prevented. For the prevention of diabetic foot infection, good glycemic control, lifestyle modifications with proper feet cares like keeping their feet dry and clean while also keeping them moisturized and protection from injury that may cause infection.[10] Treatment of underlying disease processes, ensuring adequate blood supply, local wound care, infection control and pressure offloading are the essential components of diabetic foot management. Diabetic foot ulcers tend to heal slowly, need intensive care, and healing can be complicated by infection and gangrene, leading to long-term in-hospital treatment and / or amputations.[9] We proposed this study to determine the microbiological profile and antibiotic susceptibility patterns of organisms isolated from diabetic foot ulcer. The study results may facilitate physicians by increasing information pool about common organisms in our country as well as initiating measures to control such infections and antibiotic management, which ultimately help them reduce hospital stay and economic and psychological burdens of the patients and thereby improve their quality of lives.

Methods

This cross-sectional, descriptive type study was conducted in the Department of Surgery, Mymensingh Medical College Hospital, Mymensingh, Bangladesh, from October 2014 to September 2015. All diabetic patients with foot ulcers admitted into the Department of Surgery were the study population. However, a total of 130 patients were finally selected based on inclusion and exclusion criteria. Inclusion criteria included type 2 diabetic patients with foot ulcers admitted in the hospital and age more than 40 years. Exclusion criteria included patients having type 1 diabetes mellitus and with previous amputation. We adopted a purposive type of non-random sampling technique. From each patient, pus and wound swabs were collected and sent for culture and sensitivity test by maintaining all aseptic precautions.

All diabetic foot infections cases were treated in hospital within available facilities. However, some of the ischemic and critically infective cases were referred to higher facility centre after preliminary treatment for short duration. Since it was difficult to eradicate the etiological factors of diabetic foot infection, treatment was protracted.

Moreover, it was difficult to achieve and maintain healing without continued care. This demands proper hygiene and sound financial background as most of the treatment needs out-of-pocket expenses.

Data was checked multiple times to ensure its correctness and consistency. Data analysis was done by SPSS software version 18.0 for Windows. The significance of this study was tested statistically by using the appropriate tests. The study was approved by the Ethical Review Committee of Mymensingh Medical College, Mymensingh, Bangladesh.

Results

A total of 130 patients were selected for this study. The mean age of the patients was 60.1±9.8 years. Most of the respondents (42.4%) were in the 50-59 years age group. Male-female ratio was 2.3:1. Out of 130 cases, the highest number of patients 55(42.4%) were in 50-59 years age group. The mean age was 60.1±9.8 years. Most of the patients (70%) were male. 90(69.2%) samples yielded growth, while 40(30.8%) did not show any bacterial growth. Out of those 90 samples with growths, 112 bacteria were isolated. Of them, 59(52.7%) organisms were gram-positive, while 28(25%) were gram-negative and 25(22.3%) organisms were both gram-positive and gram-negative (Table-I). Out of 59 gram-positive isolates, 35(59.3%) were *S. aureus*, 18(30.5%) were *Enterococci,* and 6(10.2%) were *Streptococci*. In 28 gram-negative isolates, 15(53.7%) were *E. coli*, 6(21.4%) were *Pseudomonas*, 4(14.2%) were *klebsiella*, and 3(10.7%) were *proteus* (Table-I). Regarding antibiotic sensitivity, all gram-positive bacteria (100%) were sensitive to vancomycin.

Table I: Distribution of bacterial isolates from diabetic foot ulcers (n=130)

Type of bacteria	Frequency	Percentage
Gram-positive bacteria	**59**	**52.7**
Staphylococcus aureus *Enterococcus spp.* *Streptococcus spp.*	35 18 6	59.3 30.5 10.2
Gram-negative bacteria	**28**	**25.0**
E.coli *Pseudomonas Aeroginosa* *Klebseilla* *Proteus spp.*	15 6 4 3	53.7 21.4 14.2 10.7
Both gram-positive and negative	**25**	**22.3**

However, *S. aureus* was 80% sensitive to ceftriaxone, 71.4% to flucloxacillin, 65.7% to clavulanic acid, 54.2% to ampicillin, 48.5% to amoxicillin, and 28.5% to cotrimoxazole. *Enterococci spp*. was 61.1% sensitive to ceftriaxone, 33.3% to clavulanic acid, (27.7%) to ampicillin, and 16.6% to both amoxicillin and cotrimoxazole. *Streptococcus spp*. showed 83.3% sensitivity to ceftriaxone, 66.6% to flucloxacillin, 33.3% to clavulanic acid, and 16.6% to cotrimoxazole (Table-II). Among gram-negative bacteria, *E. coli* was found to be sensitive to imipenem (100%), ceftriaxone (86%), amikacin (100%), cefuroxime (73.3%), ampicillin (33.3%), ciprofloxacin (60%), and gentamycin (60%). *Pseudomonas* was found to be sensitive to imipenem (50%), ceftriaxone (66.6%), amikacin (83.3%), and cefuroxime (66.6%). *Klebsiella* was found to be sensitive to imipenem

(100%), ceftriaxone (75%), amikacin (75%), cefuroxime (50%), and ciprofloxacin (25%). *Proteus* was found to be sensitive to imipenem (100%), ceftriaxone (66.6%), amikacin (66.6%), cefuroxime (33.3%), ciprofloxacin (66.6%), and gentamycin (66.6%) (Table-III).

Table II: Distribution of antibiotic sensitivity pattern of gram-positive isolates

Antibiotics	***S. aureus* N(%)**	***Enterococci* N(%)**	***St.coccus spp.* N(%)**
Vancomycin	35(100.0)	18(100.0)	6(100.0)
Ceftriaxone	28(80.0)	11(61.1)	5(83.3)
Flucloxacillin	25(71.4)	-	4(66.6)
Clavulanic acid	23(65.7)	6(33.3)	2(33.3)
Ampicillin	19(54.2)	5(27.7)	-
Amoxacillin	17(48.5)	3(16.6)	-
Cotrimoxazole	10(28.5)	3(16.6)	1(16.6)

Table III: Distribution of antibiotic sensitivity pattern of gram-negative isolates

Antibiotics	***E. coli (No/%)***	***Pseudomonas* (No/%)**	***Klebseilla* (No/%)**	***Proteus (No/%)***
Imipenum	15(100)	3(50)	4(100)	3(100)
Ceftriaxone	13(86)	4(66.6)	3(75)	2(66.6)
Amikcin	15(100)	5(83.3)	3(75)	2(66.6)
Cefuroxime	11(73.3)	4(66.6)	2(50.0)	1(33.3)
Ampicillin	5(33.3)	-	-	-
Ciprofloxacin	9(60.0)	-	1(25.0)	2(66.6)
Gentamycin	9(60.0)	-	-	2(66.6)

Discussion

In our study, the age range of the patients was 40–79 years with a mean age of 60.1±9.8 years. Most of the patients (42.4%) were within the 50-59 years age group. Supporting to our study, another study showed that 56.3% were in the 51-70 years age group, with mean age of 60.5±9.9 years.10 In the present study, the majority of the patients 91(70.0%) were male with a male-female ratio of 2.3:1. Similar findings were observed in another study done by Pandurengan.[11]

Out of 130 samples, 90(69.2%) yield bacterial growths. In 90 growths, 112 types of bacteria were isolated. Of 112 isolates, 59(52.7%) were gram positive, whereas 28(25.0%) were gram negative and 25(22.3%) organisms were both gram positive and gram negative. Similar findings were observed in another study done in Bangladesh.[8] Of gram-positive bacteria, 66% were *S. aureus* and 34% were *enterococci*, while among gram-negative bacteria, 48% were *E. coli*, 24% were pseudomonas, 16% were *klebsiella* and 12% were *proteus*. Our findings were similar to Amini *et al*.[1] All gram-positive bacteria (100%) were sensitive to vancomycin. However, *S. aureus* was 80% sensitive to ceftriaxone, 71.4% to flucloxacillin, 65.7% to clavulanic acid, 54.2% to ampicillin, 48.5% to amoxicillin, and 28.5% to cotrimoxazole. *Enterococci spp*. was 61.1% sensitive to ceftriaxone, 33.3% to clavulanic acid, (27.7%) to ampicillin, and 16.6% to both amoxicillin and cotrimoxazole. *Streptococcus spp.* showed 83.3% sensitivity to ceftriaxone, 66.6% to flucloxacillin, 33.3% to clavulanic acid, and 16.6% to cotrimoxazole. Among gram-negative bacteria, *E. coli* was found to be sensitive to imipenem (100%), ceftriaxone (86%),

amikacin (100%), cefuroxime (73.3%), ampicillin (33.3%), ciprofloxacin (60%), and gentamycin (60%). *Pseudomonas* was found to be sensitive to imipenem (50%), ceftriaxone (66.6%), amikacin (83.3%), and cefuroxime (66.6%). *Klebsiella* was found to be sensitive to imipenem (100%), ceftriaxone (75%), amikacin (75%), cefuroxime (50%), and ciprofloxacin (25%). *Proteus* was found to be sensitive to imipenem (100%), ceftriaxone (66.6%), amikacin (66.6%), cefuroxime (33.3%), ciprofloxacin (66.6%), and gentamycin (66.6%). Similar sensitivity pattern was reported by Sing *et al.*[7]

Our study was of short duration and conducted only at one hospital with a small sample size and non-random sampling technique which limits the generalization of the findings. Hence, we recommend conduction of a large scale study on diabetic foot for generalization of the findings.

Conclusion

Based on the study findings, it can be concluded that in diabetic foot infections responsible microorganisms may include gram positive, gram negative and mixed types of organisms. *Staphylococcus aureus* and *Escherichia coli* are usually the most common organisms involved in diabetic foot infection. Polymicrobial infection with multi-drug resistance cases are frequently found. More sensitive antibiotics are imipenem, ceftriaxone, and amikacin. Conservative treatment, debridement and dressing, off-loading, culture-guided intellectual use of antibiotics therapy are the most successful treatment modalities. Educating our diabetic patients on how to prevent foot infection can create impacts on lowering such morbidities and mortalities.

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