Microbiological Pattern and Antibiotic Sensitivity of Infected Chronic Foot Ulcer among the Diabetic Patients in BIRDEM Hospital

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ABSTRACT:

Background: Foot infections are one of the major complications of diabetes mellitus and are significant risk factors for lower extremity amputation. Providing effective antimicrobial therapy is an important component in treating these infections, which requires information about pattern of bacterial growth and their antibiotic susceptibility. This study was designed to investigate the microbial pattern of diabetic foot infections and their antibiotic susceptibility.

Methodology: This prospective study was conducted in Surgery Unit 1 of Bangladesh Institute of Research and Development in Endocrine & Metabolism (BIRDEM) General Hospital, Dhaka, Bangladesh from September, 2013 to November 2016. A total 81 diabetic patients of infected chronic foot ulcer were selected on the basis of convenient sampling. Data were collected on demographic characteristics (age and sex), examination findings, bacterial involvement, its type and sensitivity pattern. Wagner's ulcer grading system was used to classify the chronic foot ulcers

Result: The age distribution of the sampled population depicted that over half [42(51.8%) out 81] of the patients was in their 5th decade of life. Females were slightly higher (53.1%) than the males (46.9%) with mean ages of the male and female patients being 48.0 ±1.5 and 53.0 ±1.2 respectively. Based on Wagner ulcer grading system, 45.7% of the foot ulcers were grade II followed by 21.0% grade III, 13.6% grade IV, another 13.6% grade I and only 6.2% grade 0. Most of the infections were polymicrobial (88.9%) and isolated micro-organisms were frequently *E. coli* (47.1%) and *Klebsiella* (33.3%). The antibiotics sensitivity against the micro-organisms demonstrated that colostin was the most sensitive antibiotics (97.5% of all cases), followed by imipenem (90.1%) and meropenem (90.1%).

Conclusion: Chronic foot ulcers in diabetic patients are usually associated with polymicrobial infection. *E. coli*, *Klebsiella* and *Pseudomonas* are the most common micro-organisms isolated, which are sensitive to colostin, imipenem and meropenem in majority of the cases.

Keywords: Microbiological pattern, antibiotic sensitivity, diabetic foot, infection.

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Introduction:

Diabetes is a major cause of morbidity and mortality worldwide, costing an estimated $245 billion in 2012 in the United States alone due to increased use of health resources and lost productivity.[1] Studies have shown that the prevalences of diagnosed diabetes,[2,3] total diabetes (diagnosed plus undiagnosed)[2,4] and type 1 diabetes[5] have increased during the past decades.[3] The prevalence of diabetes is also on a rising trend in developing countries including Bangladesh. In a recent scoping review of

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published literatures (22 studies), where 51,252 participants were included, the prevalence of diabetes in Bangladesh was revealed to be 7.4%. Although this life-threatening disease can be controlled, it is often accompanied by serious complications, and still today there is no cure. It is estimated that approximately 15–25% of people with diabetes develop a foot ulcer at some time during their lives, and 85% of major leg amputations are the result of a foot ulcer.[6] The organisms implicated in foot infections are generally *Staphylococcus aureus* & *Streptococcus pyogenes* arising from the patients' own skin and *Enterococci* from bowel. Among the Gram positive aerobes *Staphyloccoci* are more prevalent. Many of these microorganisms are developing resistance to commonly used antibiotics largely due to their indiscriminate use.[7]

The World Health Organization (WHO) reported increasing incidence of diabetes all around the world, especially in developing countries.[8-11] Neuropathy, peripheral arterial disease, and pressure overload make the sufferers prone to ulcer. People with diabetes can progress into chronic ulcers often leading to amputation if not treated promptly.[10-13] Poorly controlled diabetes is prone to skin infections because elevated blood sugar reduces the effectiveness of bacteria fighting cells. Carbuncles, boils, and other skin infections may be hazardous if not properly treated. Even a small cut may progress to a deep, open sore, called an ulcer.[14] Advanced age, male gender, and neglected diabetes are the other factors associated with amputation.[10,15]

Chronic wounds can be colonized on the surface by a wide range of organisms.[16] Several studies have shown different bacterial agents isolated from diabetic foot ulcers in different geographical areas.[9,16,17] The inconsistency in reports might be attributed to the varying methods of dressing and populations. If bacterial infection is mild, it is usually monobacterial and if severe infection is present, it is polymicrobial.[18] The antibiotic susceptibility patterns also show variations with geographical regions.[19,20] Multidrug resistant (MDR) bacteria, methicillin resistant *S. aureus*

(MRSA), and extended-spectrum *ß*-lactamase (ESBL) producing Gram-negative bacteria and their associated complications have created a big health concern among the medical and clinical practitioners.[21,22] In recent decades, high rates of MDR bacteria, MRSA, and ESBL positive strains have been observed in many hospitalized diabetic foot patients (DFP).[13,23,24] Such conditions make the treatment more demanding to save patients' lives.

Early diagnosis of diabetic foot ulcers and prompt initiation of appropriate antimicrobial therapy are the mainstay for controlling infection, preventing complication and improving quality of life of the patients. Antibiotic susceptibility test is essential for the management of infections which can help make better therapeutic choices. Hence, this study was designed to evaluate the presence and types of microorganisms in infected diabetic foot cases and their sensitivity patterns.

Patients & Methods:

This cross-sectional study was carried out in Surgery Unit 1 of Bangladesh Institute of Research and Development in Endocrine & Metabolism (BIRDEM) General Hospital, Dhaka, Bangladesh between September, 2013 to November, 2016 based on convenient sampling. Informed consent was taken from each of the participating patients after assuring them that the confidentiality and anonymity of the study subjects would be maintained rigorously. A total of 81 adult diabetic patients with infected choric foot ulcer were consecutively included in the study. However, critically-ill patients with septicaemia, were excluded from the study. Data were collected using a semi-structured questionnaire designed to include demographic information (age and sex), examination findings, bacterial involvement, its type and sensitivity pattern. Data were processed using SPSS (Statistical Packages for Social Sciences), version 17 and the test statistics used to analyse the data were descriptive statistics. Wagner's ulcer grading system[25] was used as an assessment tool to classify the chronic foot ulcers as follows (Table I):

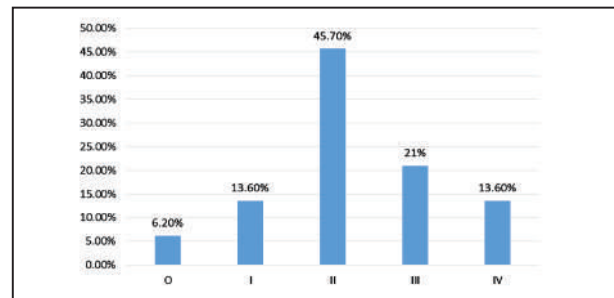| TABLE I. Wagner's ulcer grading system	
Grade	Lesion
0	No open lesions; may have deformity or cellulitis.
I	Superficial diabetic ulcer (partial or full thickness).
II A	Ulcer extension to ligament, tendon, joint capsule, or deep fascia without abscess or osteomyelitis.
II B	Deep ulcer with abscess, osteomyelitis, or joint sepsis.
III	Gangrene localized to portion of forefoot or heel.
IV	Extensive gangrenous involvement of the entire foot.

Results:

The age and sex distribution of the sampled population is depicted in Table II. Over half [51.9% (42 out 81] of the patients was in their 5th decade of life. Females were slightly higher (53.1%) than the males (46.9%) with mean ages of the male and female patients being 48.0 ± 1.5 and 53.0 ± 1.2 respectively. Wagner grading system of foot ulcer showed that about 46% had grade II ulcer followed by 21% grade III, 13.6% grade IV and another 13.6% grade I (Figure 1).

Microbiological study revealed that most the infections was polymicrobial (88.9%) (Figure 2) and *Escherichia coli* was the predominant micro-organism (47.1%) isolated on culture of pus or wound swab obtained from the infected lesion followed by *Klebsiella* (33.3%), *Pseudomonas* (28.4%), *Staphylococcus* (25.9%), *Enterococcus* (21%) and *Streptococcus* (16%) (Figure 3).
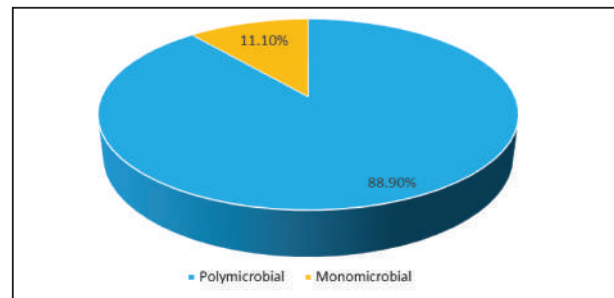
Sensitivity of the micro-organisms to antibiotics is shown in Table III. Most of the microorganisms were susceptible to colostin (97.5%), imipenem (90.1%), meropenem (90.1%) and amikacin (82.7%). The second line sensitive antibiotics were cefepime (65.4%) and piperacillin and tazobactam (63%).

Figure 1: Grading of foot ulcer by Wagner grading of system

Figure 2: Microbiological pattern of foot infection.
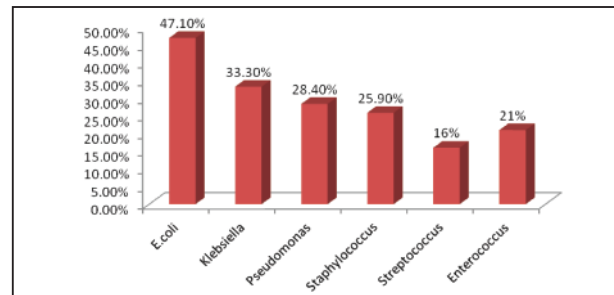
Figure 3: Isolation of micro-organisms in culture.

TABLE II. Age and sex distribution of study subjects (n = 81)				
Age (years	Male		Female	
	Frequency	Percentage	Frequency	Percentage
31-40	02	2.5	00	00
41-50	09	11.1	09	11.1
51-60	19	23.5	23	28.4
> 60	08	9.9	11	13.6
Total	38	46.9	43	53.1
Mean ± SD	48 ± 1.5		53 ± 1.2	

TABLE III. Distribution isolated bacteria by their sensitivity to antibiotics (n = 81)		
Sensitive antibiotics	Frequency	Percentage
Colistin	79	97.5
Imipenem	73	90.1
Meropenem	73	90.1
Amikacin	67	82.7
Cefepime	53	65.4
Piperacillin tazobactam	51	63.0
Gentamicin	47	58.0
Ceftazidime	41	50.6
Ceftriaxone	30	38.3
Amoxicillin clavulanic acid	29	35.8
Tobramycin	27	33.3
Cefalexin	21	25.9
Cefotaxime	19	23.4
Ciprofloxacin	18	22.2
Trimethoprim-sulfamethoxazole	17	21.0
Chloramphenicol	14	17.3
Ampicillin	11	13.6
Tetracycline	11	13.6

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Discussion:

This prospective study was conducted with a total of 81 diabetic patients with infected chronic foot. Females were a bit higher (53.1%) than the males (46.9%). Among the male population 23.5% were in 51 – 60 years age group, whereas among females 28.4% were in their 5th decade of life. The mean ages of the male and female patients were 48 ± 1.5 years and 53 ± 1.2 years respectively. In another clinical study, majority was male 55.9% and most of them were in 51 to 70 years of age group.[4] By using the Wagner ulcer grading system, 20 about 46% of the foot ulcers were graded as grade II followed by 21% as grade III and 13.6% as grade IV which in another study was 17%, 36% and 16% respectively.[24] In our study, 88.9% of all infections was polymicrobial which compares well with a previously cited similar study (81.9%).[25] Most frequently observed micro-organisms in this study were *E. coli* (47.1%) and *Klebsiella* (33.3%) which together comprised 80% of the microorganisms. Anvarinejad and associates in a similar study showed *Enterococcus* (27.0%) and *Staphylococcus* (22.0%) to be the main organisms isolated, 24 while Kiadaliri et al[7] reported *Staphylococcus* to be the predominant (42.3%) followed by *Pseudomonas* (24.3%). In another study, it was found that over 90% of all infections in diabetic foot ulcer was associated with polymicrobial infection and the most frequent organism was *Staphylococcus* aureus (37.1%) and *E. coli* (22.9%).[26] Sharply contrasting with these findings, a study reported that over 40% of the infections were associated with *Streptococcus* and *Staphylococcus*.[27]

Antibiotic sensitivity pattern in our study demonstrated that colostin was the most sensitive antibiotics (97.5%), followed by Imipenem (90.1%) and meropenem (90.1%). Similar results were observed in another study, where polymyxin B and colistin were found 100% sensitive.[24] In a prospective study, it was found that all the Gram negative isolates were susceptible to carbapenem and beta lactum antibiotic imipenem, which is resistant to inactivation by most bacterial beta lactamases. And so it has the widest spectrum of antibacterial activity.[8]

In a clinical study, it was found that most of the infections were susceptible to imipenem and meropenem, where colostin sensitivity was not measured.[26] In another study, the sensitivities of meropenem, colstin and imipenem were 96.6%, 94.8% and 90% respectively.[27] In our study, the sensitivities of aminoglycosides like amikacin and gentamycin were 82.2 and 58.0% respectively. Similar pattern was observed in most of the studies with a few exceptions.[27-31]

Conclusion:

Most of the chronic infected foot ulcers in diabetic patients are polymicrobial and *E. coli*, *Klebsiella* and *Pseudomonas* are commonly isolated micro-organisms. The microorganisms isolated were mostly sensitive to colistin, imipenem and meropenem.

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