## **Original Research Article**

DOI: http://dx.doi.org/10.18203/2349-2902.isj20201878

# Antibiotic susceptibility profiling in diabetic foot ulcer patients and evaluating treatment outcomes at a tertiary care hospital

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**Received:** 05 February 2020 **Accepted:** 01 April 2020

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#### **ABSTRACT**

**Background:** Diabetic foot infections are the predominant complications of diabetes mellitus with uncontrolled hyperglycemia levels. Multiple microbial invasion is the primary cause and the causative organism are aerobic gram positive cocci, gram negative bacilli such as *Pseudomonas* species, *Escherichia coli, Klebsiella* species, *Proteus* species and anaerobes.

**Methods:** This is a prospective, observational study conducted in the Department of General Surgery. 50 patients constituted the sample in our study. Patients pus and wound swab samples were collected using sterile and moist swab sticks under aseptic conditions and processed.

**Results:** More gram negative bacteria (66%) were isolated than gram positive bacteria (34%). *E. coli* (38%) is the major isolated microorganism. Among the isolated organisms many of them are susceptible to amikacin (60%), imipenem (52%) and ciprofloxacin (46%) respectively.

**Conclusions:** *E. coli* is the most common cause of infection. The antibiogram study showed an incidence of multiple resistant microorganisms to commonly used antibiotics.

Keywords: Diabetic foot ulcer, Gram negative and positive bacteria, Susceptibility antibiotics

### INTRODUCTION

Patients with diabetes mellitus are prone to multiple complications such as diabetic foot ulcer (DFU). Diabetic foot ulcers are among the most common complications of patients who have diabetes mellitus which is not well controlled. Poor glycemic control results with the underlying complications such as peripheral vascular disease, neuropathy, or poor foot care and also one of the commonest aetiology for osteomyelitis of the foot and lower extremities amputation. Infections are often polymicrobial, multi drug resistant and associated with inadequate glycemic control.

Although the cause of for diabetic foot ulcer is multifactorial. Diabetic neuropathy develops in 60% of diabetics which eventually leads to a foot ulcer. Individuals with a flat foot have disproportionate stress across their foot, leading to tissue inflammation and are at increased risk of foot ulcers. Many of the risk factors for foot ulcers are also predisposing factors for amputation, because ulcers are primary causes leading to amputation.<sup>2</sup> The annual incidence of diabetic foot ulcer worldwide is between 9.1 to 26.1 million.<sup>3</sup> Incidence of diabetic foot ulcer is seen in 15 to 25% of diabetic patients during their lifetime. There is no specific age for the occurrence of diabetic foot ulcers but are most prevalent in diabetics ages 45 and over.<sup>4</sup>

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Diabetic foot ulcer development is categorised into 3 stages. Development of a callus indicates the initial stage which is a result of neuropathy. Physical deformities of the foot are due to motor neuropathy, sensory loss occurs due to sensory neuropathy which leads to ongoing trauma and it becomes an ulcer.<sup>3</sup> Because blood is not able to reach the wound, healing is delayed, eventually leading to necrosis and gangrene.<sup>5</sup> Most common causative microorganism of diabetic foot infections are *Staphylococcus aureus*, *Enterococcus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella species*, *Proteus species*, etc., and few anaerobes.<sup>2</sup>

The most frequent bacterial isolates were *Staphylococcus* aureus, *Pseudomonas aeruginosa* and *Proteus*. Imipenem was most effective agent antibiotic against gram-negative organisms. Vancomycin was found to be most effective against gram positive organisms.<sup>6</sup>

#### **METHODS**

A hospital based prospective, observational study was conducted in a tertiary care hospital, Guntur, Andhra Pradesh in the in-patient department of General Surgery from July 2018 to July 2019. A total of 50 patients constituted the sample for study. The study subjects were included by complete follow-up after getting informed consent from each of them.

#### Inclusion criteria

Diabetic foot ulcer patients with a diagnosis of diabetic foot ulcers admitted in general surgery wards, age >30 years, either sex, were willing to participate and had symptoms more than 2 weeks were included.

#### Exclusion criteria

Patients with multiple or life threatening co morbidities, diagnosed as diabetes with cellulitis, gangrene were excluded. Patients on long term steroids, or immune suppressants, without antibiotic susceptibility profile, with wound infection without diabetes, who discharged against medical advice, all pregnant and lactating patients, who are not interested in the study and with incomplete information of medical records were also excluded.

This study was conducted after obtaining the approval from institutional human ethical committee of Chebrolu Hanumaiah Institute of Pharmaceutical sciences, Guntur. After obtaining consent from the patients who are willing to participate in the study, data were collected from patient medical record and entered in patient data collection form.

#### RESULTS

The total numbers of patients included in the study were 50. Among them 36 (72%) were male and 14 (28%) were

female patients. Males were predominance in diabetic foot ulcer than females due to increased outdoor work and poor compliance to foot care practice. The incidence of diabetic foot was more in patients with age group 51-60 years (52%) followed by 71-80 years (18%), and 61-70 years (14%). Our study indicates that the incidence of diabetic foot ulcer increases with the duration of diabetes mellitus. A prolonged duration of 6-10 years (54%) has higher risk of diabetic foot ulcer shown in Table 1.

Table 1: Duration of diabetes in the study population (n=50).

Duration of diabetes (years)	Number of patients	Percentage (%)
0-5	11	22
6-10	27	54
11-15	12	24

Table 2: Organisms isolated in the study population (n=50).

Organisms isolated	Number of patients	Percentage (%)
Staphylococcus aureus	17	34
Escherichia coli	19	38
Pseudomonas aureus	3	6
Pseudomonas aeruginosa	1	2
Klebsiella pneumonia	9	18
Proteus vulgaris	1	2

Table 3: Type of tissue involved undergone ulceration in the study population (n=50).

Type of tissue involved	Number of Patients	Percentage (%)
Necrotic tissue	37	74
Granulation tissue	13	26
<b>Epithelial tissue</b>	0	0

Out of the 50 study subjects 74% of them presented with deep type of lesions and 64% with ulcers on left foot. Microbial culture examination reveals 66% patients have gram negative bacteria. Commonest microorganisms found were *Escherichia coli* (38%), *Staphylococcus aureus* (34%) and *Klebsiella pneumonia* (18%) shown in Table 2. Clinical pattern of the patients showed 74% of the patients were presented with necrotic type of tissue, 26% with granulation tissue shown in Table 3.

Table 4 showed the evaluation of clinical parameters before and after therapy in the study population. Out of 50 patients studied, patients with 80% exudate, 84% tissue edema and 98% ulcer size was observed before initiation of therapy followed by 48% exudate, 56% tissue edema and 12% ulcer size was observed after completion of therapy.

Table 4: Evaluation of clinical parameters in the study population.

Clinical navametors	Before therapy		After therapy	
Clinical parameters	Number of patients	Percentage (%)	Number of patients	Percentage (%)
Exudate	40	80	24	48
Peripheral tissue edema	42	84	28	56
Reduced ulcer size	49	98	6	12

Table 5: Susceptibility of antibiotics in the study population (n=50).

Susceptibility of	Number of	Percentage	
antibiotics	patients	(%)	
Amikacin	30	60	
Aztreonam	8	16	
Azithromycin	1	2	
Ampicillin	1	2	
Clindamycin	2	4	
Cefazolin	2	4	
Cefoperazone/	22	44	
salbactum			
Ceftriaxone	14	28	
Ciprofloxacin	23	46	
Cefotaxime	11	22	
Colistin	6	12	
Cefepime	5	10	
Ceftazidime	1	2	
Cefoxitin	1	2	
Daptomycin	2	4	
Erythromycin	3	6	
Ertapenem	1	2	
Gentamicin	22	44	
Imipenem	26	52	
Levofloxacin	12	24	
Linezolid	3	6	
Meropenem	6	12	
Penicillin	1	2	
Piperacillin/	18	36	
tazobactum	10	30	
Sulfamethoxazole/	4	8	
trimethoprim	<del></del>	O	
Tobramycin	6	12	
Tigecycline	7	14	
Teicoplanin	2	4	
Tetracycline	1	2	
Trimethoprim	2	4	
Vancomycin	6	12	

In present study majority of patients were sensitive to amikacin (60%) and imipenem (52%), ciprofloxacin (42%), cefaperazone/salbactum (44%), gentamicin (44%) were the next common sensitive antibiotics. The other antibiotics used in present study were piperacillin/tazobactum (36%), ceftriaxone (28%), levofloxacin (24%), cefotaxime (22%) shown in Table 5. Majority of the gram positive organisms are sensitive to ciprofloxacin

(76.4%) followed by piperacillin/tazobactum (64.7%), imipenem (58%), amikacin (52%) and gram negative organisms are sensitive to amikacin (63.6%) followed by gentamicin (57.5%), imipenem (48.4%), cefoperazone/salbactum (36.3%).

#### **DISCUSSION**

This study was carried out because the diabetic foot infections causes of hospitalization and may result in foot amputation and disability and secondly, there is no generally accepted standard guideline for antibiotics used for diabetic foot ulcers. A total of 50 patients who fulfilled the inclusion criteria were enrolled in this study for a period of one year between July 2018 and July 2019. The culture and sensitivity reports of 50 patients prescribed with antibiotics empirically were studied.

It was found that, the antibiotics used for treating foot ulcer, in the study population included imipenem (42%) was the most commonly prescribed empirical drug in diabetic foot clinic, followed by gentamicin (40%), cefaperazone/ salbactum (40%), ceftriaxone (32%), levofloxacin (22%), amikacin (18%), piperacillin/tazobactum (10%) and vancomycin (8%) alone or in combination were used.

Proper therapeutic management of diabetes, foot care and adhering to the principles of asepsis is necessary for preventing ulceration site infection. Treatment failure could probably be due to hospital acquired infection and developing of antibiotic resistance by microorganisms.<sup>7</sup> Antibiotics selection for management of diabetic foot ulcer was done empirically in the hospital. According to microbiological sensitivity analysis, three types of gram positive cocci and four types of gram negative bacilli were isolated from the patient sample. The findings in bacterial isolates of pus showed predominance of *E. coli* (38%) followed by *Staphylococcus aureus* (34%) and *Klebsiella pneumonia* (18%) similar to the Maryam et al.<sup>8</sup>

The culture reports revealed that gram negative pathogens were more sensitive to amikacin (63.6%) compared to Gangania et al. whereas gram positive pathogens wee more sensitive to ciprofloxacin (76.4%) compared to Olorunjuwon et al. It is important to take care such that, before starting any antibiotic regimen, the wound tissue or swab should be collected as much as possible and find out the sensitivity pattern. This will identify the microorganisms which are present. This inturn helps to reduce the multidrug resistance crisis.<sup>7,9-11</sup>

Updated information on antimicrobial susceptibility profiles of various isolates will not only help in designing the most suitable dosage regimen against wound infection but also help in reducing the alarmingly expanding threat of drug resistance.<sup>8</sup>

#### **CONCLUSION**

Diabetic foot infection by Gram-negative pathogens were found to be more resistant to the prescribed antibiotics whereas, Gram-Positive pathogens showed increased sensitivity to ciprofloxacin and also the presence of nosocomial gram-positive and gram-negative pathogens is a matter of concern. Hence an active infection control team should continuously monitor the prevalent organisms and prepare their anti-biograms, periodically and inform the clinicians. Regular monitoring of culture and sensitivity reports is needed for selecting drugs for the empiric therapy. Implementation of antibiotic policy in the hospitals helps to properly audit of antibiotic usage as well as purchase procedures. Hence in conclusion the culture sensitivity testing is an important factor before determining antimicrobial therapy.

Funding: No funding sources Conflict of interest: None declared

Ethical approval: The study was approved by the

Institutional Ethics Committee

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Cite this article as: Kumar TJP, Ramineni HB, Shaik R, Yellavula SN, Chandra V. Antibiotic susceptibility profiling in diabetic foot ulcer patients and evaluating treatment outcomes at a tertiary care hospital. Int Surg J 2020;7:1607-10.