

The Microbiological Profile of Diabetic Foot Infections

K.M.MOHANASOUNDARAM

ABSTRACT

Background: Diabetic foot infections are a common cause of morbidity and mortality. This study was conducted in diabetic patients with foot ulcers to determine the bacterial profile and their anti-microbial pattern. Of the 68 patients, 44 were males and 24 were females. The presence of diabetic neuropathy was observed in 43(63.2%) patients. The swabs from 56 patients showed a positive culture and 12 patients did not grow any organisms. A total of 92 organisms were isolated from 56 patients with growth. 12(17.6%) patients had polymicrobial infections. *S.aureus* (26.1%) was the predominant pathogen which was isolated, followed by *E.coli* (18.4%).

Methods: This study was conducted on clinical specimens which were taken from 68 patients with diabetic foot infections,

over a 1 year period. The clinical specimens were processed by using the standard aerobic microbiological techniques. The anti-microbial susceptibility pattern was studied by the Kirby-Bauer disc diffusion method.

Result: *S.aureus* was the most common isolate which was recovered from 26.1% of the cases. Other organisms which were isolated were *E.coli* (18.4%), *Klebsiella* (9.7%), *Proteus spp* (6.5%), *NFGNB*(14.1%), *Pseudomonas aeruginosa* (13%) and *Enterococcus spp* (4.3%).

Conclusion: The anti-microbial susceptibility data from our study suggests that piperacillin/tazobactam or cefepime / sulbactam would be appropriate for antibiotic coverage.

Key Words: Diabetic foot, *S.aureus*, Multidrug resistant organisms

INTRODUCTION

Diabetic foot ulcerations and infections are one of the leading causes of mortality and morbidity, especially in the developing countries [1]. Diabetic patients were found to have a lifetime risk of as high as 25% for developing foot ulceration and the risk of lower leg amputation was found to increase by 15-46 times in diabetics than in persons who did not have diabetes mellitus [2].

The major factor which predisposed to the foot ulceration which led to the infection was usually related to peripheral neuropathy and an impaired circulation which limited the access of the phagocytes [3,4,5].

E.coli, *Proteus*, *Pseudomonas spp*, *S.aureus*, and *Enterococcus spp* are the most frequent pathogens which are cultured from diabetic foot ulcers [4,5,6]. The infections in the diabetic foot are usually polymicrobial due to aerobic bacteria, anaerobes and *Candida spp*. The severe infections usually yield polymicrobial isolates, whereas the milder infections are generally monomicrobial [3,5,6,7].

In recent years, there has been an increase in the incidence of multidrug resistant organisms, which could increase the duration of the hospital stay, the cost, and the morbidity and the mortality [8].

Sometimes the initial management comprises of empirical anti-microbial treatment which is based on the susceptibility data [9], but the proper management of these infections requires an appropriate antibiotic selection which is based on the culture and the antimicrobial susceptibility testing [10,11]. Therefore, this study was undertaken to determine the common aetiological agents of the diabetic foot infections in a tertiary care hospital and their invitro susceptibility pattern to the routinely used antibiotics.

MATERIALS AND METHODS

This was a prospective study in which 68 consecutive samples from diabetic patients who were admitted to a tertiary care hospital over a period of one year were included, after getting the informed consent from the study group.

Pus or discharges from the ulcer and debrided necrotic tissue were obtained at the Microbiology Laboratory and the specimens were processed without any delay. The specimens were subjected to gram staining and they were inoculated onto Blood agar and MacConkey's agar for the isolation of aerobic bacteria. The isolates were identified by the standard biochemical tests.

Anti-microbial susceptibility testing was performed by the Kirby-Bauer disc diffusion method according to the CLSI guidelines [12]. The antibiotic panel for the gram negative bacilli were *cefuroxime*, *ceftazidime*, *cefepime*, *cefepime/sulbactam*, *piperacillin/tazobactam*, *gentamicin*, *amikacin*, *ciprofloxacin*, *levofloxacin*, *amoxicillin/clavulanic acid* and *imipenem*. The antibiotics which were tested for *S.aureus* were oxacillin, erythromycin, gentamycin, clindamycin, ciprofloxacin, amoxicillin/clavulanic acid, cotrimaxazole and vancomycin. Penicillin, ampicillin, erythromycin, high level gentamycin, cotrimaxazole and ciprofloxacin were used for the *Enterococcus spp* and penicillin, erythromycin, ciprofloxacin, gentamicin, cotrimaxazole and amoxicillin/clavulanic acid were used for *S.pyogenes*.

RESULTS

Demographic Characteristics

68 patients were included in the study. 44(64.7%) were males and 24 (35.2%) were females. The mean age of the patients was 55.

12+/-12.08. 32(47%) were on oral antidiabetics and 25(36.7%) were on insulin, while 11 (16.17%) were on both insulin and oral antidiabetic drugs. 27(39.7%) had hypertension, and 8(11.7%) suffered from cardiovascular disease. 43(63.2%) had neuropathy, 17(25%) had nephropathy and 11(16%) had retinopathy. The demographic characteristics have been summarized in [Table/Fig- 1].

MICROBIOLOGY

A total of 92 bacteria were isolated from these 68 patients. A statistically significant correlation was found between the bacterial

| Feature | Number of Patients(N=68) |
|-------------------------------|--------------------------|
| Age(mean+/- SD years) | 55.12+/-12.08 |
| Sex | |
| male | 44 (64.7%) |
| female | 24 (35.2%) |
| Diabetic medication | |
| Oral antidiabetic | 32 (47%) |
| Insulin | 25 (36.7%) |
| Oral antidiabetic+insulin | 11 (16.2%) |
| Associated diseases | |
| Hypertension | 27 (39.7%) |
| Cerebrovascular disease | 8 (11.7%) |
| COPD | 8 (11.7%) |
| Chronic renal failure | 7 (10.2%) |
| Malignancy | 5 (7.3%) |
| Others | 13 (19.1%) |
| Duration of foot infections | |
| >30 days | 36 (52.9%) |
| <30 days | 32 (47%) |
| Duration of diabetes mellitus | |
| >1 year | 55 (80.9%) |
| < 1 year | 13 (19.1%) |
| Co-morbid conditions | |
| Neuropathy | 43 (63.2%) |
| Nephropathy | 17 (25%) |
| Urinary incontinence | 20 (29.4%) |
| Retinopathy | 11 (16.1%) |
| History of amputation | |
| Present | 9 (13.2%) |
| Absent | 54 (79.4%) |

[Table/Fig-1]: Clinical Features of the Patients

| S.No | Organism isolated | Number of isolates (n=92) |
|------|---|---------------------------|
| 1. | <i>Echerichia coli</i> | 17 (18.4%) |
| 2. | <i>Klebsiella pneumoniae</i> | 9 (9.7%) |
| 3 | <i>Proteus species</i> | 6 (6.5%) |
| 4 | <i>Non fermenting GNB</i> | 13 (14.1%) |
| 5 | <i>Pseudomonas aeruginosa</i> | 12 (13%) |
| 6 | <i>Staphylococcus aureus</i> | 24 (26.1%) |
| 7 | <i>Coagulase negative staphylococci</i> | 4 (4.3%) |
| 8 | <i>Enterococcus species</i> | 4 (4.3%) |
| 9 | <i>Beta streptococci</i> | 3 (3.2%) |

[Table/Fig-2]: Bacteria isolated from diabetic foot infections

| Organism isolated | value |
|--------------------------------------|-------------|
| Total number of specimens | 68 |
| No of patients with positive culture | 56 (82.3%) |
| No of positive cultures with | |
| One isolate | 56 (82.3%) |
| Two isolates | 23 (33.8%) |
| Three isolates | 12 (17.6%) |
| Gram negative bacteria | 57 (62%) |
| Gram positive bacteria | 35 (38.04%) |

[Table/Fig-3]: Characteristics of diabetic foot specimens

| Response | Response | | Total |
|--------------------------------|----------|-----|-------|
| | <21 | ≥21 | |
| <1 week | 8 | 22 | 30 |
| 1-2 weeks | 5 | 4 | 9 |
| Persistent for 3 weeks or more | 1 | 1 | 2 |
| Death | 9 | 0 | 9 |
| Total | 23 | 27 | 50 |

[Table/Fig-4]: p< 0.001, Association of MASCC score and response

| Response | Blood culture results | | Total |
|--------------------------------|-----------------------|----------|-------|
| | Negative | Positive | |
| <1 week | 28 | 2 | 30 |
| 1-2 weeks | 9 | 0 | 9 |
| Persistent for 3 weeks or more | 1 | 1 | 2 |
| Death | 4 | 5 | 9 |
| Total | 42 | 8 | 50 |

[Table/Fig-5] Association between bacteraemia and response

growth and the deep ulcers. The different bacteria and the number of positive isolates which were isolated from the diabetic foot infections have been summarized in [Table/Fig-2 and 3].

In 12(17.6%) patients, no growth was obtained from the specimen. 56 (82.3%) patients showed growth from one organism and two organisms were isolated from 23(33.8%) specimens, while 12(17.6%) patients showed growth from three organisms. Gram negative bacteria accounted for 62% (n=57) and gram positive bacteria accounted for 38.04% of the growth.(n=35) In our study, we found that *cefepirazole/sulbactam*, *piperacillin/tazobactam* and *imipenem* were the anti-microbial agents which were the most effective against gram negative bacilli, while *vancomycin*, *erythromycin* and *ciprofloxacin* were effective against the gram positive microorganisms. The resistance pattern of the gram negative bacilli and the gram positive coccal isolates are summarised in [Table/Fig-4 and 5] respectively.

DISCUSSION

Foot ulcers are a significant complication of diabetes and they often precede lower extremity amputation [2,4]. A wide range of bacteria can cause infection in these patients. While the foot infections with diabetes are initially treated empirically, the therapy which is directed at the known causative organisms may improve the outcome [6,7,9]. This study presents a comprehensive microbiological survey of infected diabetic foot ulcers in our hospitalized patients.

Foot ulcers account for 4% of all the diabetic hospitalizations [13] and the prevalence of diabetic foot ulceration was found to be 65% in males and 35% in females. The most common risk factors for diabetic foot ulceration include neuropathy, poor glycaemic control, ischaemia and infection.

Diabetic neuropathy was seen in 63.2% of our patients with diabetic ulcers. The detection of neuropathy before the development of its complications is the best way to prevent diabetic foot infections.

In our study, *S.aureus* (26.1%) was the predominant pathogen which was isolated, followed by *E.coli* (18.4%), which was in accordance with the findings of the study which was conducted by Diane et al and Sharma et al [6,10]. But various other studies have demonstrated gram negative bacteria as the predominant pathogens [1-5,7,8]. These discrepancies could be partly due to the differences in the causative organisms which occurred over

time and the geographical variation or the types and the severity of the infections which were included in the studies.

Poly-microbial infections were observed in 17.6% of the patients and mono-microbial infections were observed in 82.3% of the patients.

The present study confirmed the fact that multidrug resistant organisms (MDRO) were common in hospitalized patients with diabetic foot ulcers [4,7,9,11,14]. 54.2% of the *S.aureus* strains were oxacillin resistant and 50% of the isolated *Enterococcus strains* were resistant to *vancomycin*. *Imipenem*, *piperacillin/tazobactam* and *cefepazone / sulbactam* were the agents which were most effective against gram negative organisms, while vancomycin was effective against the gram positive organisms. The increasing resistance to various anti-microbial agents could be due to the fact that ours was a tertiary care hospital with the widespread usage of broad spectrum antibiotics, leading to the survival advantage of the pathogens. Infection with these organisms may limit the choice of the antibiotic treatment and lead to worse outcomes.

To conclude, since there is an increasing rate of multidrug resistant organisms, there is a need for continuous surveillance to provide the basis of the empirical therapy and to reduce the risk of the complications. The inadvertent use of broad spectrum antibiotics should be discouraged. The selection of the antibiotic treatment should be based on the predominant organisms which are isolated and their antimicrobial susceptibility patterns. This will improve the overall antibiotic utilization and reduce the emergence of multidrug resistant organisms.

REFERENCES

[1] Mohammad Z, Abida M, Jamal A. The clinico-bacteriology and the risk factors for diabetic foot infections with multidrug resistant micro-organisms in north India. *Biology and Medicine* 2010; 2(4):22-34.

- [2] Umadevi S, Kumar S, Joseph NM, Easow J M, Kandhakumari G, Srirangaraj S, et al. Microbiological study of diabetic foot infections. *Indian Journal of Medical Specialities* 2011; 2(1):12-17.
- [3] Anandi C, Alaguraja D, Natarajan V, Ramanathan M, Subramaniam CS, Thulasiram M, et al. Bacteriology of diabetic foot lesions. *Indian J Med Microbiol* 2004;22:175-78.
- [4] Ozer B, Kalachi A, Semerci E, Duran N, et al. Infections and aerobic bacterial pathogens in diabetic foot infections. *African J of Microbiol Research*;2010; 4(20): 2153-60.
- [5] Raja NS. Microbiology of the diabetic foot infections in a teaching hospital in Malaysia: a retrospective study of 194 cases. *J Microbiol Immunol Infect* 2007; 40(1): 39-44.
- [6] Viswanathan V, Jasmine JJ, Snehalatha C, Ramachandran A. Prevalence of pathogens in the diabetic foot infections in south Indian type 2 diabetic patients. *J Assoc Physicians India*.2002; 50:1013-6.
- [7] Citron DM, Goldstein EJC, Merriam CV, Lipsky BA, Abraham MA. Bacteriology of the moderate to severe diabetic foot infections and the in vitro activity of the antimicrobial agents. *J Clin Microbiol* 2007; 45(9):2819-28.
- [8] Shankar EM, Mohan V, Premalatha G, Srinivasan RS, Usha AR. Bacterial aetiology of diabetic foot infections in south India. *Eur J Intern Med* 2005; 16:567-70.
- [9] Yoga R, Khairul A, Sunita K, Suresh C. Bacteriology of diabetic foot lesions. *Med J Malaysia* 2006; 61:14-16.
- [10] Sharma VK, Khakda PB, Joshi A, Sharma R. The common pathogens which were isolated from diabetic foot infections in Bir hospital. *Kathmandu Univ Med J* 2006; 4(3): 295-301.
- [11] El-Tahawy AT. Bacteriology of the diabetic foot. *Saudi Med J*. 2000; 21(4); 344-7.
- [12] Pathare NA, Bal A, Talwalkar GV, Antani DU. Diabetic foot infections: A study of the microorganisms which were associated with the different Wagner grades. *Indian J Pathol Microbiol* 1998; 41(4): 437-41.
- [13] Clinical Laboratory Standards Institute. Performance standards for the anti-microbial disk susceptibility tests. Approved standard ,9th ed. CLSI document M2-A9.Wayne, PA:CLSI;2006.
- [14] Gadepalli R, Dhawan B, Sreenivas V, Kapil A, Ammini AC, Chaudhary R. A clinico-microbiological study of diabetic foot ulcers in an Indian tertiary care hospital. *Diabetes Care* 2006;29: 1727-32.

AUTHOR(S):

1. Dr. K.M. Mohanasoundaram

PARTICULARS OF CONTRIBUTORS:

1. Department of Microbiology, Vinayaka Missions Hospital, Salem, Tamil Nadu, India.

NAME, ADDRESS, TELEPHONE, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. K.M.Mohanasoundaram ,
Department of Microbiology Vinayaka Missions Hospital
Salem No,14, 3rd Street, Malligai nagar, Kandaiyan thottam,
Soolai, Erode, India - 638004.
Phone: 94431-32290
E-mail: mohanapalani@gmail.com

DECLARATION ON COMPETING INTERESTS:

No competing Interests.

Date of Submission: **Sep 27, 2011**
Date of Peer Review: **Jan 18, 2012**
Date of Acceptance: **Feb 09, 2012**
Date of Publishing: **May 01, 2012**