



CAUSATIVE ORGANISMS AND THEIR ANTIBIOTIC SENSITIVITY IN PATIENTS WITH DIFFERENT WAGNER'S GRADES OF DIABETIC FOOT.

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ABSTRACT

INTRODUCTION: Diabetes mellitus is a modern-day epidemic, with number of people with diabetes having quadrupled in the last three decades. With one in every three people living with pre-diabetes, the prevalence is only expected to rise and together with it, may increase the many complications namely blindness, kidney failure, cardiac arrest, stroke and lower limb amputation. While much effort is dedicated to control of diabetes, it is imperative that meanwhile efforts also be directed at curbing the complications. **OBJECTIVE:** To determine the frequency, causative organisms and their antibiotic sensitivity in patients with different Wagner's grades of diabetic foot. **METHODOLOGY:** This cross-sectional analysis was carried out from August 2018 to January 2019 upon a sample of 60 consenting adult diabetic patients of both genders aged 20 to 70 years (chosen via non-probability, consecutive sampling) having taken no systemic antibiotic therapy for at least the past 48 hours, presenting to the Department of Medicine, at Liaquat University of Medical & Health Sciences, Jamshoro/Hyderabad with diabetic foot infection. The patients were categorized in groups according to Wagner's classification and their data recorded onto a questionnaire containing inquiries pertaining to their basic bio data, socio-demographic details, disease particulars, infecting micro-organisms and antibiotic sensitivity patterns. The data obtained was analyzed using SPSS v. 21.0. **RESULTS:** The mean age of the sample stood at 41 years (± 9 SD). 62% of the sample comprised of males while the remaining 38% were females. Wagner's grades in decreasing order of occurrence were grade 3 (36%), grade 2 (28%), grade 4 (20%), grade 1 (10%) and grade 5 (6%). The commonest isolated organisms were *Klebsiella pneumoniae*, followed by *Proteus mirabilis*, *Staphylococcus aureus*, and *Escherichia coli*. Carbapenems (imipenem and meropenem), Piperacillin and Tazobactam, Amikacin and Vancomycin were among the most effective agents. **CONCLUSION:** After careful consideration, it can be concluded that Gram Negative organisms were the commonest causative organisms and knowing their sensitivity patterns may help with timely and informed start of appropriate empirical antibiotic therapy.

KEYWORDS: Diabetes Mellitus, Diabetic Foot, Lower Limb Amputation, Bacteriology & Antibiotic Sensitivity

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INTRODUCTION

Diabetes Mellitus (including Type 1 and Type 2, among others) is a globally prevalent non-communicable disease involving hyperglycemia and altered metabolic control, with high associated morbidities and mortalities. According to the estimates of the International Diabetes Federation, it was

estimated that in 2017 there are 451 million (age 18–99 years) people with diabetes worldwide. These figures were expected to increase to 693 million by 2045⁽¹⁾. The most recent 2nd National Diabetes Survey reports the prevalence of diabetes in Pakistan to be 26.3% and pre-diabetes as 14.4%⁽²⁾. Diabetic

foot infection, a common complication encountered in diabetics, begins with progressive loss of sensation in feet, followed by diabetic peripheral neuropathy, peripheral arterial disease and/or infection secondary to compromised microcirculation, resulting in the diabetic foot syndrome. Other complications accompany, such as Charcot neuro-arthropathy and osteomyelitis. The result is the eventual loss of the foot via amputation to curb the infection⁽³⁾. Research from within Pakistan suggests that nearly 1 in 10 of all individuals with diabetes suffer from a foot ulcer and the amputation rate among the sufferers is nearly 50%⁽⁴⁾. In the year 2005, the direct cost (cumulative mean) of amputations in Pakistan stood at almost PKR 100,000 ± 30,742 which would yield a projected current cost of over USD 1.5 million at the present time (adjusted to the nearest integer⁽⁵⁾). Additionally, urban settlements reported higher prevalence of diabetes when compared to rural populations. One such research reports that individuals residing in rural areas are less affected (2.8%) with diabetes than their urban residing peers⁽⁶⁾. Furthermore, earlier studies have found *S. aureus* as the main causative pathogen but recent investigations reported a predominance of gram-negative organisms; *E. Coli*, *Pseudomonas aeruginosa*, *Klebsiella* species, *Proteus Mirabilis*⁽⁷⁾. Furthermore, severe infections are often poly-microbial, requiring hospitalization and treatment with broad spectrum antibiotics along with appropriate medical and surgical interventions. Local data in the Pakistani population pertaining to antibiotic sensitivity patterns in patients with different Wagner's grades of diabetic foot has not been brought up to date in light of changing sensitivity patterns. This research hopes to fill this gap by identifying the common organisms and their antibiotic sensitivity patterns and emerging drug resistant strains thus facilitating the timely start of informed therapy. The Wagner's grade is utilized commonly in clinical practice and the grade refers to the degree of severity of infection of the diabetic foot. It is divided into 6 individual grades (i.e., 0, 1, 2, 3, 4 and 5) in increasing order of severity of foot infection⁽⁸⁾.

Table 1: Wagner's Classification of Diabetic Foot

Grade 0	Intact skin without any infection
Grade 1	Superficial ulcer without any deep involvement.
Grade 2	Deep ulcer reaching tendon or bone /joint.
Grade 3	Deep ulcer with abscess / osteomyelitis.
Grade 4	Forefoot gangrene.
Grade 5	Full foot gangrene

MATERIALS AND METHODS

This was a hospital-based, cross sectional descriptive study to determine the frequency, causative organisms and antibiotic sensitivity in diabetic patients with different Wagner grades of Diabetic foot over a six-month period from 01-08-2018 to 01-01-2019 in Department of Medicine (OPD and inpatient), Liaquat University Hospital, Hyderabad / Jamshoro. Non-probability consecutive sampling was utilized for sample collection. Following informed consent, the data was collected on pre-designed proforma. Inclusion criteria were: Patients of both genders, between age 20 years and 70 years, diagnosed with Diabetes mellitus type 1 or 2. i.e., the serum fasting blood sugar level above 126 mg/dl along with HbA1c levels above 6.5% considered as Diabetes mellitus, who were willing to participate in the study after informed consent. Exclusion criteria were patients who had received antibiotics 48 hours prior to culture sample and patients with malignancy. The collected data was entered in SPSS (version 20.0) and analysed accordingly. The frequency and percentage were calculated for gender, residence (urban or rural), type of diabetes mellitus, Wagner's grade, causative organism, antibiotic sensitivity and resistance, type of ulcer, and probable risk factors. The mean and standard deviation (SD) were calculated for quantitative variables such as age, duration of diabetes mellitus, duration of foot ulcer and random blood sugar. The stratification was done for age, gender, and ulcer grade and ulcer duration to see the effect on outcome and to control the effect modifiers. The post stratification Chi-square test was applied on categorical variables at 95% confidence interval and the p-value ≤0.05 was considered as statistically significant.

RESULTS

A total of 60 patients were recruited in this study. The mean age of the sample stood at 41 years (±9 SD). 61.6% of the sample comprised of males while the remaining 38.4% were females. A greater proportion (nearly 70%) of the study participants hailed from rural areas. 26% of the sample was diagnosed with Type I diabetes mellitus, while type II diabetes mellitus was documented in the remaining 74% of the study participants. The mean time elapsed since development of diabetic foot ulcer among the patients was 38 days (±11 SD). The mean time elapsed since diagnosis of diabetes (either type) was 9 years (±4 SD). The mean recorded random blood sugar of the sample was 353 mg/dl. Wagner's grades

in decreasing order of occurrence were Grade 3 (36%), Grade 2 (28%), Grade 4 (20%), Grade 1 (10%) and Grade 5 (6%). The commonest isolated organisms were Klebsiella pneumoniae, Proteus mirabilis, Staphylococcus aureus, and Escherichia coli. Carbapenems (Imipenem and Meropenem), Amikacin, Piperacillin and Tazobactam and Vancomycin were among the most effective agents.

Figure 1: Antibiotic Sensitivity Patterns among study subjects with Diabetic Foot

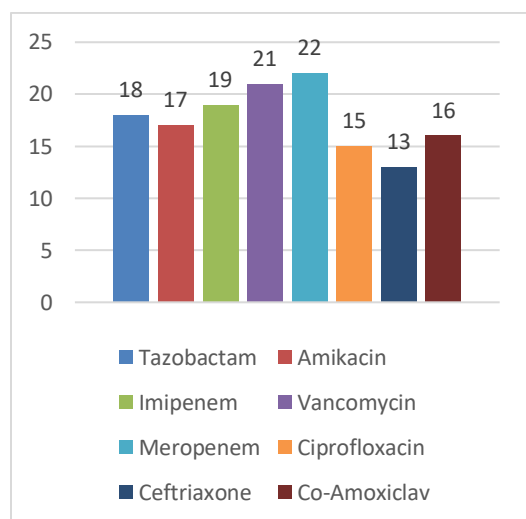
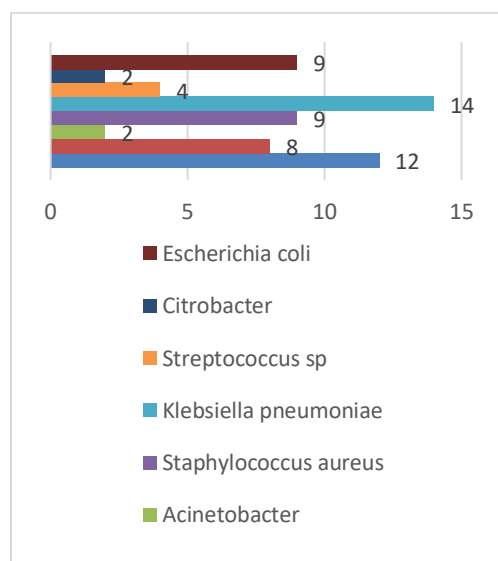


Figure 2: Causative organisms among study subjects with Diabetic foot



DISCUSSION

With the rising incidence of diabetes, more people will fall prey to diabetic foot infections, worldwide. These ulcers are debilitating and have significant rates of recurrence despite standard management. Published evidence states that middle aged individuals are mostly affected by the condition (9). This research observed a similar trend as the mean age of the sample stood at 41 years (± 9 SD). The age of the

study sample was normally distributed with no skewedness at either extreme of age. There was a predisposition towards the male gender with 61.7% of the sample comprising of males while the remaining 38.3% being comprised of females. Literature review reveals that there is conflicting evidence on the matter with some suggesting that the condition is more common in females than in males, while others reporting that diabetes is more prevalent in men (16.7%) than in women (9.5%) (9). In this research, 30% of the study participants belonged to urban areas, while the remaining 70% hailed from rural background, additionally most of the patients with advanced disease were from rural background.. Recent research by Dagenais et al, shows that age-adjusted prevalence of diabetes mellitus is significantly higher in the urban population compared to rural population (10). Anecdotally, it is suggested that different diabetes prevalence among cohorts of patients inhabiting urban and rural set-ups may arise from differences in quality and type of food and differing levels of physical activity which needs to be evaluated by comprehensive population-based studies. However, there may be another side to this aspect which is yet to be explored at length. The urban population may lead lifestyles that are less precarious to the feet and less opportunity of injuries may arise with less active lifestyles and greater affluence and access to better awareness of pedal care and easier access to medical care in instances of injury to the feet. On the other hand, rural population is more prone to the foot injuries due to their life style, lack of awareness and lack of medical facilities. Wagner’s grades in decreasing order of occurrence were grade 3 (36%), grade 2 (28%), grade 4 (20%), grade 1 (10%) and grade 5 (6%). Thus, showing that most of the study participants were at a moderate phase of infection and a smaller percentage had progressed to much worrisome stages. The commonest types of ulcers in our research were neuro-ischemic, followed by ischemic and then finally neuropathic. This may be attributed to the fact that a greater proportion of our study subjects presented with higher grades of ulcers and such types of ulcers usually pertain to higher Wagner grades. Literature too supports this assumption (9). Most infections were poly-microbial, with greater prevalence of Gram-Negative bacteria. This is synonymous with published evidence suggesting a similar bacteriologic trend. Carbapenems (imipenem and meropenem), Piperacillin and tazobactam were the commonest antibiotics to which the bacteria were sensitive. Gram positive bugs were

most sensitive to vancomycin⁽⁷⁾. Pharmacologic agents that had formerly been used commonly at our clinical setting such as ciprofloxacin, ceftriaxone and combination drugs such as co-amoxiclav, did not produce encouraging sensitivity values. On analysing the bacteriology of different Wagner's grades of ulcers, it was revealed that staphylococcus aureus and Klebsiella were the commonest organisms afflicting patients in Grade 1. E. coli, Klebsiella and Staphylococcus aureus were commonest among Grade 2, Klebsiella and Proteus Mirabilis were common in Grade 3, Proteus Mirabilis, and Staphylococcus aureus were common in Grade 4 and among the commonest in Grade 5 were Proteus, Klebsiella and Staphylococcus aureus. The findings of this research were synonymous with another bacteriological study that reveals Staphylococci to be common in grade 1. Klebsiella and E. coli too are likewise common in grade 2 ulcers in this research and comparative investigation from literature. Interestingly, evidence based literature does not show a similar trend in terms of Proteus mirabilis being common among higher Wagner's grades as in this research and thus it is advisable that drugs affecting the microorganism to be empirically administered to patients with higher grades of Wagner's ulcers at our study setting and adjoining healthcare set-ups⁽⁷⁾.

CONCLUSION:

Foot ulcers may be considered the single most distressing morbidity associated with diabetes; leading to decreased mobility, greater limitations for social and psychological functioning and general well-being. This together with the added burden (monetary and otherwise) in term of regimen of treatment contributes to the reportedly poorer health-related quality of life scores than diabetic patients with diabetes without foot ulcers. The importance of appropriate care of feet, timely detection and appropriate treatment together with optimized glycemic control (and control of damaging habits such as smoking) cannot be stressed enough. Timely identification of at-risk individuals and administration of directed care may save economic cost which is often among the priorities of the patients and the health authorities in the developing world.

ETHICS APPROVAL: The ERC gave ethical review approval

CONSENT TO PARTICIPATE: written and verbal consent was taken from subjects and next of kin

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CONFLICT OF INTEREST: No competing interest declared.

REFERENCES:

1. Cho NH, Shaw JE, Karuranga S, Huang Y, da Rocha Fernandes JD, Ohlrogge AW, et al. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Research and Clinical Practice*. 2018; 138.
2. Basit A, Fawwad A, Qureshi H, Shera AS, Ur Rehman Abro M, Ahmed KI, et al. Prevalence of diabetes, pre-diabetes and associated risk factors: Second National Diabetes Survey of Pakistan (NDSP), 2016-2017. Vol. 8, *BMJ Open*. 2018.
3. Bandyk DF. The diabetic foot: Pathophysiology, evaluation, and treatment. *Seminars in Vascular Surgery*. 2018; 31(2-4).
4. Syed F, Arif MA, Afzal M, Niazi R, Ramzan A, Hashmi UEL. Foot-care behaviour amongst diabetic patients attending a federal care hospital in Pakistan. *Journal of the Pakistan Medical Association*. 2019; 69(1).
5. Muhammad Labeeq, Tariq MA, Tung SA, Yar MA, Rehman W, Badar Ehsan S. The Economic impact of Lower Extremity Amputations in Diabetics. A retrospective study from A Tertiary Care Hospital of Faisalabad, Pakistan. *Pakistan Journal of Surgery and Medicine*. 2020; 1(1).
6. Aamir AH, Ul-Haq Z, Mahar SA, Qureshi FM, Ahmad I, Jawa A, et al. Diabetes Prevalence Survey of Pakistan (DPS-PAK): Prevalence of type 2 diabetes mellitus and prediabetes using HbA1c: A population-based survey from Pakistan. Vol. 9, *BMJ Open*. 2019.

7. Nageen A. The most prevalent organism in diabetic foot ulcers and its drug sensitivity and resistance to different standard antibiotics. *Journal of the College of Physicians and Surgeons Pakistan*. 2016; 26(4).
8. Huang Y, Xie T, Cao Y, Wu M, Yu L, Lu S, et al. Comparison of two classification systems in predicting the outcome of diabetic foot ulcers: The Wagner grade and the Saint Elia Wound score systems. *Wound Repair and Regeneration*. 2015; 23(3).
9. Zhang P, Lu J, Jing Y, Tang S, Zhu D, Bi Y. Global epidemiology of diabetic foot ulceration: a systematic review and meta-analysis†. Vol. 49, *Annals of Medicine*. 2017.
10. Dagenais GR, Gerstein HC, Zhang X, McQueen M, Lear S, Lopez-Jaramillo P, et al. Variations in diabetes prevalence in low-, middle-, and high-income countries: Results from the prospective urban and rural epidemiological study. *Diabetes Care*. 2016; 39(5).



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