COMMUNITY-ACQUIRED PSEUDOMONAL GROWTH IN PATIENTS WITH DIABETIC FOOT INFECTION AND ITS ANTIBIOTIC SENSITIVITY PATTERN

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ABSTRACT

Objective: This study aimed to determine community-acquired pseudomonas aeruginosa growth in patients with diabetic foot infections and check its antibiotic sensitivity patterns.

Materials And Methods: This descriptive cross-sectional study was performed on 180 diabetic patients with foot infections. Blood samples and wound culture samples were sent to the hospital laboratory for analysis. Data was analyzed using SPSS version 20.0. After stratification, the chi-square test was applied, keeping the p-value less than 0.05 as significant.

Results: The mean and standard deviation for age was 58.9± 5.9 years. One hundred and two (56.7%) patients were male, while 78(43.3%) were female. Pseudomonas aeruginosa was isolated from 16.1 % of patients with diabetic foot infections. Nearly 100% were sensitive to colistin and polymyxin B. Piperacillin, tazobactam, and imipenem showed a sensitivity of 93.1%, while cefipime and amikacin showed a sensitivity of 89% and 82%, respectively.

Conclusion: Pseudomonas aeruginosa is a commonly isolated gram-negative rod from patients with diabetic foot infections, especially in our setup. It is usually resistant to commonly prescribed oral antibiotics and requires hospital admission for intravenous antibiotics. Pseudomonas aeruginosa growth is equally common in males and females and patients with different socioeconomic and educational classes.

Keywords: Diabetes mellitus, Diabetic foot infection, Culture and Sensitivity

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INTRODUCTION

Diabetes mellitus is defined as a chronic metabolic disease characterized by persistent hyperglycemia. Hyperglycemia is due to impaired secretion of insulin or resistance to the action of insulin at the tissue level, or the presence of both. [1] The worldwide frequency of diabetes mellitus has amplified from 108 million in 1980 to 425 million in the year 2017, and it is expected to be 630 million by the year 2045. [2] The frequency of diabetes mellitus in Pakistan was approximately 17%, and pre-diabetes was 11% in the year 2019. [3]

Diabetes Mellitus encompasses pathology of vasculature leading to both micro-vascular and macro-vascular complications. [4] Micro-vascular complications of DM comprise neuropathy, nephropathy, and retinopathy, whereas macro-vascular complications include cardiovascular diseases like coronary artery disease, cerebrovascular disease, and peripheral artery disease. [5] Diabetic foot ulcer has been defined as the occurrence of foot ulcer related to neuropathy, peripheral artery disease, and foot infection. [6]

Approximately 25 percent of diabetic patients will develop a foot ulcer in their lifespan. There is a greater all-cause mortality percentage in diabetic patients with a Diabetic Foot Ulcer than in those without foot ulcers. [7] The infection encompassing the foot wound fallouts from the microbial incursion into the involved tissue in sufficient amounts to provoke a host response, resulting in compromised wound healing. The worldwide frequency of Diabetic Foot Infection has been described between 25 and 50 percent. [8] Diabetic foot infections (DFI) are frequently poly-microbial, involving both gram-positive, gram-negative and anaerobic bacteria. [9] Previously, gram-positive organisms were most commonly isolated from diabetic foot infections, but there is now a shifting tendency noted in various studies, with gram-negative bacteria replacing gram-positive bacteria as the causative organism in diabetic foot infections and pseudomonas aeruginosa having a prevalence of 13.54%. [10] Pseudomonas presents a grave

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therapeutic challenge for both treatment and cost burden.

Keeping in mind the higher prevalence of gram-negative organisms causing diabetic foot infections and pseudomonas aeruginosa being a therapeutic challenge, this study is being conducted to find the frequency of pseudomonas aeruginosa growth in diabetic foot infection and its antibiotic sensitivity. The objective of the study was to determine the frequency of pseudomonal growth in patients with diabetic foot infection and its antibiotic sensitivity pattern. This study will help in prescribing empirical treatment for pseudomonas infection of the foot in diabetic patients in areas where wound culture and sensitivity tests are not available.

MATERIAL AND METHODS

This study was conducted in the endocrinology unit of Lady Reading Hospital, Peshawar, on 180 patients with diabetic foot infections after approval from the hospital's ethical committee. Written informed consent was taken from all the patients, and a non-probability consecutive sampling technique was used. Symptomatic (polyuria, polydipsia) patients with random blood glucose of more than 200 mg/dl or HBA1C of more than 6.5 were labeled as having diabetes (both newly diagnosed and those already on treatment). Diabetic patients with foot ulcers and purulent discharge with two more of the following, including white cell count of more than 10000 per cubic milliliter, signs of inflammation (swelling, redness, and pain), and raised inflammatory markers, were labeled as having diabetic foot infection. Pseudomonas is a bacterium and belongs to the gram-negative rod family. When an antibiotic produces an inhibitory zone of 14 mm or more for a bacterium at 37 degrees centigrade, that specific bacterium is said to be sensitive to that antibiotic, and an inhibitory zone of less than 14 mm will be considered as resistant. Infections that develop within 48 hours of hospital admission were labeled as community-acquired.

Patients with diabetic foot infections who had not received antibiotics were included in this study. Patients who received antibiotics before hospital visits were excluded from the study. Samples of blood were taken from all patients and were sent to the hospital laboratory for measurement of complete blood count, CRP, random blood sugars, and HBA1C. Swabs from wounds were taken using sterile culture sticks and were sent to the hospital laboratory for culture and sensitivity. Information regarding demographics was taken and recorded using pro forma. Data was analyzed using SPSS version 20.0. Means and standard deviations were calculated for continuous variables like age, HBA1C, and duration of diabetes. Frequencies and percentages were calculated for categorical variables like gender, pseudomonas growth, education, socioeconomic status, and residence. Pseudomonal growth was stratified against gender, education, socioeconomic status, and residence to see effect modification. Post-stratification chi-square tests were applied, keeping the p-value less than 0.005 as significant. Results were presented in tables.

RESULTS

This study was conducted on 180 patients with diabetic foot infections. The following results emerged from the analysis. The mean and standard deviation for age was 58.9 ± 5.9 years, the mean and standard deviation for HBA1c was 9.6 ± 1.8, while the mean and standard deviation for the duration of diabetes was 9.8 ± 3.0 years. One hundred and two (56.7%) patients were male, while 78 (43.3%) patients were female. Fifty-six (31.1%) patients were illiterate, 78 (43.3%) patients had primary education, and 30 (16.7%) patients had intermediate education, while 16 (8.9%) patients had secondary and higher qualifications. Ninety-one (50.6%) patients belonged to rural areas, while 89 (49.4%) patients represented urban areas. Sixty (33.35) patients had monthly income less than Rs.16000, 80 (44.4%) patients had monthly income between Rs.16000 and 35000 and 40 (22.2%) patients were having monthly income more than Rs.35000. Pseudomonas was found in 29 (16.1%) patients while 151 (83.9%) patients did not show pseudomonal growth (Table no. 1).

Pseuodomonal growth was stratified among gender, socioeconomic status, education status, and residence for effect modifications using the chi-square test, and the results are shown in Tables no 2,3,4, and 5. Gender and pseudomonal growth cross-tabulation showed no significant difference in pseudomonal growth among male and female patients. The Chi-square test was applied and showed a value of 0.5 (table no. 2).

Pseudomonas growth and socioeconomic status cross-tabulation showed no significant difference among different socioeconomic status patients with a p-value of 0.9 (Table no. 3) Pseudomonal growth and education status cross-tabulation showed that the majority of patients with pseudomonal growth were either illiterate or had primary education qualifications. The chi-square test was applied giving a p-value of 0.6 (table no. 4). Pseudomonal growth and residence cross-tabulation showed no significant difference in growth among patients with rural and urban residences, with a p-value of 0.39 (table no. 5). The sensitivity of pseudomonas was checked against commonly used antibiotics (Table no. 6). Isolates showed 100 % sensitivity to colistin and polymyxin B. Imipenem, meropenem, and piperacillin, tazobactam were sensitive against 93.1% isolates of pseudomonas aeruginosa.

DISCUSSION

Diabetic foot infection is one of the common chronic complications of diabetes with significant morbidity. Many different bacterial pathogens including Pseudomonas aeruginosa are responsible for diabetic foot infections. Pseudomonas aeruginosa isolated from these infections are usually multidrug resistant. In our study, we found that pseudomonas as aeruginosa was isolated from 16.1% of patients with diabetic foot infections, which were resistant to the majority of commonly prescribed oral

Table No 1: Pseudomonal Growth in DFI

	Frequency	Percent
Yes	29	16.1
No	151	83.9
Total	180	100.0

Table No 2: Gender and Pseudomonal Growth Cross Tabulation

			Pseudomonal Growth		Total	P value
			yes	no		
Gender	Male	Count	18	84	102	
		% within gender	17.6%	82.4%	100.0%	0.5
	Female	Count	11	67	78	
		% within gender	14.1%	85.9%	100.0%	
Total		Count	29	151	180	
		% within gender	16.1%	83.9%	100.0%	

Table No 3: Pseudomonal Growth Socioeconomic Status Cross Tabulation

			Socioeconomic Status			Total	P value
			Less than 16000	16 to 35000	More than 36000		
Pseudomonal Growth	Yes	Count	10	12	7	29	
		% Within pseudomonal growth	34.5%	41.4%	24.1%	100.0%	0.9
	No	Count	50	68	33	151	
		% Within pseudomonal growth	33.1%	45.0%	21.9%	100.0%	
Total		Count	60	80	40	180	
		% Within pseudomonal growth	33.3%	44.4%	22.2%	100.0%	

Table No 4: Pseudomonal Growth Education Status Cross Tabulation

			Socioeconomic Status				Total	P value
			Illiterate	Primary	Intermediate	Secondary and Higher		
Pseudomonal growth	Yes	Count	9	15	3	2	29	
		% Within pseudomonal growth	31.0%	51.7%	10.3%	6.9%	100.0%	0.6
	No	Count	47	63	27	14	151	
		% Within pseudomonal growth	31.1%	41.7%	17.9%	9.3%	100.0%	
Total		Count	56	78	30	16	180	
		% Within pseudomonal growth	31.1%	43.3%	16.7%	8.9%	100.0%	

Table No 5: Pseudomonal Growth Residence Cross Tabulation

			Residence		Total	P value
			Rural	Urban		
Pseudomonal growth	Yes	Count	17	12	29	
		% within pseudomonal growth	58.6%	41.4%	100.0%	0.39
	No	Count	74	77	151	
		% within pseudomonal growth	49.0%	51.0%	100.0%	
Total		Count	91	89	180	
		% within pseudomonal growth	50.6%	49.4%	100.0%	

and intravenous antibiotics. A study published in the Journal of the American Podiatric Medical Association showed that pseudomonas aeruginosa was the most commonly isolated organism (25%) followed by staphylococcus aureus. [11] Another study published in the International Journal of Microbiology showed that 55% of pseudomonas aeruginosa species isolated from diabetic foot ulcers were resistant to more than 10 antibiotics. Most of these strains were sensitive to cefotaxime and ciprofloxacin.[12] In our study, pseudomonas showed 100% sensitivity to colistin and polymyxin B followed by imipenem, meropenem, piperacillin, and tazobactam.

A study published in the American Journal of Podiatric Medical Association showed that pseudomonas aeruginosa was isolated from 5.4% of patients with diabetic foot ulcers. Commonly isolated organisms were streptococcal species and staphylococcus aureus. Pseudomonal growth was not related to age, HBA1c, and prior antibiotic use. [13] We did not study risk factors for pseudomonas growth in detail and the prevalence of pseudomonal growth in our study was higher than the mentioned study. A study done in India showed that 56% of organisms isolated from patients with diabetic foot infections were gram-negative rods, the majority of which were pseudomonas aeruginosa and 44% of these pseudomonal growth were multidrug resistant.[14] Another study done in Egypt showed that Pseudomonas aeruginosa is the most common gram-negative bacteria isolated from diabetic foot ulcers. The majority of these were sensitive to meropenem and amikacin. [15] In our study, sensitivity to meropenem was 93.1% and sensitivity to amikacin was more than 80%. Another study from Nigeria demonstrated that Pseudomonas aeruginosa and Staphylococcus aureus are the most common organisms causing diabetic foot infections. 71% of isolates of pseudomonas were sensitive to levofloxacin. [16] Sensitivity to levofloxacin in our study was lower than this and was approximately 62%.

A study done in Iran revealed Pseudomonas aeruginosa was isolated from 7% of patients with diabetic foot infections. The majority of these isolates were sensitive to meropenem. [18] Sensitivity to meropenem in our study was 93.1% and sensitivity to colistin and polymyxin B were 100% which were not tested in the mentioned study. Another study done in Gujrat, India presented that pseudomonas is the most common organism isolated from diabetic foot ulcers. 27% of these isolates were of pseudomonas aeruginosa. Fifty percent of these were extended-spectrum beta-lactamase producers. The majority of these species were sensitive to meropenem[18]. Pseudomonas aeruginosa producing extended-spectrum beta-lactamase and those not producing extended-spectrum beta-lactamase were not studied in detail in our study, but the majority of pseudomonal growth was multidrug resistant. A study done in Italy revealed that 11.7% of isolates from patients with diabetic foot ulcers were Pseudomonas aeruginosa. Fifty-seven percent of these strains were resistant to fluoroquinolones, 23% were resistant to carbapenems and 17.5% were resistant to piperacillin. [19] Resistance to fluoroquinolones was 49% while carbapenem, piperacillin, and tazobactam showed 7% resistance respectively to pseudomonas in our study. This study was done on patients presented to Lady Reading Hospital, Peshawar, so there is a lack of generalizability of results. The risk factors responsible were not studied in detail. Sensitivity to some of the commonly prescribed antibiotics was not checked due to limited resources

CONCLUSION

Pseudomonas aeruginosa is a commonly isolated gram-negative rod from patients with diabetic foot infections especially in our setup. This is usually resistant to commonly prescribed oral antibiotics and requires hospital admission for intravenous antibiotics. Pseudomonas aeruginosa growth is equally common in males and females and in patients with different socioeconomic and education classes. Pseudomonas aeruginosa is among the commonly isolated organisms from diabetic foot infection in our part of the world and is usually resistant to commonly prescribed antibiotics. Care must be taken while prescribing antibiotics to patients with diabetic foot infections when pseudomonas aeruginosa growth is expected to avoid resistance. Antibiotics must be used for two to four weeks in diabetic foot infections due to pseudomonas aeruginosa. Further studies are needed to know the risk factors responsible for pseudomonal growth and its resistance patterns in diabetic foot infection.

REFERENCES

1. Zheng Y, Ley SH, Hu FB. Global etiology and epidemiology of type 2 diabetes mellitus and its complications. Nat Rev Endocrinol. 2018 Feb;14(2):88-98.
2. Glovaci D, Fan W, Wong ND. Epidemiology of diabetes mellitus and cardiovascular disease. Current cardiology reports. 2019 Apr;21:1-8.
3. Aamir AH, Ul-Haq Z, Mahar SA, Qureshi FM, Ahmad I, Jawa A, Sheikh A, Raza A, Fazid S, Jadoon Z, Ishtiaq O. Diabetes Prevalence Survey of Pakistan (DPS-PAK): prevalence of type 2 diabetes mellitus and prediabetes using HbA1c: a population-based survey from Pakistan. BMJ open. 2019 Feb 1;9(2):e025300.
4. Chawla A, Chawla R, Jaggi S. Microvascular and macrovascular complications in diabetes mellitus: distinct or continuum? Indian J Endocrinol Metab. 2016 Jul;20(4):546.
5. Chawla A, Chawla R, Jaggi S. Microvascular and macrovascular complications in diabetes mellitus: distinct or continuum? Indian J Endocrinol Metab. 2016 Jul;20(4):546.
6. Papatheodorou K, Banach M, Edmonds M, Papanas N, Papazoglou D. Complications of diabetes. Journal of diabetes research. 2015;2015.
7. Hicks CW, Selvin E. Epidemiology of peripheral neuropathy and lower extremity disease in diabetes. Curr. Diabetes Rep. 2019 Oct;19(10):1-8.
8. Jia L, Parker CN, Parker TJ, Kinnear EM, Derhy PH, Alvarado AM, Huygens F, Lazzarini PA, Diabetic Foot Working Group, Queensland Statewide Diabetes Clinical Network (Australia). Incidence and risk factors for developing infection in patients presenting with uninfected diabetic

foot ulcers. PloS one. 2017 May 17;12(5):e0177916.

9. Akhi MT, Ghotaslou R, Asgharzadeh M, Varshochi M, Pirzadeh T, Memar MY, Bialvaei AZ, Sofla HS, Alizadeh N. Bacterial etiology and antibiotic susceptibility pattern of diabetic foot infections in Tabriz, Iran. GMS hygiene and infection control. 2015;10.
10. Miyan Z, Fawwad A, Sabir R, Basit A. Microbiological pattern of diabetic foot infections at a tertiary care center in a developing country. Age Years. 2017;53:10-20.
11. Ertugrul BM, Lipsky BA, Ture M, Sakarya S. Risk factors for infection with Pseudomonas aeruginosa in diabetic foot infections. J. Am. Podiatr. Med. Assoc.2017 Nov 1;107(6):483-9.
12. Sivanmaliappan TS, Sevanan M. Antimicrobial susceptibility patterns of Pseudomonas aeruginosa from diabetes patients with foot ulcers. Int. J. Microbiol. 2011 Oct;2011.
13. Young H, Knepper B, Hernandez W, Shor A, Bruntz M, Berg C, Price CS. Pseudomonas aeruginosa: an uncommon cause of diabetic foot infection. J. Am. Podiatr. Med. Assoc.2015 Mar 1;105(2):125-9.
14. Shankar EM, Mohan V, Premalatha G, Srinivasan RS, Usha AR. Bacterial etiology of diabetic foot infections in South India. Eur. J. Intern. Med. 2005 Dec 1;16(8):567-70.
15. Hefni AA, Ibrahim AM, Attia KM, Moawad MM, El-Ramah AF, Shahin MM, Al-Molla M, Al-Satar LA. Bacteriological study of diabetic foot infection in Egypt. J Arab Soc Med Res. 2013 Jun 1;8(1):26-32.
16. Agwu E. Prevalence of Quinolone susceptible Pseudomonas aeruginosa and Staphylococcus aureus in Delayed healing DFU's in Ekpoma, Nigeria.
17. Akhi MT, Ghotaslou R, Asgharzadeh M, Varshochi M, Pirzadeh T, Memar MY, Bialvaei AZ, Sofla HS, Alizadeh N. Bacterial etiology and antibiotic susceptibility pattern of diabetic foot infections in Tabriz, Iran. GMS Hyg Infect Control. 2015;10.
18. Ahmed A, Getti G, Boateng J. Medicated multi-targeted alginate-based dressings for potential treatment of mixed bacterial-fungal infections in diabetic foot ulcers. Int. J. Pharm.2021 Sep 5;606:120903.
19. Boschetti G, Sgarabotto D, Meloni M, Bruseghin M, Whisstock C, Marin M, Ninkovic S, Pinfi M, Brocco E. Antimicrobial resistance patterns in diabetic foot infections, an epidemiological study in Northeastern Italy. Antibiotics. 2021 Oct 13;10(10):1241.

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Authors Contribution:

Following authors have made substantial contributions to the manuscript as under

Authors	Conceived & designed the analysis	Collected the data	Contributed data or analysis tools	Performed the analysis	Wrote the paper	Other contribution
Khan S	✓	×	✓	×	✓	×
Ubaid M	✓	✓	×	✓	✓	×
Wazir N	×	✓	×	×	✓	×
Rehman MU	✓	✓	✓	×	✓	✓
Irfanullah	✓	✓	×	✓	✓	×
Ahmed I	×	✓	×	×	✓	×

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethical Approval:

This Manuscript was approved by the Ethical Review Board of Lady Reading Hospital, Peshawar. Vide No. 663/LRH/MTI. Dated: 14 02 2023