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Clinical Profile and Management of Diabetic Foot Infection at Hayatabad Medical Complex, Peshawar

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Abstract: Diabetic foot infection (DFI) represents a severe and potentially limb-threatening complication of long-standing and poorly controlled diabetes mellitus, a condition currently affecting over 422 million individuals globally and associated with more than 2 million annual deaths. This retrospective observational study was conducted at Hayatabad Medical Complex (HMC), Peshawar, with the objective of characterizing the clinical features, comorbidities, antibiotic regimens, and management outcomes of patients diagnosed with DFI. Clinical records of 341 patients admitted over a three-month period were reviewed. A male predominance was observed, with the highest prevalence noted among individuals aged 40–60 years. The majority of cases involved insulin-dependent diabetes mellitus, and an extended disease duration was identified as a major predisposing factor for DFI development. The mean hospitalization period was 25 days. Notably, complications such as peripheral neuropathy, diabetic nephropathy, and peripheral vasculopathy were more frequently documented in patients aged 65 years and older. Empirical treatment commonly involved poly-antibiotic regimens, which were administered in 64.81% of cases, underscoring the polymicrobial nature and severity of infections encountered. An amputation rate of 44.07% was recorded, which exceeds figures reported in comparable regional studies and is likely attributable to delayed clinical presentation and advanced stages of infection at the time of admission. The findings underscore the urgent need for enhanced early screening protocols, timely initiation of pathogen-targeted antimicrobial therapy, and multidisciplinary surgical intervention to reduce the risk of lower extremity amputation and the associated socio-economic burden.

Keywords: Diabetic foot infections; Neuropathy; Nephropathy; Vasculopathy; Antibiotics; Amputation; Poly-antibiotic therapy

1. Introduction

Diabetes mellitus is a serious global health concern, affecting approximately 422 million individuals worldwide and leading to more than 2 million deaths annually (Cousin et al., 2022). Diabetic foot infection (DFI) is a chronic condition of ulceration of poorly controlled and long-term diabetic patients (Raja et al., 2023). Among diabetic patients, 15% will develop foot ulcers. Foot infection is poorly treatable, and 14-24% will require amputation (CDC, 2020). The psychological burden associated with potential limb loss has been reported to exceed even the fear of death in many patients (Chastain et al., 2019).

Once infection develops in diabetic patients, it is difficult to cure it, depending on the severity of infection (Lavery et al., 2006). The mortality rate of DFI is more than that of prostate and breast cancer (Armstrong et al., 2007). Patients with severe infection have a substantial risk of mortality (Wukich et al., 2018).

Open wounds are the major cause of DFI in diabetic patients (Glenn et al., 2017; Hobizal & Wukich, 2012). According to some researchers, patients with wounds are more likely to get infections than those with intact skin (Lavery et al., 2006). Ulcerations are a common risk factor of DFI (Walsh et al., 2016), and other risk factors include neuropathy, nephropathy, vasculopathy, prior amputation, and walking barefoot (Lazzarini et al., 2018). Researchers have suggested that ulceration significantly increases mortality rate in this group (Robbins et al., 2008). DFI development and progression are multifactorial health concerns, breaching the skin and making it

susceptible to microbes (Lavery et al., 2006). *Staph. aureus*, *P. aeruginosa*, *E. coli*, etc. are the common bacteria of DFI.

Anti-microbial resistance has further complicated the rising incidence of DFI. Common microbes, found in infected feet, have developed resistance to most of the antibiotics. New molecular techniques have solved the problem of uncultivable microbes but clinicians face challenges in treatment, i.e., which pathogen should be targeted (Singh et al., 2023).

The incumbent study aims to examine the demographic factors of patients suffering from DFI and record clinical history, management strategies, and antibiotic prescribing patterns.

DFI remains a serious problem with prolonged hospitalization, high morbidity and high mortality rates, often leading to severe complications. There is a limited understanding of how demography, clinical records, and antibiotic prescribing patterns play roles in the care and management of DFI, despite advancement. Inappropriate antibiotic prescription leads to prolonged hospitalization and poor clinical outcomes. The current study focuses on carefully examining the demographic factor, clinical history, management strategies, and antibiotic prescribing patterns to improve the patients' care and management.

2. Methodology

A prospective and observational type of study was conducted at Hayatabad Medical Complex (HMC) and Peshawar. First, ethical approval was taken from the Post Graduate Medical Institute (PGMI), Hayat Abad Peshawar. Then, through a proper channel, permission was taken from the Medical Director (MD) and Deputy Medical Superintendent (DMS) of HMC, the Head of the Endocrinology Ward, and the Head of the Microbiology Section.

The study was carried out over a period of three months, from April 15, 2017 to July 15, 2017, during which a total of 341 patients diagnosed with DFI were examined. In this study, the inclusion criteria were specifically focused on patients diagnosed with diabetes mellitus and DFI. The primary aim was to assess the prevalence and characteristics of foot infections in individuals with diabetes, as these are common complications that can lead to severe health issues if left untreated. The study intentionally excluded patients who had other types of infections, such as upper and lower respiratory tract infections, urinary tract infections, or any other non-foot-related infections. This exclusion was essential to ensure that the study results were concentrated on DFI alone, revealing distinct pathophysiological mechanisms, risk factors, and treatment approaches. By narrowing the scope to just DFI, the research aimed to provide more specific insights into how the infection develops and progresses in diabetic patients. This also allowed for a clearer understanding of the impact of diabetes on foot health, ensuring that the outcomes are directly applicable to managing and preventing diabetic foot complications.

During observation, patients' demography, clinical history, antibiotic prescription and management outcomes were recorded in a history sheet, including name, age, sex, address, type of diabetes, durations of diabetes and diabetic foot, hospital stay, diabetic shoes, imputation (whether advised or not), medication (whether insulin dependent or not), number of antibiotics used and effectiveness. All these were present in the questionnaire entitled "Clinical Record of Diabetic Foot". Examinations of every patient were done 2-3 times and the observation, effectiveness and improvement of the infection were noted.

After collecting complete information on patients suffering from DFI, a statistical analysis was applied.

3. Results

Table 1. Demography of DFI

Variable	Categories	Frequency (n)	Percentage (%)	p-value
Sex	Male	220	61.10%	≈ 0.003
	Female	140	38.90%	
Age	< 30	18	5.27%	< 0.00001
	31 – 40	55	16.12%	
	41 – 50	125	36.65%	
	51 – 60	93	27.27%	
	> 60	50	14.66%	
Diabetes type	Insulin dependent	25	7.33%	< 0.00001
	Insulin independent	316	92.66%	

Note: $p < 0.005$ indicates statistical significance.

In this study, a total of 341 patients were examined at HMC, Peshawar, in a three-month period. In the current study, the incidence rate of DFI is 60.1% among the male patients and is 38.9% among the female ones. The p-value is about 0.003, which is statistically significant. In terms of age, the patients were divided into five groups, namely less than 30, 31-40, 41-50, 51-60, and above 60. The corresponding incidence rates are 5.27%, 16.12%,

36.65%, 27.27%, and 14.66%, respectively, and the p-value is less than 0.00001. However, patients using insulin account for 7.33%, and those not using insulin account for 92.66%, with the p-value being less than 0.00001. It demonstrates a significant result. The demographic details of the patients are given in Table 1.

Figure 1 demonstrates the duration of diabetes mellitus since onset and provides a visual representation. It shows how long each patient has been living with the condition. Figure 2 shows the current status of glycaemia. The bar chart represents the details of fasting blood sugar (FBS) and random blood sugar (RBS) levels of the diabetic patients with foot infections.

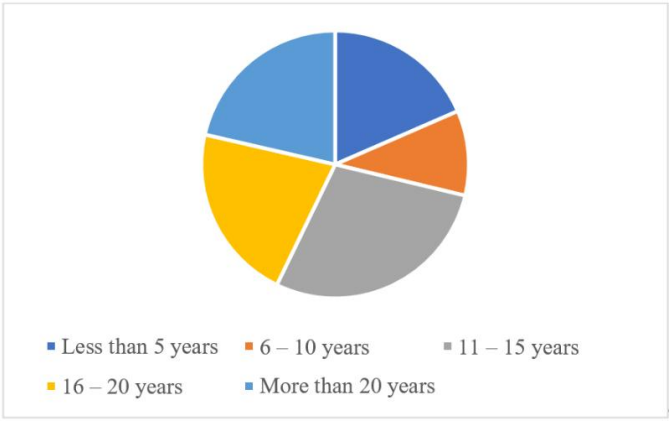

Figure 1. History of diabetes mellitus

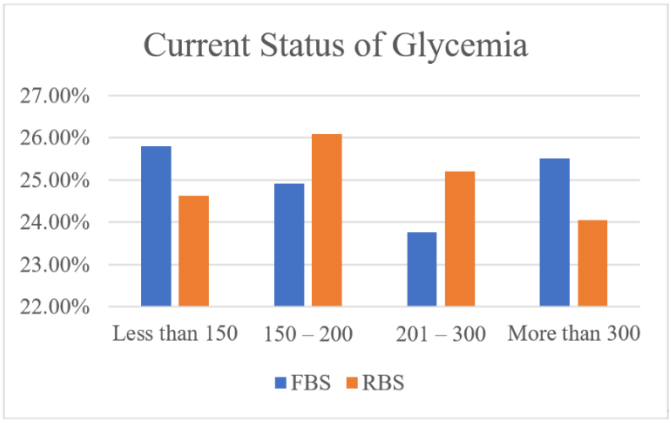

Figure 2. Current status of glycaemia

Upon careful examination of the patients, DFI duration was categorized since its onset, i.e., infected less than 1 month (46.33%), 1-2 months (25.21%), and more than 2 months (28.44%). The p-value is 0.002, which is statistically significant ($p < 0.05$). This suggests that the distribution across the infection duration categories is not uniform and potentially meaningful. In terms of prolonged hospitalization, 2.93% of patients stayed in the hospital for less than 1 month, 23.46% for 11-20 days, 47.8% for 21-30 days, and 25.80% for more than 30 days. The p-value is 4.23×10^{-18}, which is highly significant, indicating a very strong difference in the distribution of hospital stay durations, as shown in Table 2.

Table 2. History of DFI and hospital stay

History of DFI			**p-value**
Less than 1 month	158	46.33%	
1 – 2 months	86	25.21%	0.002
More than 2 months	97	28.44%	
Hospital Stay			**p-value**
Less than 10 days	10	02.93%	
11 – 20 days	80	23.46%	4.23×10^{-18}
21 – 30 days	163	47.80%	
More than 30 days	88	25.80%	

Note: $p < 0.05$ indicates statistical significance.

Common DFI complications include neuropathy, nephropathy and vasculopathy, and their occurrences are shown in Figure 3.

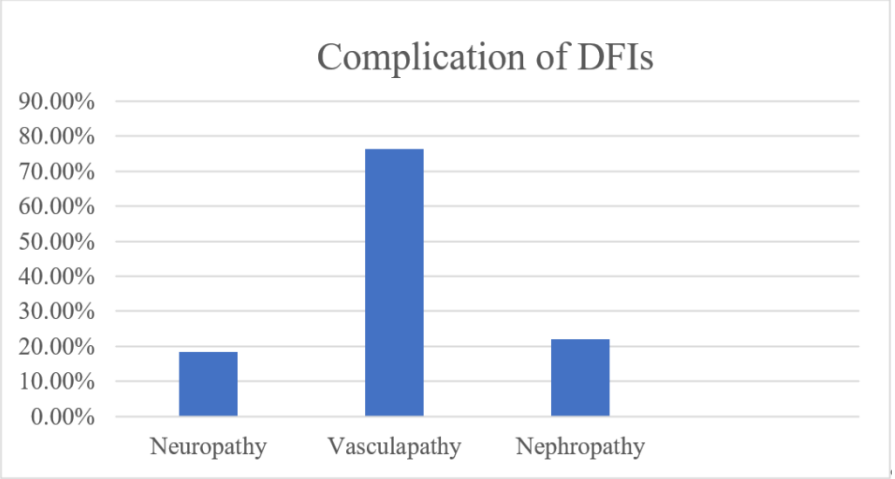

Figure 3. Complications of DFI

DFI management includes insulin prescription, antibiotic therapy, surgical intervention and specific shoe usage for diabetic patients. The treatment and management of DFI depend upon its severity and duration. As shown in Table 3, the diabetic patients using insulin account for 89.14% and those not using insulin account for 10.85%. Different numbers of antibiotics were prescribed, such as 1 (35.19%), 2 (31.67%), 3 (19.06%), 4 (8.21%), and 5 (5.86%). Surgical intervention includes imputation. 44.07% of patients were advised for imputation while 63.93% were not. The diabetic shoes were advised for all diabetic patients.

Table 3. Management of the diabetic foot ulcer

Insulin Prescription		
Prescribed insulin	304	89.14%
Not prescribed insulin	37	10.85%
Number of Antibiotics Prescribed		
1	120	35.19%
2	108	31.67%
3	65	19.06%
4	28	08.21%
5	20	05.86%
Amputation		
Advised amputation	151	44.07%
Not advised amputation	190	63.93%
Shoes Advised		
Shoes advised	341	100%
Shoes not advised	--	--

3.1 Antibiotic Prescription and Efficacy

In the current study, it can be noted that antibiotics were prescribed to individuals infected with diabetic foot. The most commonly prescribed antibiotic was Augmentin. It was given to most of the individuals (48 patients), with its effectiveness and non-effectiveness being recorded at 70.83% and 29.16%. Other antibiotics are Penro, Grasil, Tanzo, Moxiget, Cebac, Meropenem, Rocephin, Meroncan, Fuzidin, Cefzone, Calamox, Zyvox, Cleocin HCl, Colistin, Cipro, Abomox, Garamycin, Levaquin and Cefsol. Their effectiveness was recorded at 38.29%, 87.50%, 86.67%, 50%, 58.33%, 66.66%, 33.33%, 66.66%, 60%, 33.33%, 80%, 86.66%, 26.66%, 100%, 56.66%, 25%, 66.66%, 100%, and 75%, respectively. And their non-effectiveness was recorded at 61.7%, 14.28%, 13.33%, 50%, 41.66%, 33.33%, 66.66%, 33.33%, 40%, 66.66%, 20%, 13.33%, 73.33%, 0%, 44.33%, 75%, 33.33%, 0% and 25%, respectively. Flagyl is a protozoal antibiotic given to most of the patients. Its effectiveness was not mentioned in Figure 4. The test yielded a p-value of approximately 8.3×10^{-35}, which is highly significant ($p < 0.05$), indicating that the effectiveness of treatment varies significantly among the antibiotics.

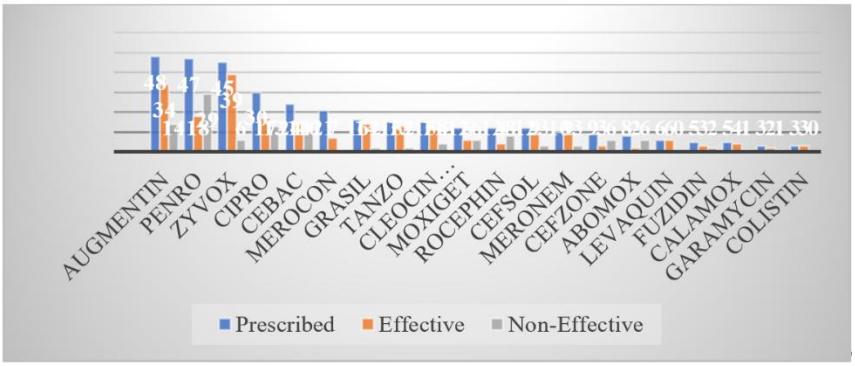

Figure 4. Antibiotic prescription and efficacy

3.2 Routes of Antibiotic Administration

Mostly antibiotics are given orally. But in the case of DFI, antibiotics were given either intravenously (IV) or intramuscularly (IM). Flagyl was mostly administered as IV and in few cases was orally. IV-administered antibiotics include Penro, Grasil, Tanzo, Augmentin, Cebac, Meronem, Rocephin, Merocan, Cefzone, Calamox, Zyvox, Cleocin, Colistin, Cipro, Garamycin, and Levaquin. Only Penro was administered as IM. It can be noted that Levaquin, Cleocin HCl and Calamox were also administered orally. Antibiotics administered only orally include Moxiget and Avelox. It can be noted that Fuzidin was the only topical antibiotic (Table 4).

Table 4. Routes of antibiotic administration

S. No	Trade Name	Route of Administration			
		IV	IM	Oral	Topical
1	Flagyl	*	-	*	-
2	Penro	*	*	-	-
3	Grasil	*	-	-	-
4	Tanzo	*	-	-	-
5	Augmentin	*	-	-	-
6	Moxiget	-	-	*	-
7	Cebac	*	-	-	-
8	Meronem	*	-	-	-
9	Rocephin	*	-	-	-
10	Merocan	*	-	-	-
11	Fuzidin	-	-	-	*
12	Cefzone	*	-	-	-
13	Calamox	*	-	*	-
14	Zyvox	*	-	-	-
15	Cleocin HCl	*	-	*	-
16	Colistin	*	-	-	-
17	Cipro	*	-	-	-
18	Avelox	-	-	*	-
19	Garamycin	*	-	-	-
20	Levaquin	*	-	*	-
21	Cefsol	*	-	-	-

4. Discussion

DFI is a serious issue worldwide, as its prevalence continuously rises, leading to serious socio-economic challenges. The current study was conducted in various hospitals across KP. 341 patients were examined over a three-month period, and their clinical records and medications (antibiotic prescriptions) were documented.

According to Gadepalli et al. (2006), male patients (85%) were predominant, whereas female ones accounted for 15%. However, in the current study, the proportion is slightly lower. The predominance of male patients in both studies may be attributed to the fact that the male is engaged in fieldwork and is more exposed to the infection than the female. Some researchers have suggested that slower healing in diabetic patients increases susceptibility to the infection (Vowden, 1997).

It can be noted that people of 40-60 years old have the highest risk, aligning with the findings of Gadepalli et al. (2006), who recorded 57 ± 11.29 years. Similarly, the insulin-dependent diabetic patients' proportion aligns with the study by Assaad-Khalil et al. (2014), who reported 96.75%.

The duration of diabetes since its onset is also a significant factor in the occurrence and development of DFI. The incumbent study shows a similar result to previous studies (54.5%) (Gadepalli et al., 2006). DFI often leads to prolonged hospitalization, depending on its severity. The clinical history shows 25 days of hospitalization on average, comparable to the study of Gadepalli et al. (2006), who reported 20 ± 20 days.

Prolonged DFI leads to complications like neuropathy, nephropathy, vasculopathy, cardiopathy, etc. The percentage (41.6%) of the previous result is higher than that of the current study. However, this study shows a higher incidence in patients aged more than 65 years old (Akkus & Sert, 2022). Whereas nephropathy shows contrasting results with previous studies. The variation is maybe caused by the fact that the current study focuses on DFI while the previous research focuses on all diabetic patients (Dòria et al., 2016). The vasculopathy result aligns with the study by Ikem et al. (2010), and has few discrepancies with some previous reports (Rahman et al., 2009).

Poly-antibiotic therapy depends on the severity of infection. In this study, the participants were divided into five groups based on the numbers of prescribed anti-microbial drugs. However, in previous studies, the category includes a poly-antibiotic therapy with more than two antibiotics. The antibiotic prescription patterns in DFI in the incumbent study reveal a slight difference. The current study demonstrates that 64.81% of patients used more than two prescribed antibiotics compared to the previous results (57.3%). The slight difference depends on the severity of infection (Nagaya et al., 2024).

The progression of DFI and related complications leads to amputations. The amputation incidence rate in the current study is 44.07% compared to earlier research (31%). The discrepancies may be caused by delayed presentations, poor response to the prescribed antibiotics, advanced infection stage or the effectiveness of early surgical intervention strategies (Luo et al., 2024).

In this study, the most commonly prescribed anti-microbial drug was Augmentin. Its efficacy was 70.83%, aligning with its established role as the first-line treatment for mild and moderate infection (Gariani et al., 2019). On the other hand, the non-effectiveness shows antibiotic resistance, a significant concern in chemotherapy of DFI (Peter-Riesch, 2016). The variation in antibiotic prescription demonstrates the poly-microbial nature of infection, requiring broad-spectrum antibiotics to completely cover gram-positive and gram-negative strains. Prescribed antibiotics included Penro, Grasil, Moxiget, and Meropenem.

The variation in efficacy of prescribed anti-microbial drugs like Penro (38.29%) and Cefzone (33.33%) emphasizes the importance of local surveillance of antibiotic resistance and is considered a growing concern in diabetic patients, specifically with the extensive use of broad-spectrum antibiotics like Cefepime and Meropenem. The 100% efficacy rate of Zyvox and Levaquin suggests that these may be the promising and drugs of choice for the treatment of poly-microbial and multi-drug-resistant infections (Bouza, 2009).

For treating DFI, the most common routes of antibiotic administration were IV and IM as these require vigorous and intensive management. This aligns with previous reports that Penro, Grasil, and Meropenem antibiotic are administered IV, particularly in severe and complicated infections. For mild and moderate infections, Moxiget and Avelox were administered orally and Fuzidin was used for localized wound care as a topical antibiotic (Mougakou et al., 2023; Olid et al., 2015).

The current study highlights the importance of a critical need for proper antibiotic therapy in treating DFI, as misuse of antibiotics can lead to high antibiotic resistance that could worsen the issue. Previous reports emphasize the antibiotic stewardship program to guide clinical practitioners in choosing effective therapeutic treatment to minimize resistance concerns (MacDougall & Polk, 2005). The inefficacy of anti-microbial drugs like Cefzone and Penro further stresses the need for continuous surveillance of local resistance patterns. Furthermore, the frequent use of IV antibiotic administration underscores the importance of infection control measures to prevent nosocomial infection and multi-drug-resistant strain spreading. It is emphasized that the region-specific treatment guideline should be developed based on local resistance data to optimize and control resistance development.

5. Conclusion

This study highlights the growing severity and socio-economic burden of DFI, which continues to present significant challenges to healthcare systems worldwide. The findings, which align with and diverge from previous research, emphasize the importance of age, gender, and insulin dependency as significant risk factors for DFI. The study underscores the need for effective management strategies, particularly given the complications and prolonged hospitalization associated with advanced stages of DFI. Compared to previous reports, the higher incidence of amputations observed in this study (44.07%) reflects the critical need for early intervention and better antibiotic stewardship.

The findings also point to a concerning trend of antibiotic resistance, particularly with commonly prescribed drugs like Penro and Cefzone, which highlights the need for vigilant surveillance of local resistance patterns. The predominance of IV and IM antibiotic administration in severe cases further emphasizes the intensive nature of treatment required for DFI. These results underscore the urgent need for region-specific treatment guidelines to combat multi-drug-resistant infections and optimize patient care.

Looking to the future, it is crucial to implement more robust antibiotic stewardship programs aimed at reducing the misuse of antibiotics and preventing the development of resistance. Regular monitoring of antibiotic efficacy and resistance patterns is essential for adapting treatment strategies to local needs. Additionally, improving early diagnosis and timely intervention could prevent the progression of DFI, reducing the incidence of amputations and associated complications. Lastly, ongoing research should focus on the development of more effective, localized therapies that address the poly-microbial nature of DFI, ensuring better patient outcomes and reduced healthcare costs.

Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflict of interest.

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