From Wound to Ward: A Cross-Sectional Study of Diabetic Foot Ulcers and Their Microbial Burden in Tertiary Care Hospital, Peshawar , Pakistan"

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ABSTRACT

Diabetic foot ulcer (DFU) is one of the most debilitating complications of diabetes mellitus, contributing significantly to morbidity, limb amputations, and economic burden worldwide. Defined by the World Health Organization and the International Working Group on the Diabetic Foot as ulceration, infection, or destruction of foot tissues associated with neuropathy and peripheral vascular disease, DFU represents a global health challenge with regional variations in prevalence and management. This descriptive cross-sectional study, conducted over ten months at a tertiary care hospital in Peshawar, Pakistan, aimed to evaluate pharmacotherapy patterns and microbial profiles in DFU patients. A total of 200 patients were studied, with the highest concentration from Peshawar (n=80), followed by Charsadda, Hangu, Kohat, and Parachinar. Most patients were aged 50–60 years, and pain was the predominant complaint (n=120). Culture sensitivity testing revealed a polymicrobial infection landscape, with 44 cases showing no growth, while the most frequently isolated organisms were *Enterobacter* with *Pseudomonas aeruginosa* (n=32), *E. coli* (n=28), *Proteus mirabilis* (n=20), and *Providencia* species (n=20). These pathogens are often associated with multidrug resistance and complicate wound healing due to biofilm formation and immune evasion. Findings highlight the urgent need for early detection, culture-guided antibiotic therapy, and multidisciplinary foot care approaches to prevent complications like chronic infections and amputations. Moreover, the high prevalence of resistant strains stresses the importance of antibiotic stewardship and region-specific treatment protocols. The study underscores the need for patient education, improved wound care practices, and decentralized access to diabetic foot services, especially in high-burden areas like Peshawar. With DFUs continuing to impose a silent yet severe impact on diabetic populations, focused interventions at both community and clinical levels are essential to curb this preventable complication.

Keywords: Diabetic Foot Ulcer (DFU), Microbial Profile, Culture Sensitivity

INTRODUCTION:

According to the World Health Organization and to the International Working Group on the Diabetic Foot, Diabetic foot is defined as "the foot of diabetic patients with ulceration,infection and/or destruction of the deep tissues, associated with neurological abnormalities and various degrees of peripheral vascular disease in the lower limb"[1].Diabetic foot is a severe public health issue, yet rare studies investigated its global epidemiology. A systematic review and meta-analysis through searching PubMed, EMBASE, ISI Web of science, and Cochrane database found that that global diabetic footulcer prevalence was 6.3%, which was higher in males than in females, and

higher in type2 diabetic patients than in type 1 diabetics. North America had the highest prevalence, Oceania had the lowest, and the prevalence in Asia, Europe, and Africa were 5.5%, 5.1%,and 7.2%, respectively. Australia has the lowest 1.5%, and Belgium has the highest prevalence (16.6%), followed by Canada (14.8%) and USA (13.0%). The patients with diabetic foot ulcer were older, had a lower body mass index, longer diabetic duration, and had more hypertension, diabetic retinopathy, and smoking history than patients without diabetic [2]. The issue of diabetic foot disease is of particular concern in the Latino communities of theEastern United States, in African Americans, and in Native Americans, who tend to have the highest prevalence of diabetes in the world [3].

The pathophysiology of diabetic foot ulcers(DFUs) has neuropathic, vascular, and immune system components, which all show a base relationship with the hyper glycemic state of diabetes. Hyperglycemia produces oxidative stress on nerve cells and leads to neuropathy. Additional nerve dysfunction follows from glycosylation of nerve cell proteins, leading tofurther ischemia. These cellular changes manifest in motor, autonomic, and sensorycomponents of neuropathic foot ulcers. Damage to motor neurons of the foot musculaturemay lead to an imbalance of flexors and extensors, anatomic deformities, and eventual skinulcerations. Damage to autonomic nerves impairs sweat gland function, and the foot may develop decreased ability to moisturize skin, leading to epidermal cracks and skin breakdown. Lastly, patients may not notice foot wounds because of decreased peripheral sensation. Because the blood supply required to heal a diabetic foot ulcer is greater than that needed to maintain intact skin, chronic ulceration can develop. Vascular changes that lead to DFUs correlate with hyperglycemia-induced changes in the peripheral arteries of the foot and begin on the cellular level. Endothelial cell dysfunction leads to a decrease in vasodilators; also, plasma thromboxane A2 levels become elevated. The result is vasoconstriction and plasma hypercoagulation in peripheralarteries leading to ischemia and increased risk of ulceration. Immune changes include reduced healing response in DFUs. Increased T lymphocyte apoptosis, which inhibits healing, has been observed in patients with DFUs [4].

The Diabetic foot ulcer can be managed by; Debridement is an act of disposing of non-living materials, foreign bodies, and unhealthy tissues that are difficult to recover from injury. Debridement should be performed on all chronic wounds to remove necrotic tissue and debris. This action is carried out by removingthe base of abnormal injuries and wound edge tissue such as callus and necrotic dermal tissue, debris and bacterial elements that can inhibit wound healing. There are five types of debridement: surgery, enzymatic, auto lithics, mechanics and biologics, only surgical debridement has been shown to be effective in clinical trials. Surgical debridement is a sharp debridement to remove all dead tissue and bone. The purpose of debridement is to transform the chronic wound healing environment into acutewound healing. Offloading; In patients with lesions on the soles of the feet, it takes offloading through various methods.The purpose of this offloading is to prevent tissue trauma and facilitate wound healing. Bedrest is an ideal way to reduce pressure but it is difficult to do total contact casting (TCC) isthe most effective offloading method. TCC is made of specially formed casts to spread thepatient's burden out of the ulcer area. Dressing; Dressing is a material used topically on the wound to protect the wound and help wound healing. Hydrogel dressing, film, composite is well used for cuts with a small amount of exudate. For wounds with exudate amounts being used hydrocolloids and for wounds with exudate amount widely used alginate, foam and negative pressure wound therapy (NPWT). Injuries with large necrotic tissue should be done debridement before dressing [5].

There are several components that cause the emergence of DFUs in diabetic patients, Diabetes leads to intrinsic wound healing, including collagen cross-linking disorders, metric proteinase matrix functional disorders and immunologic disorders, especially impaired PMN function. In addition,

diabetics have higher rates of onychomycosis and tinea infections, so the skin is easy to peel and infections. In DM, characterized by sustainedhyperglycemia as well as increased inflammatory mediators, triggering an inflammatory response, leading to chronic inflammation, but this is considered to be low-grade inflammation, since hyperglycemia leads to impaired cellular defense mechanisms [6].

METHODOLOGY:

This descriptive cross-sectional study was conducted at Tertiary Care Hospital,Peshawar over a period of 10 monthd to assess pharmacotherapy practices and identify prevalent micro-organisms in DFUs. Adult patients (≥18 years) with type 1 or type 2 diabetes and foot ulcers classified under Wagner's Grades 1–5 were included, while those with non-diabetic ulcers, recent antibiotic use, or immunosuppressive therapy were excluded. Data were collected through patient interviews, clinical examinations, and medical record reviews, capturing demographic details, diabetes duration, glycemic control (HbA1c), comorbidities, and current medication Ethical approval was obtained from the Institutional Ethics Committee, and written informed consent was secured from all participants. Data were analyzed using recent SPSS version

RESULTS

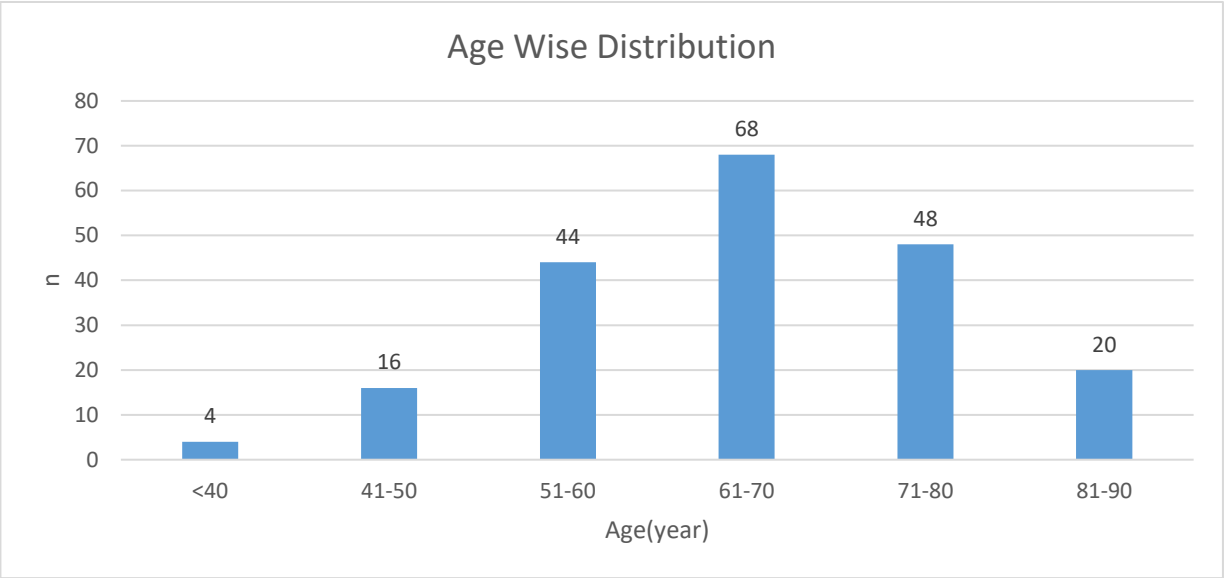
The geographical distribution of patients is depicted in table1.

Table 1 Geographical Distribution

Variable	Category	Number of Patients (n)
Residence (KPK Regions)	Peshawar	80
	Bannu	10
	Charsadda	20
	Hangu	20
	Parachinar	20
	Lakki Marwat	10
	Kohat	20
	Landi Kotal	10

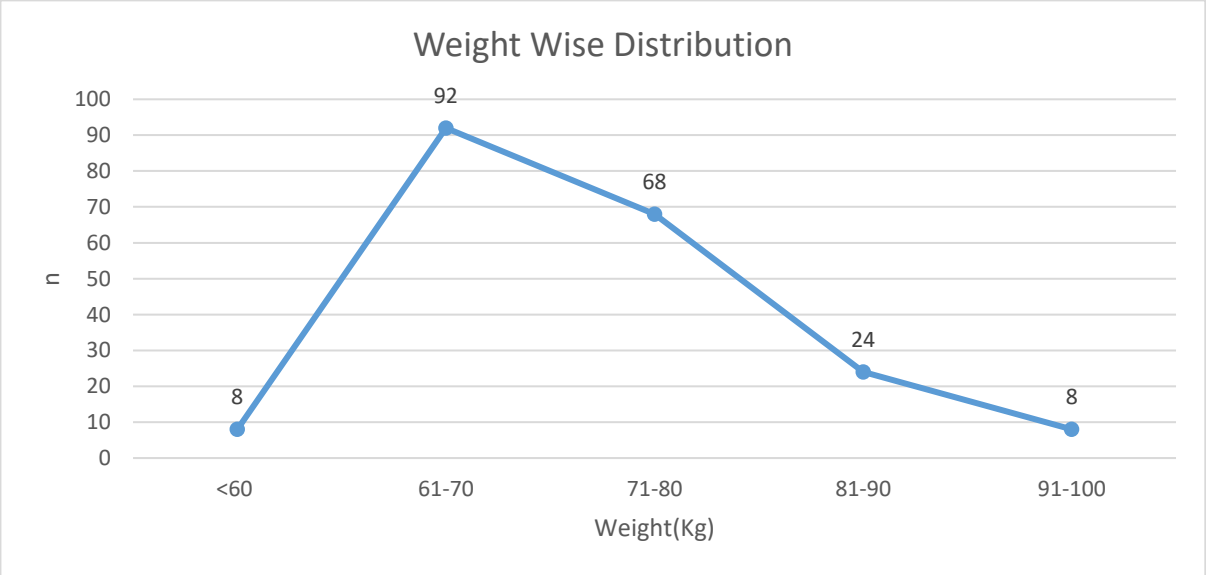
The age wise distribution of patients is depicted in Figure 1.

Figure 1 Age Wise Distribution



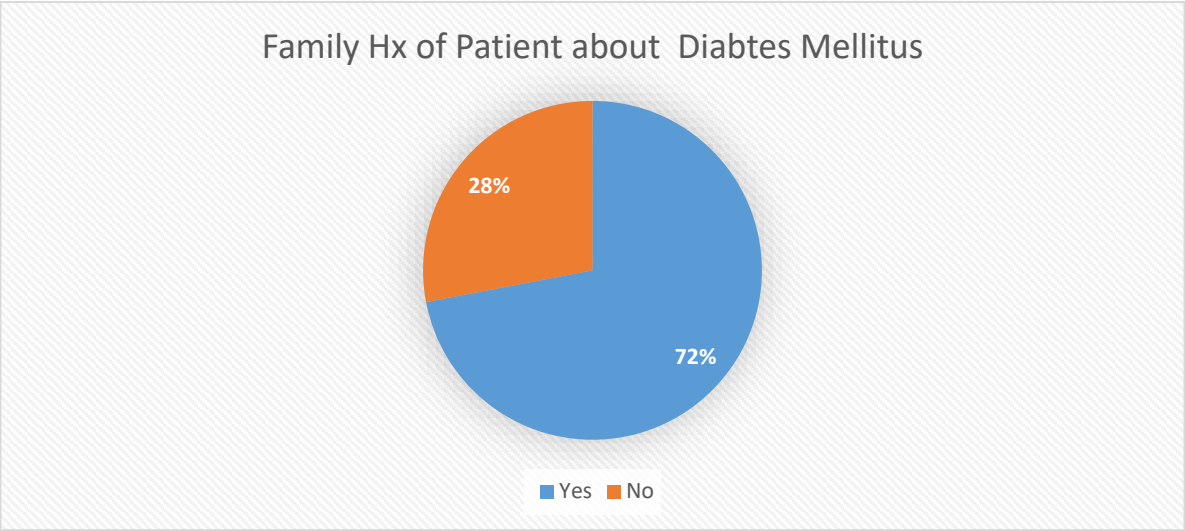
The Weight wise distribution of patients is depicted in figure 2.

Figure 2 Weight wise distribution



The family history of patients about Diabetes Mellitus is depicted in figure 3.

Figure 3 Family Hx patients about Diabtes Mellitus



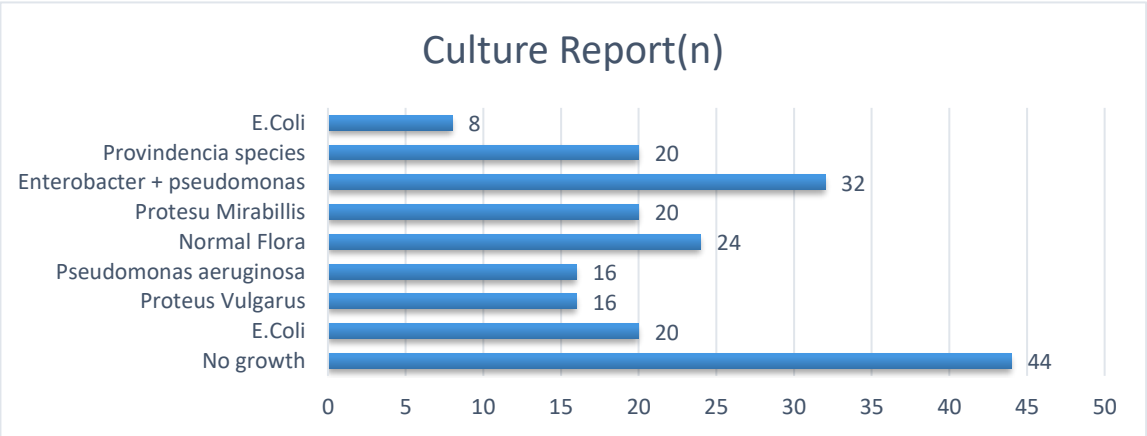
The Chief Complaints of patients is depicted in table 2.

Table 2 Chief Complaints

Clinical Feature	Category	Number of Patients (n)
Chief Complaints	Pain	120
	Post-blister wound	20
	Swelling	20
	Fever	30

The culture report of patients is depicted in figure 4.

Figure 4 Culture Report



DISCUSSION:

DFUs are among the most common complications of patients who have diabetes mellitus which is not well controlled. It is usually the result of poor glycemic control, underlying neuropathy, peripheral vascular disease, or poor foot care. It is also oneof the common causes for osteomyelitis of the foot and amputation of lower extremities. These ulcers are usually in the areas of the foot which encounters repetitive trauma and pressure sensations. The present study focused on the demographic distribution and chief clinical presentations of patients with DFUs in various regions of Khyber Pakhtunkhwa (Kp), Pakistan. Among the 200 documented cases, a significant proportion of patients (n=80) were from Peshawar, indicating a higher prevalence or better accessibility to healthcare facilities in this urban center. Other contributing regions included Charsadda, Hangu, Parachinar, and Kohat, each with 20 patients, suggesting a relatively consistent burden across smaller cities and semi-urban areas. The lower number of cases from Bannu, Lakki Marwat, and Landi Kotal (n=10 each) could reflect underreporting, limited healthcare access, or population size differences in those areas. The chief complaints among patients highlight the typical clinical course of diabetic foot complications. Pain was the most frequently reported symptom (n=120), underscoring the discomfort and inflammation commonly associated with DFUs. This aligns with previous literature that emphasizes pain as a common early manifestation of neuropathy and infection in diabetic individuals. Other frequent symptoms included fever (n=30), post-blister wounds (n=20), and swelling (n=20), all of which are indicative of ongoing infection or delayed wound healing—a major concern in diabetic foot management. These findings are consistent with similar regional studies, suggesting a pattern of late presentation and inadequate foot care among diabetic patients.The results reinforce the need for increased awareness and early intervention strategies, especially in high-burden regions like Peshawar. Community-level diabetic education, timely screening, and access to multidisciplinary foot care services could help in reducing the incidence and severity of DFUs.

As part of the diagnostic workup for DFU patients, culture sensitivity testing was performed prior to initiating empirical antibiotic therapy. This approach is crucial for identifying the exact pathogens involved in the infection, enabling more targeted treatment. The culture sensitivity analysis revealed a wide range of bacterial isolates, demonstrating the polymicrobial nature of DFUs. This finding is consistent with existing literature, which identifies DFUs as commonly associated with both aerobic and anaerobic bacteria, and often multiple pathogens.A total of 44 cases showed no bacterial growth, which could be attributed to several factors, including prior antibiotic use before hospital admission, improper sample collection, or the presence of organisms that are difficult to culture in standard laboratory conditions [7] .In 24 other cases, normal flora was identified, which likely represents either superficial contamination or colonization of the wound by non-pathogenic organisms [8]. Although these organisms may not be directly responsible for infection, they could play a role in wound chronicity or delayed healing when coupled with other factors.

The most frequently isolated pathogen was *Enterobacter species* combined with *Pseudomonas aeruginosa* (n=32). This combination is concerning because both pathogens are known for their high levels of antibiotic resistance, particularly to beta-lactams, aminoglycosides, and fluoroquinolones [9]. *Pseudomonas aeruginosa*, a gram-negative, opportunistic pathogen, is particularly common in chronic wounds due to its ability to form biofilms, making it more difficult to treat [10]. This organism's isolation in 16 cases alone and in combination with *Enterobacter species* highlights the complexity of treating chronic DFUs and the critical need for culture-guided therapy. *Escherichia coli (E. coli)* was also commonly found, with a total of 28 cases (20 initially and 8 in a subsequent entry). E. coli is typically associated with gastrointestinal flora and often linked to wound infections in diabetic patients with poor glycemic control or inadequate hygiene

practices.[8] The persistence of E. coli in DFU infections points to the potential role of fecal contamination and improper hygiene in the development of foot infections, especially in neglected ulcers.

Another prominent pathogen identified was *Proteus species*, which included both *Proteus vulgaris* (n=16) and *Proteus mirabilis* (n=20). These bacteria are known for producing urease, which increases the local pH and promotes an alkaline environment that can inhibit the healing of diabetic ulcers. Proteus species are also associated with urinary tract infections and can contribute to persistent, chronic infections in diabetic patients [11]. *Providencia species* were identified in 20 cases. While less commonly reported than other pathogens, *Providencia species* are increasingly recognized in chronic diabetic wounds. These organisms have been associated with poor wound healing and may be more prevalent in patients who have undergone prolonged or repeated hospitalizations [12], such data is differ from other manuscript[13-26]. The high prevalence of multi-drug-resistant (MDR) organisms, including *Pseudomonas aeruginosa* and *Enterobacter species*, underscores the importance of proper antibiotic stewardship and the need for regular surveillance of local resistance patterns. It also highlights the need for personalized, culture-guided antibiotic therapy to minimize unnecessary broad-spectrum antibiotic use, which is a major contributor to the growing problem of antibiotic resistance in healthcare settings [27].

In conclusion, the culture sensitivity results of this study reflect the complex and polymicrobial nature of infections in DFUs, which can often involve multidrug-resistant organisms. This reinforces the importance of conducting culture sensitivity testing before initiating empirical antibiotic therapy, as it ensures more effective and targeted treatment. The findings also emphasize the need for improved infection control measures, routine screening for antimicrobial resistance, and a multidisciplinary approach to managing DFUs, especially in patients with poor glycemic control.

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