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Original Article

Clinical Characteristics and Healing Outcomes of Diabetic Foot Ulcers in Hospitalized Patients - Insights from a Tertiary Center in Khulna, Bangladesh

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ABSTRACT

Background: *The study aims to investigate the clinical characteristics, management approaches, and healing outcomes of hospitalized patients with DFUs at a tertiary center in Khulna, Bangladesh.* ***Methods & Materials:*** *This hospital-based retrospective study was conducted from January to December 2024 at two tertiary care hospitals (KMCH & GMCH) in Khulna, Bangladesh. Sixty adult diabetic patients with active foot ulcers were consecutively enrolled based on specific inclusion and exclusion criteria. Using structured tools, data were collected through interviews, clinical examinations, and medical record reviews. Variables included demographics, diabetes profile, ulcer characteristics, risk factors, management, and outcomes. Peripheral neuropathy and PAD were assessed using standard tools. Ulcers were graded using the Wagner system. Data were analyzed in SPSS v26.0 using descriptive statistics and Chi-square tests, with significance at p<0.05.* ***Result:*** *The study identified key demographic and clinical features among diabetic foot ulcer (DFU) patients aged 40–59, male, and from rural areas. Type 2 diabetes was dominant (93.33%), with poor glycemic control (HbA1c >9% in 55%) and common comorbid hypertension (73.33%). Most ulcers were single, deep, toe-located, with moderate to severe infection (58.33%) and frequent neuropathy (83.33%). PAD was present in 38.33% (mean ABI 0.78). Treatment involved debridement (80%) and offloading (60%), yet only 25% fully healed; complications included osteomyelitis (28.33%) and sepsis (16.67%). Better outcomes correlated with shorter diabetes duration, lower Wagner grade, absence of PAD, and improved glycemic control.* ***Conclusion:*** *Poor glycemic control, delayed presentation, neuropathy, and peripheral arterial disease significantly hinder diabetic foot ulcer healing. Only 25% achieved complete healing, while complications and amputations were common. Early intervention, absence of PAD, and metabolic optimisation were linked to better outcomes, highlighting the need for multidisciplinary, timely diabetic foot care.*

Keywords: *Clinical Characteristics, Healing Outcomes, and Diabetic Foot Ulcers.*

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INTRODUCTION

Diabetes mellitus (DM) is a rapidly escalating public health issue worldwide, with complications that significantly impair quality of life and increase morbidity and mortality. Among these, diabetic foot ulcers (DFUs) represent a severe and debilitating complication. DFUs affect approximately 15–25% of individuals with diabetes during their lifetime, often leading to infection, hospitalization, and amputation if not managed promptly and effectively. [1,2]. The burden is disproportionately higher in low- and middle-income countries (LMICs), such as Bangladesh, due to delayed diagnosis, limited access to specialized care, and suboptimal management strategies.[3] Bangladesh is among the countries experiencing a dramatic rise in diabetes prevalence, with current estimates indicating over 13 million affected adults, a number expected to double by 2045. [4] In this context, diabetic foot complications are becoming an increasingly visible challenge in the country's healthcare landscape. Several studies have shown that DFUs in Bangladesh are frequently associated with poor glycemic control, peripheral neuropathy, peripheral arterial disease (PAD), and delayed hospital presentation.[5,6] However, comprehensive hospital-based studies exploring the clinical characteristics and healing outcomes of DFUs remain limited, particularly in tertiary care centers outside the capital. DFUs are inherently multifactorial in origin, often resulting from a combination of neuropathy, ischemia, and infection. [7] The Wagner grading system is commonly used to assess ulcer severity and guide management, with higher grades correlating with poor healing and increased risk of amputation.[8] Early

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identification and targeted interventions such as offloading, debridement, infection control, and vascular evaluation are essential to improve prognosis. However, these strategies may not be consistently applied in resource-constrained settings due to infrastructural and logistical limitations.[9] Despite advancements in wound care and infection control, DFUs remain a leading cause of non-traumatic lower limb amputation worldwide.[10] Mortality rates among patients hospitalized with DFUs also remain high, with estimates ranging between 11% and 20% in different settings. [11] Understanding the clinical and demographic factors influencing healing outcomes is crucial for optimizing treatment protocols and reducing disease burden. While a few cross-sectional studies have assessed the prevalence and basic characteristics of DFUs in urban centers of Bangladesh, data from peripheral tertiary hospitals are scarce. Therefore, the present study aims to investigate the clinical characteristics, management approaches, and healing outcomes of hospitalized patients with DFUs at a tertiary center in Khulna, Bangladesh.

METHODOLOGY & MATERIALS

This hospital-based retrospective observational study was conducted at the Department of Surgery in Khulna Medical College and Hospital (KMCH) and Gazi Medical College and Hospital (GMCH), Khulna, Bangladesh over a period of one year, from Jan 2024 to Dec 2024. The hospital caters to a large population from both rural and urban areas and provides specialized care to diabetic patients, including those with foot complications. A total of 60 adult patients with diabetic foot ulcers (DFUs) admitted for treatment during the study period were consecutively enrolled. Only patients with a confirmed diagnosis of diabetes mellitus and active foot ulceration at the time of admission were included.

Inclusion Criteria

- Adults aged ≥18 years
- Diagnosed with Type 1 or Type 2 diabetes mellitus
- Presence of one or more-foot ulcers below the malleoli
- Willingness to participate and provide informed consent

Exclusion Criteria

- Patients with non-diabetic foot ulcers
- Critically ill patients unable to respond or consent
- Patients with cognitive impairment or mental illness interfering with participation
- Re-admitted patients with previously recorded ulcers during the study period

Data Collection Procedure

Data were collected using a pretested structured questionnaire and a clinical examination checklist through direct patient interviews, medical record reviews, and physical examinations. The collected data encompassed several categories, including demographics (age, sex, residence, and occupation), diabetes profile (type, duration, HbA1c levels, and medications), and detailed ulcer characteristics (site, number, size, duration, depth, laterality, Wagner grade, and infection status). Risk factors such as smoking, alcohol use, the presence of neuropathy and peripheral arterial disease (PAD), and comorbid conditions were also recorded. Management details included the type of wound care, use of antibiotics, surgical interventions, offloading methods, and duration of hospital stay. Outcomes at discharge were assessed regarding healing status, complications, recurrence, and mortality. Peripheral neuropathy was evaluated using monofilament testing and vibration perception threshold, while PAD was assessed clinically and confirmed by ankle-brachial index (ABI) measurements. Ulcers were graded according to the Wagner classification system.

Statistical Analysis

Collected data were entered and analyzed using SPSS version 26.0. Descriptive statistics such as mean, standard deviation (SD), frequency, and percentages were used to summarize variables. Associations between ulcer healing outcomes and clinical characteristics were assessed using Chi-square test, with a p-value <0.05 considered statistically significant.

RESULTS

The study revealed key sociodemographic and clinical insights into hospitalized patients with diabetic foot ulcers (Table-I). Most patients were aged 40–59 years (55%), predominantly male (65%), and from rural areas (58.33%). Type 2 diabetes was overwhelmingly prevalent (93.33%), with over half having diabetes for more than 10 years (55%) and HbA1c levels above 9% (55%), indicating poor glycemic control. Hypertension was the most common comorbidity (73.33%). Ulcer-specific findings (Table II) showed that 40% of patients had ulcers for more than 30 days before admission, and 60% were on the toes. The majority had single (75%), deep ulcers (53.33%), with a mean size of 5.2 cm^2. About 58.33% had moderate to severe infections, 83.33% had neuropathy, and 38.33% had peripheral arterial disease (PAD), with a mean ABI of 0.78, indicating compromised blood flow. Regarding management (Table III), offloading and debridement were commonly employed (60% and 80%, respectively). Half of the patients received IV antibiotics, and 16.67% underwent major amputation. Conventional gauze was the most frequent dressing method (45%), with an average hospital stay of nearly 15 days. At discharge (Table IV), only 25% achieved complete healing, 40% had partial healing, and 10% worsened. Common complications included osteomyelitis (28.33%) and sepsis (16.67%), while mortality remained low at 5%. Comparative analysis (Table V) highlighted significantly better outcomes in patients with shorter diabetes duration (<10 years, p=0.045), lower Wagner grade (0–2, p=0.001), milder infection (p=0.003), absence of PAD (p=0.009), and better glycemic control (HbA1c <8%, p=0.012). These findings underscore the importance of early intervention, vascular assessment, and metabolic control in improving DFU outcomes.

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Table – I: Sociodemographic and Clinical Characteristics of Hospitalized Patients with Diabetic Foot Ulcers (*n*=60)

Variable	Frequency (n)	Percentage (%)
Age group (years)		
<40	6	10.00
40–59	33	55.00
≥60	21	35.00
Sex		
Male	39	65.00
Female	21	35.00
Residence		
Urban	25	41.67
Rural	35	58.33
Type of Diabetes		
Type 1	4	6.67
Type 2	56	93.33
Duration of Diabetes		
<5 years	9	15.00
5–10 years	18	30.00
>10 years	33	55.00
HbA1c (%)		
<7	6	10.00
7–9	21	35.00
>9	33	55.00
Smoking history		
Never	32	53.33
Past	12	20.00
Current	16	26.67
Comorbidities (multiple allowed)		
Hypertension	44	73.33
CKD	15	25.00
IHD	19	31.67

Table – II: Ulcer-Specific Characteristics, Infection Status, and Vascular Findings at Presentation

Variable	Frequency (n)	Percentage (%)
Ulcer duration before admission		
<7 days	9	15.00
7–30 days	27	45.00
>30 days	24	40.00
Ulcer location		
Toe	36	60.00
Heel	7	11.67
Forefoot	14	23.33
Other	3	5.00
Laterality		
Right	32	53.33
Left	25	41.67
Bilateral	3	5.00
Number of ulcers		
Single	45	75.00
Multiple	15	25.00
Ulcer size (cm^2)		
Mean±SD	5.2 ± 2.1	
Depth of ulcer		
Superficial	13	21.67
Deep	32	53.33
Bone involved	15	25.00
Wagner grade		
0–1	6	10.00
2	15	25.00
3	21	35.00
4	14	23.33
5	4	6.67
Infection status		
None	6	10.00
Mild	14	23.33
Moderate	24	40.00
Severe	17	28.33
Neuropathy	50	83.33
PAD (by clinical or ABI < 0.9)	23	38.33
ABI value		
Mean±SD	0.78 ± 0.14	

Table – III: Management Approaches and In-Hospital Interventions for Diabetic Foot Ulcers

Variable	Frequency (n)	Percentage (%)
Offloading used		
Yes	36	60.00
No	24	40.00
Debridement performed	48	80.00
Antibiotic therapy		
IV only	30	50.00
Oral only	8	13.33
Both	18	30.00
None	4	6.67
Surgical intervention		
None	27	45.00
Minor amputation	23	38.33
Major amputation	10	16.67
Type of dressing		
Conventional gauze	27	45.00
Hydrogel	14	23.33
Honey-based	7	11.67
Silver-containing	12	20.00
Hospital stay		
Mean±SD	14.8 ± 6.3 days	

Table – IV: Healing Outcomes, Complications, and Short-Term Prognosis at Discharge

Variable	Frequency (n)	Percentage (%)
Healing status at discharge		
Completely healed	15	25.00
Healing (partial closure)	24	40.00
Not healed	15	25.00
Worsened	6	10.00
Complications		
Sepsis	10	16.67
Osteomyelitis	17	28.33
Gangrene	9	15.00
Ulcer recurrence (within 3 months)	9	15.00
Readmission within 1 month	7	11.67
Mortality		
Survived	57	95.00
Died	3	5.00

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Table – V: Comparison of Key Clinical Variables between Healed and Non-Healed/Worsened Ulcer

Variable	Healed (n=39)		Not Healed/Worsened (n=21)		p-value
	n	%	n	%	
Duration of diabetes (<10 years)	21	53.85	6	28.57	0.045 *
Wagner grade (0-2)	24	61.54	3	14.29	0.001 **
Infection severity (None-Mild)	22	56.41	3	14.29	0.003 **
PAD (Absent)	29	74.36	8	38.10	0.009 **
HbA1c (<8%)	20	51.28	4	19.05	0.012 *

DISCUSSION

This study comprehensively evaluates the clinical characteristics, management practices, and healing outcomes of diabetic foot ulcers (DFUs) among hospitalized patients in a tertiary care center in Khulna, Bangladesh. The findings reflect the complex interplay of long-standing diabetes, poor glycemic control, infection, and peripheral vascular and neuropathic complications, all of which influence healing outcomes and prognosis. The predominance of middle-aged males (65%) with type 2 diabetes (93.3%) and rural residence (58.3%) aligns with regional and global trends that indicate higher DFU risk in males due to greater outdoor activity and footwear neglect, especially in rural populations with limited access to diabetic foot care.[1,10] Furthermore, the high proportion of patients with over 10 years of diabetes duration (55%) and poor glycemic control (HbA1c >9% in 55%) underscores the long-term metabolic dysregulation contributing to ulcer development, as supported by studies that link chronic hyperglycemia to impaired wound healing and neuropathy. [12,2] The majority of patients presented with chronic, deep ulcers many existing for over 30 days (40%) and involving bony structures (25%) which aligns with delayed health-seeking behavior and inadequate primary wound management reported in low-resource settings.[13] Neuropathy was present in 83.3% of patients, and 38.3% had peripheral arterial disease (PAD), both of which are established contributors to ulcer progression and poor healing. [14] The mean ABI of 0.78 confirmed underlying ischemia, a known impediment to tissue repair and infection resolution. Treatment approaches varied, with 60% receiving offloading and 80% undergoing debridement, which is critical for reducing pressure and bacterial load. [15] However, 40% lacked offloading, possibly due to limited availability or patient non-compliance. Surgical intervention, including minor (38.3%) and significant (16.7%) amputations, reflected the advanced stage of disease at presentation. The relatively low use of advanced dressings such as silver (20%) or hydrogel (23.3%) highlights the reliance on conventional methods in resource-limited settings, which may compromise optimal healing. [16] Only 25% achieved complete healing at discharge, while 40% showed partial healing and 10% experienced clinical worsening. Notably, healing was significantly associated with shorter diabetes duration, lower Wagner grades, milder infections, absence of PAD, and better glycemic control. These associations echo previous findings indicating that early-stage ulcers, adequate perfusion, and metabolic optimization are key predictors of favorable outcomes. [17,18] The 5% in-hospital mortality and 11.7% readmission rate, though modest, indicate the severity of DFU complications and the need for continued post-discharge surveillance. The study's limitations include its single-center design, limited sample size, and lack of long-term follow-up. Nevertheless, it emphasizes the urgent need for early detection, multidisciplinary care, and education to prevent DFUs and improve outcomes in high-risk diabetic populations.

Limitations of the study

The study design and reliance on inpatient data restrict the ability to establish causal relationships and prevent the assessment of long-term outcomes, such as ulcer recurrence, limb salvage rates, and post-discharge mortality. The absence of follow-up data also limits insights into the durability of healing and the effectiveness of interventions over time. Additionally, heterogeneity in treatment approaches and potential inconsistencies in clinical documentation may introduce selection and information bias, affecting the validity of the results.

CONCLUSION AND RECOMMENDATIONS

In conclusion, the study found that Poor glycemic control, delayed presentation, neuropathy, and peripheral arterial disease were major contributors to poor healing outcomes. Only 25% of patients achieved complete healing, while significant complications and amputations were noted. Better outcomes were significantly associated with early-stage ulcers, absence of PAD, and improved metabolic control. These findings underscore the importance of early intervention, comprehensive vascular assessment, and multidisciplinary diabetic foot care to reduce morbidity and improve recovery.

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REFERENCES

1. *Boulton AJ, Vileikyte L, Ragnarson-Tennvall G, Apelqvist J. The global burden of diabetic foot disease. The Lancet. 2005 Nov 12;366(9498):1719-24.*
2. *Armstrong DG, Boulton AJ, Bus SA. Diabetic foot ulcers and their recurrence. New England Journal of Medicine. 2017 Jun 15;376(24):2367-75.*
3. *Abbas ZG, Archibald LK. Challenges for management of the diabetic foot in Africa: doing more with less. International wound journal. 2007 Dec;4(4):305-13.*
4. *Han Cho N. International Diabetes Federation (IDF). IDF Diabetes Atlas.*
5. *Akter S, Rahman MM, Abe SK, Sultana P. Prevalence of diabetes and prediabetes and their risk factors among Bangladeshi adults: a nationwide survey. Bulletin of the World Health Organization.*

ISSN: 2663-9491 E-ISSN: 2789-6897

2014 Jan 10; 92:204-13A.

6. *Banik PC, Barua L, Moniruzzaman M, Mondal R, Zaman F, Ali L. Risk of diabetic foot ulcer and its associated factors among Bangladeshi subjects: a multicentric cross-sectional study. BMJ open. 2020 Feb 1;10(2):e034058.*
7. *Lavery LA, Armstrong DG, Wunderlich RP, Mohler MJ, Wendel CS, Lipsky BA. Risk factors for foot infections in individuals with diabetes. Diabetes care. 2006 Jun 1;29(6):1288-93.*
8. *Wagner Jr FW. The dysvascular foot: a system for diagnosis and treatment. Foot & ankle. 1981 Sep;2(2):64-122.*
9. *Islam SM, Lechner A, Ferrari U, Laxy M, Seissler J, Brown J, Niessen LW, Holle R. Healthcare use and expenditure for diabetes in Bangladesh. BMJ global health. 2017 Jan 1;2(1):e000033.*
10. *Zhang P, Lu J, Jing Y, Tang S, Zhu D, Bi Y. Global epidemiology of diabetic foot ulceration: a systematic review and meta-analysis. Annals of medicine. 2017 Feb 17;49(2):106-16.*
11. *Prompers L, Huijberts M, Apelqvist J, Jude E, Piaggesi A, Bakker K, Edmonds M, Holstein P, Jirkovska A, Mauricio D, Ragnarson Tennvall G. High prevalence of ischaemia, infection and serious comorbidity in patients with diabetic foot disease in Europe. Baseline results from the Eurodiale study. Diabetologia. 2007 Jan; 50:18-25.*
12. *Al-Rubeaan K, Al Derwish M, Ouizi S, Youssef AM, Subhani SN, Ibrahim HM, Alamri BN. Diabetic foot complications and their risk factors from a large retrospective cohort study. PloS one. 2015 May 6;10(5):e0124446.*
13. *Ugwu E, Adeleye O, Gezawa I, Okpe I, Enamino M, Ezeani I. Burden of diabetic foot ulcer in Nigeria: Current evidence from the multicenter evaluation of diabetic foot ulcer in Nigeria. World journal of Diabetes. 2019 Mar 15;10(3):200.*
14. *Hinchliffe RJ, Brownrigg JR, Andros G, Apelqvist J, Boyko EJ, Fitridge R, Mills JL, Reekers J, Shearman CP, Zierler RE, Schaper NC. Effectiveness of revascularization of the ulcerated foot in patients with diabetes and peripheral artery disease: a systematic review. Diabetes/metabolism research and reviews. 2016 Jan; 32:136-44.*
15. *Cavanagh PR, Bus SA. Off-loading the diabetic foot for ulcer prevention and healing. Journal of the American Podiatric Medical Association. 2010 Sep 1;100(5):360-8.*
16. *Jeffcoate WJ, Vileikyte L, Boyko EJ, Armstrong DG, Boulton AJ. Current challenges and opportunities in the prevention and management of diabetic foot ulcers. Diabetes care. 2018 Apr 1;41(4):645-52.*
17. *Ugwu E, Adeleye O, Gezawa I, Okpe I, Enamino M, Ezeani I. Predictors of lower extremity amputation in patients with diabetic foot ulcer: findings from MEDFUN, a multi-center observational study. Journal of foot and ankle research. 2019 Dec; 12:1-8.*
18. *Yazdanpanah L, Nasiri M, Adarvishi S. Literature review on the management of diabetic foot ulcer. World journal of diabetes. 2015 Feb 15;6(1):37.*