

Study of Patient with Diabetic Foot Infection – Observational Study in Tertiary Care CenterChirag Panara¹, Deepak Sanwal², Sandeep Rao³¹Senior Resident, Department of General Surgery, GMERS Medical College, Morbi, Gujarat, India²Senior resident, Department of Neurosurgery, Jawaharlal Nehru Medical College, AMU, Aligarh, Uttar Pradesh, India³Associate Professor and Head of Unit, Department of General surgery, Baroda Medical College, Vadodara, Gujarat, India

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Abstract:**Background:** Diabetic foot ulcers (DFUs) are a major complication of diabetes mellitus (DM), particularly in India, where high prevalence and poor control exacerbate risks of infection, gangrene, and amputation. This study correlated Wagner grades with outcomes and identified associated risk factors in a tertiary care setting.**Methods:** In this prospective observational study at SSG Hospital, Government Medical College, Vadodara, 40 adult patients admitted for DFU management were purposively sampled. Data on sociodemographic, DM duration/control, neuropathy, peripheral vascular disease (PVD), comorbidities, foot self-care, and Wagner grades (1–5) were collected via structured proforma, clinical exams, and labs. Outcomes included amputation rates, mortality, and hospital stay. Analysis used descriptive statistics, t-tests, and chi-square/Fisher's exact tests (SPSS v25; $p \leq 0.05$).**Results:** Mean age was 57.62 years; 65% were male, 92.5% had type 2 DM (mean duration >10 years in most). Poor glycaemic control affected 60%; neuropathy (42.5%) and PVD (37.5%) were common; 95% had poor foot self-care. Amputation rates rose with Wagner grade: 0% (grades 1–2), 23.5% (grade 3), 75% (grade 4), 100% (grade 5). Neuropathy (76.5% vs. 17.4% in amputees/non-amputees; $p < 0.05$) and gangrene (76.5% vs. 8.7%; $p < 0.05$) significantly predicted amputation. Mortality (12.5%) occurred in advanced grades, mainly non-surgical cases due to sepsis.**Conclusion:** Higher Wagner grades strongly predict amputation and mortality in DFUs. Neuropathy, gangrene, prolonged DM duration, and poor control worsen outcomes. Emphasizing prevention via glycaemic management, neuropathy screening, and foot self-care education is crucial to reduce amputations in resource-limited settings.**Keywords:** Diabetic Foot Ulcer, Wagner Classification, Amputation, Neuropathy, Gangrene.**DOI:** 10.25258/ijcpr.18.1.97

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Introduction

Diabetes mellitus (DM) is a highly prevalent metabolic disorder and continues to increase globally, with projections historically estimating a marked rise by 2030. [1] Among the chronic complications of diabetes, diabetic foot disease is one of the most disabling because it frequently leads to ulceration, infection, prolonged hospitalization, and limb loss. [2,3] Diabetes mellitus has become a major public-health problem in India, with large, population-based evidence showing a high and heterogeneous prevalence across states and a substantial pool of dysglycaemia that is likely to drive further growth in future caseloads. The ICMR–INDIAB national survey (covering 31 states/UTs) reported an overall weighted prevalence of diabetes of about 11.4% among adults (≥ 20 years) and prediabetes of about 15.3%, indicating that a

sizeable proportion of the population is already at high risk for progression to diabetes and its vascular complications. (4) This burden is compounded by marked interstate variation and a broader cardiometabolic risk milieu (e.g., hypertension and obesity) documented in the same dataset, implying major future demands on India's health system for chronic care, complication prevention, and long-term disability reduction.[4,5]

Diabetic foot ulceration is multifactorial, typically resulting from interactions between peripheral neuropathy, infection, peripheral vascular disease (PVD), sustained hyperglycaemia, and trauma. Neuropathy can reduce protective sensation and contribute to abnormal biomechanics, pressure points, callus formation, and unnoticed injuries that

progress to ulcers. Ischaemia (from PVD) impairs wound healing and increases risk of gangrene and amputation, while infection accelerates tissue destruction and systemic complications.[6,7]

Because diabetic foot disease spans a wide clinical spectrum—from superficial ulcers to extensive gangrene—classification systems help clinicians standardize assessment and predict outcomes. The Meggitt–Wagner classification is widely used and grades ulcers from superficial (Grade 1) to extensive gangrene (Grade 5). [8]

The clinical importance of such correlation is practical: lower Wagner grades may respond to conservative management (antibiotics, debridement, dressings), whereas advanced grades often require amputations to control infection and prevent mortality. Understanding which patient factors are associated with progression to amputation can guide preventive strategies, early referral, and more timely surgical decision-making. The primary aim was to correlate patient outcomes with Wagner grades 1–5, while the secondary aim was to examine how risk factors such as duration and control of diabetes, neuropathy, and other comorbidities correlate with diabetic foot infection outcomes.

Methodology

Study Design and Setting: This study was a cross-sectional study. This study was conducted in the Department of Surgery at SSG Hospital, Government Medical College, Vadodara, Gujarat, India. The time-bound design allowed for a focused capture of real-world clinical data on diabetic foot ulcers (DFUs) in a tertiary care setting with a high burden of diabetes-related complications. Purposive sampling was employed to include 40 adult patients admitted for DFU management, ensuring representation of typical cases encountered in routine surgical practice. Exclusion criteria were strictly applied to patients unwilling or unable to provide informed consent, thereby prioritizing ethical participation and data quality.

Participant Selection and Ethical Considerations: Ethical clearance was obtained from Institutional ethical Committee (IEC). Following institutional ethical clearance from Government Medical College, Vadodara, all eligible patients received comprehensive information about the study in their preferred language (Gujarati or English). Written informed consent was obtained voluntarily after explaining study aims, procedures, potential risks (e.g., minimal discomfort from examinations), benefits (e.g., contributing to local DFU knowledge), and the right to withdraw at any stage without affecting care. Confidentiality was safeguarded through coded data storage, with no personal identifiers reported in analyses or publications. As a purely observational study with

no experimental interventions, risks were minimized; standard clinical protocols were followed, including COVID-19 safety adaptations such as masking, distancing, and prioritized triage for vulnerable diabetic patients. The study adhered to ICMR and NMC guidelines for research involving diabetics, emphasizing equity and non-maleficence. Results were aggregated for dissemination, avoiding individual-level disclosures.

Data Collection Procedures: After consent, a structured proforma facilitated detailed history-taking, capturing chronological symptom evolution (e.g., onset, progression, prior treatments). This was complemented by thorough clinical examinations, including foot inspection for ulcer characteristics and systemic assessments. Routine investigations encompassed haematological, biochemical, and radiological tests (e.g., complete blood count, HbA1c, Doppler ultrasound where indicated). Variables were comprehensively documented across three domains:

- **Sociodemographic factors:** Age (years), sex (male/female), education level (illiterate/primary/secondary/graduate), monthly income.
- **Clinical factors:** Type and duration of diabetes mellitus (DM; Type 1/Type 2, in years), glycaemic control (via fasting blood sugar [FBS]), body mass index (BMI), peripheral neuropathy, comorbidities (e.g., hypertension, CKD), history of prior ulcers/amputations, and peripheral vascular disease (PVD).

Data collection was performed by trained resident doctor under senior supervision, ensuring inter-rater reliability through standardized checklists.

Operational Definitions and Measurements

- **Diabetic Foot Ulcer:** A diabetic foot ulcer was operationally defined as a non-traumatic or traumatic partial- or full-thickness lesion distal to the malleolus in a person with DM, aligning with IWGDF criteria. [9]
- **Glycaemic control:** Glycaemic status was assessed using FBS: diabetes as FBS >125 mg/dL, controlled diabetes as 100–125 mg/dL, and uncontrolled as >125 mg/dL. [10]
- **Neuropathy:** Neuropathy was diagnosed clinically if ≥ 1 symptom was present: numbness, paraesthesia, lack of coordination, hypersensitivity to touch, or muscle weakness.
- **PVD:** PVD required ≥ 1 clinical sign: calf cramps on exertion, skin colour changes, shiny/atrophic skin, non-healing sores, or resting pain (pre-diagnostic ABI where feasible).
- **Obesity:** BMI was calculated as weight (kg)/height² (m²) and categorized as

Underweight (<18.5), Normal (18.5–22.9), Overweight (23–24.9), or Obese (≥25), using Asia-Pacific WHO cutoffs for Indian populations. [11]

- Foot self-care practices were evaluated via a validated 10-item structured questionnaire (score range 0–10), with "good" practices defined as ≥7 (mean or above). Items included daily foot inspection, shoe checking for foreign objects, washing/drying feet (especially interdigital areas), avoiding prolonged soaking, and using appropriate footwear indoors/outdoors—scored on a yes/no or frequency basis.
- Ulcer severity was graded using the Wagner classification: Grade 1 (superficial ulcer), Grade 2 (deep ulcer to tendon/bone), Grade 3 (abscess/osteomyelitis), Grade 4 (partial foot gangrene), Grade 5 (full foot gangrene).

Outcomes and Statistical Analysis: Primary outcomes were amputation rate (minor/major), and in-hospital mortality. Secondary outcomes included ulcer healing rates and complication profiles. Data were analysed using SPSS version 25. Descriptive statistics — means ± standard deviations (SD), medians (IQR), Frequencies/percentages —

summarized variables, with 95% confidence intervals (CI) for proportions. Normality was assessed via Shapiro-Wilk tests. Between-group comparisons (e.g., good vs. poor self-care) employed independent t-tests for continuous variables (e.g., hospital stay) and chi-square/Fisher's exact tests for categorical data. Statistical significance was set at $p \leq 0.05$ (two-tailed), with effect sizes reported where relevant. No adjustments for multiplicity were needed due to the exploratory design.

Results

A total of 40 patients with diabetic foot-related ulcer/infection were studied, with a mean age of 57.62 years (range 26–75 years). The largest age group was 50–59 years (37.5%), followed by 60–69 years (32.5%). Males constituted 65% (26/40), and females 35% (14/40).

Diabetes profile and control: Most patients had type 2 diabetes (92.5%, 37/40), while 7.5% (3/40) had type 1 diabetes. Regarding current diabetic treatment, 57.5% (23/40) were on oral hypoglycaemic drugs, 27.5% (11/40) were on insulin, and 15% (6/40) were newly diagnosed.

Table 1: Distribution of participants according to duration of Diabetes Mellitus

No.	Duration of DM	Frequency	Percentage
1	Newly diagnosed	6	15%
2	<5 years	5	12.5%
3	6-10 years	9	22.5%
4	11-15 years	13	32.5%
5	>15 years	7	17.5%

Duration of diabetes showed a large proportion with longer disease history: 32.5% had DM for 11–15 years, and 17.5% had DM for more than 15 years, while 15% were newly diagnosed.

On admission, diabetes control was categorized as good in 40% and poor in 60%, with an additional newly diagnosed group recorded separately. Among those with poor control, a high proportion underwent

amputation (12 amputations among 21 poorly controlled patients, reported as 57.14%).

Clinical risk factors and comorbidities: A past history of diabetic foot ulcer was present in 22.5% (9/40). Hypertension was the most common comorbidity (42.5%), followed by asthma/COPD (20%), renal disease (15%), and heart disease (5%). Peripheral vascular disease was present in 37.5% (15/40). Neuropathy was present in 42.5% (17/40).

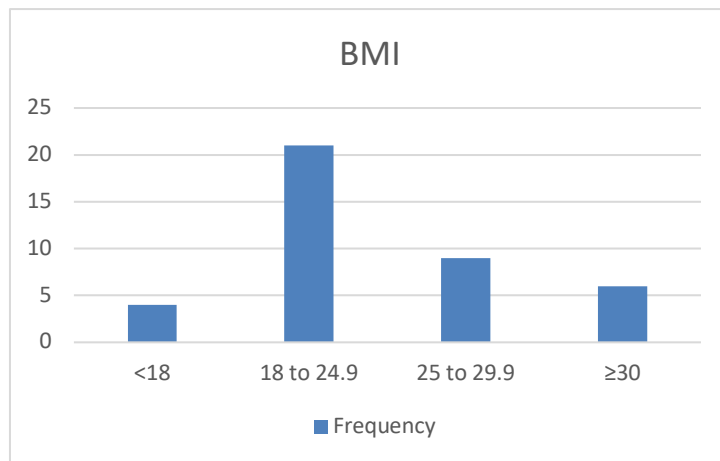


Figure 1: Distribution of study participants according to BMI

BMI distribution showed most patients in the “Normal” BMI category (18–24.9) at 52.5%, with smaller proportions in overweight and higher BMI categories. Foot self-care practices were poor in the majority: 95% (38/40) were categorized as having poor foot care practice, and only 5% (2/40) as good in the reported table/figure.

Wagner grade, amputation, and mortality: The Wagner grade distribution included patients across grades 1–5, and management differed strongly by grade. The study reports that all grade 1 and grade 2 ulcers (4 patients each) were managed conservatively with no amputations. In grade 3 (17 patients), 4 (23.53%) underwent amputation while 13 (76.47%) were managed without amputation.

Table 2: Wagner’s classification of patients having amputation and not having amputation

Wagner Classification	Amputation	No Amputation	Total
Grade 1	0 (0%)	4 (100%)	4
Grade 2	0 (0%)	4 (100%)	4
Grade 3	4 (23.53%)	13 (76.47%)	17
Grade 4	6 (75%)	2 (25%)	8
Grade 5	7 (100%)	0 (0%)	7

In grade 4 (8 patients), 6 (75%) underwent amputation and 2 (25%) were managed without amputation. In grade 5 (7 patients), 100% underwent amputation. It was observed that higher Wagner grades were significantly associated with undergoing amputation.

The type of amputation also varied by grade: in Wagner grade 3, amputations included forefoot procedures [3] and one below-knee amputation (BKA); in grade 4, one forefoot and five BKA were performed; in grade 5, six BKA and one above-knee amputation (AKA) were done.

Mortality findings showed a total of five deaths, with deaths concentrated among higher Wagner grades and particularly among those managed conservatively in advanced disease. The study reports that in grade 3, deaths occurred in the non-amputation group due to sepsis (2 deaths among non-amputees), while no deaths occurred among grade 3 amputees. In grade 4, both conservatively managed patients (who were unfit for surgery) died due to sepsis, while no deaths occurred among grade 4 amputees. In grade 5, one death occurred among amputees.

Factors associated with amputation: When comparing amputees (n=17) vs non-amputees (n=23), gangrene and neuropathy were statistically significant factors associated with amputation in this cohort. Specifically, gangrene was present in 76.47% of amputees vs 8.6% of non-amputees, and neuropathy was present in 76.47% of amputees vs 17.39% of non-amputees, both marked significant in the thesis. Other factors such as male sex, type 2 diabetes, hypertension, PVD, and nephropathy was not statistically significant in the presented analysis.

Discussion

In the present study at SSG Hospital, Government Medical College, Vadodara, the mean age of patients with diabetic foot ulcer/infection was 57.62 years and males constituted 65% of the cohort. This age–sex pattern is comparable to many hospital-based Indian DFU series that report clustering in the 5th to 7th decades with male predominance, likely reflecting higher exposure to outdoor trauma, delayed care-seeking, and referral bias to tertiary surgical units. [12]

Most participants in our study had type 2 diabetes (92.5%), which mirrors the epidemiologic reality

that type 2 diabetes accounts for the majority of diabetes burden in India. This aligns with national data from ICMR–INDIAB analyses showing a large and growing pool of diabetes and prediabetes, implying a sustained pipeline of future DFU cases and late vascular complications presenting to tertiary hospitals. [5]

Our study found that longer duration of diabetes was common (32.5% had 11–15 years; 17.5% had >15 years), supporting the concept that cumulative glycaemic exposure increases neuropathy, vasculopathy, and infection susceptibility. Similarly, a prospective observational study by Bal BS et al. (reported in the International Journal of Research in Medical Sciences) observed that duration of diabetes was significantly longer in the amputation group than in the limb-salvage group, emphasizing duration as a proxy marker for complication load. [13]

Regarding glycaemic status, our cohort had a high proportion with poor control on admission (60%), and amputations were frequent among poorly controlled patients (12 amputations among 21 poorly controlled patients). This direction of association (poor control → worse outcomes) is consistent with broader DFU literature where uncontrolled hyperglycaemia is linked to impaired immunity and wound healing, though many hospital studies vary in whether HbA1c/FBS remains independently significant after adjusting for ulcer severity and infection. [14,15]

Comorbidity patterns in our study showed hypertension as the most common comorbidity (42.5%), with notable proportions of renal disease (15%) and respiratory disease (asthma/COPD, 20%). These findings are compatible with ICMR–INDIAB summaries documenting a high cardiometabolic risk milieu (including high hypertension prevalence) coexisting with diabetes in India, which can indirectly worsen DFU prognosis through systemic inflammation, atherosclerosis, and reduced physiological reserve during sepsis. [5]

Peripheral vascular disease (PVD) was present in 37.5% of our patients, while neuropathy was present in 42.5%, reflecting the classic DFU substrate of neuro-ischemic compromise. Importantly, when amputees were compared to non-amputees in our cohort, neuropathy was statistically significant (76.47% in amputees vs 17.39% in non-amputees), supporting neuropathy as a key pathway to unrecognized injury, delayed presentation, and deeper infection. [13]

A striking operational finding in our study was that 95% of patients had poor foot self-care practices, indicating a major preventable gap at community level. Although many published cohorts do not quantify self-care using a structured score, the

broader DFU evidence base consistently emphasizes that delayed detection and late presentation (often due to low-risk perception and poor foot-care behaviors) drive high-grade ulcers and subsequent amputations. [12]

The strongest and most clinically actionable result in our study was the stepwise increase in amputation with rising Wagner grade: grade 1 and 2 ulcers had 0% amputation, grade 3 had 23.53%, grade 4 had 75%, and grade 5 had 100%.

In our cohort, gangrene showed a very strong association with amputation (present in 76.47% of amputees vs 8.6% of non-amputees), reinforcing that tissue necrosis is a near “point-of-no-return” marker prompting definitive surgery. Comparable findings were reported by Chapparbandi et al. in a North Karnataka diabetic foot profile study, where gangrene was markedly more common among amputees than non-amputees and was highlighted as a critical predictor of amputation. [16]

Mortality in our study (5 deaths) clustered in higher Wagner grades and notably occurred among conservatively managed advanced cases (patients unfit for surgery) due to sepsis. This parallels the clinical reality described in DFU outcomes research: when advanced infection/gangrene cannot be surgically controlled, systemic sepsis risk rises, and mortality concentrates in the most severe grades.

Overall, the comparative literature supports the central inference from our data: Wagner grade captures severity that strongly forecasts amputation, while neuropathy, gangrene, diabetes duration, and poor metabolic control commonly co-travel with advanced grades and worse outcomes. These comparisons underline that preventing progression (through early detection, structured foot-care education, and timely referral before grade 3–5 disease) is likely to yield the biggest reduction in amputations and sepsis-related deaths in similar tertiary-care Indian settings. [12]

Conclusion

This observational study of 40 hospitalized diabetic foot ulcer/infection cases found that Wagner grade strongly correlated with outcomes, with higher grades associated with substantially higher amputation rates. Neuropathy and gangrene were significantly associated with undergoing amputation, and mortality was highest in advanced Wagner grades when patients could not undergo surgery and progressed to sepsis. The findings support using Wagner classification to guide timely, grade-appropriate management and reinforce that prevention—through glycaemic control, neuropathy screening, and improved foot self-care—remains the most effective approach to reduce amputations and deaths in diabetic foot disease.

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