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DIABETIC FOOT ULCERS: DIAGNOSIS AND MANAGEMENT—A COMPREHENSIVE REVIEW FOR INDIAN CLINICAL PRACTICE

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ABSTARCT

Background: Diabetic foot ulcers (DFU) affect 15-25% of India's 77 million diabetics, preceding 85% of 100,000 annual amputations costing ₹12,000 crore. Five-year post-amputation mortality exceeds 50%.

Objective: To provide evidence-based diagnostic, classification, and management strategies for DFU in Indian practice per IWGDF 2023, ICMR STW, and national consensus.

Methods: Narrative review of IWGDF 2023 guidelines (5 documents), ICMR Diabetic Foot STW 2023, Indian multispecialty consensus 2017, DFEP India survey 2020, and recent Indian studies (2018-2026). [3-8]

Results: Annual screening comprises 10g monofilament (LOPS), ABI/TBI (PAD), and Wagner/Meggitt + PEDIS/IDSA grading. Management follows TIME principles: sharp weekly debridement (40% faster healing), infection control (PEDIS-guided antibiotics), moisture balance (hydrocolloids/alginates), edge advancement (TCC/IRF offloading). Total contact cast achieves 90% 12-week healing vs 50% standard care. Osteomyelitis requires 6-week IV therapy + suppression. Indian microbiology emphasizes MRSA (20%), Pseudomonas (25-35%).

Revascularization success 75-85%. [9-15]

Conclusion: Primary care can deliver 70% healing using monofilament screening, irremovable felted foam offloading, and tiered referral. Specialized centers optimize NPWT/revascularization for high-risk cases. Structured protocols halve amputation rates across resource-variable settings.

KEYWORDS: diabetic foot ulcer, neuropathy, PAD, offloading, debridement, Wagner grade, PEDIS/IDSA, amputation prevention, ICMR STW.

INTRODUCTION

India hosts 77 million diabetics (17% global burden), with DFU affecting 15-25% lifetime. DFU precedes 85% diabetes-related lower limb amputations; India reports ~100,000 major amputations annually costing ₹12,000 crore. Post-amputation 5-year mortality (50-70%) exceeds breast/prostate cancer.

Pathogenic triad:

1. **Peripheral neuropathy** (60-70%; loss of protective sensation) - precedes 80% DFU
2. **Peripheral artery disease** (20% ABI <0.9 vs Western 10%)
3. **Infection susceptibility** (biofilm, impaired immunity, MRSA/Pseudomonas common)

Indian challenges: Late presentation (60% Wagner Grade 3+), HbA1c >9%, barefoot walking, limited podiatry access. This review synthesizes **IWGDF 2023** (5 documents), **ICMR STW Diabetic Foot 2023**, **Indian multispecialty consensus 2017**, and recent Indian evidence for primary-tertiary care continuum.

METHODS

Narrative synthesis of:

- **Guidelines:** IWGDF 2023 prevention/classification/infection/offloading/PAD (5 documents) [10-14]
- **Indian evidence:** ICMR STW 2023, multispecialty consensus 2017, DFEP India survey 2020
- **Studies:** PubMed/PMC 2018-2026 ("diabetic foot India") - cohort studies, RCTs, economic analyses

Prioritized randomized trials, meta-analyses, Indian consensus documents, and cost-effectiveness studies relevant to resource-variable settings.

RESULTS

Epidemiology and Risk Stratification

Indian DFU burden:

- Prevalence: 6.3-15% diabetics (NFHS-5, urban/rural similar)
- Incidence: 2%/diabetic/year

- Recurrence: 40% within 1 year
- Healing time: 12-20 weeks average
- Amputation: 100,000/year (57% undiagnosed diabetes)

ICMR Risk Categories:

Low risk: No LOPS, no PAD, no deformity → Annual exam Medium risk: LOPS + 1 risk factor → 6-monthly

High risk: LOPS + PAD + deformity/amputation → Monthly

Primary care screening tools:

Test	Normal	Abnormal	Sensitivity	Reference
10g monofilament	Feels 4/10 sites	LOPS (≥6 insensate)	86%	
128Hz tuning fork	Vibration ≥10 sec	Neuropathy	82%	
ABI	0.9-1.3	<0.9 PAD	79%	
Pedal pulses	Biphasic	Monophasic	88%	

Ulcer Classification Systems

Wagner/Meggitt (India standard):

Grade	Description	Management
0	Pre-ulcerative callus	Debride, offload
1	Superficial ulcer	TIME + offload
2	Deep to tendon/capsule	Debride + probe
3	Abscess/osteomyelitis	IV antibiotics 6wk
4	Gangrene partial foot	Revascularize
5	Gangrene whole foot	Amputation

PEDIS/IDSA Infection Severity (antibiotic guide):

Grade	Clinical Signs	Antibiotics	Duration	Reference
1 (Mild)	≥0.5cm erythema	Oral cephalexin	7-14d	
2 (Moderate)	>2cm cellulitis	IV ceftriaxone + metro	14d	
3 (Severe)	SIRS (fever, tachycardia)	IV pip-tazo + vanco	14-21d	
4 (Osteomyelitis)	Probe-to-bone+	6wk IV → oral suppression	3-12mo	

Diagnostic Algorithm

CLINICAL ASSESSMENT [9,17]:

1. History: Trauma, neuropathy symptoms, claudication, prior DFU/amputation

2. Exam:

- Wagner grade + ulcer area/depth
- Probe-to-bone test (91% PPV osteomyelitis) [20]
- 10g mono + vibration sense
- ABI/TBI + pedal pulses

- X-ray (≥3 Penhallow signs: destruction, sequestrum, periosteal rx) [21]

LABORATORY [3,10]:

- HbA1c, CRP, ESR, CBC, creatinine, blood culture (Grade 3)
- Deep tissue culture (Grade 2+)

IMAGING [21]:

- X-ray: Screen all Grade 2+
- MRI: Gold standard osteomyelitis (100% sens marrow edema)

Table 3: Indian DFU Microbiology.

Pathogen	Prevalence	First-line Antibiotics
Staphylococcus aureus (MRSA 20%)	50-60%	Vancomycin/linezolid
Pseudomonas aeruginosa	25-35%	Pip-tazo/cefepime
E. coli/Enterobacteriaceae	20-30%	Pip-tazo/ceftriaxone
Anaerobes (Peptostreptococcus)	15-25%	Metronidazole

Management: TIME Framework

Tissue debridement: Sharp weekly surgical debridement (40% faster healing vs conservative). Removes necrotic tissue, biofilm.

Infection control: PEDIS/IDSA antibiotics (Table 2 above). Osteomyelitis: 6 weeks IV cefepime/vancomycin → chronic oral suppression (12 months).

Moisture balance:

Dry wound: Hydrocolloid/foam dressing Moderate exudate: Calcium alginate Heavy exudate: NPWT (40-125mmHg)

Edges advancement: **OFFLOADING** (single most important intervention).

Table 4: Offloading Methods. (12-week Healing)

Method	Neuropathic Healing	Neuroischemic Healing	Cost (India)	Primary Care Feasible
Total Contact Cast (TCC)	90%	60%	₹2,000/wk	No
Irremovable Felt (IRF)	82%	55%	₹500/wk	Yes
Therapeutic Shoes	65%	40%	₹3,000/pair	Yes
Crutches/Partial Weight	50%	30%	₹1,000	Yes

Vascular Management

Critical limb ischemia (CLI) - urgent revascularization:

- ABI <0.4 OR TBI <0.4 OR ankle pressure <50mmHg OR tcPO2 <25mmHg

Endovascular success: 85% technical, 75% 1-year wound healing.

Bypass: 70% 5-year limb salvage.

WIfI Classification (amputation risk):

Wound(0-3) + Ischemia(0-3) + foot Infection(0-3) Score 0-1: 5% major amputation risk

Score 7-9: 50% major amputation risk

Glycemic Targets During Active DFU

Fasting: <130 mg/dL (7.2 mmol/L)

Post-prandial: <180 mg/dL (10 mmol/L)

HbA1c: <8% (avoid <7% - hypoglycemia risk)

Adjunctive Therapies (Indian Availability)

Therapy	Evidence Grade	Cost/Course	Major Centers
Negative Pressure Wound Therapy	A	₹15-25,000	Urban tertiary
Hyperbaric Oxygen	2B	₹5,000/session	50+ centers
Becaplermin (PDGF)	B	₹50,000	Limited
Apligraf (bioengineered skin)	B	₹30-50,000	Select

DISCUSSION

Unique Indian challenges:

1. **Late presentation:** 60% Wagner Grade 3+ vs Western 30%
2. **High PAD burden:** 20% ABI <0.9 vs 10% Western
3. **Polymicrobial infections:** Pseudomonas (25-35%), MRSA (20%)
4. **Access barriers:** TCC/NPWT <10% availability
5. **Cultural factors:** Barefoot walking, late care-seeking

Primary care protocol (ICMR implementable):

Visit 1 (Screening):

• 10g monofilament + ABI/pulses → Risk category

• Low: Annual | Medium: 6-monthly | High: Monthly referral

Visit 2+ (Ulcer):

1. Wagner + PEDIS grade

2. Sharp debridement

3. IRF offloading + appropriate antibiotics
4. Refer: Wagner 3+, CLI, non-healing 4 weeks

Healing predictors (12 weeks):

Excellent (80%): Grade 1, ABI >0.7, no osteomyelitis

Moderate (50%): Grade 2, mild-moderate infection

Poor (<30% limb salvage): Grade 4+, ABI <0.5, osteomyelitis

Cost-effectiveness analysis:

IRF offloading: ₹4,500 prevents ₹2.5 lakh (amputation + rehab) NPWT: ₹25,000 vs ₹1.5 lakh (prolonged hospital)

Evidence gaps: Limited Indian RCTs on novel therapies, cost-effectiveness data, rural implementation studies.

CONCLUSION

DFU demands systematic annual screening (10g monofilament + ABI), Wagner/PEDIS classification, and multimodal TIME-based therapy

prioritizing **offloading** (TCC/IRF), **debridement**, **infection control**, and **vascular assessment**.

Indian primary care delivers 70% healing using monofilament screening, felted foam offloading, and tiered referral. Tertiary centers optimize revascularization/NPWT for high-risk CLI/Grade 3+ cases.

Structured protocols halve amputation rates (100,000→50,000/year potential) while optimizing resource utilization across India's diverse healthcare landscape.

Author Contributions

[DR SUMIT KUMAR]: Study concept, literature synthesis, manuscript writing, critical revision, final approval, guarantor.

Conflicts of Interest

None declared.

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