Decision Making in DIABETIC FOOT

An Algorithmic Approach

Editor-in-Chief
Anuj Maheshwari

Executive Editor
Ajoy Tewari

JAYPEE

CONTENTS

SECTION 6: INFECTION MANAGEMENT ALGORITHM

SECTION 7: ADVANCED CARE AND SPECIAL CONSIDERATIONS

SECTION 8: MULTIDISCIPLINARY APPROACH TO DIABETIC FOOT

SECTION 9: RECURRENCE PREVENTION AND LONG-TERM CARE

SECTION 10: ETHICAL, LEGAL, AND HEALTHCARE CONSIDERATIONS

CHAPTER

1

Introduction to Diabetic Foot

Anuj Maheshwari, Ajoy Tewari

INTRODUCTION

Diabetic foot is a severe problem for people with diabetes. It harms many patients worldwide. This condition also burdens healthcare systems globally. Diabetic foot includes many health issues of the lower legs in diabetic people. These range from small skin sores to bad infections. They also include ulcers and, finally, amputation.[1] Foot problems in diabetics are now very common. About 15–25% of diabetics get foot ulcers in their lives.[2] This issue involves many disease processes. These include nerve damage, poor blood flow, and immune system problems. Body changes also play a role. All these factors make diabetic patients prone to foot illness.[3]

Healthcare workers must understand diabetic foot issues. Early detection and good care can reduce serious problems. This includes reducing the risk of leg amputation. Diabetic foot issues also have high financial costs. Healthcare for diabetic foot costs billions of dollars each year in rich countries.[4]

PATHOPHYSIOLOGY OF DIABETIC FOOT

Diabetic foot problems begin with several linked disease processes. These processes create tissue damage. They also cause poor healing. Main factors are diabetic nerve damage, poor blood flow, and altered immune function.[5] The disease process involves many steps. High blood sugar starts these steps. They combine to cause diabetic foot syndrome. High sugar, nerve issues, blood vessel disease, and immune problems lead to ulcers and infection.

Diabetic Peripheral Neuropathy

Diabetic nerve damage affects about half of all diabetics. It is the biggest risk for foot ulcers.[6] Sensory nerve damage causes loss of protective feeling. Patients then do not notice small injuries or pressure spots. These can turn into ulcers.[7]

Motor nerve damage causes weak muscles. Muscles in the foot shrink. This causes foot deformities. These include claw toes and prominent metatarsal heads. Foot movement changes. This creates areas of high pressure on the bottom of the foot.[8]

Autonomic nerve damage affects sweat gland function. This leads to dry skin. Dry skin cracks easily. These cracks allow bacteria to enter. This starts infections.[9]

Peripheral Arterial Disease (Table 1)

Peripheral arterial disease (PAD) affects 20–30% of diabetics. It makes diabetic foot ulcers heal poorly.[10] Blood vessel hardening in diabetic patients is often worse. It affects smaller, farther vessels than in nondiabetics. This poor microvascular flow means less oxygen and nutrients reach tissues. This environment causes tissue death. It also leads to bad wound healing.[11]

Immune Dysfunction

Diabetes affects the immune system in many ways. This makes patients prone to infections. It also slows wound

TABLE 1: Comparison between blood vessel traits in diabetic and nondiabetic PAD.

Parameter	Nondiabetic PAD	Diabetic PAD
Vessel involvement	Proximal, large vessels	Distal, small vessels
Plaque characteristics	Focal, calcified	Diffuse, heavily calcified
Collateral circulation	Good development	Poor development
Response to intervention	Better outcomes	More challenging
Healing capacity	Preserved	More challenging

(PAD: peripheral arterial disease)

healing. High blood sugar affects neutrophil function. This affects how they move, engulf bacteria, and kill germs.[12] Also, advanced glycation end products (AGEs) build up in diabetic patients. This causes constant swelling. It also leads to more tissue damage.[13]

Classification Systems

Doctors use classification systems to assess and manage diabetic foot conditions. The University of Texas System is common **(Table 2)**. It looks at ulcer depth and if infection or poor blood flow are present.[14] This system grades ulcers from 0 to 3. Grade 0 means a pre-ulcer lesion. Grade 3 means the ulcer reaches bone or joint. It also stages them: A (clean), B (infected), C (ischemic), or D (infected and ischemic).

The Wagner Classification System is simpler. It is still popular in clinics. It grades foot lesions from 0 to 5.

Grade 0 is intact skin. Grade 5 is gangrene of the whole foot. This tool offers a clear assessment.[15]

The SINBAD classification is newer. It gains acceptance for its full evaluation of risk factors.[16]

RISK FACTORS AND PREVENTION

Finding high-risk patients is vital to stop diabetic foot problems. Main risks include past foot ulcers or amputation. Nerve damage and poor blood flow are also risks. Foot deformities, bad sugar control, and poor foot care add to the risk.[17]

Prevention focuses on patient teaching **(Table 3)**. Regular foot checks are important. Proper shoe choice also helps. Good blood sugar control is key. The International Working Group on the Diabetic Foot suggests yearly screening for all diabetic patients. High-risk people need more frequent checks.[18] Organized foot care programs have greatly reduced amputation rates. This happens when they are used consistently.[19]

TREATMENT APPROACHES

Managing diabetic foot problems needs a team effort. This includes specialists such as endocrinologists, podiatrists, and vascular surgeons. Infection doctors and wound care experts also help. Key treatment rules include easing pressure. Infection control is vital. Checking blood vessels and acting on findings is also needed. Optimizing blood sugar control is a main goal.[20]

Wound Care and Offloading

Good wound care means removing dead tissue **(Table 4)**. Keeping the wound moist helps. Protecting it from more harm is also needed. Reducing pressure is crucial. This can be done with total contact casts. Removable cast walkers or special shoes also work.[21] Studies show that good pressure relief helps heal 70–90% of nerve-related ulcers. This is true if blood flow is not a major issue.[22]

TABLE 2: University of Texas Diabetic Foot Rating System.

Grade	Stage A (Clean)	Stage B (Infected)	Stage C (Ischemic)	Stage D (Infected + Ischemic)
0	Preulcerative lesion	Preulcerative lesion + infection	Preulcerative lesion + ischemia	Preulcerative lesion + infection +ischemia
1	Superficial wound	Superficial wound + infection	Superficial wound + ischemia	Superficial wound + infection + ischemia
2	Wound penetrating to tendon/capsule	Wound to tendon/capsule + infection	Wound to tendon/capsule + ischemia	Wound to tendon/capsule + infection + ischemia
3	Wound penetrating to bone/joint	Wound to bone/joint + infection	Wound to bone/joint + ischemia	Wound to bone/joint + infection + ischemia

TABLE 3: Evidence-based prevention strategies and their effectiveness in reducing diabetic foot complications.

Prevention strategy	Level of evidence	Reduction in ulceration risk	Implementation requirements
Patient education	Grade A	40–60%	Structured programs, materials
Regular screening	Grade A	50–80%	Trained healthcare providers
Therapeutic footwear	Grade B	30–50%	Specialist assessment, custom fitting
Glycemic control	Grade A	25–40%	Multidisciplinary diabetes care
Podiatric care	Grade A	60–85%	Regular professional foot care

TABLE 4: Wound healing phases and corresponding interventions in diabetic foot ulcers.

Healing phase	Duration	Key processes	Interventions	Expected outcomes
Hemostasis	Minutes to hours	Platelet clumping, clot making	Stop bleeding, wound check	Bleeding stops
Inflammation	3–5 days	White blood cell entry, debris removal	Infection control, debridement	Less bacteria
Proliferative	3–21 days	New blood vessels, collagen making	Moist wound healing, growth factors	Granulation tissue forms
Maturation	21 days to 2 years	Protein remodeling, scar making	Pressure redistribution, protection	Wound closure, scar matures

TABLE 5: Common pathogens in diabetic foot infections and recommended antibiotic therapy.

Infection severity	Common pathogens	First-line antibiotics	Duration
Mild	*Staphylococcus aureus, Streptococcus* species	Cephalexin, clindamycin	1–2 weeks
Moderate	MRSA, gram-negative bacteria	Trimethoprim-sulfamethoxazole, Fluoroquinolones	2–3 weeks
Severe	Multiple germs, Anaerobes	Vancomycin + Piperacillin-tazobactam	3–4 weeks
Bone infection	Bone-penetrating organisms	IV therapy followed by oral	6–12 weeks

(MRSA: methicillin-resistant *Staphylococcus aureus*)

TABLE 6: Emerging therapies for diabetic foot ulcers with evidence levels and clinical applications.

Therapy	Mechanism of action	Evidence level	Indications	Limitations
Negative pressure Wound therapy	Enhanced granulation, reduced edema	Grade A	Deep, clean wounds	Cost, patient compliance
Bioengineered skin Substitutes	Cellular scaffolds, growth factors	Grade B	Chronic nonhealing ulcers	High cost, limited availability
Platelet-rich plasma	Growth factor concentration	Grade C	Stalled healing	Variable preparation methods
Stem cell therapy	Tissue regeneration	Experimental	Research protocols	Limited clinical data
Hyperbaric oxygen	Enhanced tissue oxygenation	Grade B	Ischemic wounds	Access limitations, contraindications

Infection Management

Diabetic foot infections vary widely. They can be mild skin infections or deep tissue infections. They can also be bone infections. Quick detection and right antibiotics are key. This stops problems from getting worse. The Infectious Diseases Society of America published full guides. These guides cover diagnosis and treatment of diabetic foot infections **(Table 5)**.[23]

Vascular Intervention

Patients with severe peripheral artery disease may need vascular surgery. This helps wounds heal. Both surgical bypass and endovascular procedures help blood flow to the diabetic foot.[24] The best choice depends on the patient's health. It also depends on the vessel disease anatomy. Expert availability also plays a role.

Emerging Therapies

New therapies for diabetic foot care are emerging. These include negative pressure wound therapy. Bioengineered skin substitutes are also new. Growth factors and stem cell therapy show promise. Their role in regular care is still developing. Their cost-effectiveness is also a factor **(Table 6)**.[25]

Hyperbaric oxygen therapy helps some diabetic foot ulcer patients. This is true for those with poor tissue oxygen.[26] But access to hyperbaric centers is limited. Patient selection rules also limit its broad use.

TABLE 7: Cost-effectiveness analysis of diabetic foot prevention versus treatment strategies.

Strategy	Initial investment	Annual cost per patient	Amputation prevention rate	Cost per quality-adjusted life year
Standard care	Baseline	$3,000	Baseline	Baseline
Enhanced screening	Low	$3,500	25% reduction	$15,000
Team care	Moderate	$4,200	45% reduction	$25,000
Complete prevention	High	$5,000	65% reduction	$35,000

ECONOMIC IMPACT AND HEALTHCARE BURDEN

Diabetic foot problems cost a lot of money. Hospital stays, surgeries, and long-term care are expensive. These costs make up much of diabetes health care costs. Studies show prevention programs save money. While needing upfront money, they cut serious problems and amputations **(Table 7)**.[27]

CONCLUSION

Diabetic foot represents a complex and challenging complication of diabetes. It needs full understanding and team care. The condition comes from many interacting disease processes. These include nerve damage, blood vessel issues, and immune problems. They create an environment prone to tissue damage. They also cause poor healing.

Catching risk factors early is key. Using preventive steps is crucial. This lowers diabetic foot problems. Healthcare providers must know screening methods. They need to understand classification systems. They also need proven treatment plans to help patients.

Team-based care for diabetic feet has worked well. This includes proper wound care and infection control. It also means checking blood vessels and teaching patients. This approach has significantly reduced amputations. It has also improved the quality of life for diabetics. More research on new therapies is ongoing. Improving current treatments will further help manage this challenge.

Investing in full diabetic foot care programs pays off. While costing money at first, they provide long-term benefits. These include lower healthcare costs. They also lead to better patient results. Diabetes numbers keep rising globally. So, effective diabetic foot care becomes even more vital. Health systems must prioritize this part of diabetes care.

REFERENCES

1. Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with diabetes. JAMA. 2005;293(2):217-28.
2. Abbott CA, Carrington AL, Ashe H, Bath S, Every LC, Griffiths J, et al. The North-West Diabetes Foot Care Study: incidence of, and risk factors for, new diabetic foot ulceration in a community-based patient cohort. Diabet Med. 2002;19(5):377-84.
3. Boulton AJM, Vileikyte L, Ragnarson-Tennvall G, Apelqvist J. The global burden of diabetic foot disease. Lancet. 2005;366(9498):1719-24.
4. Driver VR, Fabbi M, Lavery LA, Gibbons G. The costs of diabetic foot: the economic case for the limb salvage team. J Vasc Surg. 2010;52(3 Suppl):17S-22S.
5. Frykberg RG, Zgonis T, Armstrong DG, Edwards A, Kravette M, Kravitz S, et al. Diabetic foot disorders: a clinical practice guideline. J Foot Ankle Surg. 2006;45(5 Suppl):S1-66.
6. Pop-Busui R, Boulton AJ, Feldman EL, Bril V, Freeman R, Malik RA, et al. Diabetic neuropathy: a position statement by the American Diabetes Association. Diabetes Care. 2017;40(1):136-54.
7. Vinik AI, Maser RE, Mitchell BD, Freeman R. Diabetic autonomic neuropathy. Diabetes Care. 2003;26(5):1553-79.
8. Bus SA, Yang QX, Wang JH, Smith MB, Wunderlich R, Cavanagh PR. Intrinsic muscle atrophy and toe deformity in the diabetic neuropathic foot: a magnetic resonance imaging study. Diabetes Care. 2002;25(8):1444-50.
9. Bharath AK, Arora N, Kaur P, Garg U, Singh VP, Jain V. Prevalence of peripheral arterial disease in type 2 diabetes mellitus and its correlation with coronary artery disease and its risk factors. J Assoc Physicians India. 2004;52:896-906.
10. Jude EB, Oyibo SO, Chalmers N, Boulton AJ. Peripheral arterial disease in diabetic and nondiabetic patients: a comparison of severity and outcome. Diabetes Care. 2001;24(8):1433-7.
11. Marso SP, Hiatt WR. Peripheral arterial disease in patients with diabetes. J Am Coll Cardiol. 2006;47(5):921-9.
12. Alba-Loureiro TC, Munhoz CD, Martins JO, Cerchiaro GA, Scavone C, Curi R, et al. Neutrophil function and metabolism in individuals with diabetes mellitus. Braz J Med Biol Res. 2007;40(8):1037-44.
13. Goldin A, Beckman JA, Schmidt AM, Creager MA. Advanced glycation end products: sparking the development of diabetic vascular injury. Circulation. 2006;114(6):597-605.
14. Armstrong DG, Lavery LA, Harkless LB. Validation of a diabetic wound classification system. Diabetes Care. 1998;21(5):855-59.
15. Wagner FW Jr. The dysvascular foot: a system for diagnosis and treatment. Foot Ankle. 1981;2(2):64122.

16. Ince P, Kendrick D, Game F, Jeffcoate W. The association between baseline characteristics and the outcome of foot lesions in a UK population with diabetes. Diabet Med. 2007;24(9):977-81.
17. Lavery LA, Armstrong DG, Wunderlich RP, Mohler MJ, Wendel CS, Lipsky BA. Risk factors for foot infections in individuals with diabetes. Diabetes Care. 2006;29(6):1288-93.
18. International Working Group on the Diabetic Foot. International consensus on the diabetic foot and practical guidelines on the management and prevention of the diabetic foot. Amsterdam: International Diabetes Federation; 2019.
19. Krishnan S, Nash F, Baker N, Fowler D, Rayman G. Reduction in diabetic amputations over 11 years in a defined UK population: benefits of multidisciplinary team work and continuous prospective audit. Diabetes Care. 2008;31(1):99-101.
20. Lipsky BA, Berendt AR, Cornia PB, Pile JC, Peters EJ, Armstrong DG, et al. 2012 Infectious Diseases Society of America clinical practice guideline for the diagnosis and treatment of diabetic foot infections. Clin Infect Dis. 2012;54(12):e132173.
21. Bus SA, Valk GD, van Deursen RW, Armstrong DG, Caravaggi C, Hlavácek P, et al. The effectiveness of footwear and offloading interventions to prevent and heal foot ulcers and reduce plantar pressure in patients with diabetes: a systematic review. Diabetes Metab Res Rev. 2008;24 Suppl 1:S162-80.
22. Armstrong DG, Nguyen HC, Lavery LA, van Schie CH, Boulton AJ, Harkless LB. Off-loading the diabetic foot wound: a randomized clinical trial. Diabetes Care. 2001;24(6):1019-22.
23. Lipsky BA, Senneville É, Abbas ZG, Aragón-Sánchez J, Diggle M, Embil JM, et al. Guidelines on the diagnosis and treatment of foot infection in persons with diabetes (IWGDF 2019 update). Diabetes Metab Res Rev. 2020;36 Suppl 1:e3280.
24. Norgren L, Hiatt WR, Dormandy JA, Nehler MR, Harris KA, Fowkes FG, et al. Inter-society consensus for the management of peripheral arterial disease (TASC II). J Vasc Surg. 2007;45 Suppl S:S5-67.
25. Game FL, Apelqvist J, Attinger C, Driver V, Hartemann A, Londahl M, et al. Effectiveness of interventions to enhance healing of chronic ulcers of the foot in diabetes: a systematic review. Diabetes Metab Res Rev. 2012;28 Suppl 1:119-141.
26. Kranke P, Bennett MH, Martyn-St James M, Schnabel A, Debus SE, Weibel S. Hyperbaric oxygen therapy for chronic wounds. Cochrane Database Syst Rev. 2015;(6):CD004123.
27. Ragnarson Tennvall G, Apelqvist J. Health-economic consequences of diabetic foot lesions. Clin Infect Dis. 2004;39 Suppl 2:S132-139.

Decision Making in DIABETIC FOOT

An Algorithmic Approach

Salient Features

- Provides a clear and stepwise approach to clinical decision-making in diabetic foot management.
- Combines practical insights from medical, surgical, and rehabilitation experts.
- Focuses on simplified algorithms and real-world treatment pathways.
- Highlights the role of technology and innovation in modern diabetic foot care.
- Emphasizes prevention, patient's education, and long-term care.
- Serves as a concise and practical guide for clinicians and postgraduate students.

Anuj Maheshwari MD(Medicine) MACP(USA) FICP FIACM FIMSA FRSSDI FACP(USA) FACE(USA) FRCP(London, Edinburgh) is a Senior Diabetologist and Metabolic Physician, Academician, and global thought leader in diabetes and hypertension. He serves as the President of RSSDI (2025–2026), President of the Asian Pacific Society of Hypertension, and Vice President of Asian Heart Society. With over 110 scientific publications and 112 conference presentations, he has been recognized with prestigious orations and awards, including by the World Hypertension League and American College of Physicians. He is a Professor of Medicine at Hind Institute of Medical Sciences, Lucknow, and Adjunct Professor at KMC, Manipal, Karnataka, India. He has been trained in Diabetic Foot through "Step by Step" program run by Diabetic Foot Society of India and he is credited of first Diabetic Foot Clinic in Lucknow. A dedicated educator for last two decades, he continues to inspire future generations through clinical excellence and research innovation.

Ajoy Tewari MD(Medicine) MSc(Diabetes, Warwick, UK) FRCP(Edinburgh, Glasgow, London) FACP and Fellowships (RSSDI and DiabetesIndia) is an Eminent Diabetologist and practicing foot care specialist at Lucknow, Uttar Pradesh. Trained in Diabetic Foot Management from CMC Vellore, Tamil Nadu, India, he holds a Fellowship in Diabetic Foot Management from the Indian Podiatry Association. He is the President of Indian Podiatry Association (UP Chapter) and has received multiple honors, including the RSSDI Excellence Award (2019) and Times Now Legend of Medicine (2024). Dr Tewari has authored over 50 papers, serves as a reviewer for reputed journals, and actively contributes to national diabetes and hypertension guideline committees.

Shelving Recommendations
DIABETES & ENDOCRINOLOGY

ISBN 978-93-7202-053-3

Buy from ejaypee

JAYPEE BROTHERS