DOI: https://doi.org/10.53350/pjmhs020241812.3

**ORIGINAL ARTICLE**

# Diabetic Foot- A New Era of Diagnosis and Prevention

PATRYCJA PABIS[1], MAREK SKOTARSKI[2], RADOSLAW SZYDLOWSKI[3], HANNA PORWOLIK[4], MAGDALENA BODERA[5], BARTLOMIEJ CZARNECKI[6], AGATA PORWOLIK[7], KAMIL STEFANSKI[8], DOMINIK RABSTEIN[9], PIOTR DEMBICKI[10]

[1]*Professor Zbigniew Religa Student Scientific Association at the Department of Biophysics, Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Jordana 19, 41-808 Zabrze, Poland. https://orcid.org/0009-0009-8394-5432, patrycjapabis.lek@gmail.com*

[2]*Jagiellonian University in Kraków, Świętej Anny 12, 32-008 Kraków, Poland, https://orcid.org/0009-0007-5731-5977, lek.dent.mskotarski@gmail.com*

[3]*Professor Zbigniew Religa Student Scientific Association at the Department of Biophysics, Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Jordana 19, 41-808 Zabrze, Poland, https://orcid.org/0009-0000-5771-3990, rdszydlowski@gmail.com*

[4]*Professor Zbigniew Religa Student Scientific Association at the Department of Biophysics, Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Jordana 19, 41-808 Zabrze, Poland, https://orcid.org/0009-0001-5004-3725, porwolikhanna@gmail.com*

[5]*Professor Zbigniew Religa Student Scientific Association at the Department of Biophysics, Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Jordana 19, 41-808 Zabrze, Poland, https://orcid.org/0009-0002-8890-214X, mag.bodera@gmail.com*

[6]*Provincial Specialist Hospital No. 5 named after St. Barbara in Sosnowiec, Plac Medyków 1, 41-214 Sosnowiec, Silesia, Poland, https://orcid.org/0009-0006-8960-5760 bartlomiejszymonczarnecki@gmail.com*

[7]*Professor Zbigniew Religa Student Scientific Association at the Department of Biophysics, Faculty of Medical Sciences in Zabrze, Medical University of Silesia, Jordana 19, 41-808, Zabrze, Poland, https://orcid.org/0009-0003-5533-5377, agataaporwolik@gmail.com*

[8]*Silesia Orthodontics, Juliusza Słowackiego 13, 40-094 Katowice, Poland, https://orcid.org/0000-0002-7535-1572, kamilstefanski@me.com*

[9]*You Clinic Rabstein, Spolka Jawna, Kłodnicka 10, 40-702, Katowice, https://orcid.org/0009-0006-0008-4744, rabstein.dominik@gmail.com*

[10]*Medical University of Bialystok, Jana Kilińskiego 1, 15-089 Białystok, Poland, https://orcid.org/0009-0005-0709-9220, piotr.dembickizmc@gmail.com*

*Correspondence to: Patrycja Pabis, Phone number: +48 570029107, E-mail: patrycjapabis.lek@gmail.com*

## ABSTRACT

**Background:** Diabetic foot ulcers (DFU), a common complication of long-term diabetes, significantly reduce quality of life, increase morbidity and mortality, and place a heavy burden on individuals and healthcare systems. It is require a multidisciplinary approach to treatment.

**Aim:** To overview the standards in diabetic foot prevention and care.

**Methods:** We searched for materials for this work in the Pubmed and Google Scholar databases using the keywords: "Diabetic foot", "diabetic wounds", "diabetic neuropathy"and analyzed the selected materials.

**Results:** DFU significantly reduce the quality of life and are a major burden for individuals and healthcare systems. Effective care involves specialists across various fields to address the complex causes and improve outcomes.

**Conclusion:**There are currently many published standards for the care and examination of the feet of patients with diabetes, which are presented in the following review. It is important to remember the cause of the pathophysiology of DFU and effectively treat diabetes, maintaining the patient in normoglycemia, and also examine your feet and actively look for the first signs of diabetic ulcers.

**Keywords:** Diabetic foot, diabetic wounds, neuropathy, vascular disease

## INTRODUCTION

Diabetes is still a big social problem, with many associated complications. According to the recent rise in incidence of diabetes, the result of the Balance Scenario with Medium Level of the data, its rate can reach up to 28% according to an approximation to the year 2050[1]. The term diabetes-related foot ulcer (DFU) is specified as an ulcer that occurs in the foot of a person with diabetes which at least penetrates the epidermis and some of the dermis[2]. Diabetic foot ulcers- DFU are a frequent complication of longstanding diabetes, and lifetime risk of developing a diabetic foot ulcer is 19–34% among patients with diabetes[3]. These symptoms significantly reduce quality of life, as well as incur substantial costs to the individual. Diabetic foot ulcers (DFU) have been shown to confer a significantly increased risk of morbidity and mortality. In fact, diabetic patients with DFU are 2.5 times more likely to die within five years than their counterparts without DFU[4].

Moreover, it is a heavy burden for the person's family, health workers and health care facilities, and on society as a whole. Development of an ulcer often coincides with other risk factors in a single patient with diabetes, including diabetes-associated peripheral neuropathy and/or PAD5 Because the causes of diabetic foot ulcers are multifactorial, treatment requires a multidisciplinary team. Diagnosis and management should take place in a multidisciplinary foot care service, under the supervision of a named healthcare professional including those who are specialist in the areas such as diabetology, podiatry, diabetes specialist nursing, vascular surgery, microbiology, orthopaedic surgery, biomechanics and orthoses, interventional radiology, casting. Rehabilitation services, plastic surgery, psychological services and nutritional services should also be available to multidisciplinary foot care service[6]. For burn patients, the multidisciplinary team should be led by the diabetologist as diabetic foot ulcers are a complication of diabetes and the most common underlying cause for chronic ulceration is chronic hyperglycemia[7].

Received on 09-08-2024
Accepted on 22-11-2024

**Definition and Clinical Presentation**

There are many wound grading systems, with varying degrees of focus on the degree of tissue loss, ischemia, and infection. In the research 37 classifications were identified. After a critical review 19 were included. The Wagner system was the first widely adopted classification for ulcers but is poorly validated and does not effectively differentiate between ulcer types for its primary purposes. The University of Texas classification is better validated but overlooks key factors like neuropathy and ulcer size. The Infectious Diseases Society/International Working Group system was initially for hospital admissions but later evaluated for predicting amputations. The SINBAD system, the most validated, is best for auditing outcomes, while for clinical management, the WIfI system ranks highest[8,9]. These previous classification systems were far from perfect and ignored determinants that are important to the prognosis. In response, the Society for Vascular Surgery developed a new classification system that will no longer use the term "critical limb ischemia". This classification is organized according to three principal criteria: wound characteristics (W), degree of ischemia (I) and foot infection's presence and severity (fi) SVS Wound, Ischemia, and foot Infection (WIfI) classification1 (Table 1)[10]. This includes classification of degrees of tissue loss, ischemia, and foot infection as none, mild, moderate, or severe. It helps clinicians recognize and communicate the severity of diabetic foot ulceration to channel urgent multidisciplinary clinical intervention. The WIdI is shown in figure 1. Objectives WIfI score

correlates with lower extremity amputation and morbidity; Completed WIfI score can be used to assess need for revascularization. One-year amputation rates were 0%, 8%, 11% and 38% for WIfI scores of 1, 2, 3, and 4, respectively[10,11].

Table 1. The classification system of Society for Vascular Surgery[10]

| Component | Grade | Description | | |
|---|---|---|---|---|
| W- Wound | 0 | Ulcer- No<br>Gangrene- No | | |
| | 1 | Ulcer- Small or superficial on leg or foot<br>Gangrene- No | | |
| | 2 | Ulcer- Deep with exposed bone, joint, or tendon<br>Gangrene limited to digits | | |
| | 3 | Ulcer- extensive ulcer involving forefoot and/or midfoot, calcaneal involvement<br>Gangrene—Extensive | | |
| I- Ischemia | | ABI | SBP of the ankle | TP, TcPO2 |
| | 0 | ≥ 0.80 | > 100 mmHg | ≥ 60 mmHg |
| | 1 | 0.6-0.79 | 70-100 mmHg | 40-59 mmHg |
| | 2 | 0.4-0.59 | 50-70 mmHg | 30-39 mmHg |
| | 3 | ≤ 0.39 | < 50 mmHg | < 30 mmHg |
| fI- foot Infection | 0 | Uninfected | | |
| | 1 | Mild local infection, involving only the skin and subcutaneous tissue, erythema > 0.5 to ≤ 2 cm | | |
| | 2 | Moderate local infection, with erythema > 2 cm or involving deeper structures | | |
| | 3 | Severe local infection with signs of SIRS | | |

**Mechanism**

Diabetic foot ulcers (DFU) usually have a multi-pathological origin which yiel... Neuropathy is present in most of the cases of DFU (70%-90%), however, about 15%-20% of subjects with DFU has simultaneous neuropathy and peripheral artery disease (PAD)[27]. As such,multiple processes resulting in ulceration may be present concurrently[12]. The key etiologies of diabetic foot are shown in Figure 1.

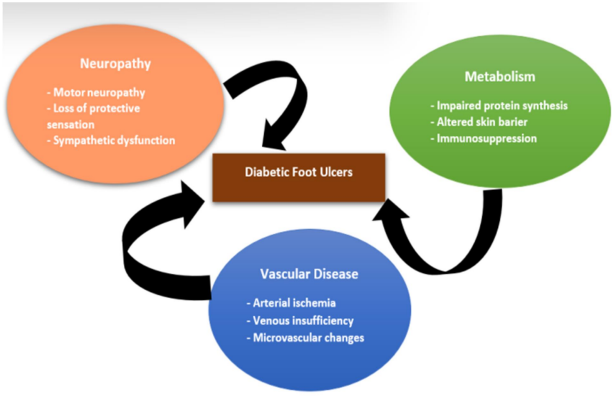
The normal wound-healing process is generally divided into four major phases: (a) the “hemostasis” stage, consisting of vasoconstriction and platelet aggregation, followed by activation of coagulation factors at the area of injury; the platelets also release mediators including transforming growth factor-beta (TGF-β), interleukin-1 (IL-1), and platelet-derived growth factor (PDGF) that recruit and activate macrophages and fibroblasts. (b) the “inflammation” phase is characterized by immune cell accumulation and the release of inflammatory mediators, such as matrix metalloproteinase (MMP)-9 from macrophages and neutrophil extracellular traps (NETs) from neutrophils; (c) during the “proliferation” phase, inflammation subsides, and skin cells such as keratinocytes that produce epidermal growth factor (EGF) proliferate and migrate towards the wound site; and (d) the “remodeling” phase is identified by tissue restructuring and deposition, driven by extracellular matrix formation and neovascularization, with fibroblasts secreting fibroblast growth factors (FGF) and vascular endothelial cells producing vascular endothelial growth factor (VEGF)[13].

In diabetic wounds, the disruption of these healing stages occurs due to tissue ischemia condition, oxygen-poor sites, and the hyperglycemic environment that dominate diabetes, suggesting compromised wound healing and clinical complications. Diabetic wounds show increased levels of pro-inflammatory cytokines like tumor necrosis factor-alpha (TNF-α) and interleukin-1 beta (IL-1β), resulting in reduced granulation and reepithelialization[14]. In diabetes, "cellular and cytokine functional capacity is diminished, and migratory potential to the sites of injury is markedly reduced," along with the "potent activity of important growth and angiogenic factors is greatly down regulated.

Furthermore, diabetic foot ulcers result from vascular disease and diabetic sensory, motor and autonomic neuropathy. Loss of protective sensation, coupled with foot deformities and limited joint mobility, due to diabetic neuropathy, can result in abnormal mechanical loading of the foot. So it most commonly forms where the skin is under the heaviest load— for example, the bottom of the foot under the metatarsal head, and the plantar midfoot. This causes intense mechanical stress in certain areas that is typically protected by the thickened skin (callus) The callus continued then to overload the foot, often with subcutaneous hemorrhage and ultimately skin ulceration. Diabetic foot ulcers also arise from other mechanisms, such as sustained low pressure, i.e., from tight shoes leading to necrosis of the underlying tissue, and high pressure from sharp objects causing acute mechanical[4].

In patients with poorly controlled diabetes for a long period, consistently elevated glucose concentrations induce damage to nerve fibers via mechanisms like advanced glycation end product (AGE) accumulation, protein kinase C activation, increased reactive oxygen species (ROS) and nitric oxide (NO) activity, DNA damage, and chronic inflammatory processes[15].

Figure 1. Mechanism of diabetic foot ulcers[4]




**Neuropathy**

Diabetic neuropathy is a unique neurodegenerative disease of the peripheral nervous system with a predominant involvement of sensory and autonomic axons and only late and mild involvement of motor axons. The gradual progression of the disease results in the degeneration and "dying back" of the peripheral sensory axon termini, while the cell bodies (perikarya) usually remain intact[17]. Although diabetes can impact all neural tissues, the most common forms of diabetic neuropathy are distal symmetric polyneuropathy and cardiovascular autonomic neuropathy, both of which are more prevalent in individuals with type 2 diabetes[18]. Besides these more generalized forms, diabetes can also involve focal or multifocal neuropathies, such as cranial, truncal, focal limb, or proximal motor neuropathies (e.g., diabetic amyotrophy) as well as chronic inflammatory demyelinating polyneuropathy.

The length of the disease is another factor that affects diabetic neuropathy prevalence. In patients with type 2 diabetes (T2DM), there was an increase in neuropathy from 8% at baseline to 42% over a 10 year follow-up period[4,19]. Because of the variable nature of the neuropathy in DFU, which can range from loss of protective sensation to deep sensory neuropathy, three significant concepts are present:

The initial, electric muscle neuroplasty causes muscular weakness and atrophy, creating a muscular weakness imbalance between the flexor and extensor muscles of the foot. This imbalance causes the metatarsal heads to jutt out, and puts added pressure on the skin overlying the toes, causing a “claw toe appearance.”

Second is sensory neuropathy– loss of protective sensation from minimal to deep pressure, temperature and vibration causes repetitive trauma to the feet which precipitates ulcer formation.

The second feature is that as the function of the lower extremities is diminished autonom mobiliring synthesis face to

torrential draught, which makes drainage blanches easily under rarefaction and repeated damage, forming arteriovenous fistulas and trophic disorders. The combination of altered skin texture, foot deformity, and repeated trauma makes patients more susceptible to ulcers.

Screening tests must be fast, accurate and easy. Simple sensory examination for diabetic neuropathy can be done with several simple tests, for example, the 10 g monofilament test, vibration testing using a 128 Hz tuning fork, vibration perception threshold test, pinprick sensation and ankle reflexes the Michigan Neuropathy Screening Instrument is a validated screening and severity test for neuropathy using questionnaire and simple examination and is also useful in screening and grading severity of neuropathy[20].

**Vascular Disease**

Recent studies indicate that both venous insufficiency and microvascular affections are significant contributing factors in diabetic foot disease.

**Metabolic:** Diabetes is a recognized risk factor for peripheral artery disease (PAD). Diabetic microangiopathy. Microvascular abnormalities appears early, with capillaries of reduced size and basement membrane thickening in the early stage of diabetes, along with arteriolar hyalinosis. 21 In patients with diabetes, sustained hyperglycemia causes dysfunction of endothelium and abnormalities in smooth muscles, resulting in vasoconstriction due to diminished vasodilators[22]. Moreover, increased levels of the vasoconstrictor and platelet aggregation agonist thromboxane A2 lead to hypercoagulability of plasma. These factors combine to manifest into occlusive arterial disease leading to ischemia and ulcers.

**Metabolism**

Moreover, poor glycaemic control is a major factor that predisposes patient to develop DFU. Wound; hypertension; in one Diabetic patients, the high blood sugar causes the proteins to break down into amino acids catabolic state which is sending part of its protein to make sugar instead of human body repair, by gluconeogenesis high blood sugar and fasting in torn injuries, the decrease of collagen synthesis, increase the release of proteinase activity, reduce the synthesis of the ECM non- collagen protein, reduce fibroblast proliferation. In fact, hyperglycemia is reported to compromise the barrier function in skin, exampled in diabetic mice with impaired keratinocyte proliferation and differentiation. As a result, hyperglycemia generates unfavorable conditions for ransitional factors of healing use and generation Moreover, hyperglycemia has numerous adverse immunological outcomes that promote the initiation and maintenance of DFU. It causes stage of chronic inflammatory and antitumor immunity by modulating neutrophil and macrophage activity.

Studies have shown that hyperglycemia can alter the cytokine profile of the inflammatory cascade involved in wound healing. Collectively, these findings suggest that hyperglycemia alters both immune function and immune response to injury in a way that may accelerate DFU tissue pathology.

**Foot ulcer prevention**

The presence of other professionals working closely with the diabetologist in the diabetic unit (the core of the multidisciplinary team) is crucial. This includes the podiatrist, who helps prevent and treat diabetic foot lesions, and the nurse, who provides education and reassurance. Prevention is fundamental, and patient education is key. Essential measures include identifying at-risk feet, regular inspections, wearing appropriate footwear, and treating pre-ulcerative signs.Foot self-care empowers patients, who are central to the multidisciplinary team, to recognize early signs of ulceration. This proactive approach is one of the greatest benefits of a multidisciplinary team, as it enables the early identification of foot problems. Early detection can prevent the onset of ulcerations and the progression to more severe complications, such as infection, gangrene, and ultimately, amputation or death.[7]The The most important steps in preventing ulcers and detecting them early are shown in Table 2.

**The screening**

A major component in ulcer prevention is screening. There is increasing focus on how community podiatry services can enable diabetic foot care. This appears to correlate with declining hospital admissions and changing patterns referring to avoidable amputations. Gibson et al. Apart from providing changes in behaviour after receiving podiatry services, the study by T[14] also estimated that individuals receiving podiatric care in the year before a diabetic foot ulcer were at lower risk of lower limb amputation, and had a lower rate of hospital admission[27]. The researchers observed that patients treated by both a podiatrist and a lower-extremity-care specialist for ulcerations had a 36% lower risk of having to undergo lower limb amputation than those treated only by other physicians[28].

The National Institute for Clinical Excellence has proposed a useful stratification strategy to facilitate stratification of the individual patient's risk of either developing diabetic foot problems or requiring amputation (2023 Diabetic foot problems: prevention and management). Undress all items during the foot examination, including the shoe, socks, bandages and dressings, and check each foot for the following risk factors: neuropathy, limb ulceration, callus infection or inflammation deformities gangrene Charcot arthropathy

- Assessment of sensation in the foot by 10/g monofilament or by vibration (in the absence of 10/g monofilament, assessment can be performed by lightly touching the toes of the patient with index finger for 2–3 s)
- Foot pulse palpation
- Assessment of foot deformity and shoe wear
- Routine podiatric treatments (debridement of callosities and hyperkeratosis)
- Evaluation of current footwear and deformities, and education on ulceration risk
- Educating patients and their families/caregivers about the principles of ulceration prevention, with an emphasis on appropriate footwear choice
- Management/elimination of other risk factors: smoking, overweight, hypertension, lipid disorders, glycemic control of diabetes,
- Walking training can only be used in patients without plantar foot ulcers with appropriately selected shoes[29].

  Use the risk stratification (Table 2) to assess the person's current risk of developing a diabetic foot problem or requiring an amputation.

Table 2. The risk stratification table

| The risk level | Describtion | What to do |
|---|---|---|
| Low risk | no risk factors present except callus alone. | Continue to carry out foot assessments at their annual diabetes review<br>Advise about the risk and foot care |
| Moderate risk | deformity or<br>neuropathy or<br>peripheral arterial disease. | Within 6 to 8 weeks:<br>-Assess the feet.<br>-Give advice about, and provide, skin and nail care of the feet.<br>-Assess the biomechanical status of the feet, including the need to provide specialist footwear and orthoses.<br>-Assess the vascular status of the lower limbs. |
| High risk | previous ulceration<br>previous amputation<br>on renal replacement therapy<br>neuropathy and peripheral arterial disease together<br>neuropathy in combination with callus and/or deformity<br>peripheral arterial disease in combination with callus and/or deformity. | Within 2 to 4 weeks<br>-Assess the feet.<br>-Give advice about, and provide, skin and nail care of the feet.<br>-Assess the biomechanical status of the feet, including the need to provide specialist footwear and orthoses.<br>-Assess the vascular status of the lower limbs. |
| Active diabetic foot problem | ulceration or infection or<br>chronic limb-threatening ischaemia or<br>gangrene or suspicion of an acute Charcot arthropathy, or an unexplained hot, swollen foot with a change in colour, with or without pain | |

**Metabolic control**

According to the latest recommendations, maintaining optimal control of glycemia, lipemia and blood pressure reduces the risk of developing diabetic foot syndrome[29]. Intensive glycemic control reduces the risk of kidney, retinal, and neurologic complications whatsmore early intensive glycemic control decreases long-term DFU risk, the most important antecedent in the causal pathway to lower-extremity amputations[30]. This trend is noticeable in short- and long-term studies[30,31]. Good metabolic control in most cases of diabetes complicated by diabetic foot syndrome requires the initiation or intensification of insulin therapy. The use of oral hypoglycemic drugs in clinically uninfected wounds is permissible if this therapy ensuresproper metabolic control of diabetes.

**Treatment**

The key elements in the treatment of DFU are optimal glycemic control[30]. The preferred method of offloading is the use of non-removable offloading, recommended and applied exclusively by appropriately trained personnel. Ideally, this offloading should extend up to the knee; however, if this is not possible, offloading up to the ankle may be acceptable[32,33]. The systemic antibiotic therapy in case of infection and vascular interventions in ischemic foot, the adjuvant use of topical agents enhances the efficacy of systemic antibiotics in the case of diabetic foot infection[34,35].· Surgical procedures – debridement with debridement, drainage, and incision; flexor tendon tenotomy, Achilles tendon lengthening, and metatarsal head resection[36]. All endovascular and vascular surgery procedures[38], hybrid procedures[37]. Traditional dressings and therapy that maintain a moist wound environment – the option of using dressings with TLC-NOSF technology should be considered for non-infectious wounds of neuro-ischemic aetiology (without signs of critical/significant ischemia) if they do not heal with the best standard treatment[38], hyperbaric chamber, negative pressure therapy, low molecular weight heparin preparations, acetylsalicylic acid, use of platelet-rich fibrin[39,40].

## CONCLUSION

Diabetic foot ulcers (DFUs) remain a critical and multifaceted complication of diabetes, associated with substantial morbidity, mortality, and healthcare burden. Effective prevention, early detection, and appropriate management are crucial to reducing the risk of severe outcomes. The pathogenesis of DFUs involves complex interactions between neuropathy, peripheral arterial disease (PAD), vascular insufficiency, and metabolic dysregulation. The use of comprehensive classification systems, such as the WIfI model, offers a more nuanced approach to assessing wound severity, ischemia, and infection, aiding clinicians in decision-making and prioritizing care.Multidisciplinary team care is essential for successful prevention and treatment of DFUs. Screening measures, such as regular podiatric assessments and the use of tools like the 10g monofilament, are vital for early identification of at-risk feet.Optimal metabolic control remains the cornerstone of DFU treatment, as well as offloading, systemic antibiotic therapy, and surgical procedures. By adopting these strategies, healthcare providers can significantly improve quality of life for patients with diabetes and reduce the broader societal and economic impact of this challenging condition.

**Ethics approval**: This study was approved by the Ethical Review Board of institution.

**Authorship and contribution declaration:** Each author of this article fulfilled following Criteria of Authorship:

1. Conception and design of or acquisition of data or analysis and interpretation of data.
2. Drafting the manuscript or revising it critically for important intellectual content.
3. Final approval of the version for publication.

All authors agree to be responsible for all aspects of their research work.

**Funding:** This study was self supported. No funding was given by university

**Conflict of interest:** The authors have no conflict of interest regarding its data and publication

## REFERENCES


1. Boyle JP, Thompson TJ, Gregg EW, Barker LE, Williamson DF. Projection of the year 2050 burden of diabetes in the US adult population: dynamic modeling of incidence, mortality, and prediabetes prevalence. *Popul Health Metr*. 2010;8:29. doi:10.1186/1478-7954-8-29
2. Jeffcoate W, Boyko EJ, Game F, Cowled P, Senneville E, Fitridge R. Causes, prevention, and management of diabetes-related foot ulcers. *Lancet Diabetes Endocrinol*. 2024;12(7):472-482. doi:10.1016/S2213-8587(24)00110-4
3. Armstrong DG, Boulton AJM, Bus SA. Diabetic Foot Ulcers and Their Recurrence. *N Engl J Med*. 2017;376(24):2367-2375. doi:10.1056/NEJMra1615439
4. Paola C. Aldana, Alexander M. Cartron, Amor Khachemoune. Reappraising Diabetic Foot Ulcers: A Focus on Mechanisms of Ulceration and Clinical Evaluation 2022. Accessed August 4, 2024. https://journals.sagepub.com/doi/10.1177/1534734620944514?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%20%200pubmed
5. Armstrong DG, Tan TW, Boulton AJM, Bus SA. Diabetic Foot Ulcers. *JAMA*. 2023;330(1):62-75. doi:10.1001/jama.2023.10578
6. *Diabetic Foot Problems: Prevention and Management*. National Institute for Health and Care Excellence (NICE); 2023. Accessed November 30, 2024. http://www.ncbi.nlm.nih.gov/books/NBK553608/
7. Nigi L, Fondelli C, de Donato G, Palasciano G, Setacci C, Dotta F. Fighting diabetic foot ulcers-The diabetologist: A king maker of the fight. *Semin Vasc Surg*. 2018;31(2-4):49-55. doi:10.1053/j.semvascsurg.2018.12.003
8. Monteiro-Soares M, Boyko EJ, Jeffcoate W, et al. Diabetic foot ulcer classifications: A critical review. *Diabetes/Metabolism Research and Reviews*. 2020;36(S1):e3272. doi:10.1002/dmrr.3272
9. Game F. Classification of diabetic foot ulcers. *Diabetes/Metabolism Research and Reviews*. 2016;32(S1):186-194. doi:10.1002/dmrr.2746
10. Mills JL, Conte MS, Armstrong DG, et al. The Society for Vascular Surgery Lower Extremity Threatened Limb Classification System: risk stratification based on wound, ischemia, and foot infection (WIfI). *J Vasc Surg*. 2014;59(1):220-234.e1-2. doi:10.1016/j.jvs.2013.08.003.
11. 11.van Reijen NS, Ponchant K, Ubbink DT, Koelemay MJW. Editor's Choice - The Prognostic Value of the WIfI Classification in Patients with Chronic Limb Threatening Ischaemia: A Systematic Review and Meta-Analysis. *Eur J Vasc Endovasc Surg*. 2019;58(3):362-371. doi:10.1016/j.ejvs.2019.03.040
12. Pecoraro RE, Reiber GE, Burgess EM. Pathways to diabetic limb amputation. Basis for prevention. *Diabetes Care*. 1990;13(5):513-521. doi:10.2337/diacare.13.5.513
13. Deng H, Li B, Shen Q, et al. Mechanisms of diabetic foot ulceration: A review. *Journal of Diabetes*. 2023;15(4):299-312. doi:10.1111/1753-0407.13372
14. Dixon D, Edmonds M. Managing Diabetic Foot Ulcers: Pharmacotherapy for Wound Healing | Drugs. Accessed December 9, 2024. DOI: 10.1007/s40265-020-01415-8
15. Giacco F, Brownlee M. Oxidative Stress and Diabetic Complications | Circulation Research. Accessed December 9, 2024. https://www.ahajournals.org/doi/10.1161/CIRCRESAHA.110.223545
16. Schaper NC, van Netten JJ, Apelqvist J, et al. Practical guidelines on the prevention and management of diabetes-related foot disease (IWGDF 2023 update). *Diabetes/Metabolism Research and Reviews*. 2024;40(3):e3657. doi:10.1002/dmrr.3657
17. Feldman EL, Callaghan BC, Pop-Busui R, et al. Diabetic neuropathy. *Nat Rev Dis Primers*. 2019;5(1):42. doi:10.1038/s41572-019-0097-9
18. Strand N, Anderson MA, Attanti S, et al. Diabetic Neuropathy: Pathophysiology Review. *Curr Pain Headache Rep*. 2024;28(6):481-487. doi:10.1007/s11916-024-01243-5
19. Partanen J, Niskanen L, Lehtinen J, Mervaala E, Siitonen O, Uusitupa M. Natural History of Peripheral Neuropathy in Patients with Non-Insulin-Dependent Diabetes Mellitus | N Engl J Med. 1995 Jul 13;333(2):89-94.. DOI: 10.1056/NEJM199507133330203
20. Boulton AJM, Armstrong DG, Albert SF, et al. Comprehensive Foot Examination and Risk Assessment: A report of the Task Force of the Foot Care Interest Group of the American Diabetes Association, with endorsement by the American Association of Clinical Endocrinologists. *Diabetes Care*. 2008;31(8):1679-1685. doi:10.2337/dc08-9021
21. Dinh T, Veves A. Microcirculation of the Diabetic Foot. *Current Pharmaceutical Design*. 11(18):2301-2309. doi:10.2174/1381612054367328

22. LoGerfo FW, Coffman JD. Vascular and Microvascular Disease of the Foot in Diabetes. *New England Journal of Medicine*. 1984;311(25):1615-1619. doi:10.1056/NEJM198412203112506
23. Dinh TL, Veves A. A Review of the Mechanisms Implicated in the Pathogenesis of the Diabetic Foot - Int J Low Extrem Wounds. 2005 Sep;4(3):154-9. doi: 10.1177/1534734605280130.
24. Soyoye DO, Abiodun OO, Ikem RT, Kolawole BA, Akintomide AO. Diabetes and peripheral artery disease: A review. *World J Diabetes*. 2021;12(6):827-838. doi:10.4239/wjd.v12.i6.827
25. Tao GL, Zheng LS, Wang ZY, et al. Clinical characteristics and risk factors of diabetic foot ulcers with PAD. *Eur Rev Med Pharmacol Sci*. 2023;27(23):11412-11420. doi:10.26355/eurrev_202312_34580
26. American Diabetes Association. Peripheral arterial disease in people with diabetes. *Diabetes Care*. 2003;26(12):3333-3341. doi:10.2337/diacare.26.12.3333
27. Gibson TB, Driver VR, Wrobel JS, et al. Podiatrist care and outcomes for patients with diabetes and foot ulcer. *International Wound Journal*. 2014;11(6):641-648. doi:10.1111/iwj.12021
28. Sloan FA, Feinglos MN, Grossman DS. Receipt of care and reduction of lower extremity amputations in a nationally representative sample of U.S. Elderly. *Health Serv Res*. 2010;45(6 Pt 1):1740-1762. doi:10.1111/j.1475-6773.2010.01157.x
29. Pandarek. Zalecenia kliniczne dotyczące postępowania u osób z cukrzycą 2024 Stanowisko Polskiego Towarzystwa Diabetologicznego. Accessed January 12, 2025. https://ptdiab.pl/zalecenia-ptd/zalecania-aktywni-czlonkowie-2024
30. Boyko EJ, Zelnick LR, Braffett BH, et al. Risk of Foot Ulcer and Lower-Extremity Amputation Among Participants in the Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Study. *Diabetes Care*. 2022;45(2):357-364. doi:10.2337/dc21-1816
31. Abbott CA, Carrington AL, Ashe H, 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):377-384. doi:10.1046/j.1464-5491.2002.00698.x
32. Rizzo L, Tedeschi A, Fallani E, et al. Custom-made orthesis and shoes in a structured follow-up program reduces the incidence of neuropathic ulcers in high-risk diabetic foot patients. *Int J Low Extrem Wounds*. 2012;11(1):59-64. doi:10.1177/1534734612438729
33. Elraiyah T, Prutsky G, Domecq JP, et al. A systematic review and meta-analysis of off-loading methods for diabetic foot ulcers. *J Vasc Surg*. 2016;63(2 Suppl):59S-68S.e1-2. doi:10.1016/j.jvs.2015.10.006
34. Tchero H, Kangambega P, Noubou L, Becsangele B, Fluieraru S, Teot L. Antibiotic therapy of diabetic foot infections: A systematic review of randomized controlled trials. *Wound Repair Regen*. 2018;26(5):381-391. doi:10.1111/wrr.12649
35. Pitocco D, Spanu T, Di Leo M, et al. Diabetic foot infections: a comprehensive overview. *Eur Rev Med Pharmacol Sci*. 2019;23(2 Suppl):26-37. doi:10.26355/eurrev_201904_17471
36. Lei Y, Jiang P, Tian T. Comparative analysis of surgical and non-surgical wound approaches in diabetic foot ulcer treatment: Meta-analysis and systematic review. *Int Wound J*. 2024;21(4):e14601. doi:10.1111/iwj.14601
37. Houlind K. Surgical revascularization and reconstruction procedures in diabetic foot ulceration. *Diabetes Metab Res Rev*. 2020;36 Suppl 1:e3256. doi:10.1002/dmrr.3256
38. Meloni M, Colboc H, Armstrong DG, et al. TLC-NOSF dressings as a first-line local treatment of chronic wounds: a systematic review of clinical evidence. *J Wound Care*. 2024;33(10):756-770. doi:10.12968/jowc.2024.0208
39. Chen L, Zhang S, Da J, et al. A systematic review and meta-analysis of efficacy and safety of negative pressure wound therapy in the treatment of diabetic foot ulcer. *Ann Palliat Med*. 2021;10(10):10830-10839. doi:10.21037/apm-21-2476
40. Sharma R, Sharma SK, Mudgal SK, Jelly P, Thakur K. Efficacy of hyperbaric oxygen therapy for diabetic foot ulcer, a systematic review and meta-analysis of controlled clinical trials. *Sci Rep*. 2021;11(1):2189. doi:10.1038/s41598-021-81886-1.


---

**This article may be cited as:** Pabis P, Skotarski M, Szydowski R, Porwolik H, Bodera M, Porwolik A, Porwolik A, Skrzypiec B, Stefanski K, Rabstein D:Diabetic Foot- A New Era of Diagnosis and Prevention. Pak J Med Health Sci, 2024; 18(12): 3-7.