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# Foot disease related to diabetes mellitus: conceptual update

*Doença nos pés relacionada ao diabetes mellitus: atualização conceitual*

*Enfermedad del pie relacionada con la diabetes mellitus: actualización conceptual*

**ABSTRACT**
**Objective:** To present, for Brazilian professionals, the terminology, concepts, and descriptions related to the prevention, classification, and treatment of foot disease associated with diabetes mellitus, as established by the International Working Group on the Diabetic Foot (IWGDF). **Method:** This is a descriptive and reflective theoretical essay with a qualitative approach. The primary reference for the study was the 2023 publication by the IWGDF. **Results:** The term diabetic foot was updated to foot disease related to diabetes mellitus. The IWGDF guidelines, grounded in scientific evidence, were consolidated in 2023 into seven comprehensive documents addressing: ulcer prevention, ulcer classification, diagnosis and treatment of infections, diagnosis and treatment of peripheral arterial disease, ulcer offloading, healing interventions, and acute Charcot neuro-osteoarthropathy. **Final Considerations:** The updated guidelines provide revised concepts and recommendations across multiple areas, enabling healthcare professionals to plan, implement, and evaluate more effective strategies for managing diabetes-related foot conditions.
**Descriptors:** Diabetic foot; Diabetes mellitus; Enterostomal therapy; Practice guideline.

**RESUMO**
**Objetivo:** Apresentar na língua portuguesa a terminologia, conceito e descrição sobre a prevenção, classificação e tratamento da doença do pé relacionada ao diabetes mellitus estabelecidos pelo International Working Group on the Diabetic Foot (IWDGF). **Método:** Estudo descritivo e reflexivo de abordagem qualitativa, do tipo ensaio teórico. Para a produção, utilizou-se como referência principal a publicação de 2023 IWGDF. **Resultados:** O termo pé diabético foi alterado para doença do pé relacionada ao diabetes mellitus. As diretrizes do IWGDF são baseadas em evidências científicas e, no ano de 2023, foram desenvolvidas em sete documentos: prevenção de úlceras, classificação de úlceras, diagnóstico e tratamento de infecções, diagnóstico e tratamento da doença arterial periférica, alívio de úlceras, intervenções para cicatrização e neuro-osteoartropatia aguda de Charcot. **Considerações finais:** a diretriz apresenta conceitos e recomendações atualizadas em várias seções que permite aos profissionais planejamento, implementação e avaliação de estratégias mais efetivas.
**Descritores:** Pé diabético; Diabetes mellitus; estomaterapia; Guia de prática clínica.

**RESUMEN**
**Objetivo:** Presentar en portugués la terminología, concepto y descripción relacionados a la prevención, clasificación y tratamiento de las enfermedades del pie relacionadas a la diabetes mellitus establecidos por el Grupo Internacional de Trabajo en Pie Diabético (IWDGF). **Método:** Se trata de un estudio descriptivo, reflexivo y con enfoque cualitativo, del tipo ensayo teórico. Se utilizó como referencia principal la publicación del IWGDF de 2023. **Resultados:** Se cambió el término pie diabético por enfermedad del pie relacionada con la diabetes mellitus. Las directrices del IWGDF se basan en pruebas científicas y en 2023 se desarrollaron en siete documentos: prevención de úlceras, clasificación de úlceras, diagnóstico y tratamiento de infecciones, diagnóstico y tratamiento de la enfermedad arterial periférica, alivio de úlceras, intervenciones curativas y neuroosteoartropatía aguda de Charcot. **Consideraciones finales:** La guía presenta conceptos y recomendaciones actualizados en varias secciones que permiten a los profesionales planificar, aplicar y evaluar estrategias más eficaces.
**Descriptores:** Pie diabético; Diabetes mellitus; Stomathérapie; Guía de práctica clínica.

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## INTRODUCTION

Diabetes mellitus-related foot disease (DMRFD) is a serious complication of diabetes mellitus (DM), often resulting in hospitalizations and, in severe cases, death[1,2]. According to the International Diabetes Federation, by 2045 an estimated 783 million people will be living with diabetes—approximately one in every eight adults—representing a 46% increase[3]. The incidence of DMRFD closely follows the global rise in DM prevalence[1,3]. A systematic review and meta-analysis reported a prevalence of 6.3% for a first DMRFD ulcer, with a cumulative incidence of 5.65%[4]. Additionally, it is estimated that up to 25% of all individuals with DM will develop foot ulcers, which precede approximately 80% of all lower limb amputations[4].

Foot complications in individuals with diabetes are associated with a chronic process involving one or more of the following conditions: peripheral neuropathy—divided into sensory (loss of protective sensation), motor (foot deformities and limited joint mobility, resulting in abnormal biomechanical loading, mechanical stress, callus formation, subcutaneous hemorrhage, and ulceration), and autonomic (reduced sweating and impaired skin hydration); peripheral arterial disease (PAD); infection; ulceration; neuro-osteoarthropathy; gangrene; and amputation[5-7]. In response to the complexity of these conditions, the International Working Group on the Diabetic Foot (IWGDF) has, since 2019, revisited the conceptual terminology, advocating for the replacement of "diabetic foot" with foot disease related to diabetes mellitus, a stance formalized in its 2023 update.

International organizations play a vital role in the development, consolidation, and continuous revision of evidence-based guidelines for the prevention and treatment of diseases. These guidelines are grounded in thorough analyses of the scientific literature, offering health professionals clear, current, and reliable recommendations to support clinical decision-making[5,8].

The DMRFD guidelines emphasize the work of the IWGDF[5], an international organization established in 1996 and composed of healthcare professionals and researchers from around the world. Through a rigorous scientific process, the IWGDF develops international, multidisciplinary guidelines based on systematic reviews and evidence syntheses. These guidelines are designed to inform daily clinical practice and are published in peer-reviewed international journals(5).

In 2023, the IWGDF updated its clinical practice guidelines to define the fundamental principles of DMRFD [5]. This update provides healthcare professionals with the most current evidence-based information, supporting advances in both clinical care and the development of new research aligned with the revised terminology and concepts[5,6]. Accordingly, this study aims to present the updated terminology—replacing the term diabetic foot in Brazil—and to clarify the concepts and guidelines related to the prevention, classification, and treatment of DMRFD as established in the IWGDF's latest revision.

## METHODS

This is a descriptive and reflective study with a qualitative approach, developed as a theoretical essay. The primary reference guiding the discussion was the 2023 publication by the IWGDF[5], which introduced the term diabetes mellitus-rela-

ted foot disease (DMRFD) in place of diabetic foot. The publication also redefined the concept of DMRFD, including updated recommendations, such as new guidelines for the diagnosis and treatment of acute Charcot neuro-osteoarthropathy, a reorganization of ulcer treatment principles based on clinical decision-making, and an appendix on measuring ankle and toe blood pressure. It is important to note that the 2023 update replaces all previous versions of these practice guidelines.

Our discussion was based on a critical review of the specific literature on the topic, with the publications being obtained randomly, through a free search for original and cited articles following the 2023 update of the IWGDF.

## RESULTS AND DISCUSSION

The results and discussion were organized according to the key areas addressed in the IWGDF guidelines, which were developed based on scientific evidence and structured using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) methodology. The guidelines are presented in seven documents: 1. Prevention of foot ulcers in people with diabetes; 2. Classification of diabetes-related foot ulcers; 3. Diagnosis and treatment of foot infections in people with diabetes; 4. Diagnosis and treatment of peripheral arterial disease in people with diabetes and foot ulcers; 5. Offloading of foot ulcers in people with diabetes; 6. Interventions to promote healing of foot ulcers in people with diabetes; and 7. Management of acute Charcot neuro-osteoarthropathy[5,6].

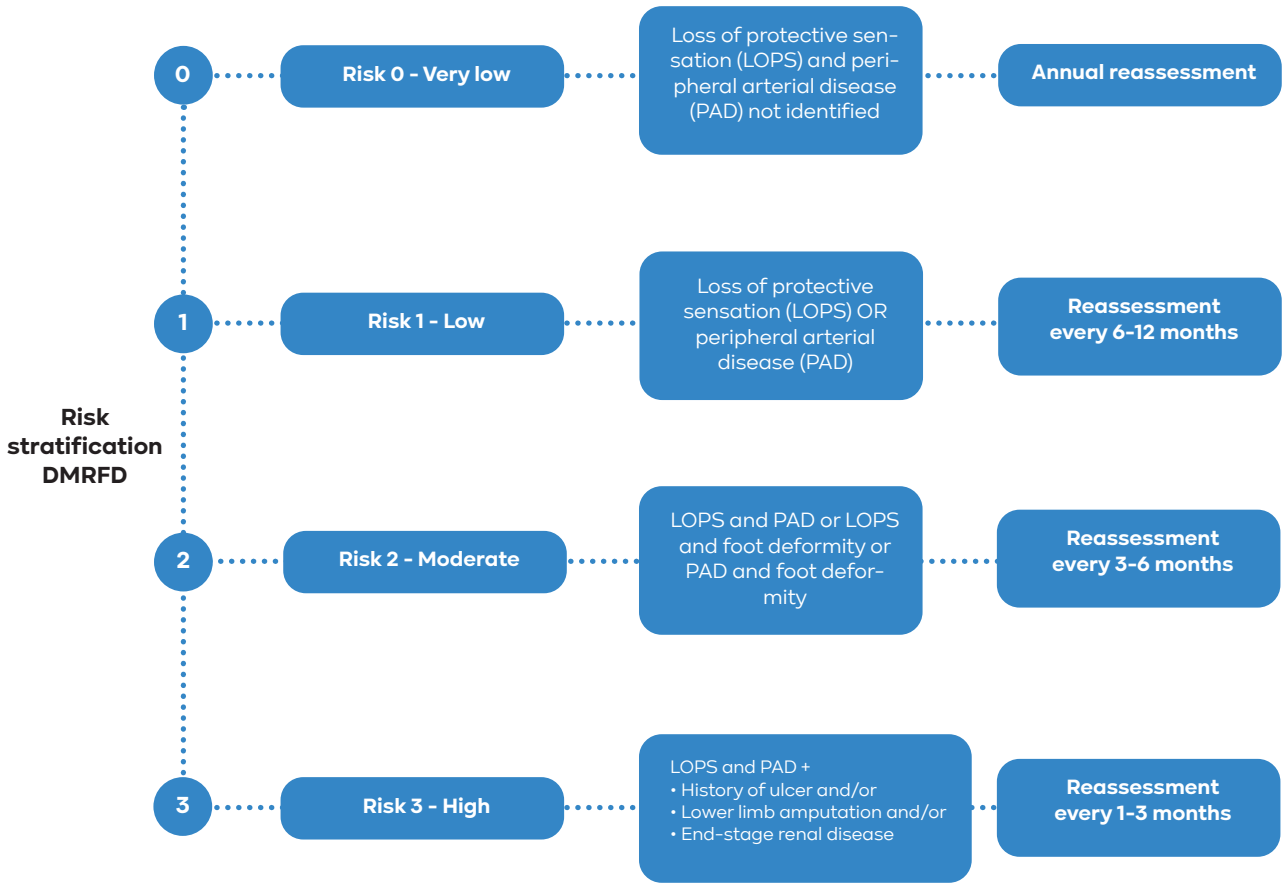
Regarding the recent updates, a new terminology has been introduced to replace the widely recognized term diabetic foot, reflecting the growing emphasis on humanized care for individuals with chronic conditions, including diabetes mellitus (DM). In Brazil, the term diabetic is gradually being replaced, as it is increasingly viewed as pejorative and reductive, reducing individuals to their diagnosis. This shift aims to dissociate the medical condition from the person's identity, fostering a more empathetic and inclusive approach. Although the word "disease" remains in the new designation diabetes mellitus-related foot disease (DMRFD), the change marks a meaningful step toward more person-centered and respectful language in healthcare[5].

In this context, the IWGDF broadened the concept of DMRFD to encompass the wide range of factors and conditions that contribute to the development of foot ulcers in individuals with diabetes. These include peripheral neuropathy and/or peripheral arterial disease, often in combination with a precipitating event such as infection, foot deformities, reduced joint mobility, gangrene, a history of amputation, previous ulcers, end-stage renal disease, Charcot neuro-osteoarthropathy, or nail pathologies[5,9]. It is worth noting that five of the seven IWGDF documents specifically focus on the prevention, classification, and treatment of foot ulcers.

1. Prevention of foot ulcers in people with diabetes - Interventions aimed at preventing foot ulcers in individuals with DM involve several key steps: regular foot inspection and assessment; education of the person with diabetes, their family, and healthcare professionals-including psychological support; management of ulceration risk factors; and ensuring consistent use of appropriate footwear alongside in-

tegrated foot care. It is important to emphasize that effective prevention depends on identifying individuals at risk, based on established risk stratification criteria[10,11].

**Figure 1 –** Screening and risk stratification for DMRFD




Source: Prepared by the authors based on the table published in the IWGDF guidelines (2023).

The annual foot assessment is recommended for all individuals with DM, even those at very low risk of ulceration, as it is key to identifying early signs of injury. This assessment should include a thorough inspection of the lower limbs to check for ulcers and evaluate the presence of protective sensation through sensory testing using a 10-gram Semmes-Weinstein monofilament to assess pressure perception or a 128 Hz tuning fork[5] to assess vibration perception. If these tools are unavailable, the Ipswich Touch Test can be used as an alternative. This simple method involves lightly touching the tips of the patient's toes with the examiner's index finger for 1 to 2 seconds[5].

Vascular assessment should include palpation of pedal pulses - specifically, the posterior tibial and dorsalis pedis arteries - as well as a clinical history to investigate symptoms of intermittent claudication. Importantly, the absence of symptoms in individuals with diabetes does not exclude the presence of DMRFD, since other indicators such as asymptomatic neuropathy or pre-ulcerative signs[5, 7] may still be present.

For individuals with DM who are classified as at risk, a more comprehensive

foot assessment is essential. This should include a review of any history of foot ulcers, evaluation of skin integrity, bone and joint health, potential cognitive impairments, the appropriateness of footwear, physical limitations, and the individual's ability to manage their foot care[5, 7].

In addition, it is recommended to wear shoes that properly accommodate the feet and help prevent excessive pressure on the skin. Appropriate footwear should allow for a 1- to 2-centimeter space beyond the length of the foot, ensuring a proper fit without causing compression or leaving too much room. Ideally, footwear should be tried on at the end of the day, when the feet are typically more swollen[5, 7].

Finally, implementing educational interventions in a structured, consistent, and repeated manner is essential for preventing diabetes-related foot ulcerations [5,7,13]. Individuals should be trained to perform regular foot inspections. When self-care is not possible due to physical limitations or visual impairment, a family member or caregiver should be informed and trained to carry out this preventive task, including checking the entire foot surface and between the toes[5]. Health professionals should also instruct individuals with DM to promptly report any changes-such as increased temperature, blisters, cuts, scratches, or ulcers-to their care team[5,7].

During educational sessions, individuals should be advised to avoid walking barefoot and refrain from wearing footwear such as thin-soled slippers, tight shoes with rough edges, or irregular seams, due to the risk of injury[5]. Wearing compression socks should also be addressed only when properly assigned by the foot care team. Opting for seamless socks or ones with inside-out seams, avoiding any that constrict the feet[5,7]. Foot hygiene should be performed with water at a temperature below 37°C, emphasizing the need to dry the feet, especially between the toes, discouraging the use of chemical products for removing corns and calluses[5,7].

To further prevent foot ulceration, it is important to avoid the development of excessive calluses and ingrown toenails. Toenails should be trimmed straight across to reduce the risk of injury. Special care must be taken to monitor for early signs of skin damage-such as blisters, cracks, or small areas of bleeding-which may indicate the onset of a pre-ulcerative condition[5,7].

2. Classification of diabetes-related foot ulcers - The classification of foot ulcers follows the six criteria of the SINBAD system, considering site (S), ischemia (I), neuropathy (N), bacterial infection (BA), and depth (D)[5, 6, 14].

For accurate localization, it is recommended to describe specific regions of the foot, such as forefoot, midfoot, and rearfoot, distinguishing between plantar, interdigital, medial, lateral, and dorsal surfaces. In cases of suspected ischemia, evaluation should include assessment of the dorsalis pedis and posterior tibial pulses, measurement of systolic blood pressure, and calculation of the ankle-brachial index (ABI) and toe-brachial index (TBI)[5,12]. The likelihood of peripheral arterial disease (PAD) is considered low when a biphasic or triphasic Doppler waveform is present, the ABI ranges from 0.9 to 1.3, and the TBI is equal to or above 0.70[5,12].

When ankle systolic pressure is below 50 mmHg or the ankle-brachial index (ABI) is less than 0.4, urgent vascular imaging, such as lower limb Doppler ul-

trasound, is recommended. Special attention should be given to the arteries of the knee and foot, with revascularization considered a priority[6,9,12]. Similarly, if toe pressure is below 30 mmHg or transcutaneous oxygen pressure ($TcPO^2$) is less than 25 mmHg, an immediate vascular assessment for potential revascularization is also advised[12,15].

The progression of PAD is strongly associated with poor ulcer healing, the development of gangrene, an increased risk of amputation, and higher rates of cardiovascular morbidity and mortality. In individuals with diabetes, PAD significantly raises the risk of both limb-related complications and systemic cardiovascular disease, affecting approximately 50% of those with diabetic foot ulcers. Early diagnosis is therefore critical. A thorough foot assessment should include checking for signs of ischemia and palpation of pedal pulses at least once a year. If clinical changes are observed in the feet, it is vital to perform both the ABI and TBI to guide further evaluation [6,12].

Medical evaluation can consider revascularization tables at high pressure levels in people with extensive tissue loss or infection with a high score in the WIFI classification system, since they impact the risk of amputation and its clinical management[16]. This classification is based on three main factors: wound (W), ischemia (I), and foot infection (FI)[16].

Neuropathy affects approximately 50% of individuals with diabetes and is a key predictor of lower limb complications[17]. According to the IWGDF, neuropathy should be assessed using a 10g monofilament and a tuning fork. Protective sensory perception (PSP) should then be classified as either present or absent[5].

The SINBAD classification recommends evaluating bacterial infection based on the presence of at least two clinical signs of inflammation or the presence of purulent discharge[5,9,15]. According to IWGDF/IDSA guidelines, infections are classified as: mild, when the ulcer is superficial with minimal cellulitis; moderate, when the ulcer penetrates deeper or is accompanied by more extensive cellulitis, with or without abscess formation; and severe, when systemic signs of sepsis are present, with or without underlying osteomyelitis[5,18].

Depth (D) can be evaluated using imaging studies or the sterile probe-to-bone test, which involves inserting a sterile metal probe or surgical instrument to assess the extension of the wounds. A positive result, particularly when supported by abnormal radiographic findings, is suggestive of osteomyelitis. Wound depth is typically classified as either superficial or deep-the latter indicating involvement of structures such as tendons, periosteum, joint capsules, or bone. As part of the assessment, the SINBAD classification also recommends measuring the wound area in square centimeters ($cm^2$), along with its depth[5,14,19].

3. Diagnosis and treatment of foot infection in individuals with DM - A foot infection in a person with DM poses a threat to both the foot and the affected limb, and can trigger serious complications and even endanger the life of the person with DM. If detected early, immediate treatment is crucial and may require hospitalization[5].

According to the IWGDF infection guidelines, extensive wounds require urgent surgical intervention, including debridement of necrotic tissue, identification

and management of infected bone, pressure relief from the affected area, and drainage of any abscesses. Assessment for the presence of PAD is also crucial, with urgent revascularization considered when indicated[5]. Empiric broad-spectrum antibiotic therapy should be initiated promptly and subsequently tailored based on clinical response and microbiological findings. Regarding soft tissue infections, a short treatment of one or two weeks is usually enough; nonetheless, persistent infection or severe PAD may necessitate extended therapy[5]. Conservative management of osteomyelitis should be considered in selected cases, based on individual clinical factors[5].

In the management of superficial ulcers with associated soft tissue infection, thorough debridement of all necrotic tissue and surrounding calluses is imperative. Following this intervention, oral antibiotic therapy directed against Staphylococcus aureus and hemolytic streptococci is indicated[5].

4. Diagnosis and Management of PAD in Individuals with DMRFD – Early detection of PAD in individuals with DM, whether lower limb ulcers are present, is crucial, particularly in those with ulcerations or gangrene. This process should include annual clinical assessment of the feet, with careful inspection for signs of ischemia and palpation of pedal pulses[5,20]. In cases where PAD is suspected, further diagnostic evaluation using Doppler waveform analysis, ankle-brachial index (ABI), and/or toe-brachial index (TBI) is recommended. An ABI between 0.9 and 1.3, a TBI above 0.70, and the presence of triphasic waveforms are indicative of a lower likelihood of PAD. A comprehensive and integrative diagnostic approach is essential, as no single clinical sign is sufficient to confirm the diagnosis[5,20].

The treatment should be evaluated by a specialist, with consideration given to revascularization, as lower extremity ischemia significantly compromises the healing capacity of foot ulcers. The primary objective of revascularization is to restore adequate blood flow to at least one of the foot arteries, preferably the artery supplying the anatomical region of the ulcer[5,20]. Revascularization should also be strongly considered in cases of elevated peripheral arterial pressure, particularly in patients with extensive tissue loss, active infection, or high WIFI scores[5,16].

If a foot ulcer shows no signs of healing within four to six weeks, angiographic evaluation and consideration of revascularization are recommended, irrespective of prior non-invasive vascular test results[5,20].

5. Offloading Foot Ulcers in Individuals with DM - Offloading is a critical component in managing foot ulcers, since it reduces mechanical stress caused by localized pressure. The gold standard for offloading neuropathic plantar ulcers is a non-removable, knee-high offloading device. When such devices are contraindicated or not tolerated by the patient, a removable offloading device, either knee-or ankle-high, may be used as an alternative. In settings where these options are unavailable, the use of felt foam in combination with appropriate therapeutic footwear should be considered[5,21].

For non-plantar foot ulcers, the use of a removable offloading device is recommended, supplemented as needed by shoe modifications, toe spacers, orthotic interventions, or digital flexor tenotomy, depending on the ulcer's type and anato-

mical location[5,21]. In cases where conservative (non-surgical) offloading measures fail to achieve healing, particularly in metatarsal head ulcers, surgical options such as Achilles tendon lengthening, metatarsal head resection, or metatarsal osteotomy should be considered. Regarding hallux ulcers, joint arthroplasty may be indicated, ideally in combination with an appropriate offloading strategy[5,21].

6. Interventions to Enhance Healing of Foot Ulcers in Individuals with DM — Optimal care of the ulcer site is essential to promote granulation tissue formation and facilitate wound healing. This process requires regular monitoring and evaluation by trained healthcare professionals[5,22]. The severity of the lesion, the presence of comorbidities, signs of infection, the volume of exudate, and the treatment strategy employed will guide the inspection frequency[5,22]. However, it is important to recognize that wound care alone is insufficient if systemic factors are not simultaneously addressed. Inadequate management of infection, ischemia, or recurrent trauma to the area can significantly compromise healing outcomes, regardless of the quality of local intervention[5,22].

In cases of non-infected ulcers that fail to heal within four to six weeks despite appropriate clinical care, additional therapeutic interventions may be considered. For neuroischemic ulcers without evidence of severe ischemia, dressings containing sucrose octasulfate have shown potential benefit. In ulcers with impaired or sufficient blood flow, multilayer patch technology composed of autologous leukocytes, platelets, and fibrin may be indicated. Topical oxygen therapy can be utilized in ulcers with moderate ischemia, while hyperbaric oxygen therapy may serve as an adjunctive option for ischemic ulcers with systemic involvement[5,22]. For post-operative wounds, negative pressure wound therapy should also be considered as a valuable treatment modality[5,22].

7. Charcot's acute neuro-osteoarthropathy - In 2023, the IWGDF published a supplementary document containing the first guideline on the diagnosis and treatment of Charcot's neuro-osteoarthropathy[23], which is an inflammatory process in individuals with peripheral polyneuropathy resulting in lesions in the bones, joints and soft tissues, which can lead to changes in the architecture of the foot and ankle, long-term deformity due to fractures, dislocations and fracture-dislocations[24].

Charcot neuro-osteoarthropathy (CNO) can affect any individual with peripheral neuropathy (PN), although it is more frequently observed in individuals with DM. In patients with PN, it typically involves the foot and ankle[5]. Treatment should be initiated promptly upon diagnosis and continued until both clinical remission of symptoms and radiographic consolidation of fractures are achieved. The main objective of the treatment is to prevent the development of progressive deformities, which can be achieved by strict offloading and immobilization of the affected limb[17,25,26].

Immobilization can be achieved by applying a non-removable total contact plaster cast positioned at knee level, and the second alternative consists of using a non-removable walker positioned at knee level[5]. It should be noted that the use of offloading devices below the ankle, such as slippers, custom-made shoes, surgical shoes, or post-operative sandals, is not recommended in the treatment of active CNO with intact skin[17,25,26]. This is due to

the inadequate immobilization of the destabilized bone and joint, and the limitation in unloading capacity. To reduce the load bearing on the affected extremity, auxiliary devices such as crutches can be used[23].

## CONCLUDING REMARKS

Preventive and therapeutic strategies for individuals with DM and DMRFD are a central focus of multidisciplinary team efforts across various healthcare settings. The document published by the IWGDF provides updated concepts and comprehensive recommendations across multiple domains, enabling professionals to plan, implement, and evaluate more effective interventions.

The guidelines present a reordering of DMRFD treatment principles in order to aid clinical decision-making, the inclusion of an appendix on ankle- and toe-blood pressure measurement and guidance on the diagnosis and treatment of acute Charcot neuro-osteарthropathy.

It is therefore up to health professionals, especially nurses, to adopt strategies for the prevention, early detection and treatment of DMRFD that can help to reduce its incidence, as well as providing quality of life without this condition.

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